University of Minnesota

Southern Experiment Station Waseca, Minnesota

Research Report 1986

Southern Experiment Station

Staff Listing
1986

Faculty

Richard H. Anderson-Superintendent
Vincent A. Fritz-Horticulturist
Rene E. Greenwald-Station Coordinator
Hugh Chester-Jones-Animal Scientist
William E. Lueschen-Agronomist
Gyles W. Randall-Soil Scientist

Agronomy

Thomas R. Hoverstad-Assistant Scientist
Paul A. Adams-Research Plot Technician
- Misc. Summer Help:
  - Mark Birr-Student Laborer
  - Archie P. Draheim-Utility Worker
  - Eugene P. Fuerst-Non-Exempt Temp. & Casual Employee
  - John R. Hinz-Student Laborer
  - Brian K. Kanne-Student Laborer

Animal Science

David M. Ziegler-Assistant Scientist
Gary L. Dobberstein-Farm Animal Attendant
John A. Krough-Farm Animal Attendant
Brian L. Lewer-Farm Animal Attendant
John R. Scholljegerdes-Assistant Farm Animal Attendant
Dale W. Gehloff-Assistant Farm Animal Attendant
Richard D. Goetz-Assistant Farm Animal Attendant
Perry P. Rieck-Assistant Farm Animal Attendant
- Misc. Summer Help:
  - Todd H. Leiding-Student Laborer

General Experiment Station

Steven L. Buker-Farm Equipment Operator
David E. Mueller-Farm Equipment Operator
Lloyd A. Peterson-Farm Equipment Operator
Dennis L. Weckwerth-Farm Equipment Operator

Horticulture

James B. Hebel-Senior Research Plot Technician
- Misc. Summer Help:
  - Kraig M. Deling-Non-Exempt Temp. & Casual Employee
  - Troy R. Ingram-Non-Exempt Temp. & Casual Employee
  - Thomas M. Lamont-Non-Exempt Temp. & Casual Employee
  - Sue J. Schoenfeld-Non-Exempt Temp. & Casual Employee

Office

Arielle W. Balak-Secretary
Steven A. Jaycox-Associate Administrator
Kathryn M. Monahan-Senior Secretary
Linda L. Oelke-Community Program Assistant

Soils

Patrick L. Kelly-Assistant Scientist
Vernon L. Ferch-Research Plot Technician
- Misc. Summer Help:
  - Russell F. Domonoske-Laborer
  - Martin L. Eberling-Student Laborer
  - Jeffrey A. Eichhorst-Student Laborer

Maintenance

Robert F. Deef-General Maint. Supervisor
Philip J. Keeley-Maint. and Operations Mechanic
- Misc. Summer Help:
  - Michael D. Good-Non-Exempt Temp. & Casual Employee
  - Gregory J. Kamm-Non-Exempt Temp. & Casual Employee
  - Charles E. Tipton-Non-Exempt Temp. & Casual Employee

SOUTHERN EXPERIMENT STATION

RESEARCH REPORT, 1986

This research report includes a complete listing of the research projects in progress at the Southern Experiment Station during 1986. Detailed reports, including summaries and conclusions, are included for a selected number of the projects. This work is a product of the Minnesota Agricultural Experiment Station, involving a cooperative effort between the Southern Experiment Station and a number of departments on the St. Paul Campus. These include:

- Agricultural and Applied Economics
- Agricultural Engineering
- Agronomy and Plant Genetics
- Animal Science
- Entomology
- Horticulture and Landscape Architecture
- Plant Pathology
- Soil Science
- College of Forestry
  - Fisheries and Wildlife
  - Forest Resources
- College of Veterinary Medicine

Special appreciation is extended to those scientists who prepared manuscripts for this report. Appreciation is also extended to the many private donors whose support enhances the entire program of research at the Southern Experiment Station. We wish to make specific mention of the Minnesota farmers who have supported our programs, including our generous neighbors who regularly loan equipment and lend their personal support to our activities and the growers who through the Minnesota Soybean Research and Promotion Council and the Minnesota Wheat Council have contributed in large measure to our research program.

Throughout the report, it will be observed that products on some occasions are identified by their generic name; in other instances, by their trade name. Inclusion of trade names does not imply recommendation or endorsement by the University of Minnesota.

Many treatments included in this report are experimental and are not registered for use. Farmers should consult product labels before using to determine if the product is registered for the intended use.

TABLE OF CONTENTS

Page

Soil Science

INTRODUCTION

The staff of the Southern Experiment Station is pleased to share with the readers of this publication the results of research conducted during 1986. As a prelude to the study of this report, it may be useful for the reader to be familiarized with the organization of the University of Minnesota, with particular reference to this Station. Created and funded by the Minnesota State Legislature, the direction of the University of Minnesota is entrusted to the Board of Regents. The President and Central Officers are the executive body of the University. Most directly responsible is Dr. Richard Sauer, Vice President for the Institute of Agriculture, Forestry, and Home Economics, who also serves as Director of the Minnesota Agricultural Experiment Station. Immediately responsible for all branch stations is Dr. Roy Thompson, Assistant Director of the Experiment Station. The resident official holding responsibility is Richard H. Anderson, Superintendent, who together with the research staff, is supported by civil service and bargaining unit employees.

A group of dedicated volunteers from across south-central and southeast Minnesota representing the principal farming enterprises and various agri-businesses make up the Southern Experiment Station Advisory Committee. Committee members serve without salary or remuneration for their personal expenses. The services of the Committee are highly valued by the staff of the Station. Members include:

Roger Asendorf, St. James
Ronald Hardesty, St. Peter
Virgil Johnson, Caledonia
Lynn Lagerstedt, Adams
Paul Nesseth, Nerstrand
Charles Priebe, Waseca
Ronald Pulley, Chatfield
Al Rindfleisch, Minnesota Lake
Virginia Roesler, New Richland
Bill Sanborn, Pine Island
Jan Schwantz, Plainview
Eldon Senske, Albert Lea
Joe Stransky, Owatonna
Randall Thalmann, Plato
Ray Thorn, Jr., Mankato

Cooperative research in a coordinated system-wide effort is the essential function of any branch agricultural experiment station. Minnesota has six major stations, together with a number of other research sites, to provide the location opportunity for research that needs to be conducted in major areas of production. These sites have been chosen to represent the significant soil and climatic regions of the State of Minnesota. The area represented by the Southern Experiment Station is a highly intensive agricultural region occupying less than one-sixth of the state's geographic area but accounting for a full third of the state's cash farm income. Most of the research is related to the principal agricultural enterprises of the region, including the production of corn, soybeans, vegetable crops, dairy cattle, dairy cattle raised for beef, and swine. Each year as many as 80 scientists or graduate students from locations other than Waseca utilize the resources in cooperation with resident staff to conduct applied phases of their research. More than 100 separate experiments are in progress at the station during each year.

General information about the station is frequently requested by visitors. The Southern Experiment Station will celebrate its 75th Anniversary in 1988. Operations began in 1913, following the authorization and funding of the Station by the Minnesota State Legislature in 1911. Observances are being planned for celebration of the Diamond Anniversary. The Station began on a 240-acre tract of land selected and purchased in 1912. An additional 358 acres of land were purchased in 1940 and another 231 acres added in 1972. An area of approximately 109 acres was made available for the development of the University of Minnesota Technical College during the early 1970s, leaving the Southern Experiment Station at its present size of 720 acres. Dairy cattle at the Station number approximately 180 head, with a 90-cow milking herd. Ninety Holstein bull calves are purchased each year for use in Holstein steer nutritional studies. They, along with an additional 40 bull calves from the dairy herd, are fed out and marketed. In the swine area, about 1,500 pigs are farrowed annually for use in nutritional and swine management studies. Research plots involved in agronomy, soil science, and horticultural science number in the tens of thousands.

Use of this report by the reader will be aided by an understanding of the remaining sections. Part II is a brief listing of each research project in which there was activity at the Southern Experiment Station during the calendar year 1986. A project may include the full scope of work conducted under the direction of a project leader in a specific area and might include several experiments. A brief statement of purpose is made in regard to each project, together with the identity of the scientists involved in the work. Many of the projects listed in Part II have not progressed to the point where conclusive remarks can be made. For this reason, they are included here primarily to inform the reader of the nature of work being conducted at the Station. A comment is made by the author in each instance if additional conclusive information about the study can be found in the more detailed report in Part III.

Part III includes reports of research that has been concluded or is advanced enough to warrant conclusive statements. Acknowledgement is made of those project leaders from other locations in those instances where Southern Experiment Station scientists have reported cooperative research. Their names are indicated in connection with each report.

Acknowledgement is also made of the generous support of the Minnesota Legislature which has facilitated an extensive physical plant development and significant programmatic improvement during the past two decades. Appreciation is also expressed for the leadership, guidance, and support of the Central Administration of the University of Minnesota and the officers of the Institute of Agriculture, Forestry, and Home Economics.

Richard H. Anderson
Superintendent

1986 AGRONOMY PROJECT LIST

SOUTHERN EXPERIMENT STATION

William E. Lueschen, Agronomist

I. Corn

A. Corn Breeding - Jon Geadelmann

This project has as its objective the development and testing of germplasm with the goal of improving corn through plant breeding techniques. Included in this project is an elite hybrid evaluation trial where 171 corn hybrids were evaluated. This project also evaluates the relative maturity of corn hybrids registered for sale in Minnesota. This phase of the project is in cooperation with the State Department of Agriculture. The tolerance of 10 corn inbreds to DPX-M6316, a herbicide that has potential for weed control in corn, was evaluated. A detailed report of the elite hybrid evaluation is included.

B. Corn Management - Gyles Randall and William Lueschen

This study was initiated in 1985 and was designed to evaluate the nitrogen needs for corn following soybeans with five different tillage systems. Nitrogen rates of 0, 40, 80, 120, 160 and 200 lb/A were evaluated in no-till, ridge-till, and Paraplow systems where corn followed soybeans. Two other tillage systems were included: (a) chisel plowing following corn and no-till following soybeans, and (b) chisel plowing following soybeans and moldboard plowing following corn. All N was applied sidedress. This study will help refine N rates for corn and will determine if tillage practices influence the nitrogen needs of corn. The response of soybeans to residual nitrogen will be assessed next year. Similar studies were also conducted at Lamberton and Morris.

C. Corn and Soybean Rotation - Kent Crookston and William Lueschen

This study, initiated in 1984, was designed to evaluate the influence of continuous corn and corn/soybean rotations on the performance of both crops. The primary tillage for this study has been fall chisel plowing. A summary of the results are included.

D. Long-Term Corn/Soybean Rotation - Kent Crookston and William Lueschen

This study was initiated in 1982 to evaluate the long-term effects of several corn/soybean rotations under a moldboard plow tillage system. Sixteen treatments are included with all but four of these consisting of five years of corn on a plot followed by five years of soybeans. Rotations are set up so that in each year there are plots with a one, two, three, four or five year history of either corn or soybeans. Also included in this study is continuous corn and continuous soybeans with the same variety planted each year and a separate treatment where the variety is alternated each year in continuous corn and soybeans. In 1986, the soybean plots were split with one-half of each plot planted to Hodgson 78 and the other one-half to BSR101. This was done because differences in Brown Stem Rot were observed in soybeans among the rotations. BSR101 has good tolerance to this disease. A summary of the results is included.

E. Popcorn, Sweetcorn and Field Corn Silage Trial - Craig Sheaffer and William Lueschen

This study was initiated because the current government farm program allows farmers to plant sweetcorn or popcorn on set-aside acres and harvest it for silage. Our objective was to compare the yield and quality of silage produced from each type of corn. Dr. Hugh Chester-Jones has evaluated the fermentation characteristics of each type of ensiled corn. A summary of the yield results is included.

F. Corn Following Alfalfa - Charlotte Eberlein

In this study, the first cutting of alfalfa was removed for hay in late May. Following hay harvest, the alfalfa was allowed to recover for approximately ten days before treatments were installed. Four systems were evaluated: (a) moldboard plowing; (b) undercutting alfalfa and removing the crowns and about 8 inches of root tissue; (c) no-tillage, with the alfalfa suppressed but not killed with atrazine; and (d) no tillage, with the alfalfa killed with Roundup. Small microplots were established within each system using labelled nitrogen. This allowed the objective of determining the nitrogen contribution of alfalfa to be met. No other nitrogen fertilizer was added to these plots. No summary of the data is included in this report.

G. Corn Rootworm Control - Ken Ostlie

This study was designed to evaluate the effectiveness of labelled and experimental insecticides for controlling corn rootworms in a continuous corn system. The year prior to planting this trial, late-planted corn was used to attract corn rootworm beetles in an attempt to have a heavy population of rootworms for evaluation. Placement of insecticides was also evaluated in this study. Very low corn rootworm pressures were observed in this trial in 1986. A summary of the results is included.

H. Long-Term Corn Rootworm Trial - Ken Ostlie

This study was designed to evaluate the influence of continuous use of five corn rootworm insecticides on the efficacy of these compounds on corn rootworm larvae in a continuous corn system. Treatments were initiated in 1982 with the same insecticide applied to the same plot area each year. Results are not included in this report.

I. Corn Rootworm Control and Tillage - Ken Ostlie

Initiated in 1986, this study was designed to evaluate the influence of tillage on corn rootworm populations. A second objective was to evaluate the efficacy of three corn rootworm insecticides. The original tillage plots were established in 1983 with no-tillage, ridge-till, fall chisel plowing and fall moldboard plowing maintained on the same plot areas in a continuous corn system. These plots were also used to monitor the effects of tillage and crop residue on cutworm infestations. A summary of the results is included in this report.

J. Corn Borer Yield Loss - Ken Ostlie

This study was designed to evaluate the influence of first generation corn borer infestations on yield loss of corn. Three corn hybrids were artificially inoculated with various levels of corn borer. Data was collected on the degree of shot-holing, tunneling, lodging, and grain yield. Due to heavy rainfall after inoculation with corn borer eggs, low populations of corn borer developed. A summary of the results is included.

K. Ethephon on Corn - William Lueschen and Thomas Hoverstad

The objective of this trial was to evaluate the response of three corn hybrids to both rates and stages of foliar applications of ethephon (Cerone). Ethephon was applied as a foliar spray at 0, 0.13, 0.25 and 0.38 lb/A when corn was in the 9th and 12th leaf stages. Parameters evaluated included plant height, leaf area index, lodging, kernel size, grain moisture, grain yield, silage yield, and nutrient content of whole plants. A detailed report is included.

L. Respond on Corn - William Lueschen, Gyles Randall, Thomas Hoverstad and Patrick Kelly

This study was designed to evaluate the use of Respond to improve the performance of corn. Respond was applied as a foliar spray at 16 oz/A when the corn was in the 10th leaf stage. Spring applied N rates of 0, 75 and 150 lb/A were included, since Respond has been reported to improve nitrogen efficiency of corn. A detailed report of this study is included.

M. Acetanilide Tolerance of Corn - Charlotte Eberlein, Paul Viger and William Lueschen

Corn has been reported to vary in tolerance to acetanilide herbicides. The objective of this study was to evaluate a response of two corn hybrids to acetochlor, CGA 18093, Dual, Lasso and propachlor. Labeled rates and excessive rates were used to evaluate tolerance to these compounds. Data was collected on rates of emergence, final plant population, early injury, plant height, and grain yield and moisture. A report of the results is included.

N. Acetanilide Herbicide Weed Control - Charlotte Eberlein and William Lueschen

This study was a companion study to the previous one. The objective of this trial was to evaluate weed control obtained with comparable rates of acetochlor, CGA 18093, Dual, Lasso and propachlor applied alone or in combination with atrazine as a preemergence treatment. Results from this research will help determine if the differences often reported in corn yield among acetanilide herbicides are related to differences in corn tolerance or are due to differences in weed control.

O. Herbicide Carryover - Jeff Gunsolus, Richard Behrens and William Lueschen

The objective of this study was to evaluate the carryover potential of four newly developed soybean herbicides--Command, Classic, Pursuit and Scepter. In 1985, each of these herbicides were applied at two rates for weed control in soybeans. No tillage was performed on these plots in the fall of 1985. Oats underseeded with alfalfa and corn were planted in the spring of 1986. Injury, stand reduction, grain yield and crop maturity were evaluated. A summary of the results is included.

P. Jerusalem Artichokes - Don Wyse and William Lueschen

This study was initiated in 1982 by planting a low population of Jerusalem artichoke tubers in soybeans. The objective of this study has been to monitor the influence of three tillage practices on the propagation of this perennial species. Primary tillage treatments have included no-till, reduced tillage consisting of chisel plowing following corn and disking following soybeans, and a moldboard plow system. Each tillage system has been maintained on the same plot area each year with corn and soybeans rotated annually. A second objective has been to evaluate the residue control of Jerusalem artichokes where 2,4-D is applied to corn and Scepter is applied to soybeans. A summary of the results is included.

Q. Herbicide Screening - Jeff Gunsolus and William Lueschen

This study is conducted annually to evaluate preplant, preemergence and postemergence weed control in corn. Experimental herbicides and experimental herbicide combinations were compared to label treatments. A similar trial was conducted at Lamberton, Morris and Rosemount to provide a basis for herbicide recommendations. A summary of the results is included.

R. New Formulations of Dual - William Lueschen

The objective of this trial was to compare various formulations of Dual herbicide for weed control in corn and to evaluate crop tolerance of the various formations. Liquid and granular formations were compared. A detailed report is included.

S. Prickly Smartweed Control - William Lueschen and Jeff Gunsolus

A study was established on the Adams Bros. Farm near Janesville to evaluate the efficacy of labeled corn herbicide treatments for control of prickly smartweed. This weed species was first positively identified in Minnesota in 1984. Preemergence and postemergence treatments were applied but very low populations of prickly smartweed development and the results were not consistent. Therefore, no report is included.

II. Soybeans

A. Soybean Breeding - Jim Orf, William Lueschen and Thomas Hoverstad

This project has been designed to improve soybean production through varietal improvement. Each year the Southern Experiment Station serves as one of the major testing locations for material developed in this program. Small plot evaluations include new experimental lines, preliminary tests, uniform regional trials, privately and publicly developed variety tests, a disease nursery and evaluation of early generation crosses. Soybean variety performance and planting dates were also evaluated. Planting dates ranged from early May to mid-June. A comparison is being made between several soybean varieties grown in 30-inch and 10-inch rows. Data collected from variety evaluations are published in "Varietal Trials of Farm Crops". A partial summary of the results from this project is included.

B. Seed Treatment and Phytophthora Root Rot Control - Ward Stienstra

The effects of fungicide seed treatment on 'bin run' and certified seed was evaluated. In another study, use of a fungicide treatment for controlling phytophthora root rot on several soybean varieties was investigated. A summary of the results is included.

C. Soybean Management - William Lueschen, Gyles Randall and Thomas Hoverstad

Initiated in 1985, this study is designed to evaluate the influence of primary tillage practices following corn on performance of eight soybean varieties. Also included in this study were three seed treatments to evaluate the need for fungicide seed treatment in reduced tillage systems. Primary tillage treatments were no-till, ridge-till and fall Paraplowing following both the corn and soybeans grown in rotation. Two other tillage systems were included: (a) moldboard plowing for soybeans following corn and chisel plowing for corn following soybeans, and (b) chisel plowing for soybeans following corn and no-till for corn following soybeans. A similar study was conducted at the Southwest and West Central Experiment Stations. This project was supported in part by a grant from the Minnesota Soybean Research and Promotion Council. A summary of the results is included in this report.

D. Interplanting and Replanting Soybeans - Dale Hicks

The objective of this study was to evaluate the potential for interplanting and replanting soybeans following hail damage. Initial plant populations of 37,500; 75,000 and 150,000 plants per acre were established in mid-May. On approximately June 10 and June 25, simulated hail damage was inflicted on certain plots while other plots were undamaged and others were torn up and replanted. One-half of the plots that received hail damage on each date were interseeded with soybeans leaving the damaged plants to recover. The other damaged plots were left to recover without reseeding. The effects of these treatments on maturity, lodging, yield and seed quality were compared to the originally established plots that were allowed to develop normally. A summary of the results is included in this report.

E. Velvetleaf Eradication - William Lueschen and Robert Andersen

The purpose of this study initiated in 1974 has been to evaluate the longevity of velvetleaf seeds in the soil under different crop management practices. Variables range from continuous corn, alfalfa and oats to chemical and cultivation fallow. Soil samples were taken to monitor the presence of seed in the soil where no velvetleaf plants are permitted to go to seed in any treatments. Samples are taken every three years and report is not included since soil samples were not taken in 1986.

F. Ethephon for Soybeans - William Lueschen and Thomas Hoverstad

This was the second year for this study designed to evaluate the influence of time and rate of ethephon (Cerone) application on performance of two soybean varieties. Ethephon is a growth regulating compound that shortens the plant. It was applied at the V-3 and V-5 stages of development at rates of 0.13, 0.25 and 0.38 lb/A. We monitored the influence of ethephon applications on plant height, maturity, lodging, seed size and seed yield. A detailed report is included.

G. Respond for Soybeans - William Lueschen

Respond has been reported to enhance yield of soybeans in certain trials. Our objective was to evaluate the influence of time of application on the performance of soybeans. Two soybean varieties were included in this study. A summary of the results is included.

H. Ethalfluralin Injury Studies - William Lueschen, James Orf and Thomas Hoverstad

Three studies were conducted to determine the effects of soil type, planting depth and ethalfluralin (Sonalan) rate on injury of soybeans. Eighteen soybean varieties, four ethalfluralin rates, two planting depths and two soil types are included. Trifluralin (Treflan) applied at 1 and 2 lb/A was also included. Data was collected on rate of emergence, plant height, and seed yield under weed-free conditions. A report of the results is included.

I. Herbicide Screening - Jeff Gunsolus and William Lueschen

This project was designed to evaluate preplant, preemergence and postemergence herbicides for weed control and crop tolerance in soybeans. Major emphasis was placed on compounds and combinations that do not have label registration for general usage. Several new experimental preemergence and postemergence herbicides and combinations were evaluated. As with the corn weed control study, this study provides information for growers as well as industry. A summary of the results is included.

J. Injury with Postemergence Herbicides - William Lueschen and Thomas Hoverstad

This study was designed to evaluate the effects of herbicides, rates and additives on soybean injury in weed-free soybeans. Acifluorfen (Blazer), bentazon (Basagran), lactofen (Cobra), and sethoxydim (Poast) were included in this study. Additives include a surfactant, an oil concentrate and two liquid fertilizers (10-34-0 and 28-0-0). Observations were made on soybean injury, plant height and seed yield. A summary of the results is included.

K. No-Till Soybean Weed Control - William Lueschen and Thomas Hoverstad

The purpose of this project was to evaluate herbicide treatments for no-till soybeans where the previous crop was corn. Treatments included early preplant, preplanting, preemergence and postemergence herbicide applications. No-till soybeans have performed well compared to other tillage systems in a weed-free environment. This study provided an evaluation of herbicide performance in no-till. This project was supported in part by the Minnesota Soybean Research and Promotion Council. A summary of the results is included.

L. Prickly Smartweed Control - William Lueschen and Jeff Gunsolus

A study was conducted on the Robert Annis Farm near Mapleton, Minnesota to evaluate postemergence corn and soybean herbicide for controlling prickly smartweed. The site for this study was in an area devoted to set-aside acres for the 1986 growing season. No summary of the results is included.

M. Effects of Herbicide Additives on Weed Control with Bentazon and Acifluorfen - William Lueschen and Thomas Hoverstad

The objective of this study was to evaluate broadleaf weed control obtained with postemergence applications of bentazon (Basagran) or acifluorfen (Blazer) and a combination of these two products. The additives used were: 1 pt/A and 1 qt/A of oil concentrate, 1 qt/A and 1 gal/A of 28% nitrogen solution, 1 qt/A of 10-34-0 liquid fertilizer, and 2.5 lb/A of ammonium sulfate. A combination of oil concentrate and 28% nitrogen was also included. A second phase of this study was designed to evaluate split applications of bentazon or bentazon plus acifluorfen combination with sethoxydim (Poast). Data was collected on weed control, crop injury and soybean yield.

N. Quackgrass Control in Soybeans - Don Wyse and William Lueschen

The objective of this study was to evaluate the influence of tillage and postemergence applications of grass herbicide on quackgrass control in soybeans. Moldboard plow, ridge-till, and no-till systems were included. Herbicides evaluated were DPX 6202 (Assure), fluazifop (Fusilade), sethoxydim (Poast) and haloxyfop (Verdict) as postemergence treatments applied to soybeans. Glyphosate (Roundup), both spring and fall applied, was included for comparative purposes. No summary of the results is included.

O. Herbicide Incorporation - William Lueschen and Thomas Hoverstad

This study, located at the Lynn Below Farm, was designed to evaluate the influence of herbicide formulation and incorporation of preplant soybean herbicides on weed control. The site for this study was in corn in 1985 with no fall and no spring tillage prior to installation of the first treatments in the spring of 1986. Our objectives were to compare the need for disking corn stalks prior to trifluralin (Treflan) and pendimethalin (Prowl) applications for weed control in soybeans and to compare granular and liquid formulations of trifluralin. Yet another objective was to compare one pass and two pass incorporation. Because of low weed pressures, there were no differences among treatments and no data is given in this report.

P. Cinmethylin for Weed Control in Soybeans - William Lueschen and Thomas Hoverstad

The objective of this research was to evaluate the efficacy of preemergence applications of cinmethylin (Cinch) for weed control in soybeans when applied alone or in combination with chloramben (Amiben), metribuzin, and AC 263499 (Pursuit). Rates of application of cinmethylin ranged from 0.75 to 1.50 lb/A. This product was being developed by Shell Chemical Company. A summary of the results is included.

Q. Air-Assist Nozzles for Herbicide Application - William Lueschen and Thomas Hoverstad

A great deal of interest has been generated in reducing the carrier volume for herbicide application. In this study we compared flat fan nozzles calibrated to deliver 20 gallons per acre with air-assist nozzles calibrated to deliver 5 gallons per acre. Three herbicides were evaluated--alachlor (Lasso) preemergence, bentazon (Basagran) and sethoxydim (Poast) as postemergence herbicides. Two rates of each compound were included. The air-assist nozzles are being developed by Spray Systems Company. A summary of the results are included.

R. Soybean Herbicide Carryover - Jeff Gunsolus and William Lueschen

This study was designed to evaluate the carryover potential of three soybean herbicides. FMC 57020 (Command) was applied at 0.5, 0.75, 1.0, 1.25 and 2.5 lb/A preemergence. DPX 025 (Classic) was applied at 0.01, 0.02 and 0.04 lb/A postemergence. AC 263499 (Pursuit) was applied at 0.063, 0.125 and 0.25 lb/A postemergence. Soybeans were grown in 1986. No tillage was done in the fall after harvest and only minimum tillage will be used prior to planting in 1987. In 1987, corn, oats and alfalfa will be seeded to evaluate carryover potential. Since this is a carryover study, no results will be obtained until 1987.

S. Seed Source Survey - Allan Simons

This study was conducted in cooperation with the Minnesota Crop Improvement Association. Soybean seed samples were collected by the Minnesota Department of Agriculture from growers' seed sources being planted in 1986. The purpose of this study was to compare certified and non-certified seed. Data was collected on plant stands and seed yields. Twenty seed samples of Corsoy 79, 20 seed samples of Hardin, and 16 seed samples of Pioneer 1677 were included in this trial. No summary of the results is included in this report.

III. Small Grains

A. Cereal Rust - Alan Roelfs and Thomas Hoverstad

Prevalence of rust on cereal crops--wheat, oats, barley and rye--was monitored to establish over a period of years the average date of the first appearance of rust and the amount of inoculum that arrives. This project is part of a regional rust survey on small grains. A summary of the results is included.

B. Oat Varieties - Deon Stuthman and Thomas Hoverstad

The development of improved oat varieties has been the object of this study. Included in this project were the oat variety evaluation plots and early advanced nursery. Maturity, lodging, disease resistance and yield were the parameters evaluated. Results of oat variety evaluations are included in "Varietal Trials of Farm Crops". A partial summary is included in this report.

C. Oat Recurrent Selection Parent Nursery - Deon Stuthman and Thomas Hoverstad

The objective of this study was to evaluate agronomic traits of oats following four consecutive cycles of recurrent selection. Yield, lodging, disease resistance and seed quality were evaluated. A similar study was conducted at other locations. No data from this study is included in this report.

D. Wheat Planting Date - William Lueschen, Harlan Ford and Thomas Hoverstad

The purpose of this study initiated in 1983 has been to evaluate the optimum planting date for wheat in southern Minnesota. Planting dates ranging from early April to early June and twelve Hard Red Spring varieties have been included to evaluate interactions between varieties and planting dates. This project was supported in part by the Minnesota Wheat Growers Research and Promotion Council. This study was also conducted at Lamberton. A detailed summary of the results is included in this report.

E. Spring Wheat Varieties - Robert Busch and Thomas Hoverstad

An evaluation of the performance of spring wheat varieties in southern Minnesota was the objective of this trial. Standard height and semi-dwarf varieties were investigated. Parameters evaluated include height, lodging, maturity, yield, protein and baking quality. A summary of the results is included in this report and are also included in "Varietal Trials of Farm Crops".

F. Uniform Regional Winter Wheat Nursery - Robert Busch and Thomas Hoverstad

Each year a Uniform Regional Winter Wheat Nursery is established to evaluate varieties and lines developed by wheat breeders in several states. This trial was evaluated for winter hardiness, lodging resistance, height and yield. Although most of the entries were experimental lines, the data is included in this report.

IV. Forage Crops and Miscellaneous Crops

A. Alfalfa Varieties - Don Barnes and William Lueschen

Two alfalfa variety trials established in 1982 and 1984 were harvested to evaluate yield and stand persistence. Data was collected on yield using a 4-cut management system. In May of 1986, a new alfalfa variety trial was seeded with 48 varieties. A summary of the results is included in this report.

B. Alternate Crops for Forages - Craig Sheaffer and William Lueschen

This study was conducted to evaluate the use of non-traditional forage crops for potential forage production. Crops harvested under a multiple cut system were Typhon, alfalfa, red clover, alsike clover, hybrid sudangrass, sorghum-sudangrass hybrid, and a combination of sorghum-sudangrass hybrid and soybeans. Single-cut crops included field peas, blue and white lupines, Corsoy 79 and Forrest soybeans and a combination of oats and field peas. The lupines were also allowed to mature and were harvested for seed. A summary of the results is included.

C. Respond on Alfalfa - William Lueschen and Thomas Hoverstad

This study was designed to evaluate the influence of foliar applications of Respond on alfalfa performance. Respond was applied at different times on two alfalfa varieties. This trial was managed on a 3-cut system. The results are included in this report.

V. Entomology

A. Black Light Trap - William Lueschen, Thomas Hoverstad and Dharma Sreenivasam

Nightly insect collections were made from late May to late August to monitor the presence of economically important insects. This data provides information on potential problems with insect pests. This project was conducted in cooperation with the Minnesota Department of Agriculture. No summary is included in this report.

B. Corn Borer Survey - Dave Andow

This project was designed to monitor the presence, severity and development of European Corn Borer. Weekly samples were taken to determine infestations and stage of development. A summary of the results is included in this report.

VI. Demonstrations

A. Small Grain Varieties - William Lueschen and Thomas Hoverstad

A planting of currently available oat and wheat varieties was planted adjacent to the road to serve as a display for visitors. No data was collected.

B. Herbicide Injury - William Lueschen

Farmers, agri-business people and teachers need to become familiar with herbicide injury symptoms. To facilitate this, we established both corn and soybean plots to show injury symptoms. In many cases, rates of application were well beyond what the label calls for. No data was collected.

1986 Animal Science Project List

Southern Experiment Station

Hugh Chester-Jones

I. Swine

A. The influence of reduced litter size on body composition and subsequent reproductive performance in primiparous sows - Brian Knudson, Ron Moser, Sayed El-Kandelgy, Steve Cornelius, Hugh Chester-Jones, Harley Hanke, Larry Clark, and Jim Pettigrew.

Swine producers have been faced with the problem of second litter sows farrowing a small litter. This seems to be dependent on a number of pre-disposing factors. This study was designed to simulate a management program based on two different litter sizes to more precisely define the effect of differing stress situations on body composition and subsequent reproductive performance of primiparous sows. The study was also conducted at the West Central Experiment Station in Morris. A final report of this study will be found in Part III.

B. Performance of barrows and gilts fed different protein (lysine) levels from 110 to 230 lbs body weight - Hugh Chester-Jones, Jim Pettigrew, Steve Cornelius and Ron Moser.

It has been well established that barrows and gilts differ in their lysine requirements to maintain optimum growth rate, feed efficiency and carcass quality. However, the precise lysine requirements have yet to be clearly defined. The objectives of this study were to determine the protein (lysine) requirements of barrows and gilts from 110 to 230 lbs body weight. A final report of this study will be found in Part III of this report.

C. Determination of the growth curve of pigs around weaning - Steve Cornelius, Dean Koehler and Hugh Chester-Jones.

It is generally accepted that after weaning pigs undergo a period of decreased growth rate and loss in weight. This "slump" varies in length but is followed by a period of compensatory growth. This study was designed to develop a procedure to objectively measure the weaning performance of pigs and assess factors that affect this performance immediately post weaning. Data from this research study is too preliminary to report.

D. Evaluation of the causes of pig mortality from birth to weaning - Jean Vaillancourt, Hugh Chester-Jones and David Ziegler.

Piglet mortality between birth and weaning remains a major source of loss for swine producers. In the past information on the cause of death has been based on producers' evaluations. The objective of this study will be to assess the accuracy of producers' evaluations by correlating the reasons for death as reported by producers to causes of death as determined by post-mortem examination. Data from this study has yet to be summarized.

E. Estimates of in vivo body composition of sows following parturition - Brian Knudson, Ron Moser, Sayed El-Kandelgy, Steve Cornelius, Hugh Chester-Jones and Arnold Hoepner.

Scientists and producers have traditionally employed live weight, backfat thickness or reproductive measures as response criteria in assessing nutritional needs of sows. Realistically this thinking may be flawed because other factors such as environment and health. etc. may be confounded with nutrition. A preferred alternative would be to assess changes in the sow's body fat, protein or ash stores. The logistics of accomplishing this have been difficult. The objectives of this study are: (1) to assess the efficacy of: a) deuterium oxide, b) tenth rib backfat and live weight, either alone or in combination, to estimate in vivo body composition of sows 2 days after parturition, and (2) to determine the distribution of fat in the sow. Data from this study are too preliminary for a meaningful summary.

F. Efficacy of litter milk for piglets - Brian Knudson, Ron Moser, Hugh Chester-Jones, David Ziegler and Arnold Hoepner.

Much interest has been generated regarding the artificial rearing of neonatal piglets. Land O'Lakes has developed a product, Littermilk, which has received some success in field trials. This study was designed to further evaluate Littermilk for piglets taken from the sow at birth up to weaning. Data from this study has yet to be completely summarized.

II. Dairy Beef

A. Performance of Holstein steer calves fed different forms of supplemental nitrogen in starter diets - Hugh Chester-Jones, Marshall Stern, Ken Miller, Steve Plegge and David Ziegler.

The efficiency of utilization of protein by the young growing calf is not fully understood. Soybean meal has been a traditional protein source for many years and urea as a cheaper non-protein nitrogen source can be utilized by the growing ruminant. This study was designed to evaluate various processed forms of soybeans as protein sources compared to soybean meal and urea in rations of equal protein content. A final report of the study will be found in Part III.

B. Utilization of beet pulp in diets fed to growing Holstein steers - Hugh Chester-Jones, Marshall Stern, Jim Linn, Steve Plegge and David Ziegler

Beet pulp supplies adequate energy to support microbial protein synthesis in ruminants and also some by-pass protein. This study was designed to evaluate the efficiency of using beet pulp as an energy source compared to corn in growing diets for dairy beef that included either soybean meal or alcohol treated soybeans as protein sources. A detailed progress report of the study will be found in Part III.

C. Performance of growing Holstein calves fed diets containing different levels of corn gluten feed - Hugh Chester-Jones, Steve Plegge, Jay Meiske, Marshall Stern and David Ziegler.

Corn gluten feed is one of the by-products of the corn wet milling industry. The majority of corn gluten feed is exported to Euuope. The domestic US supply may substantially increase if an import levy is appropriated against the feedstuff. Information on the use of corn gluten feed in starter/grower diets for Holstein steers is limited. This study is evaluating the performance of growing Holstein steers fed diets containing different levels of corn gluten feed from weaning to 400 lbs. Data is too preliminary for a meaningful summary to be reported.

D. Performance of growing Holsteins fed diets containing different levels of sweet corn processing waste - Hugh Chester-Jones, Steve Plegge, Don Otterby, Jay Meiske, Marshall Stern and David Ziegler.

Sweet corn processing waste silage is a readily available, but under-utilized, livestock feed resource in SE Minnesota. The residue resulting from the processing of sweet corn typically contains 90% husk and leaf, 2% kernel and 8% cob with a combined dry matter that can range from 23-40% plus washed corn screenings that contain 5% solids. The industry today chops and squeezes the waste before ensiling to reduce the moisture content. The objectives of this study are to evaluate feeding systems of using the waste silage in diets for Holstein steers. The data is not in a form to be summarized for this report.

E. The heritability of dairy-beef traits and relationships between dairy and beef traits in Holstein steers from two genetically different herds - Charles Young, Ken Miller, Les Hansen, and Hugh Chester-Jones.

All male calves from the Southern Experiment Station dairy herd are raised to a finished weight of 1050 lbs., and carcass data recorded for each steer. This information is used to evaluate the effect of selecting for milk production in the ongoing dairy-herd genetics project on the heritability of dairy-beef traits. Data from this research is not available in a complete form to enable a report to be forthcoming.

F. Fermentation characteristics of sweet corn processing waste ensiled at different moisture levels with or without additives - Hugh Chester-Jones, Don Otterby, Jay Meiske, Marshall Stern, Steve Plegge and David Ziegler.

The problem facing the Minnesota food processing industry is how to increase the efficiency of disposal of the sweet corn waste silage and enhance the feeding quality of the product available to local farmers. The objectives of this study were to simulate, through a small silo study, larger scale ensiling processes using sweet corn processing waste ensiled alone or with the addition of either corn, urea, bacterial innoculant or propionic acid. A progress update on this study will be found in Part III.

III. Dairy

A. Improving cattle through breeding with special emphasis on selection for a) milk yield and b) lbs protein - Les Hansen, Charles Young, Hugh Chester-Jones and David Ziegler.

A detailed report on the breeding project emphasizing selection for milk yield appeared in the 1985 Southern Experiment Station Annual Report pp 270-275. Data is still being collected for this phase of the original breeding project. In addition a commitment was made in 1986 to build on the existing genetic base of the dairy herd and establish a third herd which emphasizes selection for milk protein. A detailed outline of the new breeding project is given in Part III.

B. Effect of recombinant bovine somatotropin on lactation of dairy cows - Don Otterby, Bill Hansen, Hugh Chester-Jones, Les Hansen and David Ziegler.

Recombinant bovine somatotropin (BST) is now readily synthesized under laboratory conditions. It has been shown that daily injections of BST given to lactating cows can enhance milk production substantially. The objectives of this study are to measure the production responses to daily injections of BST given to lactating cows from two genetic lines (the control and selection herds at the Southern Experiment Station). Data from this study is too preliminary to summarize.

C. Post-partum reproductive performance under identical management of dairy cows genetically selected for two levels of milk production - Brad Seguin, Hugh Chester-Jones, Les Hansen and David Ziegler.

The study is designed to establish an indication of stage of estrus utilizing milk progesterone levels as an aid to monitor problem cows or "silent heat" cows more closely. Evaluation is based on the interval from the first post-partum luteal activity and subsequent estrus cycle patterns in the selection and control herds at the Southern Experiment Station. Data from this research is not in a form to enable a final report to be presented.

D. Evaluation of the growth of environmental mastitis pathogens in chopped straw vs shredded paper in free stalls during the dry period for multiparous cows and first calf heifers - Bob Appleman, Hugh Chester-Jones, Jeff Reneau, Ralph Farnsworth and David Ziegler.

Environmental organisms found in confinement housing systems can contaminate a cows udder and cause a toxic mastitis that can be fatal if not treated promptly or correctly. The most susceptible periods for the possibility of pathogenic organisms entering through the teat canal are at drying off at the end of lactation and during the last month of gestation. This study will compare two extreme bedding materials in terms of media for bacterial growth and categorize environmental pathogen build-up in a typical year. The contamination of the dry cow and late gestating heifer by the organisms will be established for the dry period and the initial part of the subsequent lactation. Data from this study is too preliminary for a progress report.

1986 HORTICULTURE PROJECTS

Vincent A. Fritz
Horticulturist
Southern Experiment Station

I. Sweet Corn

A. Common Maize Rust Epidemiology - Vincent Fritz and James Groth

This study is designed to evaluate the effects of different population densities and planting dates on the incidence and progression of common leaf rust (Puccinia sorghi) and to determine its effects on yield and quality of sweet corn. The main objective of the study is to develop a computer model which will help growers maximize control strategy efficiency. Data from this research is too preliminary to report.

B. Systemic Fungicides for Common Maize Rust Control - Vincent Fritz

With the increased concern for leaf rust control in the vegetable processing industry, an experiment was designed to evaluate the control potential of several systemic fungicides and to determine their effects on yield recovery. Detailed report will be found in Part III.

C. Variation in Brominal Injury Between Varieties - Vincent Fritz

This study is designed to evaluate fifteen sweet corn varieties for their sensitivity to Brominal, a postemergence herbicide. Included in the list of varieties are Su (normal), Se (surgary enhancer), SH_2 (shrunken), and commercial inbred types. Detailed report will be found in Part III.

D. Growth Regulator Effects in Sweet Corn - Vincent Fritz

This study will evaluate the effects of ethephon (Cerone) on lodging, plant growth, and yield recovery. Included in the varieties to be tested are SH_2 types which are reportedly more susceptible to lodging. Detailed report will be found in Part III.

E. Nitrogen, Population, and Planting Date Effects on Yield and Quality of Sweet Corn - Vincent Fritz and Carl Rosen

Yield recovery in sweet corn gradually declines as sweet corn fields are planted later in the season. This study was initiated to determine if reduced populations for late plantings would increase yield recovery.

Nitrogen rates are also included in the study to properly calibrate crop nitrogen demands for the different populations at various planting dates. Detailed report will be found in Part III.

F. Weed Control in Sweet Corn - Leonard Hertz and Vincent Fritz

This study is to evaluate several herbicides at different rates and in combination with other herbicides for overall weed control, injury,and yield. Detailed report will be found in Part III.

G. Sweet Corn Rust Screening Trial - James Groth and Vincent Fritz

This study is to evaluate several sweet corn varieties for resistance to common maize rust. Thirteen entries will be evaluated this year after disease inoculation. Data from this research is too preliminary to report.

II. Peas

A. Variety Screening for Root Rot Resistance - Dave Davis, Frank Pfleger, and Vincent Fritz

This study has been ongoing since 1976. The purpose of the root rot nursery is to screen pea breeding lines and commercial pea varieties for root rot resistance. This year, many of the varieties were planted in an uninoculated site to facilitate evaluation of desirable horticultural characteristics without root rot disease pressure. Detailed report will be found in Part III.

B. Nitrogen, Fungicide, and Inoculation Effects on Nodulation and Yield - Carl Rosen and Vincent Fritz

The benefits of inoculating pea seeds with bacteria for improved nodulation in heavy soils is uncertain. Pea seeds are traditionally treated with Captan fungicide which may have a negative effect on Rhizobium, the nodule forming bacteria. Nitrogen applications may also effect nodulation. The objectives of this study are to determine if the fungicide, Captan, has a deleterious effect on nodulation; to determine nitrogen effects on nodulation, nitrogen utilization, and yield; and to determine if there is any benefit from preplant inoculation of pea seeds with Rhizobium. Detailed report will be found in Part III.

C. Pea Weed Control - Leonard Hertz and Vincent Fritz

This study is designed to evaluate several herbicides for weed control potential at different concentrations and in combination with other herbicides. Treatments will be applied preplant, preemergence, early postemergence, and postemergence. Detailed report will be found in Part III.

III. Asparagus

A. Asparagus Nursery - Dave Davis and Vincent Fritz

This study is a screening of Minnesota's breeding lines. The nursery began in 1984 which contains 24 breeding lines. The study will continue indefinitely. Data from this research is too preliminary to report.

IV. Potatoes

A. Black Scurf Control in Red Potatoes - Vincent Fritz

Red potato yields in southeastern Minnesota have been significantly reduced by black scurf fungus, Rhizoctonia solani. A study has been designed to determine the effect of five systemic fungicide seed piece treatments on the incidence of black scurf. Two sites in Hollandale, Minnesota have been selected. Two varieties that were selected for the studies are 'Norland' and 'Chieftain'. Detailed report will be found in Part III.

B. Potato Variety Trial - Florian Lauer and Vincent Fritz

This trial was planted in Hollandale, Minnesota for evaluating Minnesota's breeding lines and commercial varieties for their production potential. This year fifteen varieties are included in the trial. Data from this research is too preliminary to report.

C. Ethephon Effects on Periderm Color in Red Potatoes - Vincent Fritz

Use of 2,4-D for periderm color enhancement has yielded inconsistent results for many growers. The use of 2,4-D promotes production of ethephon, a growth regulator which regulates production of anthocyanin, the pigment responsible for red color in potatoes. Ethrel (ethephon) will be applied to potatoes at tuber set and evaluated for periderm color enhancement, yield, and storability. This experiment is also located in Hollandale, Minnesota. Detailed report will be found in Part III.

V. Onions.

A. Raised Bed Onion Production - Vincent Fritz

This study is designed to determine if there are any significant effects on yield or maturity from using raised beds for bulb onion production. Two varieties were included in the experiment. Detailed report will be found in Part III.

VI. Trees and Flowers

A. Antitranspirant Effects on Conifer Winter Burn - Bert Swanson

This study was designed to evaluate four different antitranspirant spray solutions for reduced winter burn on five species of conifer material. This study will be continued over several years. Data from this research is too preliminary to report.

B. NC-7 Regional Ornamental Plant Trials - Mark Widrlechner

This study is to observe plant material from different parts of the world for adaptability to the Minnesota climate. This is a continuous study started in 1959. Eight new introductions were introduced into the trial this year. Data from this research is too preliminary to report.

C. Chrysanthemum Variety Trial - Richard Widmer

The purpose of this study is to evaluate selected numbered lines for possible named release in Minnesota. Fourteen numbered lines will be evaluated this year. Three varieties are planned to be named and released in 1988.

1986 SOIL SCIENCE PROJECTS

G. W. Randall

SOIL SCIENTIST

SOUTHERN EXPERIMENT STATION

A. FERTILIZATION PROJECTS

1. Nitrogen

a. Rotation N - Gyles Randall, Pat Kelly, and Mike Russelle

A long-term experiment involving (1) C-C-C (grain removal only), (2) C_g-C_s (where every-other-year corn is removed as silage), (3) C-Sb, (4) C-C-Sb, and (5) C-W was initiated in 1974 to determine the N needs of corn which follows these crops in the respective rotations. Nitrogen rates for corn are 0, 40, 80, 120, 160, and 200 pounds N/A. Yield results from 1975 thru 1986 indicate 10-20% yield reductions when corn followed corn as compared to corn following soybeans or wheat. Optimum N rates for continuous corn (grain only) has been about 175 lb N/A while first year corn following soybeans or wheat requires only 140 and 120 lb N/A, respectively. A detailed report is contained in Part III.

b. Split Application of N - Gyles Randall and Pat Kelly

A study was initiated in 1985 to evaluate split applications of N on the N uptake and yield of corn. Total N rates were 0, 60, 120, and 180 lb N/A. For the split applications one-third of each N rate was applied as UAN and incorporated just prior to planting or applied as anhydrous ammonia (AA). The remaining 2/3 was sidedress applied at the 8-leaf stage as either UAN or AA. These split applications were compared to a single application of AA prior to planting. A detailed report is contained in Part III.

c. UAN Placement with Ridge Tillage - Gyles Randall and Chis Zadak, graduate research assistant

A study was initiated in 1985 to determine the effect of placement of UAN with and without S in a ridge tillage system. An additional objective was to evaluate ammonium thiosulfate (ATS) and ammonium sulfate (AS) as possible urease inhibitors to retard ammonia volatilization. Placement positions immediately after planting include (a) banded on the row, (b) banded between the rows, (c) broadcast, and (d) a split application where 40% was banded on the row after planting and the remaining 60% banded between the rows at the 6-leaf stage. Studies were located at the SES and in Goodhue Co. A detailed report is contained in Part III.

A. FERTILIZATION PROJECTS

1. Nitrogen (continued)

d. Nitrogen Sources for Conservation Tillage - Gyles Randall and Pat Kelly

A study was established in 1985 to evaluate various N sources applied preemergence to continuous corn grown with reduced tillage. Sources included AA, AS, UAN, AN and urea at rates of 75 and 150 lb N/A. Ridge tillage was the primary tillage in Goodhue Co. and at the Southern Experiment Station. A detailed report is contained in Part III.

e. Nitrogen Application Methods for Improved Efficiency in Ridge-Plant Tillage Systems - Gyles Randall and Bert Bock (TVA)

A cooperative study between the University of Minnesota and the National Fertilizer Development Center at TVA was initiated in 1986. Nitrogen was applied as UAN and AA to ridge-planted corn that followed either corn or soybeans. Application time ranged from preplant (PP) to split applications at the PP and 8-leaf or PP and 15-leaf stages. A point injector, sometimes called a spoke-wheel injector, was used to inject the UAN either directly into the ridge at planting or sidedressed into the row-middles. A detailed report is contained in Part III.

2. Decline Rates of Soil Test P and K in a Corn-Soybean Rotation - Gyles Randall and Sam Evans

High rates of P and K were applied over a 12-year period (1973-84) in studies at Waseca and Morris. These rates created a wide range of soil test values upon which the decline rates of soil test P and K can be followed when no additional fertilizer P and K are added. A detailed report is contained in Part III.

3. Starter Fertilizer Placement - Gyles Randall and Pat Kelly

Because more farmers appear to be returning to the use of starter fertilizers, usually liquid materials, numerous questions are being raised as to optimum placement in reduced tillage systems. Placement of higher rates too close to the seed could cause salt damage and/or ammonia toxicity resulting in slow emergence or poor stands. A study was started in 1985 to evalaute in-row and 2 x 2" placements of 10-34-0 and 7-21-7. Both materials were applied to corn at rates of 0, 5, 10 and 15 gal/A. In 1986, 9-18-9 was added as a third source. A detailed report is contained in Part III.

4. Soil Test Laboratory Comparisons - Gyles Randall and Pat Kelly

A project was initiated in the fall of 1979 to evaluate the soil test results and recommendations of four private testing laboratories and the

A. FERTILIZATION PROJECTS

4. Soil Test Laboratory Comparisons (continued)

public University of Minnesota Lab. Initial soil samples taken from two areas showed one site to be medium and the other high to very high in P and K fertility. Fertilizer rates recommended by each of the labs have been applied annually to plots at each site. A detailed report is contained in Part III.

5. Phosphorus Application Methods for Improved Efficiency in a Corn-Soybean Rotation - John Lamb, George Rehm, Gyles Randall and Wallace Nelson

The primary objective of this study initiated in the fall of 1985 is to evaluate the efficiency of various placement methods (2 x 2" row, broadcast, and subsurface band [6" deep]) of P fertilizer. The test crops are corn and soybeans at Waseca and Lamberton, and wheat and soybeans at Crookston. Annual application rates to these low testing soils are 0, 10, 20, 30 and 40 lb P/A. A detailed report of the Waseca information is contained in Part III.

B. TILLAGE PROJECTS

1. Conservation Tillage for Corn and Soybeans - Gyles Randall and Jim Swan

This study was initiated in 1974 to compare new conservation methods of tillage with some of the established practices. The five treatments have been: (1) no tillage, (2) fall moldboard plow, (3) fall chisel plow, (4) ridge planting, and (5) till-plant without ridging. All plots have been split to determine the effect of starter vs no starter fertilizer with reduced tillage. All tillage and fertilizer treatments remain the same except treatment 5 which is disked each spring rather than till-planted. A detailed report is contained in Part III.

2. Tillage Systems for Corn and Soybean Crop Sequences - Gyles Randall and Ray Allmaras

A study had been established on this Webster clay loam site in the fall of 1980 to determine the relationship between primary tillage and the incidence of corn and soybean diseases in continuous corn, continuous soybeans and a corn-soybean rotation. The tillage systems were fall moldboard plow (MP), fall chisel plow (CP), and no tillage (NT). After this 5-yr study was completed in 1985, the initial tillage plots and some of the monoculture plots were kept intact to take advantage of the past tillage and cropping history. Some of the monoculture plots were changed to a corn-soybean sequence so that there are now four cropping systems over each tillage system. The cropping systems are continuous corn, corn-soybean, soybean-corn, and continuous soybeans. A detailed report is contained in Part III.

B. TILLAGE PROJECTS

3. Soil Compaction - Ward Voorhees and Gyles Randall

A study was initiated in 1981 to determine the effect of extremely heavy axle loads on deep soil compaction. Axle loads of 0, 10 and 20 tons were applied to a Webster soil. The degree and depth of compaction and the amelioration by natural causes as well as V-subsoil chisel were measured on these plots planted to corn and soybeans annually. Corn yields in 1983 were reduced by 7 and 12% by the 10 and 20 ton axle loads respectively. Soybean yields in 1983 were reduced only by the 20 ton axle load treatment to 85% of the 0 ton axle load treatment yields. In 1984 soybean yields were reduced to a greater extent and corn yields to a lesser extent than in 1983. Corn yields were reduced slightly but soybean yields were not in 1985. Yields in 1986 were no longer affected by the 1981 compaction treatments. The west ½ of one of the 20 ton/axle treatments was subsoiled to a 15" depth in the fall of 1982, 1984 and 1985. Subsoiling did not improve 1983, 1984, 1985 or 1986 corn or soybean yields. This long-term study is part of an international effort coordinated in Minnesota by Ward Voorhees, USDA-ARS at Morris. Data from this research are not being reported herein.

4. Tillage and P and K Placement - George Rehm and Gyles Randall

The purpose of this study is to evaluate the placement of P and K on production of corn and soybeans in rotation as affected by tillage and soil test levels. P and K were first applied in the fall of 1983 at rates of 0, x, 1.5x and 10x where x = 370 lb/A of 4-12-24. The x and 1.5x rates were either broadcast, dribbled or banded and the 10x rate was deep banded 12 inches below the row or between the row. Superimposed over these fertilizer treatments is the application of 0 or 100 lb of 7-21-7 liquid starter fertilizer applied in a 2" x 2" band. These fertilizer treatments are being evaluated under chisel and ridge tillage systems. The project leader is Dr. George Rehm, Department of Soil Science. A detailed report is contained in Part III.

5. Tillage Systems for Corn in a Corn/Soybean Management Study - William Lueschen, John Moncrief and Gyles Randall

As part of an ongoing corn/soybean management study, a new study was established in the fall of 1985 to determine the effect of tillage following soybeans on corn production; specifically, yield, the N requirements of corn, and the performance of five different corn hybrids. The tillage systems evalauted are: (1) continuous no tillage (NT), (2) continuous paraplow, (3) continuous ridge-tillage, (4) NT following soybeans/chisel plow (CP) following corn, and (5) CP following soybeans and moldboard plow following corn. Nitrogen was spring-applied as anhydrous ammonia at 0, 40, 80, 120, 160 and 200 lb N/A. A detailed report is contained in Part III.

C. ENVIRONMENTAL PROJECTS

1. Nitrogen Movement into Underground Drainage Systems as Influenced by Tillage - Gyles Randall and Pat Kelly

In the fall of 1981 two primary tillage treatments (moldboard plow and no tillage) were established on eight tile plots. Nitrogen (ammonium nitrate) was spring-applied to all plots at a rate of 180 lb N/A. Samples from the tile water, soil to a depth of 8', corn leaves, silage, and grain along with corn silage and grain yields were taken to determine the effect of tillage for continuous corn on N efficiency and movement. Detailed report is contained in Part III.

2. Pesticide Movement into Tile Drainage Water as Affected by Tillage - Gyles Randall

Water samples were taken from the 1986 tile flow and were analyzed immediately for the pesticides of concern. Data from this research are too preliminary to report.

3. Nutrient Movement and Uptake Traced by 15-N - Gyles Randall and Roland Hauck (TVA)

A nitrogen balance study with depleted 15-N to determine the movement of fertilizer N into tile drain systems was physically installed in 1976. N treatments were applied beginning in the fall of 1976. Treatments ranged from 0 to 240 lb N/A and were fall, spring or side-dress-applied. Continuous corn has been grown on 30 of the isolated plots (3 reps and 10 treatments), soybeans have been grown continuously on 3 isolated plots, and a corn-soybean sequence has been grown on the remaining 3 plots. Nitrogen traced with 15-N has been determined in the tile waters, small plants, stalks, leaves and grain at maturity and soil during the season. In 1985, N (120 lb N/A) was broadcast applied to the experimental area to erase the past history so as to obtain uniformity among the plots. Corn and soybeans were grown in 1986 to start a crop rotation for a new study to be initiated in 1987. This has been a cooperative project between TVA and the University of Minnesota. Data from this research are not being reported herein.

4. Nitrogen Sources and Rates for Continuous Corn in Goodhue Co. - Gyles Randall and Pat Kelly

The purpose of this study initiated in 1985 was to determine the influence of various N sources and N rates on corn production and residual soil NO_3-N remaining in the soil profile in a well drained silt loam soil. Nitrogen was spring-applied as ammonium nitrate, ammonium sulfate, urea, and urea-ammonium nitrate solution at rates of 0, 60, 120, 180 and 240 lb N/A. A detailed report is contained in Part III.

C. ENVIRONMENTAL PROJECTS

5. Water Quality Investigations in Southeastern Minnesota - Gyles Randall, Pat Kelly and Jim Anderson

Sites were established in Olmsted, Winona and Goodhue Counties to pursue the effects of agricultural chemical management (N fertilizer and pesticides) on the occurrence of these chemicals in the groundwater. These studies will be conducted over the next 5 years and will be coordinated by the Center for Agricultural Impacts on Water Quality on the St. Paul Campus. Preliminary data are not reported herein.

6. Acid Rain Measurements - Sagar Krupa

A study was initiated in 1983 as part of a state-wide study to monitor the source and extent of SO_2 fallout in Minnesota. Daily measurements are made of aerosol and gaseous concentrations of SO_2 as well as precipitation pH and SO_2 concentration. Alfalfa serves as an indicator crop to measure the isotopic ratio of S^{32}/S^{34} in the atmosphere to fingerprint the source of SO_2 emissions to the atmosphere. Dr. Krupa, Department of Plant Pathology, serves as project leader. Data from this research are not being reported herein.

D. WEATHER

1. Climatological Data Measurements - Don Baker, Mark Seeley and Gyles Randall

Every day at 8:00 A.M. a series of weather measurements are recorded at the Southern Experiment Station. Data gathered throughout the year include max and min air temperatures, max and min soil temperatures at 2, 4, 8 and 20", precipitation, wind movement and solar radiation. In addition, summer measurements include evaporation and water temperatures while winter measurements include snow depth and frost depth. A new addition to the weather station is an automatic recording system which records nine weather parameters on an hourly basis 24 hours a day. This system has been installed and is supervised by Mark Seeley. All data are compiled and sent to Dr. Baker and the National Weather Service. The data are published in CLIMATOLOGICAL DATA with a local mailing available upon request. Also, the data are entered weekly into the University computer bank for access and use by research and extension personnel. A detailed annual summary is contained in Part III.

2. Soil Moisture - Don Baker, Mark Seeley and Gyles Randall

A continuous monitoring of soil water was conducted again this year on a bimonthly basis. Neutron access tubes are being installed to aid in this determination. All data are sent to Dr. Baker as part of his soil water network. Data from this research are not being reported herein.

E. AERIAL PHOTOGRAPHY

1. Crop Monitoring by Infrared Imagery - Gyles Randall, Richard Anderson and Pat Kelly

Crop and soil conditions were monitored in late July via infrared and true color photography. The purpose is to 1) identify factors which may be negatively affecting our crop yields, i.e., drainage, disease, weeds, fertility, 2) assist in the interpretation of aerial photos by providing ground-truth information, and 3) provide a permanent record of crop and field conditions for 1985. Mr. Bill Johnson of the Remote Sensing Lab serves as project cooperator. No data were collected from this research activity.

1986 Elite Corn Hybrid Trial

J. L. Geadelmann, R. H. Peterson, B. M. Greenwald and W. E. Lueschen

The primary objective of these tests is to provide some information on the relative performance of approximately 70 field corn hybrids that were newly registered for sale in Minnesota for the 1986 season. The other 100 hybrids were previously registered for sale. Because the data are limited to only two locations and one year for a group of hybrids, this information should be used only as a guide to choosing some new hybrids for additional evaluation, e.g. in strip tests or on a few acres. These data alone are NOT sufficient for making decisions for large-scale commercial use.

Seed of all registered hybrids was requested from seed companies, and hybrids for which seed was obtained were included in these tests. Several additional hybrids were included for comparative purposes. No entry fee was requested to offset expenses incurred in these trials. The presence or absence of any data in these tests does NOT constitute a warranty for or against that hybrid.

The newly-registered hybrids were tested in the maturity zone for which they are relatively full-season according to the Minnesota Relative Maturity (RM) assigned by their owners. Hybrids rates 105-115 RM were tested at Lamberton and Waseca. Other hybrids included varied in their RM ratings. When comparing hybrids, the RM rating should be considered since yield potential may be influenced by RM ratings.

Management information for each location is summarized below. Row spacing at all locations was 30 inches. Plot size was two 30-inch rows, 22 feet long. Plots were planted and harvested by a modified planter and combine. Three replications were conducted at each location. Data given in the following tables are:

H_2O = % grain moisture at harvest
YLD = shelled grain yield in bushels per acre at 15.5% moisture
BS = % stalks broken below ear
RL = plants root lodged (leaning more than 30 degrees from vertical
STAND = number of plants per acre at harvest
RM = Minnesota Relative Maturity rates assigned by the owner of the hybrid. RM of newly registered hybrids is subject to change. NR indicates the hybrid was not registered for sale in Minnesota in 1986.

Management Information Summary:

Southwest Experiment Station, Lamberton: Previous Crop: Soybeans; Primary Tillage: Fall chisel plow (Soilsaver); Fertilizer: 210 lb/A N full anhydrous + 50 lb/A N as urea spring sidedress; Herbicide: Eradicane (2.5 lb/A) + Bladex (1.5 lb/A) PPI, Lasso (3 lb/A) Pre-emergence; Planted May 12 and Harvested October 15.

Southern Experiment Station, Waseca: Previous Crop: Soybeans; Primary Tillage: Fall paraplow; Fertilizer: 150 lb/A N spring anhydrous; Herbicide: Lasso (3.5 lb/A + Atrazine (1.5 lb/A) + Bladex (1.5 lb/A) preemergence; Planted May 6 and Harvested October 24.

1986 University of Minnesota Corn Breeding
Expt.341 - Late Hybrid Test

Brand - Variety	RM	Lamberton H20 %	Lamberton YLD bu.	Lamberton BS %	Lamberton STAND	Waseca H20 %	Waseca YLD bu.	Waseca BS %	Waseca RL %	Waseca STAND
AMERICAN 4040	105	28.3	156	1	22308	23.8	118	1	0	17424
AMERICAN 5050	105	28.3	164	2	23760	23.7	129	2	0	21120
BETASEED-HEIDI	105	29.3	197	0	23760	22.6	139	1	0	23100
BETASEED-EXP.446	105	26.8	196	1	23628	21.6	122	0	0	23496
CARGILL 893	115	31.9	195	1	24024	27.1	153	1	0	24024
CENEX 2107	110	30.9	188	3	23364	23.4	151	0	0	23100
CENEX 2110	110	32.2	217	1	22968	26.7	150	1	1	20724
CROWS 203	105	29.3	179	2	22704	22.6	129	4	0	23364
CROWS 446	115	27.6	200	0	23892	25.7	175	0	0	23232
CROWS 488	115	30.5	202	1	23364	25.8	206	2	5	23364
CUSTOMAIZE E94014	105	26.2	185	0	23364	22.8	152	0	1	23496
DAHLGREN DC515	105	25.3	172	0	23364	22.0	131	0	2	22836
DAIRYLAND DX1006WX	105	29.5	191	2	23364	22.7	162	1	0	24288
DEKALB-PFIZER DK547	105	27.9	196	1	23760	23.7	167	0	0	23760
DEKALB-PFIZER DK572	110	31.4	216	1	24024	24.8	161	3	3	23364
FOUR STAR 5480	105	27.0	175	0	23892	21.8	134	1	4	22968
FUNKS 4093X	115	32.9	191	1	23628	25.2	154	0	2	22176
GEORGE'S MS108	110	30.6	188	1	23364	24.4	166	0	1	22176
GEORGE'S 6103	105	26.6	166	0	22572	22.2	142	1	1	21648
GEORGE'S 6104	105	24.2	201	2	23100	20.6	128	0	0	22836
GEORGE'S 6105	110	26.1	182	3	23628	21.9	160	2	0	24156
GEORGE'S 6107	110	31.7	176	1	23232	25.1	126	1	4	22044
GEORGE'S 6108	110	32.4	210	1	23232	25.6	162	1	2	22308
GOLDEN HARVEST H2486	110	29.4	211	1	23496	23.0	183	1	1	23760
GOLDEN HARVEST H2465	110	31.3	211	0	24156	25.3	158	2	0	24024
GOLDEN HARVEST EX666	105	23.8	186	2	23364	21.9	121	0	0	22968
GREEN FIELD 6109	110	31.8	181	0	23496	24.5	145	1	2	21912
GREEN FIELD 6105	105	27.2	163	1	21120	22.3	140	0	0	21516
GROWMARK FS2243	105	24.1	180	0	22968	20.7	140	1	0	24288
HOEGEMEYER SX2566	105	25.4	194	1	23628	21.8	160	1	0	23892
JUNG 2660	110	27.7	186	1	22968	23.2	132	1	0	23892
JUNG 1700	110	27.4	181	1	23760	23.3	141	0	0	22044
KALTENBERG KX60	105	25.1	185	1	23364	21.9	128	2	1	23628
KALTENBERG KX64	110	30.7	202	1	23100	26.3	166	2	1	22572
KELTGEN KS1010	105	24.9	182	0	23100	20.5	127	0	1	22836
KING GRAIN K596	115	29.0	205	1	23628	26.6	170	1	2	23232
KING GRAIN K4422	105	26.0	186	1	23628	22.8	153	1	1	22440
KING GRAIN K4464	105	30.6	160	0	23760	24.5	164	1	0	23892
KING GRAIN K4484	110	31.2	191	1	24024	23.8	169	0	1	23892
KING GRAIN K5574	110	31.0	208	1	23760	25.8	152	2	0	23100

1986 University of Minnesota Corn Breeding
Expt.341 - Late Hybrid Test

Brand - Variety	RM	Lamberton H20 %	YLD bu.	BS %	STAND	Waseca H20 %	YLD bu.	BS %	RL %	STAND
MCCURDY 4737X	105	25.3	190	1	22968	21.6	149	0	0	23232
MOEWS WM2260	105	30.9	186	1	23496	23.1	150	1	1	23232
MOEWS SM2360	105	27.9	185	0	23760	22.9	140	0	1	24288
MOEWS SM3135	110	31.2	198	1	24024	25.9	153	1	2	23760
MOEWS WM3150	110	32.1	186	0	24024	27.1	154	0	0	22968
MOEWS SM3160	110	29.3	188	1	23892	23.7	148	1	0	23232
NORTHRUP KING PX9345	105	25.2	170	0	24024	21.6	119	0	0	22836
P.A.G. SX269	115	31.8	188	0	24024	26.4	175	0	1	21648
PAYCO 3X784	105	30.4	184	1	22704	23.5	151	1	0	23892
PAYCO SX844A	110	25.9	184	2	23496	23.4	148	1	0	23100
PAYCO SX851	110	29.5	180	0	23364	24.1	130	0	1	23364
PAYCO SX912	115	34.3	202	0	23892	28.2	193	0	2	23760
PAYMASTER X191501	105	27.3	167	3	22968	23.6	127	1	0	23364
PAYMASTER X130409	110	31.1	213	1	24288	26.0	166	1	1	23628
PIONEER XC231	105	24.4	184	0	24420	21.5	146	0	0	23364
PIONEER XC346	105	23.6	201	0	24024	22.7	149	1	1	22968
PIONEER XC548	115	31.9	199	0	23892	25.6	157	0	1	22968
PRIDE 5556	110	30.8	178	1	22440	24.0	151	0	0	23628
PRIDE 6656	115	28.9	183	0	21648	24.1	141	0	4	24024
RAMY R4052	110	28.3	187	1	24024	24.8	159	1	0	23628
RAMY R4080	110	31.0	216	2	24024	27.0	146	1	1	23496
RENK RK26	105	30.5	181	1	23100	24.9	146	1	0	22836
SAR SX4804	110	26.3	180	2	23760	22.7	138	0	0	22572
SAR SX5100	115	31.6	206	2	23892	25.2	164	1	1	23232
SEED TEC ST5900CN	110	28.5	182	1	23100	23.3	135	1	0	22704
SEED TEC KX66	115	28.4	196	1	23760	27.8	160	0	7	23496
SEED TEC KX6800	115	31.3	214	3	24024	25.8	154	1	1	24156
SOKOTA 681A	110	28.2	193	3	23364	24.0	153	1	3	23364
TRELAY 6020	110	26.7	192	0	23232	23.2	161	0	0	23760
TRELAY 7020	115	29.5	205	1	24552	23.5	170	1	0	23760
ASGROW 1170A	110	32.7	180	1	23496	25.5	171	0	0	23628
ASGROW 2230	85	19.6	155	1	23496	18.3	129	1	0	22968
ASGROW 2330	105	24.2	177	2	23232	20.2	136	0	1	23364
ASGROW 2450	110	32.6	190	0	23760	24.3	164	1	1	24552
ASGROW 6880	105	26.6	182	1	23628	21.4	154	1	0	23760
ASGROW RX480	100	26.0	182	2	23232	20.3	151	0	0	23364
ASGROW RX532	105	26.8	191	3	23100	21.1	141	1	0	22440
ASGROW XP5656	NR	27.7	183	0	23232	23.1	147	0	0	23496
AGVENTURE 307	100	25.5	182	2	23496	19.9	115	2	0	23100
AGVENTURE 350	105	27.6	175	1	23628	22.9	151	1	1	23232

1986 University of Minnesota Corn Breeding
Expt.341 - Late Hybrid Test

Brand - Variety	RM	Lamberton H20 %	Lamberton YLD bu.	Lamberton BS %	Lamberton STAND	Waseca H20 %	Waseca YLD bu.	Waseca BS %	Waseca RL %	Waseca STAND
AGVENTURE 403	110	25.6	182	2	24024	22.7	168	0	3	23892
AGVENTURE 410	110	32.4	201	2	23364	26.0	161	1	1	23892
AGVENTURE 504	110	32.5	188	0	23892	26.6	173	0	2	24024
AGVENTURE X5012	NR	29.4	187	2	24024	21.9	145	1	1	22836
AGVENTURE X6029	NR	27.8	187	0	24420	24.5	171	2	1	23760
AGVENTURE X6030	100	25.8	188	3	23892	21.3	154	1	1	23892
CARGILL 842	100	27.2	193	1	23628	20.8	145	1	1	23364
CARGILL 859	100	26.7	187	6	24156	19.8	144	2	1	23628
CARGILL 871	105	29.6	183	1	23496	22.1	165	2	1	22968
CARGILL 889	115	29.1	182	2	23892	23.1	152	1	8	23364
CARGILL 918	120	35.3	191	2	22836	28.7	189	1	4	22704
CARGILL 4167	NR	28.8	174	1	23760	22.3	150	2	1	22572
CARGILL 6377	NR	32.9	184	0	24024	26.8	188	0	2	23496
CARGILL 130409	NR	32.1	208	1	24156	24.4	177	1	3	23364
CENEX 2096	95	23.1	178	1	24288	20.6	125	2	2	23496
CENEX 2098A	100	22.2	177	3	23892	21.8	153	0	1	22308
CENEX 2100	100	24.5	189	1	23628	22.8	151	2	0	23364
CENEX 2106	105	25.4	180	2	23628	20.7	139	0	0	22836
CENEX 2108	110	29.0	171	3	23496	23.0	150	2	0	24024
CUSTOMAIZE 3759WX	95	25.9	167	2	22968	19.9	119	1	0	23364
CUSTOMAIZE 4002	100	22.2	179	1	23628	21.0	166	0	4	23100
CUSTOMAIZE 5753WX	110	31.4	190	1	24288	23.4	161	2	0	23760
CUSTOMAIZE 5801	110	33.1	176	1	22440	24.0	177	1	3	23496
CUSTOMAIZE 6203	110	31.5	202	0	24156	24.3	174	0	1	22968
DEKALB-PFIZER 484	100	28.7	185	3	23232	21.6	146	0	0	23364
DEKALB-PFIZER 524	105	27.2	202	1	23892	21.2	172	1	0	23628
DEKALB-PFIZER 498	105	26.9	188	0	23496	21.5	154	0	0	23496
P.A.G. 5157	90	28.5	193	1	24024	21.5	149	2	0	23628
FUNKS G4100	90	22.5	166	1	23628	18.9	136	0	0	23364
FUNKS G4211	95	24.8	156	2	22704	21.2	117	1	0	22176
FUNKS G4312	105	26.0	175	2	22968	19.9	154	1	1	23628
FUNKS G4326	105	29.3	165	1	23496	21.5	163	1	1	23892
FUNKS G4327	105	26.5	171	2	23496	21.1	164	0	1	24552
GARST 8702	110	26.4	189	1	22968	22.0	160	0	1	23892
GARST 8750	105	26.2	175	0	23628	21.3	166	1	0	23760
GARST 8808	100	24.0	172	1	23760	19.8	138	0	0	23760
GARST 8882	95	24.4	186	1	23628	19.9	156	1	0	24156
GARST 8912	95	22.7	174	1	23496	19.7	136	1	0	22968
KELTGEN KS89	90	20.9	161	1	23232	18.2	136	0	0	22440
KELTGEN KS95	100	24.8	180	1	23628	20.7	152	0	1	23628

1986 University of Minnesota Corn Breeding
Expt.341 - Late Hybrid Test

		Lamberton				Waseca				
Brand - Variety	RM	H20 %	YLD bu.	BS %	STAND	H20 %	YLD bu.	BS %	RL %	STAND
KELTGEN KS1050	105	25.9	181	0	23364	21.0	162	0	0	23628
KELTGEN KS1090	110	32.2	204	0	24420	25.0	165	0	0	23760
PAYCO SX500	90	21.2	169	1	22836	18.7	123	0	0	23232
PAYCO SX611	100	25.7	189	4	23364	20.5	162	1	1	23628
PAYCO SX710	110	26.4	177	2	24156	22.0	174	0	0	24684
PAYCO SX750	105	29.8	186	0	23628	23.4	166	0	2	24024
PAYCO SX788	105	29.0	181	1	23496	21.9	161	0	0	23892
PAYCO EXP.SX613	NR	25.5	184	1	23628	20.0	141	0	1	23892
PAYCO EXP.SX790	NR	29.6	182	2	23628	23.5	150	0	0	23100
PIONEER 3704	NR	26.3	185	1	24288	20.0	152	1	0	23628
PIONEER 3732	105	27.1	178	2	23760	21.2	143	2	0	23760
PIONEER 3737	100	24.3	188	3	23628	19.6	148	0	1	24024
PIONEER 3790	95	21.8	177	1	24024	18.8	140	0	0	23496
SOKOTA 270	95	20.5	167	0	23496	18.9	106	1	0	23628
SOKOTA 560	100	25.4	174	2	22836	21.1	116	1	1	22572
SOKOTA 580	105	27.2	185	1	23364	21.8	137	0	0	23100
SOKOTA 644	110	29.6	181	0	23364	22.9	152	0	0	23628
SOKOTA 680	110	31.7	208	1	24024	25.9	164	0	6	23496
STAUFFER X209	NR	21.4	165	4	23232	18.8	116	0	1	22308
STAUFFER S3303	95	22.1	185	5	23496	17.8	151	1	0	23100
STAUFFER S4502	100	25.0	178	1	22836	19.4	137	2	2	23628
STAUFFER S5430	110	31.5	205	0	22968	24.6	170	0	4	23892
STAUFFER S5750	105	27.1	186	0	23232	23.0	165	1	0	22440
SUPERCROST 1940	100	24.8	186	2	24156	21.1	140	1	1	23232
SUPERCROST 1989	100	24.6	185	2	23364	19.5	127	1	0	23496
SUPERCROST 2410	105	29.1	182	2	23496	22.8	149	0	1	23760
SUPERCROST 2989	110	32.2	202	1	23760	24.8	175	0	0	23364
SUPERCROST 3030	110	27.2	184	2	23892	22.1	156	0	1	24024
GUTWEIN 2045	90	19.0	150	2	23100	17.5	132	0	0	23496
GUTWEIN 2055	95	21.6	199	2	23760	19.2	136	0	0	23892
GUTWEIN 2151	95	26.5	173	1	22968	21.6	137	0	0	23232
GUTWEIN 2188	95	27.7	181	2	24816	21.2	172	0	0	24024
GUTWEIN 2207	105	32.5	185	0	23364	24.0	160	1	0	23232
GUTWEIN 2321	NR	26.4	175	1	23892	21.4	150	0	1	23628
GUTWEIN 2424	110	31.3	206	0	24288	24.2	180	1	0	24420
TOP FARM TFSX104	105	25.0	178	8	23760	20.6	136	1	1	21252
TOP FARM TFSX104A	105	30.0	181	1	22176	22.4	162	0	0	22968
TOP FARM TFSX1099	100	25.5	163	1	23100	21.2	132	0	1	21912
TOP FARM TFSX1100	100	25.2	176	2	23232	19.5	132	1	0	23364
TOP FARM EXP.85094	NR	23.6	166	2	23100	18.8	124	1	0	23232

1986 University of Minnesota Corn Breeding
Expt.341 - Late Hybrid Test

Brand - Variety	RM	Lamberton H20 %	Lamberton YLD bu.	Lamberton BS %	Lamberton STAND	Waseca H20 %	Waseca YLD bu.	Waseca BS %	Waseca RL %	Waseca STAND
DEKALB DK447	100	25.2	175	2	24024	21.4	149	2	0	22572
PAYMASTER SC2900	105	28.7	191	1	23760	22.8	128	0	1	22440
FUNKS 3046X	110	32.2	179	2	23100	25.2	176	1	4	22572
VIKING 4240	105	31.7	193	1	23628	24.0	172	0	1	23232
GOLDEN HARVEST EX777	90	22.8	190	1	24024	18.9	147	1	0	23364
GOLDEN HARVEST H2300	100	23.2	188	2	23364	20.1	167	0	1	23100
GOLDEN HARVEST H2344	100	24.3	208	1	23892	19.6	150	1	1	23760
GOLDEN HARVEST H2418	105	24.8	189	1	24024	21.0	134	0	0	21384
GOLDEN HARVEST H2452	110	26.2	196	1	23232	22.4	177	0	1	23628
SUNRISE EX1110	110	31.6	197	1	23760	25.5	160	0	2	22440
SUNRISE SR1050	110	28.0	184	2	23364	21.7	178	1	1	23892
MEAN		27.7	185	1	23546	22.7	151	1	1	23385
C.V.(%)		4.0	5.3	122	3.0	5.2	12.3	200	216	4.1
LSD(.05)		2.6	23	4	1650	2.8	43	3	4	2585

B. Six Year Corn/Soybean Rotation Study-R. Kent Crookston, Harlan Ford, Bill Lueschen and Jim Kurle.

Objectives

The short term (6-year) rotation studies were established to supplement the long term (10-year) rotation studies planted at Waseca and Lamberton. This study consists of rotation sequences which are not present in the long term study. It is planted at Lamberton, Rosemount and Waseca.

Procedures

Corn hybrid, P3780, and soybean variety, Hodgson 78, were planted at all locations. The treatment arrangement at all locations is given in Table 1.

Lamberton - The plots were chisel plowed in the fall. Fertilizer consisted of 125#/A N as urea side dressed on the plots. No P or K was applied. Herbicide application consisted of Lasso (2.5#/A) and Lorox(1.5#/A) applied preemergence. The plots were planted 12 May 1986 and harvested 17 October 1986.

Rosemount - The plots were chisel plowed in the fall. 160#/A N was applied as ammonium nitrate to plots where corn was planted. No P or K was applied. Lasso (2.5#/A) was applied preemergence. Basagran (1#/A) was applied postemergence. Counter was applied as insecticide at a rate of 8 oz/1000 ft. of row. The study was planted 23 May 1986 and harvested 10 October 1986.

Waseca - The plots were chisel plowed in the fall. 175#/A of N as urea was applied to plots where corn was planted. No P or K was applied. Lasso (3.5#/A) and Lorox (1.5#/A) were applied preemergence. Basagran and oil (1#/A and 1qt/A) were applied for postemergence weed control. Furadan was applied as insecticide at a rate of 8 oz/1000 feet of row.

Results

Yield results in 1986 (Table 2) were inconsistent. At Lamberton both corn and soybeans benefited from rotation. Corn in rotation or following soybeans yielded 34% higher than continuous corn. Soybeans following corn yielded 14 more than continuous soybeans.

At Rosemount corn following soybeans yielded 9% more than continuous corn. Corn planted in alternate years with soybeans yielded 7% more than continuous corn. However, soybeans grown after two years of corn yielded 5% less than continuous soybeans.

At Waseca both corn and soybeans yielded less when grown in rotation than when grown continuously. Corn yielded 2% less grown after two years of soybeans and 11% less when grown in rotation with soybeans. Soybeans yielded 20% less when grown after two years of corn than when grown continuously.

Table 1. Planting sequence of 6 year rotation study at all locations; Lamberton, Rosemount, and Waseca.

Treatment #	84	85	86	87	88	89
			Year			
1	C	C	S	C	C	S
2	C	C	C	C	C	C
3	S	S	S	S	S	S
4	C	S	C	S	C	S
5	S	S	C	S	S	C

Table 2. Yields obtained after two years of the six year rotation study.

Rotation	Rosemount Bu/A	Rosemount % of C-C-C	Lamberton Bu/A	Lamberton % of C-C-C	Waseca Bu/A	Waseca % of C-C-C
C-C-C	167.0	100	136.5	100	137.7	100
C-S-C	178.9	107	183.0	134	122.0	89
S-S-C	167.0	109	183.1	134	134.2	98
	Bu/A	% of S-S-S	Bu/A	% of S-S-S	Bu/A	% of S-S-S
S-S-S	42.4	100	36.6	100	44.9	100
C-C-S	40.4	95	41.8	114	35.9	80

I)Corn Soybean Rotations - Six Year and Ten Year Studies

A. Ten Year Corn/Soybean Rotation - R. Kent Crookston, Harlan Ford, Bill Lueschen, and Jim Kurle.

Objectives

The long term effect of various rotations of corn and soybeans has not been investigated. The objective of this study is to determine the effects of rotation for periods of one to five years of corn or soybean rotation. The results will be compared to continuous corn and soybeans.

Procedures

The design of this study consists of 16 treatments arranged in a randomized complete block design replicated four times. Treatment organization appears in Table 1. The sixteen treatments are:

1) 1 to 5 years of corn following 1 to 5 years of soybeans.

2) 1 to 5 years of soybeans following 1 to 5 years of corn.

3) Continuous corn.

4) Continuous corn (hybrids rotated).

5) Continuous soybeans.

6) Continuous soybeans (variety rotated).

7) Corn/soybean and soybean/corn in alternate years.

An accompanying study of corn and soybean rotations will continue for six years and provide information on rotation cycles not contained in the ten year study. Beginning in 1985 all soybean plots were evaluated for the presence of several plant diseases. The occurrence of brown stem rot appeared to be closely related to the rotation cycle applied to a plot. The results of these observations appear in notes following the discussion of this study.

Waseca - The entire area was moldboard plowed in the fall of 1985 and field cultivated in the spring of 1986. Fertilization consisted of 175#/A N as urea to corn on corn plots and 150#/A N as urea to corn on soybeans. No P or K was applied. Herbicide application consisted of Lasso (3.5#/A) and Lorox (1.5#/A) applied preemergence. Basagran was applied for postemergence weed control. Counter was applied at a rate of 8 oz/ 1000 feet of row. All plots were planted on 5 May 1986. Corn plots were harvested on 1 October 1986 and soybean plots were harvested on 29 September 1986.

Lamberton - The entire area was paraplowed in the fall of 1985 and disked in spring of 1986. Fertilizer consisted of 125#/A of urea applied as sidedressed application. No P or K was applied. Herbicide application consisted of Lasso (3#/A) and Lorox

(1.5#/A) applied preemergence and Basagran and oil (1# + 1 qt/A) applied postemergence. All plots were planted on 12 May 1986. Corn was harvested on 10 October 1986 and soybeans were harvested on 17 October 1986.

Results and Discussion

The study is arranged so that a cycle of rotations is considered complete after five years. The first complete sequence of rotations was obtained at Lamberton in 1985. Each subsequent year yields results containing all rotations in a full five year sequence (Table 1). Because the study began a year earlier at Lamberton than at Waseca, two years results are available for Lamberton and only one year for Waseca. Only 1986 results are presented here.

On average corn has benefited from rotation with soybeans either in an alternate year rotation (C-S-C-S-C) or in the first year after soybeans (S-S-S-S-C). Planting corn continuously for two to five years reduced yields (Table 2). However, the effect of continuous corn was not consistent. For example the average yield reduction of the 5 continuous corn rotations compared to the two corn/soybean rotations (C-S-C-S-C and S-S-S-S-C) was 32% at Lamberton in 1986 compared to 9% at Lamberton in 1985 and 8% at Waseca in 1986. In addition in 1986 at Waseca the alternate corn/soybean rotation (C-S-C-S-C) yielded no better than any of the cycles consisting of two to five years of continuous corn. It is also interesting to note that the longest continuous period of corn (C-C-C-C-C) does not produce the greatest reduction in yield. Instead in two years of the study (Lamberton 1986 and Waseca 1986) it has produced the highest yields of the 5 planting cycles where corn follows corn. Rotation of hybrids has not increased yields.

Soybeans also benefited from rotation in the three five-year rotation cycles completed. When the results of the two 1986 rotation cycles are averaged together, Hodgson 78 yields 18% higher when grown in rotation than when grown continuously from two to five years (Table 3). The yield increase was more pronounced for first year soybeans than soybeans alternated with corn (130% vs. 112%).).

The response of BSR101, a brown stem rot resistant variety, to various rotations was not consistent (Table 4). At Lamberton in 1986 the alternate year corn and soybean sequence and first year of soybeans following four years of corn did not yield significantly better than any of the continuous cropping cycles. At Waseca in 1986, first year soybeans yielded significantly higher than all treatments except 2 years of corn followed by three years of soybeans. The alternate year rotation was not significantly different.At Waseca yields did not appear to be related to the amount of brown stem rot present in Hodgson 78 plots. However, the two BSR101 rotations showing the least brown stem rot also were the highest yielding plots (Table 5).

Table 1. Treatments applied to plots in ten year rotation study.

Sequence of plot treatments (at Lamberton; Waseca is year behind i.e. 84 treatment is applied in 1985.)

	Year									
Treatment #	81	82	83	84	85	86	87	88	89	90
1	C	C	C	C	C	SB	SB	SB	SB	SB
2	SB	C	C	C	C	C	SB	SB	SB	SB
3	SB	SB	C	C	C	C	C	SB	SB	SB
4	SB	SB	SB	C	C	C	C	C	SB	SB
5	SB	SB	SB	SB	C	C	C	C	C	SB
6	SB	SB	SB	SB	SB	C	C	C	C	C
7	C	SB	SB	SB	SB	SB	C	C	C	C
8	C	C	SB	SB	SB	SB	SB	C	C	C
9	C	C	C	SB	SB	SB	SB	SB	C	C
10	C	C	C	C	SB	SB	SB	SB	SB	C
11	C	C	C	C	C	C	C	C	C	C
12	SB	SB	SB	SB	SB	SB	SB	SB	SB	SB
13	C	SB	C	SB	C	SB	C	SB	C	SB
14	SB	C	SB	C	SB	C	SB	C	SB	C
15*	C	C*	C	C*	C	C*	C	C*	C	C*
16*	SB	SB*	SB	SB*	SB	SB*	SB	SB*	SB	SB*

* Alternate hybrid or variety.

	Regular	Alternate
Corn	Pioneer 3780	Pioneer 3732
Soybeans	Hodgson78	Corsoy 79

Table 2. Long Term Rotation Study - Corn (P3780) Yields - 1986

Rotation Sequence	Lamberton 1986 Bu/Acre	% of CCCCC	Waseca 1986 Bu/Acre	% of CCCCC	Mean of Locations Bu/Acre	% of CCCCCC
CCCCC	134.2b	100	118.5b	100	126.4	100
CCCCC*	133.0**	99	109.2b	92	121.1	96
SCCCC	126.8bc	95	111.7b	94	119.3	94
SSCCC	125.5bc	94	107.3b	91	116.4	92
SSSCC	120.0c	90	109.2b	92	114.6	91
SSSSC	173.1a	129	131.1a	111	152.1	120
CSCSC	169.5a	126	108.9b	92	139.2	110
$\bar{X}$	139.5		114.3		126.5	
LSD	10.3		12.5			

*Alternate hybrids

**P3732

Yields followed by same letters are not significantly different by anova over same site and year.

Table 3. Long Term Rotation Study - Soybean(Hodgson) Yields 1986

Rotation Sequence	Lamberton 1986 Bu/Acre	Lamberton 1986 % of SSSSS	Waseca 1986 Bu/Acre	Waseca 1986 % of SSSSS	Mean of Locations Bu/Acre	Mean of Locations % of SSSSS
SSSSS	37.4c	100	35.2cd	100	36.3	100
SSSSS*	36.5*	98	32.4d	93	34.4	95
CSSSS	34.8c	93	31.7d	90	33.3	92
CCSSS	37.4c	100	41.0b	116	39.2	108
CCCSS	38.7bc	104	38.8bc	110	38.8	107
CCCCS	47.7a	128	47.31a	134	47.5	131
SCSCS	43.0ab	115	38.6bc	110	40.8	112
$\bar{X}$	39.4		37.9		38.7	
LSD	10.3		12.5			

*Alternate varieties: At Lamberton the alternate variety, Corsoy, was grown in 1986.

Yields followed by same letters are not significantly different by anova over same site and year.

Table 4. Long Term Rotation Study - Soybean(BSR101) Yields - 1986

Rotation Sequence	Lamberton 1986 Bu/Acre	% of SSSSS	Waseca 1986 Bu/Acre	% of SSSSS	Mean of Locations Bu/Acre	% of SSSSS
SSSSS	49.7a	100	45.3bc	100	47.5	100
SSSSS*	44.5a	90	43.6c	95	44.1	92
CSSSS	44.7a	90	44.4bc	98	44.6	94
CCSSS	48.4a	97	48.2ab	106	48.3	102
CCCSS	45.3a	91	45.1bc	100	45.2	98
CCCCS	50.3a	101	52.5a	116	51.4	108
SCSCS	46.2a	93	47.5bc	105	48.9	99
$\overline{X}$	47.0		46.7		46.9	
LSD	7.9		4.5			

*Alternate varieties

**P3732

Yields followed by same letters are not significantly different by anova over same site and year.

Table 5. Brown Stem Rot Ratings** - Waseca 1986.

	Variety	
Rotation	Hodgson 78	BSR101
S-S-S-S-S	4.4	2.4
S-S-S-S-S*	3.9	2.5
C-S-S-S-S	4.0	2.1
C-C-S-S-S	4.1	1.8
C-C-C-S-S	4.2	2.3
C-C-C-C-S	2.7	1.3
S-C-S-C-S	4.1	2.2

*Alternate varieties - Corsoy and Hodgson.

** Based on average score from five plants on a scale of 1 to 5. 1 is lowest occurrence while 5 is highest occurrence.

Comparison of Popcorn, Sweetcorn, Dent Corn, and Sorghum as Silage Crops. - R. Kent Crookston, Bill Lueschen, Bob Peterson, Craig Shaeffer, and Jim Kurle.

Objectives

In 1986 dent corn was eligible for inclusion in the acreage set aside program. All dent corn acreage whether it was grown for grain or silage was included in a farm's acreage allotment. As a result there was considerable interest in alternative silage crops including popcorn, sweet corn, and sorghum. The objective of this study was to compare the dry matter yields of the these four crops.

Procedures

The study was planted at Rosemount and Waseca. The popcorn, sweetcorn, and dent corn were planted at two populations, 28,000 and 34,000 ppa. However portions of the study were abandoned at Rosemount due to poor emergence . The sorghum was planted at one population, 150,000.

Hybrids

Dent Corn: Dekalb 524 and Pioneer 3732.

Popcorn: Purdue 203 and Purdue 405.

Sweet Corn: Jubilee and Silver Queen.

Sorghum: Pioneer 956, Pioneer 931, Land o Lakes Sweet Treat, and Land o Lakes Sorgo 10.

Rosemount (Table 1) - The previous crop was soybeans. Plots received 160#/A N as anhydrous ammonia. No P or K was applied. Herbicide was Ramrod applied at 4#/A preemergence. Plots were planted 7 May 1986 and harvested at the stages noted:

Sorghum:
 Sorgo 10 - I)Dough to hard dough - 27 August
 II)Hard dough to black layer - 29 September
 Pioneer 931 - I) Does not produce seed - 12 September
 - II) " - 29 September
 Sweet Treat - Hard Dough - 29 September
 Pioneer 956 - Hard dough - 12 September
Popcorn:(Purdue 209 plots abandoned.
 Purdue 405 - Black Layer - 12 September
Sweet Corn:(Silver Queen plots abandoned)
 Jubilee - Black layer and lower leaves drying - 12 September
Dent Corn:
 Dekalb 524 - 3/4 milk to black layer - 29 September
 Pioneer 3732 - 3/4 milk to black layer - 29 September

Waseca (Table 2) - Previous crop was soybeans. Cultivation consisted of paraplowing in the fall and field cultivation in the spring. 140#/A N as anhydrous ammonia was applied to the plots. No P or K was applied in 1985. Herbicide was Ramrod which was applied at a rate of 6#/A preemergence. Plots were planted 23 May and harvested as follows:

Sorghum:
- Sorgo 10 - Dough/hard dough - 5 September
- Pioneer 931 - No seed - 30 September
- Pioneer 956 - Dough/hard dough - 30 September
- Sweet Treat - Dough/hard dough - 30 September

Popcorn:
- Purdue 203 and Purdue 405 - Black layer - 30 September

Sweet Corn:
- Silver Queen - Black layer - 30 September
- Jubilee - Milky but lower leaves drying up - 5 September

Dent Corn:
- Pioneer 3732 and Dekalb 524 - 3/4 milk - 30 September

Results: At Rosemount the highest dry matter yields were obtained from sorghum hybrids, Land o' Lakes Sorgo 10 and Pioneer 931. However, the yields were not significantly greater than those obtained from the two dent corn hybrids. The highest dry matter yields at Waseca were obtained from sorghum hybrids, Pioneer 931 and Pioneer 956. The yields were significantly higher than those obtained from the two dent corn hybrids and both sweet corn and popcorn.

Table 1. Rosemount Silage Yields of Dent Corn, Popcorn, Sweetcorn and Sorghum

Hybrid	Population		Dry Matter Yield lb/acre	kg/Ha	% Moisture Silage	Grain
Dent Corn						
Dekalb 524	28,000		19054	21359ab	59	35
	34,000		18741	21008ab	60	36
Pioneer 3732	28,000		18749	21018ab	58	38
	34,000		17975	20148ab	61	50
		$\bar{X}$	18629	20883	59.5	40
Sorghum						
Sweet Treat	-		18926	21216ab	74	-
Pioneer 956	-		17644	19779ab	65	-
Sorgo10 I	-		15198	17036bc	77	-
Sorgo10 II	-		20529	23013a	67	-
Pioneer 931 I	-		20216	22662a	67	-
Pioneer 931 II	-		18925	21216ab	68	-
		$\bar{X}$	18573	20820	69.5	-
Popcorn						
Pu405	28,000		12712	14250c	65	36
		$\bar{X}$	12712	14250	64.7	
Sweet Corn						
Jubilee	28,000		11296	12663c	66	61
Jubilee	34,000		11225	12583c	66	57
		$\bar{X}$	11260	12623	65.7	59

Yields followed by the same letter are not significantly different.

Table 2. Waseca Silage Yields of Dent Corn, Popcorn, Sweetcorn and Sorghum

Hybrid	Population	Dry Matter Yield lb/acre	Dry Matter Yield kg/ha	% Moisture Silage	% Moisture Grain
Dent Corn					
Dekalb 524	28,000	15784	17694dc	53	35
	34,000	13777	15445de	60	36
Pioneer 3732	28,000	13668	15321de	59	36
	34,000	13236	14837de	55	37
	$\bar{X}$	14116	15824	57	36
Sorghum					
Sweet Treat	-	16432	18421bc	72	-
Sorgo 10	-	15105	16933dce	74	-
Pioneer 956	-	18146	20342ab	60	-
Pioneer 931	-	19067	21374a	66	
	$\bar{X}$	17188	19268	68	-
Popcorn					
Pu 203	28,000	9540	10695f	63	35
Pu 203	34,000	8573	9611fg	65	36
Pu 405	28,000	6210	6962h	68	37
Pu 405	34,000	7668	8596fgh	66	37
	$\bar{X}$	7998	8966	66	36
Sweet Corn					
Jubilee	28,000	6873	7705gh	66	57
Jubilee	34,000	5600	6277hi	71	57
Silver Queen	28,000	6055	6788hi	68	62
Silver Queen	34,000	3825	4288i	78	63
	$\bar{X}$	5588	6265	71	45

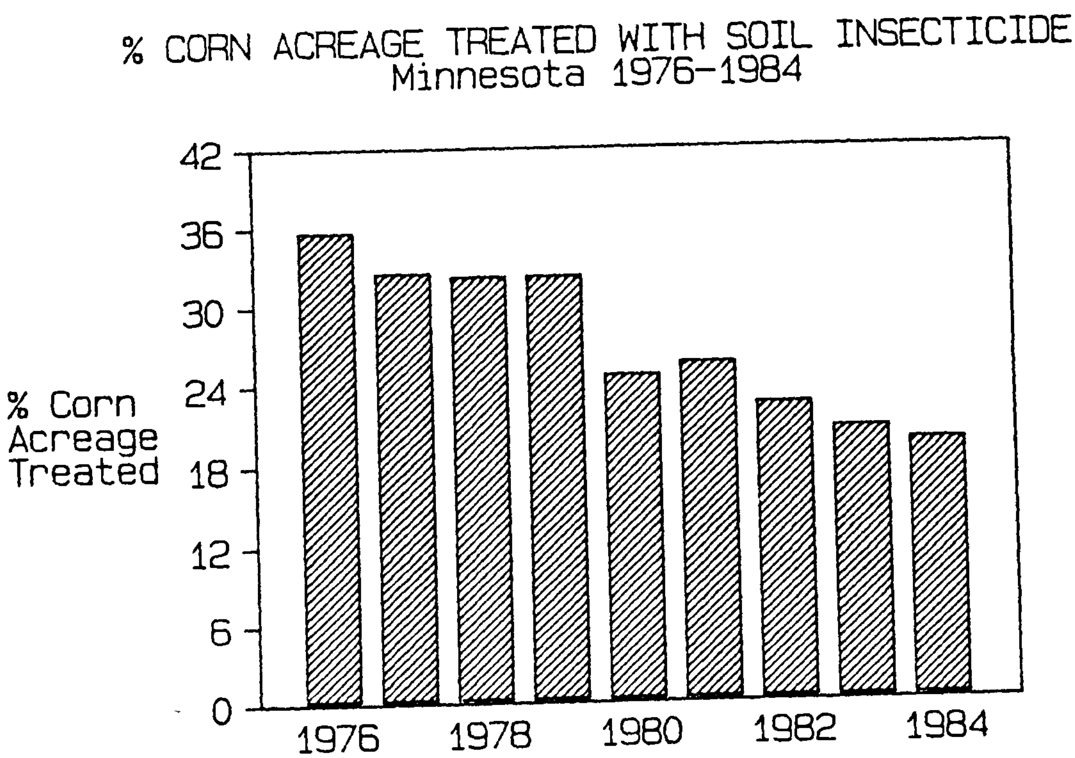
Yields followed by the same letter are not significantly different.

CORN ROOTWORM MANAGEMENT IN CONTINUOUS AND FIRST-YEAR CORN

Kenneth R. Ostlie
Extension Entomologist
Department of Entomology
University of Minnesota

INTRODUCTION

The combined strategies of crop rotation and soil insecticides in continuous corn usually limit corn rootworm damage quite effectively. Over the last 10 years, corn rootworm management strategies have shifted in favor of crop rotation as its many economic benefits became widely known. Consequently, soil insecticide use has steadily declined (Fig. 1). The need to trim input costs in farming operations is causing farmers to question further the necessity of soil insecticides. Meanwhile, the appearance of corn rootworm problems in corn/soybean or corn/wheat rotations is causing some farmers to increase their use of soil insecticides. In both of these cases, the goal is to use soil insecticides only when economically justified and to choose the most cost-effective insecticide for the job. This report contains information on soil insecticide performance and management of corn rootworms in first-year corn. Hopefully, the information will help you manage your soil insecticide inputs more efficiently while reducing unnecessary damage and yield loss.



CORN ROOTWORM STATUS IN 1986

Corn rootworm populations have benefited substantially from the mild winters of 1984-1985 and 1985-1986. Populations statewide have increased from 1.92 beetles per plant in 1984 to 2.14 in 1985 to 2.78 in 1986. The mild winters have also favored a resurgence of western corn rootworms (WCR), which are less winter hardy but more destructive than northern corn rootworms (NCR), in areas with a large proportion of continuous corn. In SE Minnesota, the proportion of WCR in the population has increased steadily: 20% - 1984, 28% - 1985, 38% - 1986. The warm springs and rapid crop development have also accentuated corn rootworm damage. Unlike growing conditions in 1985 that did not favor brace root formation, growing conditions in 1986 favored prolific brace root formation. Sufficient moisture all season and excellent brace root development minimized yield and lodging effects of corn rootworm damage.

INSECTICIDE PERFORMANCE IN 1986

The performance of soil insecticides was evaluated at four locations in Minnesota: Morris, Lamberton, Waseca, Rosemount. In contrast to previous years where all labelled insecticides appeared at each site, Rosemount was used primarily to evaluate experimental insecticides. Data from Rosemount will be used only to illustrate the performance of promising insecticides. and will not be used for calculation of performance consistency.

Corn rootworm pressure was quite variable but generally less severe than in previous years. Root damage did not exceed a 3.0 on the Iowa 1-6 rating system at either Morris or Waseca. Corn rootworm populations have been generally low at Waseca over the last 3 years. At Morris, low pressure reflects the combination of low population levels, excessive moisture and delayed crop development. For these reasons, only data from Lamberton and Rosemount will be presented. Mean root ratings for each insecticide at Lamberton and Rosemount are presented in Tables 1 and 2, respectively.

Promising unlabelled insecticides include the following:

Insecticide	Class	Company
Apache 20G	organophosphate	FMC
CGA 12223 20G	organophosphate	Ciba-Geigy
Fortress 15G	organophosphate	Dupont
Lance 15G	carbamate	BASF
PP·993 1.5G	pyrethroid	ICI Americas

Whether or not any or all of these insecticides will be labelled for corn rootworm and their relative role in the corn insecticide market remains to be seen. However, the potential increase in product selection and diversity seems encouraging.

At Lamberton all insecticides significantly reduced root damage below acceptable limits, a root rating = 3.0. At Rosemount all insecticides also significantly reduced root damage compared to the untreated check. In contrast to Lamberton, only 3 insecticides (Apache 20G, Furadan 15G, and Counter 15G) reduced root damage below acceptable limits. Note, however, that root damage at Rosemount occurred very early affecting only the first few whorls of secondary roots and leaving the later root whorls and brace roots undamaged. Since the initial secondary root system has fewer and smaller roots, a root rating 3.0 at Rosemount would not exhibit as much damage as a rating of 3.0 on a normal root system.

Table 1. Effectiveness of soil-applied insecticides against northern corn rootworms at Lamberton, Minnesota.

Insecticide	Rate (lb ai/acre)	Placement	Root rating (1-6 scale)
?Fortress 15G	0.80	F	1.85a
?PP 993 1.5G	0.10	F	2.13ab
?Fortress 15G	0.60	F	2.15ab
*Counter 15G	1.00	F	2.18ab
*Counter 15G	1.00	IF	2.23ab
?Lance 15G	1.00	F	2.25abc
?CGA 12223 20G	0.50	F	2.38 bcd
*Thimet 20G	1.00	F	2.41 bcd
Broot 15GX	1.00	F	2.43 bcd
Lorsban 15G	1.00	F	2.45 bcd
*Dyfonate 20G	1.00	R	2.58 bcd
?Lance 15G	0.75	F	2.59 bcd
*Furadan 15G	1.00	F	2.71 cd
*Dyfonate 20G	1.00	F	2.73 cd
*Mocap 15G	1.00	R	2.79 cd
Check	----	--	3.26 e

Placement is coded as follows: F = ahead of presswheel, R = behind presswheel, IF = in furrow.
Means followed by the same letter do not differ significantly ($p<0.05$, DMRT).
? Not currently labelled on corn.
* Restricted-use insecticide.

Table 2. Effectiveness of soil insecticides in preventing damage by northern and western corn rootworms. Rosemount, Minnesota, 1986.

Insecticide	Rate (lb ai/acre)	Root rating (1-6 scale)
?Apache 20G	0.75	2.53a
?Apache 20G	1.00	2.66ab
*Furadan 15G	1.00	2.74abc
*Counter 15G	1.00	2.86abc
*Dyfonate 20G	1.00	3.04 bcd
?Fortress 15G	0.80	3.06 bcd
Lorsban 15G	1.00	3.09 bcd
?CGA 12223 20G	0.50	3.15 cd
?Fortress 15G	0.60	3.34 de
Lorsban 15G	0.50	3.69 e
Check	----	4.59 f

All treatments applied at planting behind the presswheel.
? Not currently labelled on corn.
* Restricted-use insecticide.
Means followed by the same letter do not differ significantly ($p<0.05$, DMRT).

CONSISTENCY OF CORN ROOTWORM INSECTICIDE PERFORMANCE

Corn rootworm insecticides vary in their performance from year to year and from location to location depending on corn rootworm population pressure, weather, crop development, soil characteristics, tillage, and weed populations. The ability of an insecticide to consistently maintain root ratings below the economic threshold (3.0) is an extremely important attribute. Consistency should be considered along with price and pest spectrum when selecting a corn rootworm insecticide. Consistency of each insecticide performance during recent years is presented in Table 3.

Table 3. Consistency of corn rootworm insecticide performance in Minnesota, 1977-1986, as measured by the proportion of trials where the insecticide maintained root ratings below a 3.0 (Iowa 1-6 rating scale).

Insecticide	# Ratings < 3.0 / # Trials	%
Counter 15G	25/26	96
Thimet 20G	24/25	96
Broot 15GX	22/23	96
Dyfonate 20G	21/25	84
Furadan 15G	21/26	81
Mocap 15G	19/25	76
Lorsban 15G	16/25	64
Untreated check	8/26	31

SITUATION FOR CONTINUOUS CORN IN 1986

Adult corn rootworm populations vary considerably from field to field depending on relative crop phenology and cropping history. The best way to assess the need for a soil insecticide in continuous corn is to scout the field weekly during August. A general rule of thumb, or static threshold, is to treat the field if adult beetles average between 1 and 5 beetles per plant. Crop rotation is recommended when adult populations exceed 5 per plant and no insecticide is needed if populations are below 1 adult per plant.

Two problems confound the treatment decision. First, WCR are more aggressive feeders as larvae and more prolific egg producers than NCR. An approximation that can be used to compensate for changing ratios of WCR:NCR is to assume 1 WCR equals 2 NCR. Second, the current static threshold of 1 beetle per plant was developed for the WCR. In Minnesota, the climate and cropping practices favor the NCR. As presented in Table 4, WCR comprise only ca. 10% of the beetles. Consequently, the threshold may be too conservative, resulting in unneccessary insecticide use. Future research on damage and population vs field history and economic thresholds tailored to Minnesota conditions are needed to improve decisions about soil insecticide use.

The Minnesota Department of Agriculture - Plant Industry Division annually surveys corn rootworm populations throughout the southern 2/3 of Minnesota in early August. The results of this survey are presented in Table 4. Adult populations increased substantially or remained constant throughout most of Minnesota. Adult populations in all districts except the C and EC are well above threshold level. Clearly populations and the probability for damage in untreated fields are high throughout most of the state. If a field was not scouted last August, a soil insecticide is highly recommended for 1987.

Table 4. Corn rootworm adult beetle survey (Aug. 1-13) in continuous corn in Minnesota. Data supplied by Minnesota Department of Agriculture - Plant Industry Division.

District	No. Fields	CRW beetles/plant 1985	CRW beetles/plant 1986	Ratio NCR:WCR	% Lodging
WC	11	2.12	4.57	89:11	1.5
C	20	1.93	1.43	99: 1	0.0
EC	18	1.03	0.85	95: 5	0.0
SW	27	1.33	4.17	96: 4	2.0
SC	29	1.90	2.86	96: 4	0.0
SE	38	3.18	3.22	62:38	Trace
State average		2.14	2.85	90:10	0.6

NCR DAMAGE TO FIRST-YEAR CORN

Isolated occurrences of corn rootworm damage in corn/soybean and corn/small grain rotations has been observed in Minnesota over the last 15 years. Although some damage to a few fields was expected in 1985, the magnitude of the problem was completely unexpected. I estimate that over 150 fields suffered damage sufficient to produce lodging problems. Surveys of affected farmers (N=60) indicated 90% had never noticed the problem in previous years. Lodged acreage comprised from 3 to 95% of the field, averaging 37%. Preliminary evidence quickly pointed to NCR as the cause of the problem. Adult populations in these fields dramatically exceeded the normal levels expected for first-year fields (<.5 beetle per plant). Adult counts averaged 5.4 beetles per plant, ranging from 2.8 to 12.5 beetles per plant. Approximately 97% of the adults were NCR.

Possible explanations for NCR problems in first-year corn center on egg laying in the previous crop or egg carryover from the last corn crop. The term "extended diapause" is used to describe the NCR egg's ability to successfully overwinter more than one winter. Recent research on eggs gathered from Minnesota beetles indicate ca. 40% of eggs in corn/soybean areas can hatch the second year. In contrast, only 11% of the eggs gathered from adults in continuous corn areas can hatch the second year. Review of field histories from affected fields strongly points to extended diapause as the most likely explanation. For example, 97% of the problem fields in 1985 were planted to corn. Recall the 1983 PIK/set aside program. If egglaying in noncorn crops were the answer, I'd expect a greater variation in 1983 crop histories including set aside. Perhaps the most convincing evidence comes from fields with a split history of set aside and corn in 1983. Of 9 fields with verified NCR damage in 1985, none exhibited lodging or significant corn rootworm damage in the part that was set aside in 1983.

STATUS OF FIRST-YEAR CORN ROOTWORM PROBLEMS IN 1986

After the explosive increase in first-year problems with NCR in 1985, it was natural to wonder what 1986 would hold for us. If crop rotation actually select for extended diapause, the problem should predictably persist in 1986. However, the problem is not always apparent. Remember that NCR damage is only visible when lodging occurs. Damage can occur and for many reasons lodging may not occur. Thus, lodged fields represent the "tip of the iceberg". In 1985, conditions (damage, poor brace root formation, storms) were favorable for lodging to occur. In 1986, excellent brace root formation and adequate moisture obscured lodging and yield response to NCR damage. I received scattered reports of lodging in first-year corn but the magnitude of the "visible" problem declined substantially from 1985. Root damage at my first-year corn research sites was sufficient to produce lodging problems under 1985 conditions. The bottom line is that the problem is still here and not temporary in nature.

SOIL INSECTICIDES ON FIRST-YEAR PROBLEM FIELDS

Research was initiated in 1985 to determine if the problem repetitively occurred in the same fields and if soil insecticides provided an economical solution to the problem. A total of 8 fields, 3 in 1985 and 5 in 1986, with a prior history of the problem were selected. In each field untreated and treated strips were alternated across the field by filling half of the planter's insecticide boxes with Counter 15G. Stand, root ratings, lodging, and yield were measured on selected strips. A summary of mean values for each treatment is presented by site in Table 5.

Table 5. Root damage, yield and percent lodging in first-year corn fields with strips treated with Counter 15G.

		Root Rating		Yield (bu/acre)		% Lodging	
Year	Site	Counter	Check	Counter	Check	Counter	Check
1985	Mn. Lk. 1	2.45	3.13	151.3	153.4	48.2	62.5
	Mapleton	2.16	2.42	170.8	167.4	0.0	0.0
	Janesville1	2.56	2.86	180.6	175.3	27.6	48.7
	Average	2.39a	2.80b	167.6a	165.4a	25.3a	37.0a
1986	Mn. Lk. 1	2.15	2.86	159.2	155.0	1.3	29.3
	St. Clair	2.17	3.19	144.2	143.0	0.6	2.7
	Waldorfr	2.33	2.96	164.6	162.8	1.5	22.5
	Mn. Lk. 2	2.94	3.51	148.0	145.7	1.5	14.5
	Janesville2	2.58	3.00	174.0	156.5	---	----
	Average	2.43a	3.15b	158.0a	152.6a	1.2a	17.3a

Within each year and variable, means followed by the same letter do not differ significantly ($p<0.05$, DMRT).

NCR damage was evident each year in fields with a previous history of the problem. Root pruning was commonly observed and root ratings in most fields averaged near 3.0 (= 1 root pruned to within 1" of the stalk). At these damage levels, lodging and yields begin to be affected. Surprisingly, severe root damage like that commonly observed in lodged fields in 1985 was not present in any of the research fields. Counter 15G significantly reduced root ratings each year but did not significantly affect yield or lodging. A trend for Counter 15G to reduce lodging and increase yields is evident but not significant with such small sample sizes within years.

A summary of soil insecticide benefits analysed across years and sites is presented in Table 6. Overall, Counter 15G significantly reduced root ratings and lodging but only approached significance in increasing yields. Yield response to insecticide averaged only 4.2 bu/acre. Assuming a cost of $12.72/acre for Counter 15G (8.7 lb/acre X $1.46) and corn prices of either $1.75 (loan rate) or $1.35 (market price), the breakeven point for a farmer would be ca. 7.3 bu/acre (program) or ca. 9.4 bu/acre (market). The average yield benefit with the insecticide (4.2 bu/acre) is substantially below the breakeven point. The "average" farmer would have lost $5.36/acre (program) or $7.05/acre (market). Only the farmer in 1 of the 8 trials would have used the soil insecticide profitably. Clearly, previous history of the problem is not a reliable indicator of problem severity or profitable use of the insecticide input.

Table 6. Summary of soil insecticide benefits in first-year corn fields with a previous history of severe corn rootworm damage, 1985-1986.

Treatment	Root rating (1-6 scale)	% Lodging	Yield (bu/acre)
Counter 15G	2.42	11.5	161.6
Untreated check	3.02	25.8	157.4
Benefit	-.60	-14.3	+4.2
Range	(-.26, -1.02)	(0, -28.0)	(-2.1, +17.5)
Significance	.0004	.011	.084

ADULT COUNTS AS A PREDICTIVE TOOL

The evidence just presented indicates that NCR problems in first-year corn have little initial warning and that previous field history of the problem does not offer a reliable indicator of profitable insecticide use. In this situation, how can a farmer make a sound decision about insecticide use in first-year corn? One potential solution is to routinely monitor all corn fields for adult corn rootworms. Combined with good record keeping, these adult counts may serve as valuable guides for planning crop rotation and insecticide use.

To determine if adult counts have any predictive value, I examined root damage in 11 first-year fields scouted 2 years previously. Field locations and adult counts were generously supplied by Paul Miller, L $ M Consulting of Waseca. Preliminary evidence indicates a strong correlation (r=.73) between these adult counts and damage 2 years later. The data suggest that at least 3-4 NCR beetles per plant are required before damage exceeds a root rating of 3.0 (Iowa 1-6 scale) 2 years later. Additional data are required to determine if this relationship holds true and to generate a robust threshold that reflects variation in survival over 2 or more winters.

CROP ROTATION AS A MANAGEMENT STRATEGY

Despite the excitement over NCR problems in first-year corn, the fact remains that most fields escape the problem or do not suffer sufficient damage to be readily detected. Last year, I proposed that one solution in fields with a previous problem might be to lengthen the crop rotation. In addition to economically viable crop options, another possible problem has emerged with this option. Extended diapause means that NCR eggs can successfully overwinter 2 or more winters. Evidence surfaced this summer of a field extensively damaged 3 years after corn was last planted in the field. The field in Yellow Medicine Co. was split between set aside and corn in 1983, soybeans in 1984, wheat in 1985, and planted back into corn in 1986. To the row, damage (root rating >4) and severe lodging was only observed where corn was grown in 1983.

ACKNOWLEDGEMENTS

The research presented in this paper would not have been possible without the generous support of the people of Minnesota through the Minnesota Agricultural Experiment Station and the agrichemical companies whose products were evaluated in this research. In the first-year corn studies, I especially appreciate the cooperation of Paul Miller, L & M Consulting, and the farmers who offered their fields for study: Bill Daly, Steve Dimmel, Rick Hoehn, Joe Kluender, Ambrose Sonnick, Dan Stevermer, The Trahms, Danny Trio. Special recognition is extended to American Cyanamid for their support of NCR studies in first-year corn.

SOIL INSECTICIDES, PLACEMENT, AND TILLAGE

K. Ostlie, S. Chadda, S. Ross
Department of Entomology

and

B. Lueschen
Southern Experiment Station

Advertizing claims and label changes regarding soil insecticide placement have fueled the debate over soil insecticide placement. Current issues include wind drift of granules, cutworm performance, interception of granules by crop residue in reduced or notill systems. These issues raise many unresolved questions. Which placement is best for corn rootworm control? How is control of other soil insect pests like cutworms, wireworms, and white grubs affected by placement? Does optimal placement vary between insecticides? Should the tillage system influence the choice of placement? How important are placement decisions in the overall performance of a soil insecticide? As part of our research efforts on tillage and insects, we decided to examine the effects of placement on soil insecticide performance.

Experimental Methods

The objective of our experiment was to evaluate the performance of three soil insecticides (carbofuran [Furadan 15G], chlorpyrifos [Lorsban 15G], terbufos [Counter 15G]) in three placements (ahead of the presswheel, behind the presswheel, infurrow) against corn rootworms in various tillage systems. Existing tillage system plots at Waseca provided the ideal setting for this experiment. Four tillage systems (fall moldboard, fall chisel, ridge-till, and no-till) with 8 replications were established in 1980. The tillage plots measured 150 feet by 54 feet (18 rows). Since 1985 all replications had been planted to corn and would, hopefully, provide economic populations of corn rootworm larvae in 1986.

The experiment was laid out as a split-split plot design with tillage systems forming the main plots. Within each tillage plot, subplots of three rows received an insecticide treatment or were left untreated. Within each insecticide subplot each row received a different placement. The experiment was planted May 20-21 to Pioneer 3737 at ca. 26,000 plants per acre using a Hiniker planter. All insecticides were applied at planting at rates of 1 lb a.i./acre. Emerging stand and black cutworm damage were measured on June 12-13. Five corn roots per row were dug, washed, and corn rootworm damage was rated using the Iowa 1 to 9 scale on August 18-19. Final stand and yields were taken Oct. 20-21 on each row. Other procedures and data were taken as described elsewhere in this annual report by Andow et al.

Results

A significant influx of migrating black cutworm adults was detected in the Waseca area on May 9. Over 30 moths in 2 nights were captured, which substantially exceeded the threshold of 8 moths in 2 nights. Cutting from this flight was projected to occur in the Waseca area from June 3-8. As in 1985, black cutworm damage was observed in the plots. The infestation was severe enough in 1986 to provide an excellent evaluation of soil insecticide performance against black cutworm. Black cutworm activity varied between tillage systems (Table 1). Moldboard and chisel systems suffered significantly less damage than no-till and ridge-till. Ridge-till suffered significantly more damage than no-till. Differences in timing of damage between tillage systems were also observed. An indicator of timing is the ratio of cut plants to regrowing plants. A higher ratio indicates more recent cutting. The ratios for moldboard, chisel, ridge-till and no-till are 0.76, 0.98, 1.10, and 1.16, respectively. Based on these ratios, it appears that damage occurred earliest in the moldboard system, then in the chisel system, and finally in the ridge- and no-till systems. These findings are consistent increasing residue cover and decreasing soil temperatures in these systems.

Table 1. Black cutworm damage (cut plants), corn rootworm damage (root rating), final stand and yield among tillage systems as affected by the presence or absence of a soil insecticide. Waseca - 1986.

Variable	Tillage System: Moldboard		Chisel		Ridge-Till		No-Till	
	+	0	+	0	+	0	+	0
Cut plants (1000s/A)	1.31	0.91	1.32	1.66	2.50	2.46	1.56	1.81
Final Stand (1000s/A)	19.0	18.2	18.6	16.4	17.8	16.4	19.4	17.7
Root Rating (1-9 scale)	2.44	3.20	2.40	3.30	2.49	3.15	2.73	3.65
Yield (bu/A)	116.7	107.8	112.5	93.3	116.5	106.5	105.8	95.1

Insecticide treatment coded as follows: + - Insecticide (Counter, Furadan, Lorsban) applied, 0 - No insecticide applied.

While on the average, soil insecticides did not reduce black cutworm damage, differences between insecticides were detected (Table 2). Counter and Furadan did not reduce damage nor preserve stand when compared to the untreated check. Only Lorsban significantly reduced damage and preserved higher stands. These findings are consistent with product labels which use the word "suppression" for Furadan and Counter and "control" for Lorsban.

It should be noted, however, that Lorsban did not stop cutting activity from exceeding and significant stand loss still occurred. Insecticide placement had no effect on insecticide performance against black cutworms (Table 3).

Table 2. Soil insecticide performance across tillage systems and placements as measured by black cutworm and corn rootworm damage, final stand, and yield. Waseca - 1986.

	Insecticide Treatment				Significance	
Variable	None	Counter	Furadan	Lorsban	A	B
Cut plants (1000s/A)	1.70	2.13	1.70	1.19	NS	***
Final stand (1000s/A)	17.2	17.4	17.9	20.8	***	***
Root rating (1-9 scale)	3.33	2.27	2.58	2.70	***	***
Yield (bu/A)	100.7	108.5	111.7	118.7	***	***

Means averaged across 4 tillage systems (moldboard, chisel, ridge- and no-till) and 3 insecticide placements (ahead or behind presswheel, in-furrow).
Comparisons: A - no insecticide vs insecticide, B - between insecticides.
Statistical significance coded as follows: NS - not significant, * - .01<p<.05, ** - .001<p<.01, *** - p<.001.

Table 3. Effects of placement on soil insecticide performance. Waseca - 1986.

	Placement			
Variable	Ahead	Behind	In-furrow	Significance
Cut plants (1000s/A)	1.61	1.80	1.59	NS
Final stand (1000s/A)	18.6	18.7	18.8	NS
Root rating (1-9 scale)	2.50	2.46	2.59	NS
Yield (bu/A)	112.3	114.7	111.9	NS

Means averaged across 4 tillage systems (moldboard, chisel, ridge-till, no-till) and 3 insecticides (Counter, Furadan, Lorsban).
Statistical significance coded as follows: NS - not significant, * - .01<p<.05, ** - .001<p<.01, *** - p<.001.

Corn rootworm damage was less than expected. On the Iowa 1 to 9 scale, the following guide should be helpful in interpreting results: 1 = no damage, 4 = 1 root pruned (The point at which yield losses and lodging began to occur.), 9 = 3 or more nodes of roots destroyed. Generally damage was less than the economically important rating of 4. Under this year's moisture conditions, these damage ratings were not expected to produce yield losses or lodging. Consequently, it's not surprising that yields paralleled black cutworm damage rather than corn rootworm damage (Table 2).

Between tillage systems, no-till suffered significantly more corn rootworm damage than the other systems (Table 1). As expected, soil insecticides reduced root damage compared to the untreated check in all tillage systems. Treated root ratings paralleled untreated root ratings. The worst damage with insecticides was encountered in the no-till system. The insecticides also differed significantly in their root ratings (Table 2). Root protection was best with Counter, intermediate with Furadan, and least with Lorsban. This ranking follows long-term consistency values for these insecticides in our corn rootworm trials, 1977-1986: Counter - 96%, Furadan - 81%, Lorsban - 64%. Placement did not effect the corn rootworm performance of these insecticides under 1986 conditions (Table 3).

Conclusions

Since these results represent only 1 year of study, it is not possible to generalize for southern Minnesota. The following tentative conclusions seem reasonable. Black cutworm and corn rootworm damage varied between tillage systems. Least damage was suffered by moldboard and chisel. No-till suffered greater corn rootworm damage and ridge-till suffered greater black cutworm damage. Performance of Counter, Furadan, and Lorsban against these pests was consistent with previous studies. Placement did not alter the performance of these soil insecticides against black cutworm and corn rootworm.

Acknowledgements

We sincerely thank the Southern Experiment Station, especially the work crew for their technical support and assistance in planting, sampling, and harvesting the 320 plots that comprised this experiment. The contribution of soil insecticides by American Cyanamid, FMC, and Dow was greatly appreciated.

CONSERVATION TILLAGE AND CORN PESTS

David A. Andow, Thor Kommedhal, Ken Ostlie,
William E. Lueschen, John F. Moncrief

Departments of Entomology, Plant Pathology, and
Soil Science and Southern Experiment Station

University of Minnesota

Conservation tillage has gained widespread acceptance throughout the Corn Belt during the last decade (Phillips et al. 1980, Phillips and Phillips 1984). Primary motivations for adopting no till or reduced-tillage systems include conserving basic farm resources and reducing capital outlays for equipment (Phillips et al. 1980). The USDA (1975) estimates that by the year 2000, about 65% of acreage in corn, soybeans, sorghum, wheat, oats, barley, and rye will be grown under reduced-tillage. Despite this potential for widespread use, adoption of conservation tillage is limited by uncertainty about the relative economics of tillage options, economic risk during transition, acquisition of new crop and pest management skills, and yield stability (Benson 1984, Triplett 1976, Phillips et al. 1980). While farmers who adopt new practices may display a greater propensity to take risks (Bultena et al. 1985), continued adoption of conservation tillage systems may be contingent upon reducing risk perceptions through research (Benson 1984). In particular, the consequences of the tillage decision in terms of pest problems need to be investigated.

Increases in pest problems are a major potential disadvantage of conservation tillage in corn production (Gregory and Musick 1976, Phillips et al. 1980). Principal corn insect pests in the Upper Midwest include the European corn borer (*Ostrinia nubilalis* Hubner), northern and western corn rootworms (*Diabrotica barbari* (Smith and Lawrence) and *D. virgifera* LeConte), black cutworm (*Agrotis ipsilon*) stalk rot (*Fusarium gramineanum* Schw.), and eyespot (*Kabatiella zeae* Narita and Y.Hiratsuka). Losses over this region are estimated at 2.0% (*O. nubilalis*) and 0.4% (*Diabrotica* spp). Pest management programs for these insects currently use "nominal" thresholds (Poston et al. 1983). Nominal thresholds are static, despite changes in economic conditions (crop price, control costs) or in expected yield loss (from weather, other crop stresses).

The purpose of our study is to elucidate and quantify the interactions among European corn borer, corn rootworm, black cutworm, stalk rot, eyespot and tillage in southern and southeastern Minnesota. We aim to understand the underlying causes of changes in pest incidence in different tillage systems, to determine the extent that major pests affect corn yield independently of each other, and to develop economic budgets of various tillage/pest-control crop management strategies. In this report, we describe our results from the Southern Experiment Station, Waseca, MN.

Cultural Methods

The experiment at Waseca was a RCB-split-split-split-split plot design replicated eight times. This experiment was designed to test if various pest damages affected corn plants independently. The whole plots were four tillage systems: fall moldboard plow, fall chisel plow, ridge-till, and no till. The first subplot level was two control tactics for corn rootworm: 1.0 pound a.i. Counter 15G (terbufos)/acre, and no insecticide application. The second subplot level was two treatments of first generation European corn borer attack: natural populations of European corn borer, and artificial infestations of an additional one egg mass/plant above natural levels (about 25 blackheaded eggs/egg mass placed in the whorl). The third subplot level was two treatments of stalk rot attack: natural levels of attack, and artificial innoculations with F. graminearum infested toothpicks (Young 1943). The fourth subplot level was two treatments of second generation European corn borer attack: natural populations of European corn borer, and artificial infestations of an additional one egg mass/plant above natural levels (about 25 blackheaded eggs/egg mass placed in the axil of the ear leaf). About 10 to 12 plants were in each sub-sub-sub-sub plot. All tillage systems were originally established prior to 1980 and all had stabilized by 1982. Soils were Webster clay loams/typic argiaquolls. The tillage plots were 150 x 54 feet (18 corn rows).

Sampling Methods

Soil Physical Characteristics. Soil samples from 2 to 10 cm depth were taken from five of the replicates of the tillage plots at Waseca. Using a hand operated Uhlen sampler, two samples from each of two locations in each plot were taken. The locations were within corn rows, but not on a corn plant, and midway between corn rows, but not in wheel tracks. Samples were dried, and bulk density, volumetric water content, and air filled pore space were calculated.

The percent of soil covered with plant residue (mainly corn residue) was measured using point-intercept techniques. Cover was measured seperately within and between rows, where the row area was six inches wide, centered on the emerging corn row.

Corn Growth and Yield. Corn heights were measured using extended leaf heights, and corn developmental stages were measured as number of leaves with collars fully exposed. Heights were measured on Julian date 182 and 230 in all sub-sub plots. Developmental stages were measured only on JD 182.

Yield samples were taken after corn had reached physiological maturity. All plants in each sub-sub-sub-sub plot in 5 replicates were hand harvested. Dropped ears and stalk breakage were noted. All samples were dried, shelled, and weighed, and yield was calculated to 15.5 percent moisture.

Black Cutworm. Black cutworm appeared in spring 1985 and 1986. We measured corn cutting rates in the four tillages. In 1985, half the corn was planted into corn residue corn (north series, Fig. 2) and the other half was planted into soybean residue (south series, Fig. 2). On 5 June in 1985 and 12-13 June in 1986 we examined four 1/1000 acre samples of corn row, and counted the number of healthy corn plants, the number of cut corn plants, and the number of plant that had been cut but were now regrowing. We estimated total percent cutting by cutworms by adding the number cut and the number regrowing and dividing by the total number of plants (healthy plus cut plus regrowing).

Corn Rootworm. Spring 1986 eggs were sampled using a 10 x 100 cm frame after tillage and planting. The frame was centered over the corn row, and samples were taken from six locations, three horizontal locations at two depths: depths were 0-10 cm and 10-20 cm from the surface; horizontal locations were 0-7.6 cm, 7.6-22.8 cm, and 22.8-38.1 cm from the corn row. Several samples were taken from each tillage plot in 4 replicates in late June. Eggs were identified to species.

Corn rootworm root damage ratings were taken after rootworm damage had occurred. Five plants were removed from different locations in each subplot. The roots were washed and rated in the field according to the Iowa scale. We modified the scale as follows: 2.0 -at least 1 root damaged by CRW's, root mass mainly white;, 2.25 -no root pruned back to within about 15 cm of stalk, root mass mainly brown; 2.5 -at least 1 root pruned back to within 15 cm; 2.75 -severe pruning of one main root to within about 7.5 cm of the stalk, or 3 or more roots pruned to within 15 cm; 3.0 -one root pruned to within about 3 cm of stalk. Ratings were made in early August.

European Corn Borer. First generation damage to Waseca corn in 1986 was negligable (less than 2%). Fall population densities of live European corn borer larvae were estimated when larvae were mainly 5th instars. About 16 plants per sub-sub-sub plot were dissected. The position of live larvae, fresh larval damage (no live larva), and old larval damage was recorded. Larvae attacking the ear were recorded on the ear tip, in the ear shank, or elsewhere. Larvae attacking the stalk were either in the lower, middle, or upper stalk. The middle stalk was defined as the internodes spanning the primary ear node. Old damage was distinguished from fresh damage by having the wound totally healed over with callus or blackened from secondary infection. Putative stalk rot infections were recorded when the internode showed extensive rotting that was not directly related to corn borer damage, or when a strong anthocyanin reaction occurred in the white cortex of the internode. These infections need to be confirmed, so these data will not be reported here.

Pathogens. Root infecting fungi and stalk infecting fungi were examined. Root pieces were excised from young 3-5 leaf plants, and from the plants dug for estimating corn rootworm damage (c.f. Corn Rootworm). From the rootworm damaged plants, root samples from severely damaged, moderately damaged, and slightly damaged roots were taken. All root samples were plated out on PDA and fungal colonies were transfered to CWA for identification.

Corn stalks were split and examined for stalk rot infection at the end of the season. Infections were rated based on the proportion of the second elongated internode above the soil surface that was infected.

Statistical Analysis

All data were analysed with a general linear model using a RCB split-split-split-split plot model. Slight modifications of these were used for some data. When appropriate, all data were tested for homogeneity of error variance using Levene's test (Snedacor and Cochrane 1980), and when necessary, transformed by Box-Cox transformations. Proportions were analysed with ANOVA or analysed with a long-linear model. Proportions were arcsine-square root transformed before analysis with ANOVA. Means were seperated with the student-Neuman-Keuls (SNK) method.

Results

Soil Physical Characteristics. Soil bulk density was lower where ever tillage occurred (Table 1). This included within rows for all tillages and between rows for moldboard and chisel. Two apparent exceptions were the high value within rows for no till, and the low value between rows for ridge. Corn root penetration might have been more difficult in the untilled areas.

Denser locations in the soil held higher volumes of water (Table 1) and were therefore wetter, although this pattern was not particularity apparent in the clay soils at Waseca. The wetter soil locations had lower amounts of air filled pore space (Table 1). Between rows in no till, air filled pore space was so low that it could have affected root respiration, and created an anaerobic/aerobic soil mosaic. This in turn, could have affected plant growth.

Crop residue cover was lowest where the greatest amount of tillage occurred (Table 1). Lowest cover was in moldboard, then chisel and within rows in ridge till, then within rows in no till, between rows in ridge till, and finally between rows in no till. Ridge and no till were conservation tillages. Based on crop residue covers, corn growth should be slowest in no till, then ridge till, then chisel, and fastest in moldboard.

Corn Growth and Yield. In general corn developed the fastest and grew the tallest where early growth was fastest, which occurred where soil cover by plant residue was the least (Table 1 and Figure 1). Exceptions were: Waseca 1986, ridge till and chisel were similar in height and ridge till was more mature than chisel despite lower cover in chisel. The reasons for these differences are at present unknown.

At Waseca, yield depended in a complex way on tillage type and the intensity of attack by corn rootworm and second generation corn borer (Figure 2). Yield loss by the two pests was not simply additive or multiplicative (Figure 2). It was much less than additive or multiplicative in ridge till and no till, and more so in moldboard.

Stalk breakage had a complex relation to pest attack (Figure 3). Stalk rot exacerbated breakage in moldboard (the most vigorous corn), but had little effect in the other tillages (Figure 3). First generation corn borer caused the most breakage in chisel and no till (the least mature corn), (Figure 3). Second generation corn borer caused more breakage at higher population densities (Figure 4). There was a complex relation between stalk breakage and infestation by corn rootworms, first and second generation corn borer and stalk rot.

Black Cutworm. More corn plants were cut by cutworms in the conservation tillages (ridge and no till) than in chisel or moldboard at Waseca, (Figure 5). Corn population was lowest where cutting was highest (Figure 5). Higher cutting was observed in corn planted into corn residue than corn planted into soybean residue (Figure 5).

An insecticide experiment looking at tillage, insecticide and placement was carried out. Placement of the insecticide had no significant effect on cutting, regrowth, initial or final stand, or yield. Insecticides varied in efficacy with tillage type. Lorsban was effective at reducing cutting in all tillages, and Furadan was the most variable insecticide (Table 2).

Corn Rootworm. The egg distribution of corn rootworm eggs was greatly effected by tillage (Table 3). Natural oviposition concentrated near the corn rows in the upper 10 cm of the soil (no till). Moldboard plowing tended to invert the vertical distribution, and with chisel plowing tended to homogenize the horizontal distribution (Table 3). Ridge tilling shaved off some of the eggs in the ridges in the rows and threw them between the rows.

Egg densities were low, but damage ratings correlated with egg densities (Table 3). About 10 percent of the eggs were western corn rootworms at Waseca. The rest were northern corn rootworms.

European Corn Borer. First generation attack by European corn borer was less than 2 percent at Waseca. Second generation attack by European corn borer was higher than first generation. Chisel plowed corn had the highest population density and no till corn had the lowest (Table 4). Tillage had the greatest effect on the density of larvae feeding on the ear tip, but all locations on a plant showed a similar trend (Figure 6). Between 1/3 to 1/2 of the larvae were in the stalk (Figure 6).

Total feeding sites (Table 4) are the number of sites where larvae fed on corn. These sites were made by 3rd instars and older. No till had fewer total feeding sites than any other tillage. Feeding site density was only loosely related to the density of live larvae. Variation in feeding site density can be related to variation in oviposition rate, egg hatch, early instar survival, late instar movement, or any combination of these. Tenure on sites (Table 4) is the proportion of total feeding sites that still harbored a live larva. Low tenure occurs because of higher mortality, greater site to site movement, or both. High tenure was closely associated with high densities of live larvae. The differences in European corn borer population density among tillages could be related to differences in tenure; high densities might be related to low mortality or low rates of movement by larvae. Tenure on stalks, ear tips and ear shanks varied (Table 4). Tenure on stalks was most closely related to tenure on the entire plant.

At Waseca, there were more live larvae and more fresh damage by ECB on plants that were artificially infested with second generation ECB than naturally infested plants (Table 5). There was more old damage to the lower stalk in plants that were artifically infested with first generation ECB than naturally infested plants (Table 5).

Pathogens. Two to 5 percent fewer root-infecting Fusarium colony-forming units (cfu) grew from no till corn (Table 6). Tillage effects on Fusarium assemblages were inconsistant. Infection by Fusarium was greatest on root pieces that had the greatest corn rootworm feeding damage (Tables 6).

Tillage effects on infection by F. graminearum were inconsistent (Tables 6 and 7). F. graminearum in 1985 dropped from 38% of 750 Fusarium cfu in seedling roots to 3% of 6530 cfu in mature roots; in 1986 this species varied from 12 to 14% cfu on all roots. Other populations were: F. oxysporum (50%); F. acuminatum, F. equiseti, and F. solani (<10%); F. avenaceum, F. crookwellense, F. moniliforme, F. proliferatum, F. sambucinum, F. semitectum, and F. sporotrichioides (<1%).

Stalk rot was more severe in innoculated stalks, and relatively more severe in no till corn (Table 8).

References

Benson, F.J. 1984. Economic analysis of corn and soybean tillage practices for southeastern Minnesota. Conservation Tillage for Minnesota, pp. 90-97.

Bultena, G., E. Hoiberg, and G. Dewitt. 1985. Chemical control paradigm in transition: IPM adoption by Iowa farm operators. Bull. Entomol. Soc. Amer. (submitted).

Gregory, W.W. and G.J. Musick. 1976. Insect management in reduced tillage systems. Bull. Entomol. Soc. Amer. 22:302-304.

Ostlie, K.R. 1985. Corn rootworm larval control in field corn, 1984. Insecticide and Acaricide Tests (In press).

Phillips, R.E., R.L. Blevins, G.W. Thomas, W.W. Frye, and S.H. Phillips, 1980. No-tillage agriculture. Sciences 208: 1108-1113.

Phillips, R.E. and S.H. Phillips (eds.), 1984. No-tillage Agriculture: Principles and Practices. Van Nostrand Reinhold, NY, 306 pp.

Poston, F.L., L.P. Pedigo, and S.M. Welch. 1983. Economic injury levels: Reality and practicality. Bull. Entomol. Soc. Amer. 29: 49-53.

Snedecor, G.W., and W.G. Cochran. 1980. Statistical Methods, 7th Edition. Iowa State University Press, Ames, Iowa.

Triplett, G.B., Jr. 1976. Management of weeds in reduced tillage systems. Bull. Entomol. Soc. Amer. 22: 298-299.

USDA. 1975. Minimum tillage: A preliminary technology assessment. Government Printing Office, Publ. No. 57-398, Washington, D.C.

Vandermeer, J., and D.A. Andow, 1986. Prophylactic and responsive components of an integrated pest management program. J. Econ. Entomol. (in press).

Table 1. Soil physical characteristics in 2 to 10 cm, depth plant residue and weeds (percent soil cover) in different tillages and position relative to the corn row at Waseca 1986, June 6, June 23 - July 7.

Site	Year	Position	Moldboard	Chisel	Ridge	No-till
BULK DENSITY (gm/cw^3)						
Waseca	1986	In row	0.97	0.98	0.98	1.11
		Between row	1.00	1.01	1.06	1.17
VOLUMETRIC SOIL MOISTURE (% cm^3/cm^3)						
Waseca	1986	In row	32.9	36.7	31.8	35.1
		Between row	33.9	37.4	36.9	36.4
AIR FILLED PORE SPACE (% cm^3/cm^3)						
Waseca	1986	In row	30.5	26.3	31.2	23.0
		Between row	28.4	24.5	23.1	19.4
RESIDUE (% cover)						
Waseca	1986	In row	7.3	17.5	19.4	64.6
		Between row	9.8	28.8	50.0	74.0
WEEDS (% cover)						
Waseca	1986	In row	0.3	0.6	2.3	1.8
		Between row	1.8	0.5	2.6	0.9

Table 2. Insecticide effects on cut and regrowing plants initial and final stand, root damage, and yield, Waseca 1986.

		Treatment			Significance	
Variable	No insecticide	Counter	Furadan	Lorsban	A	B
Cut	1695	2125	1698	1188	ns	***
Regrow	1657	1849	1927	1760	ns	ns
Initial Stand	19961	19875	20375	23677	*	***
Final Stand	17167	17435	17908	20799	***	***
Root Rating	3.33	2.27	2.58	2.70	***	***
Yield	100.7	108.5	111.7	118.7	***	***

A - No insecticide vs. insecticide   * $p<0.05$, ** $p<0.01$ *** $p<0.001$

B - Among insecticides

Table 3. Spatial distribution of northern corn rootworm eggs after tillage in no-till, ridge-till, chisel and moldboard plow tillage systems at Waseca, 1986. Spatial dimension in distance from row at surface.

Spatial Dimension		Egg Density (eggs/pint)			
Horizontal (cm)	Vertical (cm)	No till	Chisel	Ridge-till	Moldboard
0 - 7.6 cm	0 - 10 cm	13.53	7.13	5.08	2.28
	10 - 20 cm	4.23	2.27	0.67	4.
7.6-22.8 cm	0 - 10 cm	9.03	3.00	1.75	2.54
	10 - 20 cm	3.13	1.30	1.29	3.58
22.8-38.1 cm	0 - 10 cm	1.83	3.58	3.79	2.42
	10 - 20 cm	2.08	1.67	2.46	4.75
Average egg density		8.20	2.85	2.43	3.34
Corn Rootworm Damage		3.65	3.30	3.15	3.20

Table 4. Second generation European corn borer population density, total late instar feeding sites, tenure on all feeding sites, and tenure on stalks, earl tips, and ear shanks, at Goodhue and Waseca in relation to tillage.

	Tillage	Goodhue 1985	Goodhue 1986	Waseca 1986
Live Larvae	moldboard	----	----	114.4
(#/100 plants)	chisel	15.3	103.5	125.1
	ridge till	24.3	130.8	96.2
	no till	17.6	119.9	81.4
Total Feeding sites				
	moldboard	----	----	285.2
(#/100 plants)	chisel	54.7	148.5	276.4
	ridge till	53.6	174.1	268.5
	no till	46.9	156.0	225.6
Tenure on Sites	moldboard	----	----	.68
	chisel	.28	.73	.71
	ridge till	.45	.79	.63
	no till	.38	.79	.66
Tenure on Specific sites				
Stalks	moldboard	----	----	.74
	chisel	.21	.67	.76
	ridge till	.41	.74	.71
	no till	.34	.75	.76
Ear tips	moldboard	----	----	-----
	chisel	.36	.76	-----
	ridge till	.38	.85	-----
	no till	.31	.82	-----
Ear Shanks	moldboard	----	----	.49
	chisel	.62	.63	.54
	ridge till	.65	.65	.41
	no till	.65	.71	.22

Table 5. Incidence of ECB and ECB damage at Waseca tillage study, 1986.

	Moldboard	Chisel	Ridge till	No till
Live Larvae ECB2/100 plants				
Nat ECB	114.4	125.1	96.2	81.4
+ ECB1	108.1	93.4	112.6	65.1
+ ECB2	184.9	182.5	158.6	137.1
Fresh Damage/100 plants				
Nat ECB	53.2	50.5	56.6	42.5
+ ECB1	53.3	41.3	50.2	41.7
+ ECB2	88.7	75.4	84.8	82.0
Tenure in Damage				
Nat ECB	.68	.71	.63	.66
+ ECB1	.67	.69	.69	.61
+ ECB2	.68	.71	.65	.63
Old Damage/100 plants				
Nat ECB	46.3	35.6	46.7	28.4
+ ECB1	45.4	53.7	53.1	52.5
+ ECB2	51.7	51.3	51.5	72.4
Old Damage to Lower Stalk/100 plants				
Nat ECB	14.4	13.8	12.5	10.2
+ ECB1	20.4	28.5	24.3	20.6
+ ECB2	16.8	14.3	15.1	25.0
Total Feeding Sites/100 plants				
Nat ECB	285.2	276.4	268.5	225.6
+ ECB1	270.0	251.1	296.0	217.2
+ ECB2	420.7	391.0	392.1	371.2

Table 6. Percent of Fusarium spp. colony forming units of the total Fusarium spp. isolated from corn roots on August 18, 1986 at Waseca.

Tillage	R,D,C*	ac	eq	gr	ox	pr	se	so	sp
Moldboard	R	0	14	1	62	4	<1	18	<1
	D	1	30	2	55	3	0	9	<1
	C	1	32	2	44	3-	1	17	0
Chisel	R	0	22	3	58	2	0	15	0
	D	1	25	4	57	4	0	7	2
	C	1	17	2	57	11	0	12	1
Ridge till	R	0	22	1	55	3	0	19	1
	D	<1	29	3	55	<1	0	11	1
	C	1	32	3	48	4	0	12	0
No till	R	<1	20	2	66	<1	0	12	<1
	D	0	27	5	51	4	0	12	1
	C	2	39	9	38	4	0	7	1

* R = Rootworm Damage, D = Discolored (no rootworm), C = Clean

ac = *F. acuminatum*
eq = *F. equiseti*
gr = *F. graminearum*
ox = *F. oxysporum*
pr = *F. proliferatum*
se = *F. semitectum*
so = *F. solani*
sp = *F. sporotrichioides*

Table 7. Number of colony forming units of Fusarium spp. isolated from roots of complants in the 3 - 5 leaf stage at Waseca. Parentheses give the percent of each species of the total isolated for a single tillage.

Tillage	ac	eq	gr	ox	se	so
Moldboard	6 (6)	2 (2)	12 (13)	69 (72)	0 (0)	7 (7)
Chisel	10 (12)	7 (8)	15 (18)	52 (61)	0 (0)	1 (1)
Ridge till	15 (10)	9 (6)	10 (7)	106 (70)	0 (0)	10 (7)
No till	15 (11)	3 (2)	20 (15)	90 (68)	1 (1)	4 (3)

ac = *F. acuminatum*
eq = *F. equiseti*
gr = *F. graminearum*
ox = *F. oxysporum*
se = *F. semitectum*
so = *F. solaninone*

Table 8. Stalk rot ratings for different tillages and ECB generations at Waseca.

ECB Generations	Moldboard	Chisel	Ridge till	No till
"Checks"				
ECB 1,2,SR	1.8	2.4	2.0	2.3
range	1.3-2.4	2.0-2.9	1.7-2.2	1.9-3.2
ECB 1,SR	2.0	2.1	1.9	2.5
range	1.7-2.2	1.6-2.7	1.4-2.3	2.0-3.2
ECB 2,SR	1.8	2.3	1.8	2.9
range	1.4-2.2	1.7-2.8	1.4-2.2	2.3-3.3
SR	2.0	2.1	2.0	2.7
range	1.7-2.2	1.5-2.7	1.4-2.7	2.2-3.0
Counter- trted				
ECB 1,2,SR	1.6	1.7	2.0	2.1
range	1.2-2.3	1.2-2.4	1.3-2.7	1.5-2.6
ECB 1,SR	1.7	2.1	1.8	1.9
range	1.2-2.0	1.2-2.8	1.4-2.0	1.1-2.3
ECB 2,SR	2.2	2.0	1.9	2.1
range	1.1-3.1	1.7-2.3	1.6-2.1	1.7-2.7
SR	1.7	1.8	1.8	2.2
range	1.2-2.3	1.4-2.1	1.2-2.4	2.1-2.3

Figure Legends

Figure 1. Plant heights and stages at Waseca in 1986.

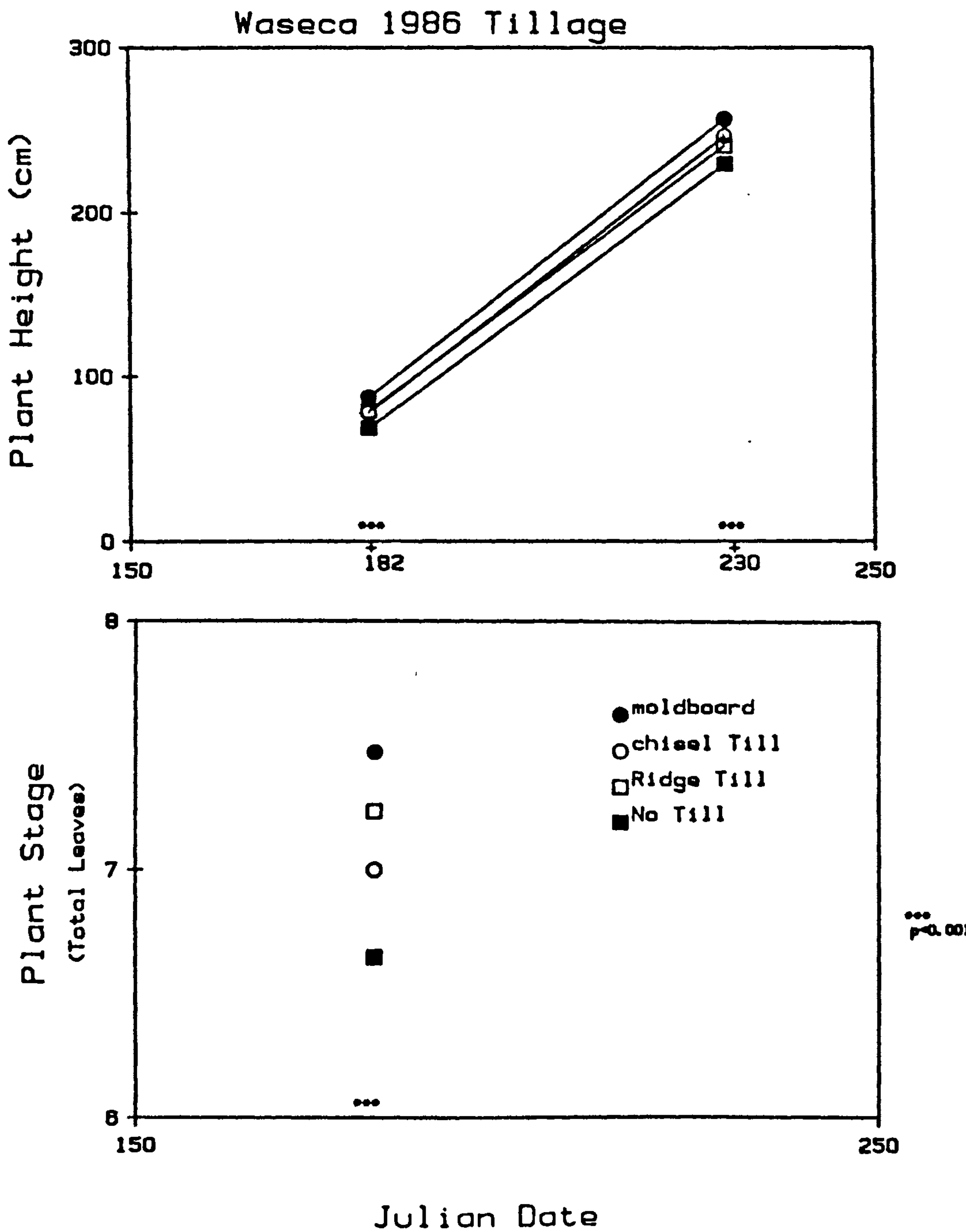
Figure 2. Corn yield at Waseca 1986 depends on tillage and level of attack by corn rootworm and second generation European corn borer. a) Additive yield loss, b) multiplicative yield loss.

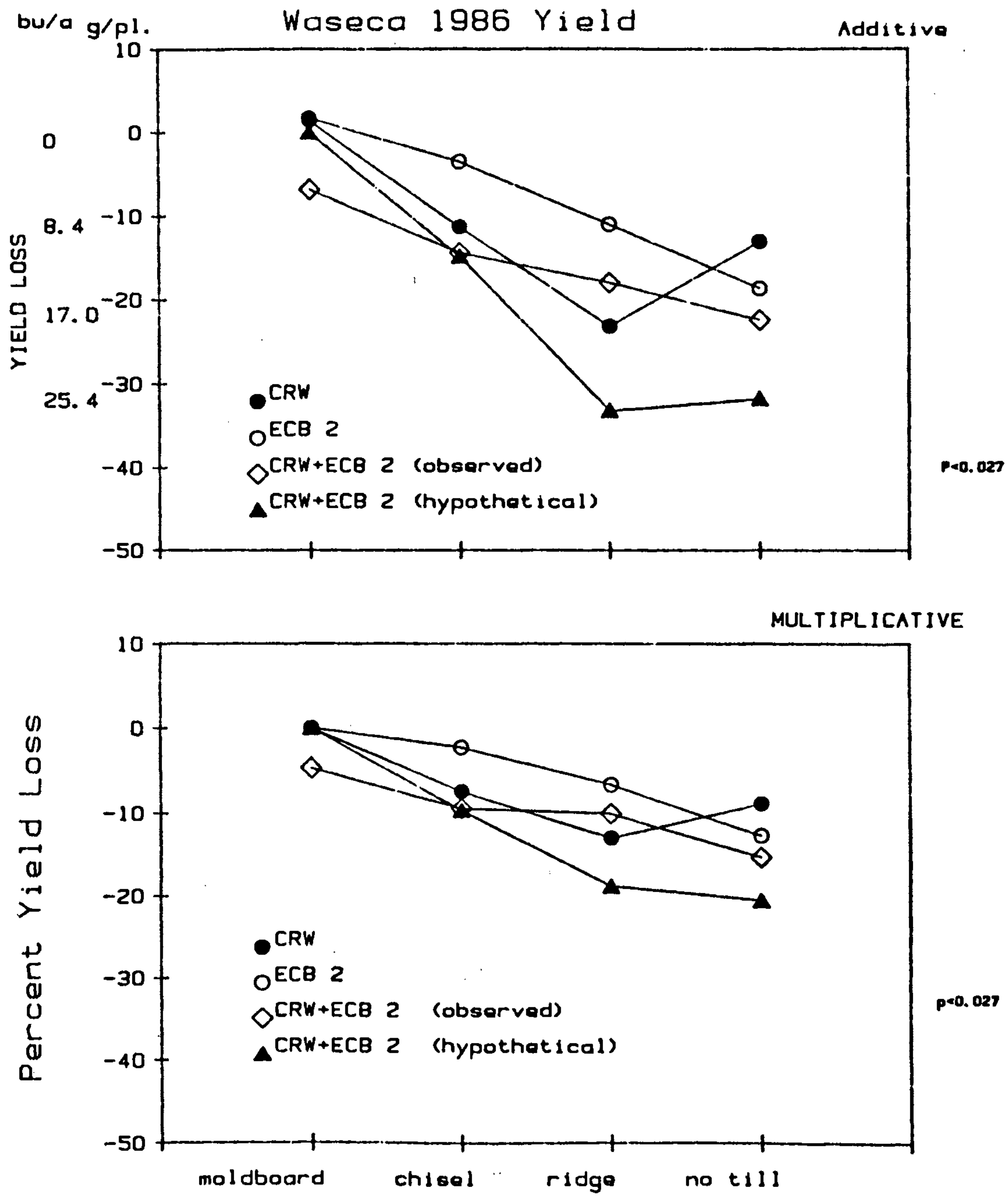
Figure 3. Percent stalk breakage at Waseca in 1986 depends on tillage, level of inoculation with stalk rot, and level on attack by first generation European corn borer. a) Percent stalk breakage, b) increase in stalk breakage over "none" (no added stalk rot or European corn borer) in a.

Figure 4. Percent stalk breakage at Waseca in 1986 depends on level of attack by second generation European corn borer.

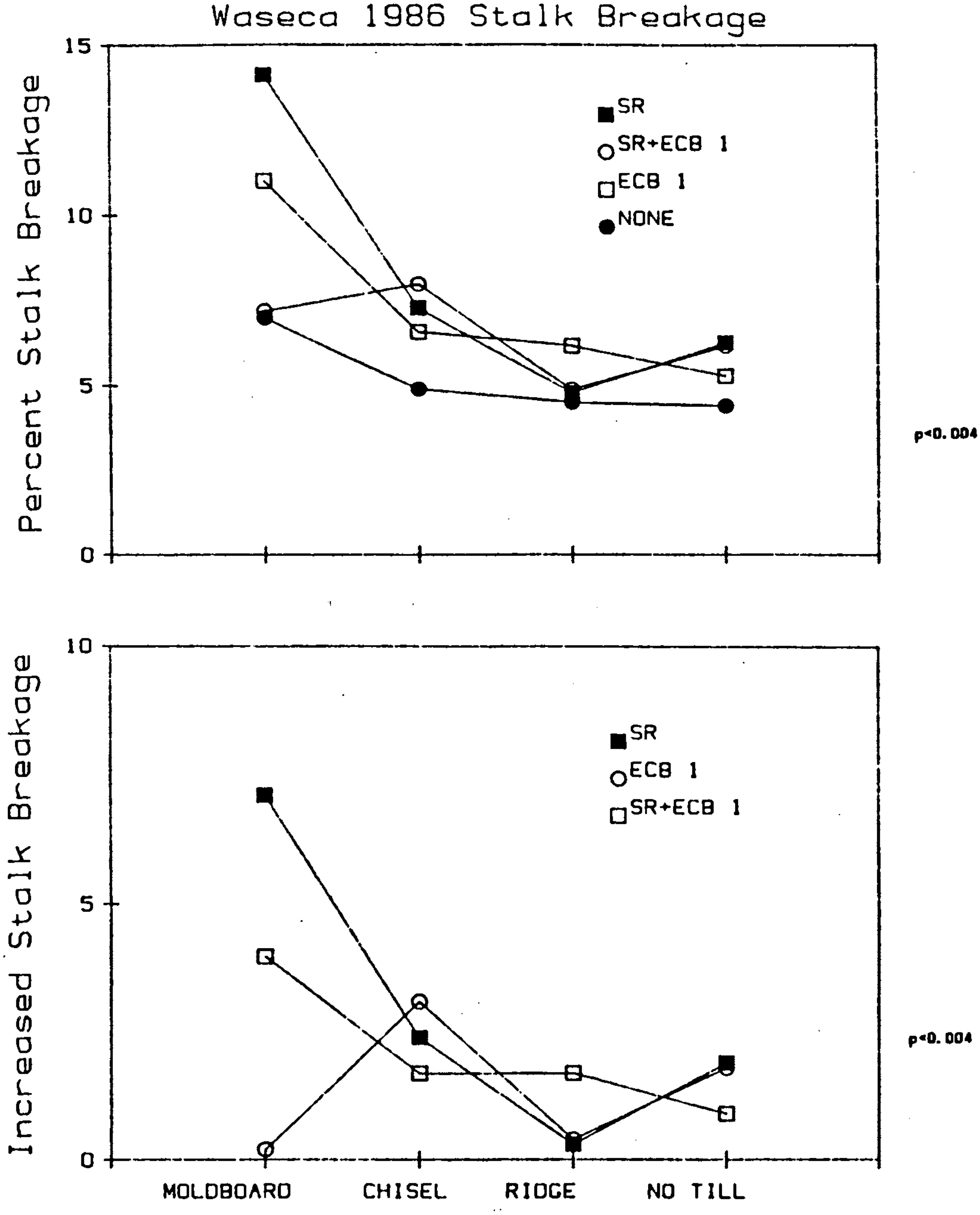
Figure 5. Corn stand after damage by black cutworm and percent cutting at Waseca in 1985 and 1986.

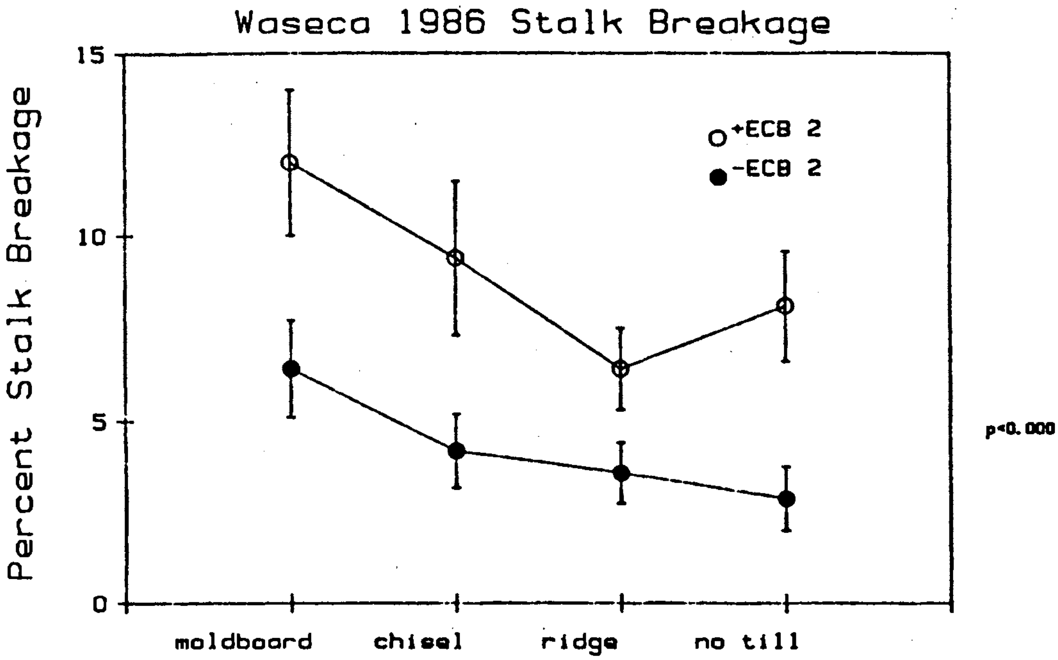
Figure 6. Distribution of second generation European corn borer in four tillage systems at Waseca in 1986. Number - live larvae/100 stalks; parentheses indicate fresh damage; brackets indicate old damage. MB - moldboard; CH - chisel; RT - ridge till; NT - no till.


Waseca 1986 Tillage
Plant Height (cm)
300
200
100
0
150
182
230
250
***
***
8
7
6
Plant Stage
(Total Leaves)
moldboard
chisel Till
Ridge Till
No Till
***
150
250
Julian Date
***
p<0.001

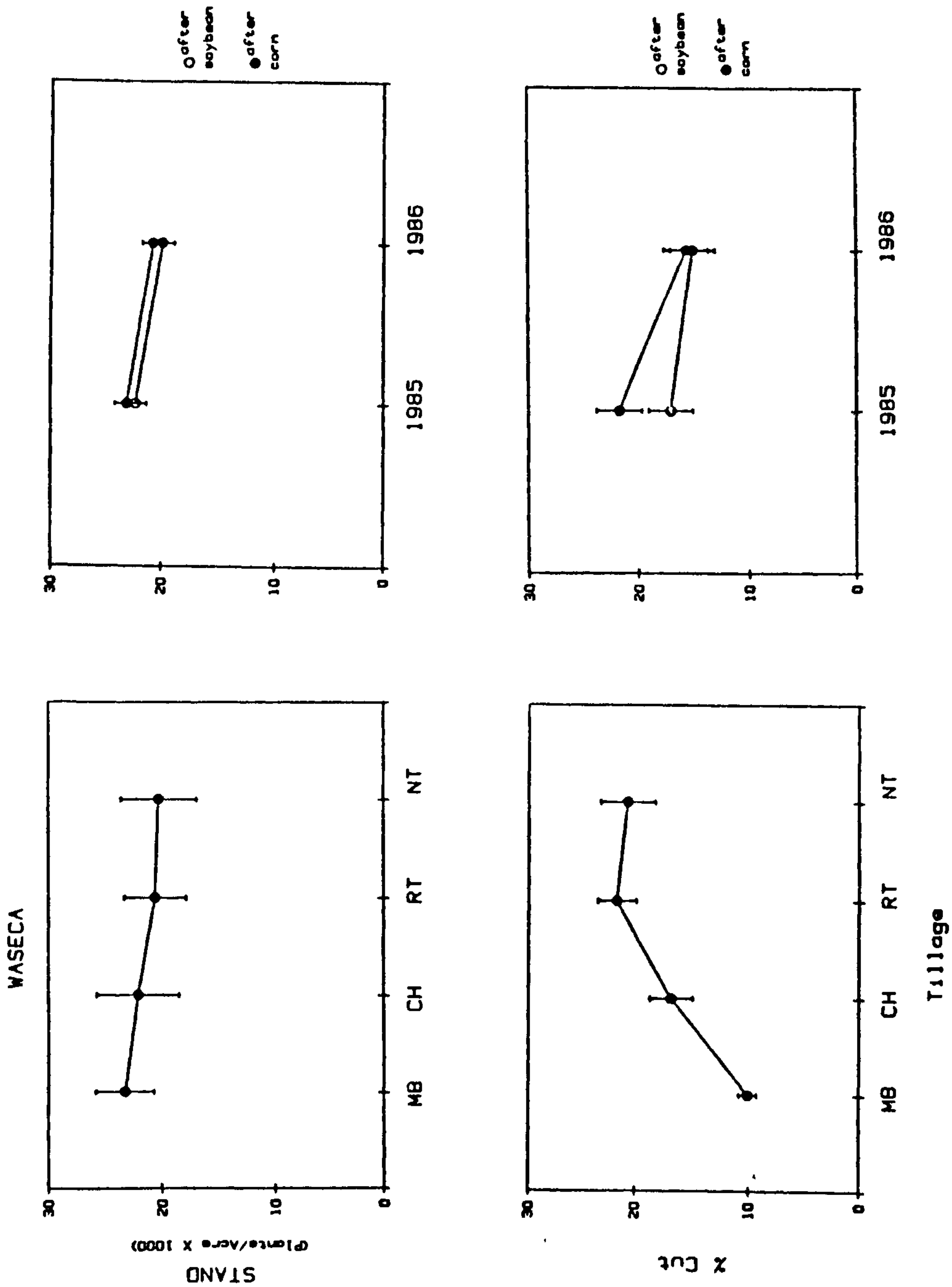


Waseca 1986 Yield
Additive
bu/a
g/pl.
YIELD LOSS
10
0
-10
-20
-30
-40
-50
0
8.4
17.0
25.4
CRW
ECB 2
CRW+ECB 2 (observed)
CRW+ECB 2 (hypothetical)
P<0.027
MULTIPLICATIVE
Percent Yield Loss
10
0
-10
-20
-30
-40
-50
CRW
ECB 2
CRW+ECB 2 (observed)
CRW+ECB 2 (hypothetical)
p<0.027
moldboard
chisel
ridge
no till

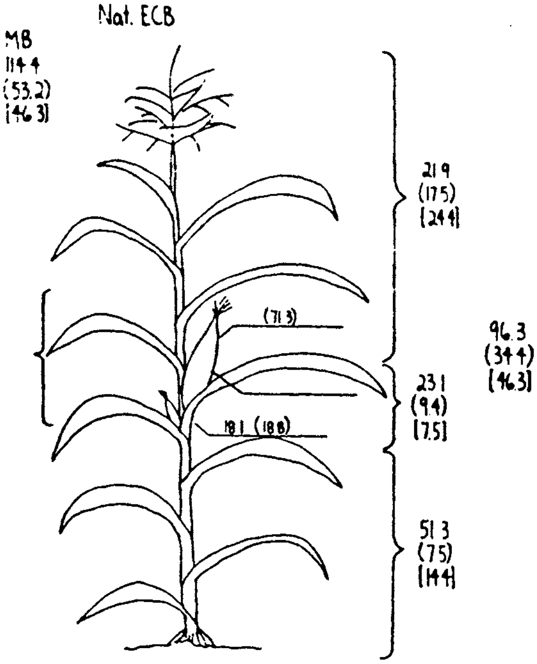

Waseca 1986 Stalk Breakage
Percent Stalk Breakage
15
10
5
0
SR
SR+ECB 1
ECB 1
NONE
p<0.004
Increased Stalk Breakage
10
5
0
SR
ECB 1
SR+ECB 1
p<0.004
MOLDBOARD
CHISEL
RIDGE
NO TILL

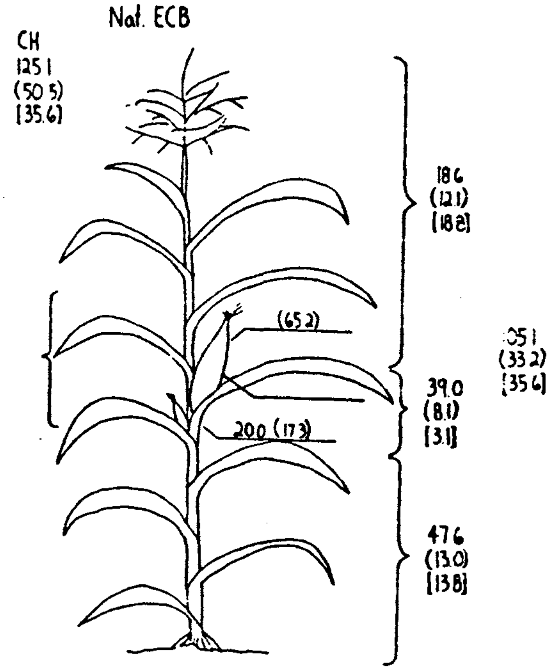


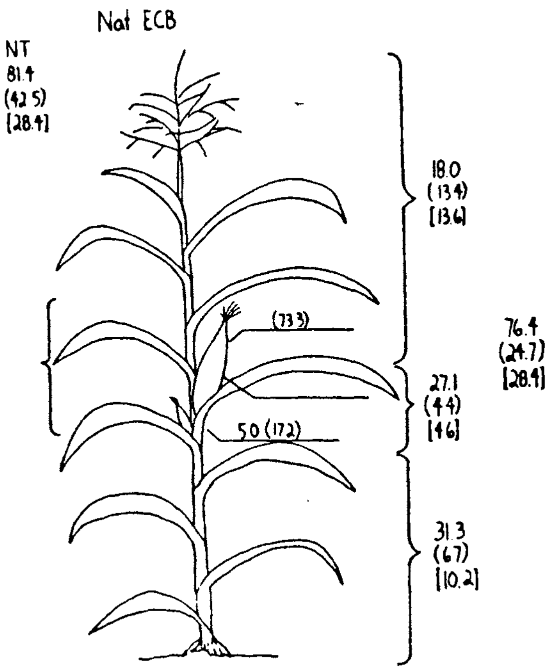
Waseca 1986 Stalk Breakage
Percent Stalk Breakage
15
10
5
0
+ECB 2
-ECB 2
moldboard
chisel
ridge
no till
p<0.000

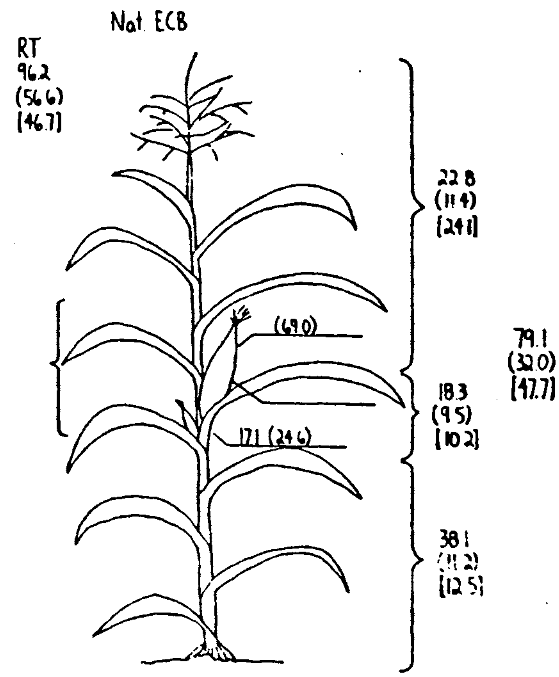

WASECA
STAND
(Plants/Acre X 1000)
% Cut
Tillage
MB
CH
RT
NT
1985
1986
after soybean
after corn
0
10
20
30

Waseca 1986


Nat. ECB
MB
114.4
(53.2)
[46.3]
21.9
(17.5)
[24.4]
(71.3)
96.3
(34.4)
[46.3]
23.1
(9.4)
[7.5]
18.1 (18.8)
51.3
(7.5)
[14.4]


Nat. ECB
CH
125.1
(50.5)
[35.6]
18.6
(12.1)
[18.2]
(65.2)
105.1
(33.2)
[35.6]
39.0
(8.1)
[3.1]
20.0 (17.3)
47.6
(13.0)
[13.8]


Nat ECB
NT
81.4
(42.5)
[28.4]
18.0
(13.4)
[13.6]
(73.3)
76.4
(24.7)
[28.4]
27.1
(4.4)
[4.6]
5.0 (17.2)
31.3
(6.7)
[10.2]


Nat. ECB
RT
96.2
(56.6)
[46.7]
22.8
(11.4)
[24.1]
(69.0)
79.1
(32.0)
[47.7]
18.3
(9.5)
[10.2]
17.1 (24.6)
38.1
(11.2)
[12.5]

EUROPEAN CORN BORER AT WASECA, 1987

David A. Andow

University of Minnesota

Department of Entomology

St. Paul, Minnesota 55108

As a part of a long term study investigating the factors precipitating outbreaks of European corn borer, I have been monitoring populations annually at Waseca. Two samples a week are taken to estimate the number and stage of development of the borer. From these data, I estimate oviposition and mortality rates, which describe population fluctuations.

In 1986, first generation populations were much higher than in 1985. Total generational survival was only around 0.6 percent, and greatest mortality occurred in the egg and last instar (Table 1). Second generation populations were also much higher than in 1985. Total generational survival could not be calculated, but third instar survival was high, while fifth instar survival was low (Table 1). No larvae were observed to diapause during first generation (less than 5.7 percent diapaused (95% confidence interval)).

Corn planting was interrupted by about 10 days during the spring of 1986. Thus, throughout much of southern Minnesota, corn was planted either early or late. Early planted corn supported the bulk of first generation, while late planted corn supported the bulk of second generation European corn borer (Table 2).

Acknowledgements

I would like to thank John Hinz for his excellent work, and William Lueschen, Tom Hoverstad and Tim Schenk for their assistance.

Table 1. Tentative partial life table for Ostrinia nubilalis in early planted corn at Waseca in 1986 (last census of the year on 21 October in unharvested corn).

Stage Interval	Density Number/100 plants	Number Dying	Mortality Rate (%)
First Generation, 1986			
Egg	557.0	467.0	83.8
Instar 1	90.3	20.2	22.3
Instar 2	70.1	20.5	29.3
Instar 3	49.6	16.6	33.5
Instar 4	33.0	10.5	31.6
Instar 5	22.5	10.8	48.0
Mature Instar	11.7	8.1	69.7
Pupae	3.6	?	
Adults	?		
Second Generation, 1986			
Egg	?	?	
Instar 1	?	?	
Instar 2	?	?	
Instar 3	56.7	11.2	19.8
Instar 4	45.5	15.3	33.7
Instar 5	30.2	18.2	60.2
Mature Instar	12.0		

Table 2. Density of mature larvae and percent of corn plants damaged by European corn borer larvae at Waseca in 1986.

	European Corn borer			
	First Generation		Second Generation	
	Number/ 100 plants	Percent Damage	Number/ 100 plants	Percent Damage
Early Planted Corn	11.7	27	12.0	-----
Late Planted Corn	----	<2	114.4	(>90)

RESPONSE OF CORN TO FOLIAR APPLICATION OF ETHEPHON

William E. Lueschen and Thomas R. Hoverstad

Objectives: This study was designed to evaluate the effects of time and rate of ethephon (Cerone)[1/] application on agronomic characteristics and yield of three field corn hybrids.

Procedures: This study was conducted in 1985 and 1986 at the Southern Experiment Station on a Webster clay loam soil containing 6 to 7% organic matter. The soil tests for the sites used each year had the following soil chemical properties: pH=6.5 and 6.6; P=48 and 48 lb/A; and K=381 and 230 lb/A for 1985 and 1986, respectively. The previous crop in both years was soybeans with the sites fall chisel plowed after harvest. The 1985 site received 165 lb N/A as anhydrous ammonia with 'N-Serve' in the fall of 1984. The 1986 site received 150 lb N/A as anhydrous ammonia in the spring of 1986. Just prior to planting each year the seedbed was prepared with one pass with a field cultivator. All plots were seeded at a uniform seeding rate of approximately 29,000 seeds/A. Ten gallons/A of 7-21-7 liquid fertilizer was applied at planting in a band 2 inches to the side and 2 inches below the seed. Weed control consisted of a preemergence application of alachlor (Lasso) + cyanazine (Bladex) + atrazine (3.5+2.0+1.5 lb/A). Ethephon treatments were applied broadcast over-the-top with a high clearance sprayer calibrated to deliver 18 gallons/A at 40 psi using 8002 flat fan nozzle tips in 1985 and at 25 gallons/A at 40 psi using 8003 flat fan nozzle tips in 1986. No spray additive was used with the ethephon treatments.

This study was conducted as a randomized complete block design with a split plot arrangement of treatments--three corn hybrids were main plots and ethephon treatments were subplots. In 1985 and 1986 we evaluated 0.25 and 0.38 lb/A of ethephon applied at the V9 and V12 stages of corn development. In 1986 we added 0.13 lb/A at the V9 stage of corn. Treatment dates and environmental conditions are given in Table 1. Each plot was 10 (4-30 inch rows) x 55 feet with data collected on the two center rows.

Table 1. Planting dates and time of ethephon application and environmental conditions

	1985	1986
I. Planting Dates	May 4	April 25
II. Treatment Dates		
V9 Stage	June 29	June 25
Temperature (°F)	75	85
Relative Humidity (%)	50	45
Tassel Length (inches)	1	0.1
V12 Stage		
Temperature (°F)	July 9	July 3
Relative Humidity (%)	65	40
Tassel Length (inches)	2.5	1.0

1/ Cerone is a trade name of Union Carbide Agricultural Products Company, Inc. The active ingredient is ethephon-(2-chloracthyl) phosphonic acid.

Percent root lodging and percent barren plants were calculated from actual plant counts taken just prior to harvest. Silage yields represent total biomass in 25 ft^2 of plot area. Lea area index (LAI) was determined in mid-August each year by measuring total leaf area from five randomly selected plants using an electronic leaf area meter. At harvest randomly selected 10-ear samples were taken from each plot. This sample was used to determine ear length, ear weight, numbers of kernels/row and numbers of kernel rows/ear, and shelling percentage. Grain yields were corrected to 15.5% moisture.

To assess nutrient status of plants, the entire above ground portion of a randomly selected five-plant sample of Pioneer '3732' was taken at the full-silking stage. These plant samples were dried and ground prior to analysis for nutrient content.

Results: Plant height measurements taken in early July and when plants had reached maximum height in August indicate that the hybrids differed in plant height and ethephon also influenced plant height (Table 2). Greater height reductions occurred when ethephon was applied to the V9 stage of corn than at the V12 stage. At both stages of application the 0.38 lb/A rate of ethephon reduced plant height more than the 0.25 lb/A rate. In 1986, the 0.13 lb/A rate of ethephon applied at the V9 stage reduced plant height measured on July 16 compared to the untreated control. When plants reached maximum height, this rate of ethephon still reduced plant height, however, the reduction was not as great as was observed for the 0.25 and 0.38 lb/A rates. Mature plant height averaged over the three hybrids was reduced by 15 to 25 inches in 1985 and by 3 to 11 inches in 1986 compared to the untreated control. Plants were significantly taller in 1986 than 1985 regardless of ethephon treatment. Stauffer 'S5340' did not respond as much to ethephon treatment as Pioneer '3737' or Pioneer '3732'. Reductions in ear height followed the same pattern as reductions in plant height (Table 2).

Ethephon application significantly reduced lodging in 1985 but not in 1986 when very low incidences of lodging were observed. Although ethephon significantly reduced lodging in all three hybrids, the hybrids benefiting most from ethephon application were Pioneer 3737 and 3732, since they had more lodging in the untreated control plots than was observed for Stauffer S5340.

The percentage of barren plants, plants without ears, was very low both years and was not influenced appreciably by ethephon (Table 3). Differences were significant but not meaningful.

LAI, the ratio of leaf surface to soil surface, was influenced by hybrid, year, and ethephon treatment (Table 3). There was a highly significant hybrid x year interaction for this trait. LAI for Pioneer 3737 and Pioneer 3732 was greater in 1985 than in 1986; the opposite was true for Stauffer S5340. In both 1985 and 1986, ethephon reduced leaf area when applied at the V9 stage but did not reduce leaf area when applied at V12.

Silage yields were similar for all hybrids in 1986 with Pioneer 3732 having the highest silage yield among the three hybrids in 1985 (Table 2). Averaged over the three hybrids, in 1985 ethephon applied at 0.25 lb/A at the V12 stage of corn or 0.38 lb/A at the V9 and V12 stages significantly reduced silage yield. In 1986 there was a trend toward lower silage yields where ethephon was applied, especially at the V9 stage of application. However, silage yields were not significantly different from the untreated check. The hybrid x ethephon treatment interaction was significant for silage yield in 1985. Stauffer S5340 had the greatest loss of plant dry matter in 1985 with the V9 stage of ethephon application whereas Pioneer 3737 was more affected by V12 stage applications. Pioneer 3732 had the greatest silage yield reduction in 1985 when 0.38 lb/A of ethephon was applied at the V9 stage. Silage yields for the 0.13 lb/A rate of ethephon applied at the V9 stage in 1986 was similar to the other two rates at V9 and was significantly lower than the untreated control.

Grain yield was influenced by corn hybrid and ethephon treatment (Table 3). In 1986 all ethephon treatments significantly reduced yield for all hybrids compared to the untreated control. This decrease in yield ranged from 6 to 19 bu/A. Although the yield difference between the ethephon treatments and the untreated control were not significant in 1986, there was a consistent trend toward reduced yield for all ethephon treatments. Even the 0.13 lb/A rate of ethephon applied at V9 reduced yield compared to the untreated control for Pioneer 3737 and Pioneer 3732. Yield for this treatment was not reduced when applied to Stauffer S5340. Test weight of grain was not affected by ethephon treatment.

Ear length was reduced by ethephon application both years when applied at 0.38 lb/A at the V9 stage of corn development (Table 4). In 1985 the 0.25 lb/A rate of ethephon applied at V9 also reduced ear length. None of the ethephon treatments applied at V12 reduced ear length. The differences among the three hybrids and the ethephon treatments, averaged over hybrids, for ear weight were significant but not meaningful since the differences were very small (Table 4).

In 1985 there was a significant and consistent reduction in the numbers of kernels/row/ear for all ethephon treatments as compared to the untreated control (Table 4). The number of rows of kernels on an ear was also reduced where ethephon was applied in 1985. Neither of these affects were observed in 1986. In 1985 shelling percentage was not affected by ethephon treatment (Table 4). The 0.38 lb/A rate of ethephon applied at V12 significantly reduced shelling percentage in 1986 compared to the untreated control but this difference was very small (0.6%).

In 1985 and 1986 whole plant samples of Pioneer 3732 were analyzed for mineral content. Both years there was a significantly higher level of phosphorus in whole plant tissue for most ethephon treatments (Table 5). The greatest increase in phosphorus concentration occurred when ethephon was applied at the V9 stage of corn development. The higher phosphorus concentration is most likely the result of less biomass production where ethephon was applied. In 1986 ethephon applied at 0.25 and 0.38 lb/A at the V9 stage increased N concentration in the plant. This was not observed in 1985. Rate of ethephon application, averaged over the two stages of application, did not affect the concentration of any nutrient. Certain trace elements exhibited some response to ethephon but these were generally small and of little importance.

Summary: In these studies, ethephon significantly reduced plant height in July and when plants were fully mature. In 1985 lodging was reduced where ethephon was applied. The consistent yield reductions observed where ethephon

was applied to three corn hybrids is certainly a negative factor for this compound. Since most commercially available corn hybrids have a reasonable level of lodging resistance, ethephon does not appear to have much potential for field corn. Growers should select hybrids that have high yield potential and also possess good lodging resistance.

Table 2. Influence of corn hybrid and ethephon treatment on plant and ear height, population, and lodging.

Hybrid	Ethephon	Stage	July[1/] Plant Height 1985	1986	Mature Plant Height 1985	1986	Final Ear Height 1985	1986	Plant Pop 1985	1986	Lodging[2/] 1985	1986
	--lb/A--		--inches--						---plt/A---		----%----	
P 3737	Check		58	101	84	106	34	41	27958	26257	19	2
P 3737	0.13	V9	--	93	--	99	--	34	---	26146	--	2
P 3737	0.25	V9	43	90	74	91	26	32	29025	26037	2	2
P 3737	0.38	V9	40	83	64	87	21	29	28625	25631	1	2
P 3737	0.25	V12	52	92	71	99	28	37	29514	26217	0	2
P 3737	0.38	V12	55	88	66	92	27	35	28358	25944	0	1
P 3732	Check		58	98	82	103	36	42	27914	25462	10	1
P 3732	0.13	V9	--	96	--	98	--	37	---	25213	--	2
P 3732	0.25	V9	45	89	65	94	26	35	28136	25471	0	2
P 3732	0.38	V9	43	89	58	89	24	33	28269	26240	1	1
P 3732	0.25	V12	56	97	69	98	32	41	28225	25383	1	2
P 3732	0.38	V12	56	85	64	88	31	39	28270	25346	1	1
S 5340	Check		60	88	82	105	31	47	28803	26322	6	3
S 5340	0.13	V9	--	86	--	103	--	45	---	26164	--	4
S 5340	0.25	V9	44	82	60	101	22	42	28758	25633	0	2
S 5340	0.38	V9	45	76	53	96	20	38	27736	25498	0	3
S 5340	0.25	V12	57	87	65	101	30	44	28047	25904	1	5
S 5340	0.38	V12	56	82	64	97	30	43	28314	25742	1	3

Average across Cerone rates and stages:

Hybrid		July[1/] Plant Height 1985	1986	Mature Plant Height 1985	1986	Final Ear Height 1985	1986	Plant Pop 1985	1986	Lodging[2/] 1985	1986
		--inches--						---plt/A---		----%----	
P 3737		50	91	72	96	27	35	28696	26039	4	2
P 3732		52	92	68	95	30	38	28163	25519	3	2
S 5340		52	84	65	101	27	43	28332	25877	2	3
	BLSD(.05)	ns	3	3	2	1	1	ns	ns	1	2

Average across Hybrids:

Ethephon	Stage	July[1/] Plant Height 1985	1986	Mature Plant Height 1985	1986	Final Ear Height 1985	1986	Plant Pop 1985	1986	Lodging[2/] 1985	1986
--lb/A--		--inches--						---plt/A---		----%----	
Check		59	96	83	105	34	43	28225	26014	12	2
0.13	V9	--	92	--	100	--	39	---	25841	--	3
0.25	V9	44	87	66	95	25	36	28640	25714	1	2
0.38	V9	43	83	58	91	22	33	28210	25790	1	2
0.25	V12	55	92	68	99	30	41	28595	25835	1	3
0.38	V12	56	85	65	92	29	39	28314	25677	1	2
BLSD(.05)		2	3	3	2	1	1	ns	ns	2	ns
		--(Level of Significance)--									
Hybrid x Ethephon:		48	85	92	99	95	98	35	37	99	45

See Footnotes following Tables.

Table 3. Influence of corn hybrid and ethephon treatment on barrenness, leaf area index, silage and grain yields, grain moisture, and test weight.

Hybrid	Ethephon	Stage	Barren[1/] Plants 1985	Barren[1/] Plants 1986	LAI[2/] 1985	LAI[2/] 1986	Silage Yield 1985	Silage Yield 1986	Grain[3/] Yield 1985	Grain[3/] Yield 1986	Grain H20 1985	Grain H20 1986	Test[4/] Weight 1985	Test[4/] Weight 1986
	--lb/A--		-----%-----		----A/A----		---TDM/A---		---bu/A----		------%-----		---lb/bu---	
P3737	Check		0	2	3.95	3.75	9.26	9.27	176	164	20.1	18.0	58.0	57.2
P3737	0.13	V9	-	2	--	3.62	--	8.48	---	157	--	17.8	--	57.5
P3737	0.25	V9	1	1	3.75	3.48	9.11	8.42	163	149	19.6	18.0	58.0	57.2
P3737	0.38	V9	1	1	3.40	3.87	8.52	8.85	157	151	19.2	19.4	57.7	57.3
P3737	0.25	V12	0	1	4.23	3.52	7.60	8.42	157	157	19.3	18.1	57.3	56.1
P3737	0.38	V12	1	2	3.63	3.82	7.74	9.30	162	153	19.9	18.9	58.1	57.3
P3732	Check		0	1	3.84	3.40	9.75	9.68	165	153	24.2	21.0	58.3	57.6
P3732	0.13	V9	-	3	--	3.50	--	8.72	---	140	--	20.6	--	57.9
P3732	0.25	V9	0	2	3.46	3.37	9.12	8.62	159	136	23.9	20.0	58.5	58.2
P3732	0.38	V9	1	1	3.22	3.60	8.35	8.78	147	140	23.9	20.2	58.6	58.7
P3732	0.25	V12	1	3	3.77	3.50	8.64	9.10	156	145	23.9	20.3	58.1	58.2
P3732	0.38	V12	1	3	3.75	2.85	8.45	8.45	150	137	23.5	20.2	57.9	58.6
S5340	Check		0	3	3.27	4.18	8.51	9.70	160	161	20.6	26.8	58.4	58.6
S5340	0.13	V9	-	3	--	3.80	--	9.10	---	161	--	26.2	--	59.5
S5340	0.25	V9	1	3	2.94	3.75	7.83	9.58	146	154	21.1	26.2	58.0	58.4
S5340	0.38	V9	0	3	2.88	3.72	7.21	8.30	141	160	20.4	26.8	58.2	59.3
S5340	0.25	V12	0	5	3.06	4.20	8.68	9.95	150	148	20.1	25.1	58.5	60.3
S5340	0.38	V12	0	3	3.20	4.35	8.00	9.22	147	148	20.0	25.8	58.6	58.9

Average across Cerone rates and stages:

Hybrid	Barren[1/] Plants 1985	Barren[1/] Plants 1986	LAI[2/] 1985	LAI[2/] 1986	Silage Yield 1985	Silage Yield 1986	Grain[3/] Yield 1985	Grain[3/] Yield 1986	Grain H20 1985	Grain H20 1986	Test[4/] Weight 1985	Test[4/] Weight 1986
	-----%-----		----A/A----		---TDM/A---		---bu/A----		----%-----		---lb/bu---	
P3737	1	2	3.79	3.68	8.45	8.79	163	155	19.6	18.4	57.8	57.1
P3732	1	2	3.61	3.37	8.86	8.89	155	142	23.9	20.4	58.3	58.2
S5340	0	3	3.07	4.00	8.05	9.31	149	155	20.4	26.2	58.3	59.2
BLSD(.05)	ns	1	0.10	0.37	0.50	ns	10	7	0.5	0.9	ns	1.1

Average across Hybrids:

Ethephon	Stage	Barren[1/] Plants 1985	Barren[1/] Plants 1986	LAI[2/] 1985	LAI[2/] 1986	Silage Yield 1985	Silage Yield 1986	Grain[3/] Yield 1985	Grain[3/] Yield 1986	Grain H20 1985	Grain H20 1986	Test[4/] Weight 1985	Test[4/] Weight 1986
--lb/A--		-----%-----		----A/A----		---TDM/A---		---bu/A----		-----%-----		---lb/bu---	
Check		0	2	3.69	3.78	9.17	9.55	167	159	21.6	21.9	58.2	57.8
0.13	V9	-	3	--	3.64	--	8.77	---	153	--	21.5	--	58.3
0.25	V9	1	2	3.38	3.53	8.69	8.87	156	146	21.5	21.4	58.2	57.9
0.38	V9	1	2	3.17	3.73	8.03	8.64	148	150	21.2	22.1	58.2	58.4
0.25	V12	0	3	3.69	3.74	8.31	9.16	154	150	21.1	21.2	58.0	58.2
0.38	V12	1	3	3.53	3.67	8.06	8.99	153	146	21.1	21.6	58.2	58.3
BLSD(.05)		1	1	0.20	ns	0.60	ns	6	ns	0.6	ns	ns	ns

	Barren 1985	Barren 1986	LAI 1985	LAI 1986	Silage 1985	Silage 1986	Grain 1985	Grain 1986	H20 1985	H20 1986	Test 1985	Test 1986
	---(Level of Significance)---											
Hybrid x Ethephon:	69	58	99	95	97	30	27	2	78	48	48	87

See Footnotes following Tables.

Table 4. Influence of corn hybrid and ethephon treatment on ear size, kernels/ear, shelling percentage, and kernel weight

Hybrid	Ethephon	Stage	Ear[1/] Weight 1985	Ear[1/] Weight 1986	Ear[1/] Length 1985	Ear[1/] Length 1986	Rows[1/] of Kernels 1985	Rows[1/] of Kernels 1986	Kernels[1/] per row 1985	Kernels[1/] per row 1986	Shelling 1985	Shelling 1986	Seed Weight 1985	Seed Weight 1986
	--lb/A--		----lb----		--inches---		----------per	ear	--------		-----%-----		--g/100---	
P3737	Check		0.43	0.40	7.1	7.0	17.5	17.2	37.5	39.4	88.2	88.7	27.6	24.5
P3737	0.13	V9	--	0.42	---	7.0	--	16.6	--	39.0	--	88.2	--	24.8
P3737	0.25	V9	0.33	0.38	6.2	6.7	16.5	17.0	33.8	37.3	88.6	88.6	23.3	22.0
P3737	0.38	V9	0.34	0.34	6.3	6.4	16.0	16.8	34.3	35.5	88.1	88.3	21.5	22.5
P3737	0.25	V12	0.36	0.34	6.7	6.7	16.0	17.0	34.0	37.7	88.2	87.8	25.6	20.8
P3737	0.38	V12	0.37	0.37	7.0	6.8	16.5	17.0	35.8	37.2	88.0	88.6	24.4	23.4
P3732	Check		0.44	0.39	7.1	6.9	14.0	13.6	38.0	39.8	86.4	87.3	32.2	27.2
P3732	0.13	V9	--	0.39	---	6.9	--	13.8	--	39.0	--	87.2	--	25.2
P3732	0.25	V9	0.40	0.41	6.8	7.2	14.0	13.8	36.3	40.8	86.9	87.6	31.3	26.2
P3732	0.38	V9	0.40	0.40	6.9	6.9	13.5	13.8	35.5	40.1	87.0	88.0	31.4	27.5
P3732	0.25	V12	0.39	0.41	7.2	7.3	13.0	13.8	38.0	40.8	86.8	87.1	29.9	26.2
P3732	0.38	V12	0.37	0.43	6.9	7.4	14.0	13.9	35.2	41.0	86.8	85.9	30.4	27.8
S5340	Check		0.38	0.46	6.4	7.3	14.0	14.2	35.8	40.5	87.0	88.4	27.8	31.5
S5340	0.13	V9	--	0.44	---	7.1	--	15.0	--	39.5	--	89.0	--	29.0
S5340	0.25	V9	0.33	0.44	6.0	7.1	13.5	14.4	32.8	39.2	86.6	88.2	29.2	30.2
S5340	0.38	V9	0.32	0.38	6.0	6.5	14.0	14.4	32.2	38.9	87.0	88.8	26.7	27.2
S5340	0.25	V12	0.35	0.43	6.7	7.2	14.0	14.3	36.2	40.8	86.6	88.4	27.7	28.0
S5340	0.38	V12	0.38	0.44	7.1	7.4	14.0	14.1	36.5	41.0	86.9	88.1	28.6	28.2

Average across Cerone rates and stages:

Hybrid	Ear[1/] Weight 1985	Ear[1/] Weight 1986	Ear[1/] Length 1985	Ear[1/] Length 1986	Rows[1/] of Kernels 1985	Rows[1/] of Kernels 1986	Kernels[1/] per row 1985	Kernels[1/] per row 1986	Shelling 1985	Shelling 1986	Seed Weight 1985	Seed Weight 1986
	----lb----		--inches--		----------per	ear	--------		-----%-----		--g/100---	
P3737	0.37	0.38	6.7	6.8	16.5	16.9	35.1	37.7	88.2	88.4	24.5	23.0
P3732	0.40	0.41	7.0	7.1	13.7	13.8	36.6	40.3	86.8	87.2	31.0	26.7
S5340	0.35	0.43	6.4	7.1	13.9	14.4	34.7	40.0	86.8	88.5	28.0	29.0
BLSD(.05)	0.03	0.03	0.3	0.2	0.6	0.4	ns	1.1	0.4	0.6	1.3	1.6

Average across Hybrids:

Ethephon	Stage	Ear[1/] Weight 1985	Ear[1/] Weight 1986	Ear[1/] Length 1985	Ear[1/] Length 1986	Rows[1/] of Kernels 1985	Rows[1/] of Kernels 1986	Kernels[1/] per row 1985	Kernels[1/] per row 1986	Shelling 1985	Shelling 1986	Seed Weight 1985	Seed Weight 1986
--lb/A--		----lb----		--inches--		----------per	ear	--------		-----%-----		--g/100---	
Check		0.42	0.42	6.9	7.1	15.2	15.0	37.1	39.9	87.2	88.1	29.2	27.7
0.13	V9	--	0.42	---	7.0	--	15.1	--	39.2	--	88.1	--	26.3
0.25	V9	0.35	0.41	6.3	7.0	14.7	15.1	34.3	39.1	87.4	88.1	27.9	26.1
0.38	V9	0.35	0.37	6.4	6.6	14.5	15.0	34.0	38.2	87.4	88.4	26.5	25.7
0.25	V12	0.37	0.39	6.8	7.1	14.3	15.0	36.1	39.8	87.2	87.8	27.7	25.0
0.38	V12	0.37	0.41	7.0	7.2	14.8	15.0	35.8	39.7	87.2	87.5	27.8	26.5
BLSD(.05)		0.04	ns	0.4	0.4	1.0	ns	2.0	ns	ns	0.5	2.3	ns

	------------(Level	of	Significance)	------------								
Hybrid x Ethephon:	43	13	63	38	63	47	67	65	29	96	85	11

See Footnotes following Tables.

FOOTNOTES

Table 2

1/ Plant height data taken on 7/12/85 and 7/16/86.

2/ Lodging--percentage of plants lodged more than 30° from vertical.

Table 3

1/ Barren plants--plants with no ears.

2/ LAI--leaf area index--the ratio of corn leaf surface to ground surface

3/ Yields adjusted to 15.5% moisture.

4/ Test weight was taken using a 10-ear sample that was allowed to air dry for approximately 30 days before shelling.

Table 4

1/ These parameters were determined on a 10-ear sample.

Table 5. Influence of ethephon application on plant nutrient content of Pioneer 3732.

Hybrid	Ethephon	Stage	N 1985	N 1986	P 1985	P 1986	K 1985	K 1986	CA 1985	CA 1986	MG 1985	MG 1986	AL 1985	AL 1986
	--lb/A--		ppm in whole plant											
P3732	Check		1.60	1.31	2020	2146	22276	12662	4071	2453	3727	2125	48	29
P3732	0.13	V9	----	1.30	----	2193	----	12780	----	2319	----	2244	--	32
P3732	0.25	V9	1.74	1.54	2293	2543	22282	13546	4161	2275	3602	2148	46	31
P3732	0.38	V9	1.68	1.58	2381	2554	23235	14432	4053	2461	3503	2242	42	29
P3732	0.25	V12	1.50	1.34	2056	2300	21670	13184	4047	2240	3629	2236	44	27
P3732	0.38	V12	1.76	1.40	2231	2363	20925	14068	4199	2532	3786	2311	44	33
BLSD (0.05)			ns	0.17	304	222	ns	ns	ns	ns	ns	ns	ns	ns

Average for ethephon rates:

Ethephon	N 1985	N 1986	P 1985	P 1986	K 1985	K 1986	CA 1985	CA 1986	MG 1985	MG 1986	AL 1985	AL 1986
--lb/A--	ppm in whole plant											
Check	1.66	1.31	1997	2146	22276	12662	4277	2453	3916	2125	55	29
0.25	1.62	1.44	2174	2421	21976	13365	4104	2257	3615	2192	45	29
0.38	1.72	1.49	2306	2558	22080	14250	4126	2496	3644	2276	43	31
Level of significance (%):	71	63	83	41	11	89	13	90	20	61	31	68

Average for application stages:

Stage	N 1985	N 1986	P 1985	P 1986	K 1985	K 1986	CA 1985	CA 1986	MG 1985	MG 1986	AL 1985	AL 1986
	ppm in whole plant											
Check	1.66	1.31	1997	2146	22276	12662	4277	2453	3916	2125	55	29
V9	1.71	1.56	2337	2548	22758	13989	4107	2368	3552	2195	44	30
V12	1.63	1.37	2143	2331	21297	13626	4123	2385	3707	2273	44	29
Level of significance (%):	65	99	95	99	93	52	9	10	79	57	4	12
Interaction between ethephon rate x stage: (Level of significance)	91	15	37	29	73	1	65	31	71	8	43	91

Table 5. (continued)

Hybrid	Ethephon	Stage	FE 1985	FE 1986	NA 1985	NA 1986	MN 1985	MN 1986	ZN 1985	ZN 1986	CU 1985	CU 1986	B 1985	B 1986	PB 1985	PB 1986	NI 1985	NI 1986	CR 1985	CR 1986	CD 1985	CD 1986
	--lb/A--		ppm in whole plant																			
P3732	Check		99	61	18	5	36	34	23	19	4.9	5.1	8.3	6.7	0.1	0.9	0.3	0.3	0.2	0.1	0.08	0.08
P3732	0.13	V9	--	62	--	6	--	36	--	20	---	4.9	---	7.7	---	0.9	---	0.3	---	0.2	----	0.06
P3732	0.25	V9	131	70	12	7	43	33	28	20	5.2	5.6	10.7	8.0	0.1	0.9	0.3	0.3	0.3	0.2	0.07	0.06
P3732	0.38	V9	91	68	12	6	38	35	25	22	5.5	5.3	9.5	8.7	0.1	1.0	0.3	0.3	0.3	0.1	0.07	0.08
P3732	0.25	V12	94	61	11	7	34	31	24	18	4.9	4.9	8.9	6.7	0.1	0.9	0.3	0.3	0.2	0.2	0.06	0.07
P3732	0.38	V12	104	68	15	7	37	38	27	19	4.9	5.1	10.0	7.3	0.1	0.9	0.3	0.3	0.2	0.2	0.06	0.06
BLSD (0.05)			ns	ns	ns	ns	7	ns	ns	ns	ns	0.7	2.4	1.7	ns	ns	ns	ns	ns	0.1	ns	ns

Average for ethephon rates:

Ethephon	FE 1985	FE 1986	NA 1985	NA 1986	MN 1985	MN 1986	ZN 1985	ZN 1986	CU 1985	CU 1986	B 1985	B 1986	PB 1985	PB 1986	NI 1985	NI 1986	CR 1985	CR 1986	CD 1985	CD 1986
--lb/A--	ppm in whole plant																			
Check	99	61	18	5	36	34	23	19	4.9	5.1	8.3	6.7	0.1	0.9	0.3	0.3	0.2	0.1	0.08	0.08
0.25	113	66	12	7	39	32	26	19	5.1	5.3	9.8	7.4	0.1	0.9	0.3	0.3	0.3	0.2	0.07	0.07
0.38	98	68	14	7	38	37	26	21	5.2	5.2	9.8	8.0	0.1	1.0	0.3	0.3	0.3	0.2	0.07	0.07
Level of significance (%):	55	40	57	12	48	90	2	60	48	24	7	96	66	47	60	1	29	88	32	24

Average for application stages:

Stage	FE 1985	FE 1986	NA 1985	NA 1986	MN 1985	MN 1986	ZN 1985	ZN 1986	CU 1985	CU 1986	B 1985	B 1986	PB 1985	PB 1986	NI 1985	NI 1986	CR 1985	CR 1986	CD 1985	CD 1986
	ppm in whole plant																			
Check	99	61	18	5	36	34	23	19	4.9	5.1	8.3	6.7	0.1	0.9	0.3	0.3	0.2	0.1	0.08	0.08
V9	111	69	12	7	41	34	27	21	5.4	5.5	10.1	8.4	0.1	1.0	0.3	0.3	0.3	0.2	0.07	0.07
V12	99	65	13	7	36	35	26	19	4.9	5.0	9.5	7.0	0.1	0.9	0.3	0.3	0.2	0.2	0.06	0.07
Level of significance (%):	46	63	35	6	97	10	47	83	86	97	72	99	66	47	41	0	79	72	59	24

Interaction between ethephon rate x stage:

	FE 1985	FE 1986	NA 1985	NA 1986	MN 1985	MN 1986	ZN 1985	ZN 1986	CU 1985	CU 1986	B 1985	B 1986	PB 1985	PB 1986	NI 1985	NI 1986	CR 1985	CR 1986	CD 1985	CD 1986
	(Level of significance)																			
	78	64	44	26	93	63	82	9	37	71	91	15	66	82	41	1	13	63	32	63

EFFECTS OF FOLIAR APPLICATIONS OF RESPOND[a] AND N FERTILIZATION ON CORN PERFORMANCE IN 1986

William E. Lueschen, Gyles W. Randall
Thomas R. Hoverstad and Patrick L. Kelly
University of Minnesota
Southern Experiment Station
Waseca, Minnesota

Objectives: This study was designed to evaluate the agronomic effects of foliar applications of 'Respond' to corn fertilized with 0, 75 and 150 lb/A of N fertilizer.

Procedures: This study was conducted at the Southern Experiment Station on a Nicollet clay loam soil containing 5% to 6% organic matter. Soil test results from 1985 indicated the following soil chemical properties: pH=6.9; P=58 and K=358 lb/A. The 1985 crop was a uniform planting of corn with no N fertilizer. The site was moldboard plowed in the fall of 1985. Anhydrous ammonia was injected into the soil on appropriate plots on April 24, 1986. Spring tillage consisted of one field cultivation prior to planting Pioneer '3737' on May 7, 1986. All plots were planted at a rate of 27,700 seeds/A.
A uniform preemergence application of Lasso + atrazine (3.5 + 3.0 lb/A) was applied to all plots on May 15, 1986. Respond at 16 oz/A was applied broadcast over-the-top on July 3, 1986 when corn was in the V9 to V10 stage with a high clearance sprayer calibrated to deliver 20 gallons per acre at 40 psi. On the treatment date, the air temperature was 80°F with a relative humidity of 55%. This study was designed as a randomized complete block with six replications and a split plot arrangement of treatments. N rates were the main plots and subplots were the Respond treatments. Each plot consisted of four rows (30-inch spacing) 55 feet in length. All data were collected on the two center rows.

To evaluate the N status of whole plants, five randomly selected plants were removed from each plot on July 24 when the corn was silking. These samples were dried and ground prior to analysis. Plant and ear heights were measured on August 28 when plants had reached maximum height. Plant height was measured to the top of the tassel and ear height was measured to the node where the ear shank was attached. Population counts were made on August 28, counting the number of plants in each of the two center rows. Silage yields were taken on September 24 by harvesting the entire above ground plant material in a 25 ft^2 area in each plot. Grain and stover portions of these samples were separated and measured separately. N content of each were also analyzed. Grain yields were taken on October 15, 1986 with a modified combine after end trimming each plot to 45 feet. Ear weight, ear length, the number of rows of kernels/ear and the number of kernels/row on each ear, shelling percentage, test weight and seed weight were measured from 10 randomly selected ears taken from the two outside rows of each plot. These samples were allowed to air dry before processing.

---

[a]Respond is a trade name for a crop and soil supplement distributed by United Agri Products, Inc., 419-18th Street, Box 1286, Greeley, CO 80632. Respond consists of 0.0011% natural plant extracts having 7.6 mg/l of Vitamin B Complex compounds, and 3.4 mg/l of Purine-like and Adenine-like structures. It also contains 0.2% inorganic compounds.

Discussion: Tables 1 and 2 show the effects of foliar applications of Respond to corn fertilized with 0, 75 and 150 lb N/A. N rate significantly affected all agronomic traits except final population (Table 2) and seed weight. Grain yields were increased by 56.2 and 71.9 bu/A over the check plots for the 75 and 150 lb N/A treatments, respectively. Even at the highest rate of N significant mid-season N deficiency was observed which limited yields. Compared to the unfertilized check, silage yields were increased an average of 3.20 and 4.03 TDM/A for the 75 and 150 lb/A N rates, respectively (Table 2).

Whole plant N content averaged across Respond treatments increased from 0.89% for the check plot to 1.20% for 75 lb N/A and to 1.58% for 150 lb N/A. Likewise, stover N content at silage harvest increased from 0.43% for the check to 0.48 and 0.59% for 75 lb N/A and 150 lb N/A, respectively. Grain N content 1.12 for the check plot to 1.23 for 75 lb N/A and 1.38 for 150 lb N/A. (Table 2). Plant height, ear height, ear weight, ear length, number of rows of kernels and number of kernels/row were all increased as N rate was increased (Tables 1 and 2). There was a trend toward lower test weight with increased N rates. Shelling percentage was not consistently influenced by N treatments. Grain moisture at harvest was highest where no N was applied and lowest for the 150 lb/A rate of N.

There was a trend toward reduced yields where Respond was applied (Table 1). Averaged over all N rates, Respond resulted in a 5 bu/A decrease in yield, significant at the 92% level. Although shelling percentage (Table 1) and plant height (Table 2) tended to be reduced slightly by Respond treatment these differences were small and probably not meaningful. All other agronomic traits of corn were not affected by Respond application.

We did not observe any significant Respond and N rate interactions for any traits, i.e. the effects of Respond application were consistent across all three N rates.

Conclusion: In this study where corn followed corn that received no N in 1985 to deplete the soil of residual N, excellent response to N application was obtained. However, corn yields were limited because of N deficiency that occurred in mid-season. Heavy June rainfall (7.89 inches) created very wet soil conditions that likely lead to denitrification. The relatively low N rates used in this study also contributed to N deficiencies and the reduced grain yields we observed. Respond applied at 16 oz/A at the V9 to V10 stage of corn generally did not affect corn performance although there was a trend for reduced yields--up to 5 bu/A--where Respond was applied.

In 1985, Respond was evaluated on Pioneer 3732. Foliar applications (16 oz/A) were made at three corn growth stages--V3, V9 and V15. An additional treatment involved repeat applications of Respond at 8 oz/A at both the V3 and V9 stages of corn growth. In this trial, none of the agronomic traits of corn, including grain yield, were affected by Respond treatment. Therefore, it does not appear from our results that foliar applications of Respond to corn have potential for improving yield or influencing other traits of corn.
Based on the 1986 study involving three levels of nitrogen, it does not appear that Respond affects the efficiency of N use.

Table 1. Effects of foliar applications of Respond and N fertilization on yield components and grain yield of corn at Waseca, MN in 1986.

Nitrogen	Respond	Ear Weight	Ear Length	Rows of Kernels	Kernels per Row	Shell-ing	Test Weight	Seed Weight	Grain H2O	Grain Yield[a]
(lb/A)		(lb)	(in)	--(per	ear)---	(%)	(lb/bu)	(g/100)	(%)	(bu/A)
Check	---	0.14	4.2	14.2	24.4	89.7	56.4	17.8	22.6	57
Check	16 oz	0.14	4.1	13.6	23.6	88.6	56.5	18.3	22.4	52
75	---	0.23	5.3	16.6	29.9	89.9	55.7	18.2	18.3	112
75	16 oz	0.22	5.3	16.8	29.8	89.7	56.1	17.5	18.3	110
150	---	0.26	5.6	17.3	32.3	89.1	55.6	18.2	17.7	131
150	16 oz	0.26	5.8	16.7	32.6	88.6	55.4	18.5	17.5	123

Average across N rates :

Respond	Ear Weight	Ear Length	Rows of Kernels	Kernels per Row	Shell-ing	Test Weight	Seed Weight	Grain H2O	Grain Yield[a]
	(lb)	(in)	--(per	ear)---	(%)	(lb/bu)	(g/100)	(%)	(bu/A)
---	0.21	5.0	16.0	28.9	89.6	55.9	18.1	19.5	100
16 oz	0.21	5.1	15.7	28.7	89.0	56.0	18.1	19.4	95
Level of signif.(%)	0	7	78	39	88	30	12	33	92

Average across Respond treatments :

Nitrogen	Ear Weight	Ear Length	Rows of Kernels	Kernels per Row	Shell-ing	Test Weight	Seed Weight	Grain H2O	Grain Yield[a]
(lb/A)	(lb)	(in)	--(per	ear)---	(%)	(lb/bu)	(g/100)	(%)	(bu/A)
Check	0.14	4.2	13.9	24.0	89.2	56.5	18.1	22.5	55
75	0.23	5.3	16.7	29.9	89.8	55.9	17.9	18.3	111
150	0.26	5.7	17.0	32.5	88.9	55.5	18.4	17.6	127
BLSD(.05)	0.04	0.4	0.9	1.9	0.8	0.7	ns	0.6	7.4

Interaction between Respond x N :	Level of Significance (%)								
	22	68	67	56	44	30	63	9	29

[a] Grain yield adjusted to 15.5% moisture.

Table 2. Effects of foliar applications of Respond and N fertilization on on plant and ear height, plant population, N content of whole plants and silage yield at Waseca, MN in 1986.

						Silage				
Nitrogen	Respond	Plant Height	Ear Height	Final Pop.	Whole Plant N	Stover	Grain	Total	Stover N	Grain N
(lb/A)		--inches--		(plts/A)	(%)	-----(TDM/A)-----			-- (%) --	
Check	---	80	27	26847	0.94	2.56	1.72	4.28	0.44	1.13
Check	16 oz	78	28	26195	0.84	2.46	1.61	4.08	0.42	1.10
75	---	100	38	27084	1.18	4.30	3.17	7.47	0.47	1.21
75	16 oz	99	37	27261	1.22	4.28	3.00	7.28	0.49	1.25
150	---	104	40	27380	1.54	4.67	3.41	8.08	0.55	1.46
150	16 oz	103	39	27676	1.62	4.73	3.59	8.33	0.63	1.30

Average across N rates :

						Silage				
	Respond	Plant Height	Ear Height	Pop.	Whole Plant N	Stover	Grain	Total	Stover N	Grain N
		--inches--		(plts/A)	(%)	-----(TDM/A)-----			-- (%) --	
	---	94	35	27104	1.22	3.84	2.77	6.61	0.49	1.27
	16 oz	93	34	27044	1.23	3.82	2.73	6.56	0.51	1.22
Level of signif.(%)		84	64	9	13	11	21	15	69	79

Average across Respond treatments :

						Silage				
Nitrogen	Respond	Plant Height	Ear Height	Pop.	Whole Plant N	Stover	Grain	Total	Stover N	Grain N
(lb/A)		--inches--		(plts/A)	(%)	-----(TDM/A)-----			-- (%) --	
Check		79	27	26521	0.89	2.51	1.67	4.18	0.43	1.12
75		99	37	27173	1.20	4.29	3.09	7.38	0.48	1.23
150		103	39	27528	1.58	4.70	3.50	8.21	0.59	1.38
BLSD(.05)		1.4	1.1	ns	0.08	0.28	0.18	0.43	0.10	0.17
Interaction between		---------------- Level of Significance (%) -------------								
Respond x N :		17	88	29	76	10	52	27	72	83

Corn Tolerance to Acetanilide herbicides

P.R.Viger, C.V. Eberlein, W.E. Lueschen, and T.L. Miller

The acetanilide herbicide family contains several compounds commonly used for weed control in corn, including alachlor (Lasso), metolachlor (Dual), propachlor (Ramrod), and an experimental herbicide, acetochlor (Harness). Over the years it has been observed that corn seeded into cold, wet soils may be injured by these herbicides. However, no information was available on the relationship between early season corn injury and yield. Therefore, field studies were conducted to examine the tolerance of early seeded corn to several rates of acetochlor, alachlor, metolachlor, and propachlor under weed free conditions.

Experiments were conducted at the Southern Experiment Station in 1985 and 1986. Two commonly grown corn hybrids, 'Pioneer 3906' and 'Pioneer 3732' were seeded on May 3, 1985 and May 5, 1986. The soil type in 1985 was a Webster clay loam with pH 7.0 and 6 to 7% organic matter (O.M.), and in 1986 the soil type was a Nicollet clay loam with pH 6.7 and 5.3% O.M. Acetochlor, alachlor, and metolachlor at rates of 2.5, 5.0, 7.5 and 10.0 lb/A, and propachlor at 5, 10, 15 and 20 lb/A were applied preemergence with a motorized plot sprayer which delivered 20 gpa. The experimental design used was a split plot arrangement of a randomized complete block design with four replications. Main plots were hybrids and subplots were herbicides and rates. Plots were kept weed free with a preemergence application of atrazine (Aatrex) at 2.0 lb/A and hand weeding as needed.

In 1985, the average temperature for the two weeks following herbicide application was 16% above the normal temperature of 55°F, and rainfall was 22% below average. Under these relatively warm, dry conditions, corn injury was insignificant even at the highest rates of alachlor, metolachlor and propachlor tested, and corn yields were not reduced by these herbicides (Table 1). Only acetochlor at 10 lb/A caused significant injury (10%) and reduced corn yields by 7% compared to the weed free control. Hybrids did not vary in their response to the acetanilides.

In 1986, temperatures were near normal (55°F) for the two weeks following herbicide application, and rainfall was about twice normal. Under these relatively cool, wet conditions, acetochlor injury ranged from 5 to 24% over the rates tested, alachlor injury ranged from 1 to 6%, metolachlor injury ranged from 2 to 9%, and propachlor injury ranged from 0 to 3% (Table 2). Acetochlor at 2.5 and 5 lb/A did not reduce yields, but acetochlor at 7.5 and 10 lb/A reduced yields by 6% and 8%, respectively. Corn yields were not reduced by any rate of metolachlor or propachlor tested, and only the highest rate of alachlor (10 lb/A) caused a significant yield reduction (6%) (Table 2). Hybrids did not vary in their response to the herbicide treatments.

This research has shown that corn is most tolerant to propachlor and least tolerant to acetochlor. Corn injury from propachlor was very slight even under the cool, wet conditions of 1986. Injury from acetochlor, alachlor, and metolachlor was greater in a cool, wet spring than a warm, dry spring, but corn showed a good ability to recover from early season injury and yields were not reduced by typical use rates of these herbicides.

Table 1. Corn tolerance to acetanilide herbicides, Waseca, MN. 1985. (Eberlein, C.V., W.E. Lueschen and T.L. Miller).[a]

Treatment[b]	Rate	Injury (6/3)	Corn Moisture	Corn Yield
	(lbs/A)	(%)	(%)	(bu/A)
Acetochlor	2.5	1	30	157
Acetochlor	5.0	0	30	153
Acetochlor	7.5	4	30	150
Acetochlor	10.0	10	30	143
Alachlor	2.5	2	30	151
Alachlor	5.0	2	30	155
Alachlor	7.5	0	30	163
Alachlor	10.0	1	29	150
Metolachlor	2.5	1	30	154
Metolachlor	5.0	1	29	159
Metolachlor	7.5	2	30	156
Metolachlor	10.0	1	29	155
Propachlor	5.0	2	30	158
Propachlor	10.0	2	30	161
Propachlor	15.0	1	30	158
Propachlor	20.0	1	29	159
Control	0.0	2	30	153
LSD(0.05)		4	1	9

[a] Averaged over two hybrids.
[b] Area received atrazine at 2.0 lbs/A preemergence.

Table 2. Corn tolerance to acetanilide herbicides, Waseca, MN. 1986. (Viger, P.R., C.V. Eberlein, W.E. Lueschen and T·L. Miller).[a]

Treatment[b]	Rate	Injury (6/3)	Corn Moisture	Corn Yield
	(lbs/A)	(%)	(%)	(bu/A)
Acetochlor	2.5	5	24	147
Acetochlor	5.0	8	25	149
Acetochlor	7.5	13	25	144
Acetochlor	10.0	24	26	141
Alachlor	2.5	1	24	154
Alachlor	5.0	3	24	151
Alachlor	7.5	4	25	147
Alachlor	10.0	6	25	145
Metolachlor	2.5	2	24	153
Metolachlor	5.0	3	24	154
Metolachlor	7.5	8	24	152
Metolachlor	10.0	9	25	154
Propachlor	5.0	0	25	156
Propachlor	10.0	1	25	155
Propachlor	15.0	1	25	155
Propachlor	20.0	3	26	155
Control	0.0	0	24	154
LSD(0.05)		4	1	8

[a] Averaged over two hybrids.
[b] Area received atrazine at 2.0 lbs/A preemergence.

CARRYOVER POTENTIAL OF AC-263,499, DPX-F6025, FMC-57020, AND IMAZAQUIN IN MINNESOTA

Jeffrey L. Gunsolus, Richard Behrens, William E. Lueschen, Dennis D. Warnes, and John V. Wiersma

Cool and short growing seasons, variable precipitation, and a wide range of soil types characterize Minnesota's crop environment. These same factors increase the potential for herbicide carryover. Therefore, it is important that new herbicides be evaluated for their carryover potential in Minnesota. Herbicides were applied in 1985 and carryover potential was evaluated in 1986 at Crookston, Morris, and Waseca, Minnesota for two rates of AC-263,499 (Pursuit), DPX-F6025 (Classic), FMC-57020 (Command), and Imazaquin (Scepter) on corn (*Zea mays* L.), oats (*Avena sativa* L.) or wheat (*Triticum aestivum* L.), and alfalfa (*Medicago sativa* L.). The Waseca site had a Webster clay loam soil with 7.7% organic matter and a pH of 6.0. Precipitation was below normal the summer of herbicide application and no fall tillage was performed. The Morris site had a Doland silt loam soil with 5.0% organic matter and a pH of 7.9. Precipitaion was above normal the summer of herbicide application and the plots were moldboard plowed in the fall. The Crookston site had a Bearden silty clay loam soil with 3.9% organic matter and a pH of 7.9. Precipitation was near normal the summer of application and the plots were moldboard plowed in the fall.

Herbicide treatments were applied preemergence (FMC-57020) and postemergence (AC-263,499, DPX-F6025, and Imazaquin) to soybeans in late May and late June of 1985, respectively. Herbicide treatments were applied to 30 feet by 30 feet plots arranged in a randomized complete block design. Rotational crops of corn, oats, or wheat, and alfalfa were seeded in the spring of 1986 in 15 feet by 30 feet strips, across the 30 feet by 30 feet plots. At each location, percent crop injury and stand reduction data were taken for each rotational crop several times over the growing season. Yield data were taken for alfalfa, corn, and oats at Waseca; corn and wheat at Morris; and wheat at Crookston.

Results varied from location to location; this may be expected due to the differences in environment and tillage practices between locations. However, both the 0.02 and 0.04 kg/ha rates of DPX-F6025 significantly injured alfalfa at all three locations and injured corn growing in the high pH (pH 7.9) soils of Crookston and Morris. Only the 0.04 kg/ha rate of DPX-F6025 injured corn in the lower pH soils of Waseca (pH 6.0). FMC-57020 significantly injured oats and wheat at both the 1.40 and 2.80 kg/ha rates. Alfalfa was significantly injured at all three locations and corn was injured at Crookston and Waseca by the high rate of FMC-57020. Only the Waseca site showed any injury due to AC-263,499 or Imazaquin carryover. Corn and oats were significantly injured by the 0.14 and 0.28 kg/ha rates of AC-263,499 and by the 0.17 kg/ha rate of Imazaquin. The 0.08 kg/ha rate of Imazaquin did not injure any of the rotational crops. The Waseca site had the most crop injury related to herbicide carryover. This may be due to the fact that Waseca had a drier than normal summer in 1985 and the plots received no fall tillage that could dilute the residual herbicides' effect on the rotational crops.

WASECA RESULTS

HERBICIDE	RATE	---------- ALFALFA ---------- INJURY (6-12-86)	STAND REDUCTION (6-12-86)	YIELD (9-29-86)
	(LB A.I./A)	(%)	(%)	(TONS/A)
SCEPTER	.075	10	12	1.04
SCEPTER	.15	8	5	1.08
PURSUIT	.125	12	0	1.04
PURSUIT	.25	26	20	1.17
CLASSIC	.02	59*	46*	0.94
CLASSIC	.04	62*	52*	0.90*
COMMAND	1.25	29	18	1.01
COMMAND	2.50	70*	46*	0.76*
NONE	--	0	0	1.10
	LSD(.05)	29	27	0.19

* SIGNIFICANTLY DIFFERENT FROM THE CHECK (P = .05 LEVEL).

WASECA RESULTS

HERBICIDE	RATE	---------- OATS ---------- INJURY (6-12-86)	STAND REDUCTION (6-12-86)	YIELD (8-11-86)
	(LB A.I./A)	(%)	(%)	(BU/A)
SCEPTER	.075	12	10	84
SCEPTER	.15	41*	25*	74*
PURSUIT	.125	56*	34*	55*
PURSUIT	.25	80*	61*	33*
CLASSIC	.02	6	2	86
CLASSIC	.04	9	0	84
COMMAND	1.25	45*	38*	82
COMMAND	2.50	85*	71*	23*
NONE	--	0	0	89
	LSD(.05)	16	23	15

* SIGNIFICANTLY DIFFERENT FROM THE CHECK (P = .05 LEVEL).

WASECA RESULTS

		Corn		
Herbicide	Rate	Percent Tasseling (7-11-86)	Percent silking (7-14-86)	Yield (9-30-86)
	(lb a.i./A)	(%)	(%)	(bu/A)
Scepter	.075	31	48	163
Scepter	.15	5*	20*	132*
Pursuit	.125	9*	20*	146*
Pursuit	.25	5*	8*	145*
Classic	.02	18	55	164
Classic	.04	14*	32*	139*
Command	1.25	18	22*	156
Command	2.50	5*	6*	137*
None	--	29	74	170
	LSD(.05)	15	39	LSD (.10) 23

*Significantly different from the check (p = .05 or .10 level).

WASECA RESULTS

		Corn		
Herbicide	Rate	Injury (6-12-86)	Stand Reduction (6-12-86)	Yield (9-30-86)
	(lb a.i./A)	(%)	(%)	(bu/A)
Scepter	.075	10	4	163
Scepter	.15	26*	0	132*
Pursuit	.125	18*	4	146*
Pursuit	.25	20*	0	145*
Classic	.02	4	0	164
Classic	.04	20*	0	139*
Command	1.25	18*	2	156
Command	2.50	54*	15*	137*
None	--	0	0	170
	LSD(.05)	15	6	LSD (.10) 23

* Significantly different from the check (p = .05 or .10 level).

SELECTIVE CONTROL OF JERUSALEM ARTICHOKE IN SOYBEANS

Donald L. Wyse, William Lueschen, and Joseph M. Spitzmueller

Abstract. Jerusalem artichoke (Helianthus tuberosus L.) control in soybeans [Glycine max (L.) Merr.] was studied in several experiments. The objective of this research was to examine Jerusalem artichoke control with cultivation, rope-wick treatments, and broadcast herbicide applications. The cultivation treatments consisted of a single cultivation at three weeks, or a double cultivation, one at three weeks the other at five weeks after planting. Rope-wick applications with a 33% solution of glyphosate or 2-4,D (v/v) were made at seven weeks after planting as a single treatment or applied following cultivation. Cultivation alone, rope-wick treatments alone, and the combination of cultivation and rope-wick treatments did not provide effective Jerusalem artichoke control. Cultivation gave poor Jerusalem artichoke control because of limited control with the crop row. Uneven emergence and growth resulted in poor rope-wick performance. In another study FMC 57020, imazaquin, DPX F6025 and PP 021 were evaluated for Jerusalem artichoke control in soybeans. DPX F6025 and PP 021 did not provide effective Jerusalem artichoke control. Imazaquin at 0.38 lb/a gave effective control when applied early postemergence, when the soybeans were in the unifoliate stage and the Jerusalem artichoke was 7 to 10 inches tall, and at late postemergence when the soybeans were in the second trifoliate and the Jerusalem artichoke was 17 to 20 inches tall. FMC 57020 applied preemergence gave good control in two of the three years. High temperatures and high soil moisture after application appeared to reduce the effectiveness of FMC 57020. Corn planted back into plots that had been treated in the previous year with imazaquin or FMC 57020 showed carryover injury. A new compound AC 263,499 gave effective Jerusalem artichoke control when applied at 0.09 lb/a as an early postemergence treatment.

Table 1. Influence of tillage on growth and development of Jerusalem artichoke in a corn/soybean/corn/soybean rotation at Waseca, MN - 1982, 1983, 1984, 1985, and 1986.

Corn - 1983

Treatment	Rate	JA Shoots	Yield
	lb/A	#/m^2	kg/ha
No Tillage			
Weed Free		0	8474
2,4-D	0.25	0	6446
Weedy		8	4692
Weedy		6	6268
Reduced Tillage			
Weed Free		0	6947
2,4-D	0.25	1	6694
Weedy		6	5674
Weedy		7	5415
Conventional Tillage			
Weed Free		1	6995
2,4-D	0.25	1	5952
Weedy		8	6951
Weedy		5	6170
LSD 0.05		2	840

Soybeans - 1984

Treatment	Rate	JA Shoots	JA Mass	Yield
	lb/A	#/m^2	g/m^2	kg/ha
No Tillage				
Weed Free		0	2	3930
Carryover		0	5	3250
Imazaquin	0.25	50	326	1489
Weedy		64	531	924
Reduced Tillage				
Weed Free		0	8	3666
Carryover		10	182	2457
Imazaquin	0.25	5	74	2938
Weedy		44	701	1016
Conventional Tillage				
Weed Free		1	2	3903
Carryover		6	175	3131
Imazaquin	0.25	2	44	3567
Weedy		38	580	872
LSD 0.05		19	246	367

Corn - 1985

Treatment	Rate	JA Shoots	JA Mass	Yield
	lb/A	#/m^2	g/m^2	kg/ha
No Tillage				
Weed Free		0	0	7063
2,4-D	0.25	1	9	7264
Carryover		7	199	5248
Weedy		8	166	5338
Reduced Tillage				
Weed Free		0	0	6148
2,4-D	0.25	3	30	7009
Carryover		3	77	6308
Weedy		3	83	6385
Conventional Tillage				
Weed Free		0	0	6644
2,4-D	0.25	2	38	6572
Carryover		4	93	5474
Weedy		7	202	3883
LSD 0.05		4	75	1205

Soybeans - 1986

Treatment	Rate	JA Shoots	JA Mass	Yield	Inj
	lb/A	#/m^2	g/m^2	kg/ha	%
No Tillage					
Weed Free		0	0	2569	0
Carryover		1	38	1979	0
Imazaquin	0.25	2	10	2433	7
Weedy		30	317	545	0
Reduced Tillage					
Weed Free		0	3	2610	0
Carryover		2	115	2320	0
Imazaquin	0.25	0	5	2545	10
Weedy		8	236	1106	0
Conventional Tillage					
Weed Free		0	1	2510	0
Carryover		4	76	1640	0
Imazaquin	0.25	1	12	2614	18
Weedy		24	261	495	0
LSD 0.05		3	65	217	2

See Footnotes following Tables.

Jerusalem artichoke tubers were hand planted in the spring of 1982 at a rate of one tuber per 3.3 m^2. Tillage was as follows:

a. No Tillage - corn and soybeans planted with a John Deere no-till planter
b. Reduced tillage following corn - fall chisel, spring disk, plant;
c. Reduced tillage following soybeans - spring disk, plant
d. Conventional tillage - fall plow, spring disk, field cultivate, plant, cultivate.

Corn variety: 'Pioneer 3906', planted at 27,500 sds/ft, 30-inch rows.
Soybean variety: 'Hodgson 78', 10 sds/ft, 30-inch rows.
Preemergence treatment of alachlor 3.5 lb/A.
Soil type: Webster clay loam, pH=6.8, organic matter = 6 to 7%.

1983 - Treatments applied on 6/16/83. Corn 5 lf., Jerusalem artichoke 6-8", temp. 58°.

1984 - Treatments applied on 6/9/84. Soybeans first trifoliate, Jerusalem artichoke 6-8", temp. 64°, R.H. 60%.

1985 - Treatments applied on 6/5/85. Corn 6 lf., 8-10"; Jerusalem artichoke 6-10", temp. 70°, RH 48%.

1986 - Treatments applied on 6/12/86. Soybeans unifoliate, Jerusalem artichoke 2-6", temp. 70°.

Table 2. Influence of tillage on growth and development of Jerusalem artichoke in a soybean/corn/soybean/corn rotation at Waseca, MN - 1982, 1983, 1984, 1985, and 1986.

Soybeans - 1983

Treatment	Rate	JA Shoots[5]	Yield
	lb/A	#/m^2	kg/ha
No Tillage			
Weed Free		1	3160
Imazaquin	0.25	5	2773
Weedy		22	1623
Weedy		11	1624
Reduced Tillage			
Weed Free		0	2858
Imazaquin	0.25	5	2852
Weedy		7	1342
Weedy		9	1434
Conventional Tillage			
Weed Free		2	2539
Imazaquin	0.25	4	2592
Weedy		6	934
Weedy		5	1318
LSD 0.05		3	379

Corn - 1984

Treatment	Rate	JA Shoots[5]	JA Mass[5]	Yield
	lb/A	#/m^2	g/m^2	kg/ha
No Tillage				
Weed Free		0	0	8202
Carryover		6	134	7319
2,4-D	0.25	13	87	7226
Weedy		30	456	3647
Reduced Tillage				
Weed Free		0	0	7710
Carryover		8	127	6050
2,4-D	0.25	26	237	4976
Weedy		24	365	3638
Conventional Tillage				
Weed Free		4	5	7238
Carryover		11	183	5627
2,4-D	0.25	29	233	5671
Weedy		33	463	3730
LSD 0.05		13	190	1449

Soybeans - 1985

Treatment	Rate	JA Shoots[5]	JA Mass[5]	Yield
	lb/A	#/m^2	g/m^2	kg/ha
No Tillage				
Weed Free		0	0	1752
Imazaquin	0.25	4	95	1730
Carryover		9	364	598
Weedy		12	293	454
Reduced Tillage				
Weed Free		0	0	1537
Imazaquin	0.25	1	37	1436
Carryover		7	375	503
Weedy		6	316	617
Conventional Tillage				
Weed Free		0	3	1426
Imazaquin	0.25	2	33	1471
Carryover		7	377	413
Weedy		9	387	333
LSD 0.05		5	143	242

Corn - 1986

Treatment	Rate	JA Shoots[5]	JA Mass[5]	Yield	Inj
	lb/A	#/m^2	g/m^2	kg/ha	%
No Tillage					
Weed Free		0	0	5462	0
Carryover		7	45	5544	16
2,4-D	0.25	9	36	5345	0
Weedy		17	116	4740	0
Reduced Tillage					
Weed Free		0	0	5716	0
Carryover		2	33	5865	26
2,4-D	0.25	7	17	5796	0
Weedy		8	59	6380	0
Conventional Tillage					
Weed Free		0	8	5863	0
Carryover		5	89	5207	17
2,4-D	0.25	34	73	5684	0
Weedy		29	202	4319	0
LSD 0.05		3	85	390	3

See Footnotes following Tables.

Jerusalem artichoke tubers were hand planted in the spring of 1982 at a rate of one tuber per 3.3 m^2. Tillage was as follows:

a. No Tillage - corn and soybeans planted with a John Deere no-till planter
b. Reduced tillage following corn - fall chisel, spring disk, plant;
c. Reduced tillage following soybeans - spring disk, plant
d. Conventional tillage - fall plow, spring disk, field cultivate, plant, cultivate.

Corn variety: 'Pioneer 3906', planted at 27,500 sds/ft, 30-inch rows.
Soybean variety: 'Hodgson 78', 10 sds/ft, 30-inch rows.
Preemergence treatment of alachlor 3.5 lb/A.
Soil type: Webster clay loam, pH=6.8, organic matter = 6 to 7%.

1983 - Treatments applied on 6/16/83. Soybeans first trifoliate, Jerusalem artichoke 6-8", temp. 58°.

1984 - Treatments applied on 6/9/84. Corn 5 lf., 8", Jerusalem artichoke 6-8", temp. 64°, R.H. 60%.

1985 - Treatments applied on 6/5/85. Soybeans first trifoliate, 4"; Jerusalem artichoke 6-10", temp. 70°, RH 48%.

1986 - Treatments applied on 6/12/86. Corn 5 lf., 6", Jerusalem artichoke 2-6", temp. 70°

Herbicide performance in corn at Waseca, MN - 1986. Gunsolus, Jeffrey L. and William E. Lueschen. The purpose of this experiment was to evaluate various herbicides and herbicide combinations for weed control efficacy and corn tolerance. Oats were grown in 1985 and the plot area received 150 lb/A of urea N and was chisel plowed in the fall of 1985 and field cultivated in the spring of 1986. On May 7 preplanting herbicide applications were incorporated to a depth of 2 to 3 inches by one pass with a tandem disk followed by a field cultivation at right angles. The soil was a Webster clay loam with 6.6% organic matter, pH 6.8, and an adequate moisture content. All herbicides were applied with a motorized bicycle-wheeled sprayer using 20 gpa, 30 psi, 3 mph, and 8002 flat-fan nozzles. Environmental conditions at preplanting application were wind 1 to 3 mph, relative humidity 60% and air temperature 50 F. The first rain after application was 0.02 inch May 8 with rainfall of 2.97 and 0.02 inch during the first and second weeks after treatment. On May 7 'Pioneer 3906' corn was planted 1.5 inches deep at 27,500 seeds/A at a soil temperature of 53 F. A randomized complete block design with four replications was used. Plots were 10 by 30 ft and contained four 30-inch rows. Preemergence treatments were applied May 7 with wind 5 mph, relative humidity 50%, and an air temperature of 67 F. Soil moisture and rainfall patterns were the same as for preplanting herbicide applications. Postemergence treatments were applied May 31 to 3 to 5 inch corn in the three leaf stage. Broadleaf weeds were 0.5 to 1.5 inches and in the cotyledon to four leaf stage. Giant foxtail was 0.5 to 2 inches and in the one to three leaf stage. Soil moisture was adequate, the wind was calm, relative humidity 70%, and air temperature was 85 F. First rain was 0.91 inch June 5 with rainfall of 0.91 and 0.22 inches the first and second weeks after treatment. Sequential postemergence treatments were applied June 6 to 8 inch corn in the five leaf stage. Broadleaf weeds were 2 inches and in the four to six leaf stage. Giant foxtail was 3.0 to 5.0 inches and in the four to five leaf stage. Soil moisture was adequate, the wind was 5 to 10 mph, relative humidity 60%, and air temperature 77 F. First rain was 0.07 inch June 11 with rainfall of 0.16 and 1.61 inches the first and second weeks after treatment. Weed densities/m^2 were 280 giant foxtail, 18 redroot pigweed, 13 common lambsquarters, and 12 common ragweed. Weed control, crop injury, and stand reduction evaluations were taken visually June 12 and are given in the table. All plots in replications two through four were cultivated on June 12. Yield data were obtained from 25 ft of the center two rows of all plots in replications two to four on September 30 and are presented in the table, corrected for 15.5% moisture. Alachlor-MT, applied preemergence, appeared to give weed control similar to alachlor-EC. Postemergence cyanazine with pendimethalin, vegetable oil concentrate, or alachlor gave the only significant corn injury in this study. (Minn. Agric. Exp. Stat., Paper No. 2089 Misc. Jour. Series, University of Minnesota, St. Paul)

Table. Herbicide performance in corn at Waseca, MN-1986. (Gunsolus and Lueschen)

Treatment[ab]	Rate[a] lb/A	Corn bu/A	Corn Inj. ind.	Corn % kill	% Weed control Gift	% Weed control Colq	% Weed control Corw	% Weed control Rrpw
Preplanting Incorporation-2X (May 7)								
EPTC + Dichlormid + Atrazine	4.0 + 1.5	158	1	0	94	99	85	93
[Butylate + Dichlormid + Atrazine]	4.8 + 1.2	159	3	0	94	99	79	95
EPTC + Dichlormid + Cyanazine-DF + Atrazine	4.0 + 1.5 + 0.75	182	0	0	97	100	85	90
Cycloate + Dichlormid + Atrazine	4.0 + 1.5	187	0	0	95	100	92	94
EPTC + Dichlormid + Dietholate + Atrazine	4.0 + 1.5	188	4	0	98	100	89	98
Metolachlor + Atrazine	2.5 + 1.5	192	4	3	92	99	85	96
Preplanting Incorporation-2X (May 7) + Postemergence (May 31)								
(Metolachlor) + (2,4-D Amine)	(2.5) + (0.5)	173	4	0	94	99	83	97
(Alachlor-MT) + (Dicamba)	(3.5) + (0.5)	144	3	0	82	100	99	100
(Butylate + Dichlormid) + (Bentazon + COC[c])	(4.0) + (0.75 + 1.3%)	155	3	0	93	100	98	93
(EPTC + Dichlormid) + (Bromoxynil)	(4.0) + (0.25)	186	0	0	98	100	98	99
Check - weed free	---	178	0	0	100	100	100	100
Check - cultivated	---	176	NA[d]	NA	NA	NA	NA	NA
LSD(0.05)		NS	NS	1	5	NS	11	NS
Preemergence (May 7)								
Alachlor	3.0	184	4	1	99	76	69	98
Cyanazine	3.0	183	3	1	85	89	83	64
Pendimethalin	2.0	181	0	0	85	86	21	89
Metolachlor	2.5	146	3	0	94	40	44	83
[Metolachlor + Atrazine][e]	2.5 + 2.0	188	4	0	97	95	78	98
[Metolachlor + Atrazine][f]	2.5 + 2.0	194	1	1	98	98	82	98
Alachlor + Cyanazine	3.0 + 2.0	187	3	0	99	97	91	98
Alachlor + Atrazine	3.0 + 2.0	193	3	0	98	95	84	100
Pendimethalin + Atrazine	1.5 + 2.0	186	3	0	83	99	76	99
Pendimethalin + Cyanazine + Atrazine	1.5 + 1.5 + 0.75	173	1	0	81	93	74	93
Alachlor + Dicamba	2.5 + 0.5	158	0	0	94	81	65	98
Cyanazine + Atrazine	3.2 + 1.6	139	0	0	86	96	94	96
Cyanazine + Atrazine	2.25 + 0.75	149	0	0	74	91	85	81
Preemergence (May 7) + Postemergence (May 31)								
(Alachlor-MT) + (Bromoxynil)	(2.5) + (0.25)	196	0	0	95	100	96	100
(Alachlor-MT) + (Bromoxynil + Atrazine)	(2.5) + (0.25 + 0.5)	196	4	1	97	100	100	100
(Alachlor-MT) + ([Bromoxynil + Atrazine])	(2.5) + (0.19 + 0.38)	184	1	0	97	100	100	100
(Metolachlor) + ([Dicamba + Atrazine])	(2.5) + (0.48 + 0.92)	186	5	0	98	100	99	100
(Metolachlor) + (Dicamba + Atrazine)	(2.5) + (0.5 + 1.0)	165	1	0	97	100	100	100
(Cyanazine) + (Atrazine + Tridiphane + COC)	(2.5) + (1.5 + 0.5 + 1.3%)	181	4	0	97	100	100	100
(Cyanazine) + (Atrazine + Cyanazine + Tridiphane)	(2.5) + (0.75 + 1.0 + 0.5)	169	1	0	97	100	100	100
(Cyanazine) + (Cyanazine + Tridiphane)	(2.5) + (1.6 + 0.5)	185	0	0	89	100	99	100
(Cyanazine) + (Cyanazine)	(2.5) + (2.0)	160	0	0	77	100	96	96
(Alachlor) + (Cyanazine)	(3.0) + (2.0)	172	1	0	98	99	80	99
(Metolachlor) + (Cyanazine)	(2.5) + (2.0)	163	0	0	96	91	64	98
Check - cultivated	---	130	NA	NA	NA	NA	NA	NA
Check - cultivated	---	124	NA	NA	NA	NA	NA	NA
LSD(0.05)		37	3	NS	6	7	13	5
Postemergence (May 31)								
Pyridate	0.9	136	0	0	54	99	81	98
Pyridate + Atrazine	0.9 + 1.5	147	1	0	70	100	100	100
Pyridate + Cyanazine	0.9 + 1.5	141	4	1	72	100	100	100
Alachlor + Cyanazine	2.5 + 2.0	155	10	0	86	100	99	100
Alachlor-MT + Cyanazine	2.5 + 2.0	145	1	0	63	99	97	100
Atrazine + COC	1.5 + 1.3%	140	0	0	67	100	98	100
Atrazine + Tridiphane + COC	1.5 + 0.5 + 1.3%	154	5	0	88	100	100	100
Atrazine + Cyanazine + Tridiphane	0.75 + 1.0 + 0.5	165	1	0	80	100	96	100
Atrazine + Cyanazine + VOC[g]	0.75 + 1.25 + 0.63%	130	21	0	73	100	100	100
Cyanazine + Tridiphane	1.6 + 0.5	145	3	0	77	100	91	100
Atrazine + Cyanazine	0.75 + 1.25	127	1	0	33	100	93	100
Cyanazine	2.0	127	0	0	33	99	78	78
Cyanazine + VOC	2.0 + 1.3%	125	21	0	71	100	99	100
Cyanazine + Tridiphane	2.0 + 0.5	125	4	1	82	100	96	100
Cyanazine + Pendimethalin	2.0 + 1.5	121	16	1	70	99	96	99
Cyanazine + Dicamba	2.0 + 0.25	127	1	0	48	100	96	100
Cyanazine + Atrazine + Pendimethalin	1.0 + 0.75 + 1.5	155	15	1	78	100	100	100
Postemergence (May 31) + Postemergence (June 6)								
(Cyanazine) + (Atrazine + COC)	(2.0) + (1.0 + 1.3%)	146	1	0	71	100	99	100
(Cyanazine + Tridiphane) + (Atrazine + COC)	(1.6 + 0.5) + (1.0 + 1.3%)	163	6	1	86	100	100	100

Continued

Table. Continued. (Gunsolus and Lueschen)

Treatment[ab]	Rate[a] lb/A	Corn bu/A	Corn Inj. ind.	Corn % kill	% Weed control Gift	% Weed control Colq	% Weed control Corw	% Weed control Rrpw
(Cyanazine + Tridiphane + VOC) + (Atrazine + COC)	(1.6 + 0.5 + 1.3%) + (1.0 + 1.3%)	156	26	5	97	100	100	100
Check - cultivated	---	136	NA	NA	NA	NA	NA	NA
Check - cultivated	---	142	NA	NA	NA	NA	NA	NA
LSD(0.05)		37	3	1	9	1	5	5

[a] Treatment(s) and rate(s) in parenthesis represent a single application.
[b] Herbicide combinations in brackets [] represent a premix.
[c] COC = crop oil concentrate = Agicide Activator.
[d] NA = data not available.
[e] Bicep L.
[f] Bicep LD.
[g] VOC = vegetable (soybean) oil concentrate.

A comparison of metolachlor formulations with alachlor and CGA-180937 for weed control in corn, 1986. Lueschen, William E. and Thomas R. Hoverstad. This study was conducted near Waseca, MN to evaluate weed control obtained with three formulations of metolachlor in comparison to alachlor and CGA-180937. The soil type at this site was a Nicollet clay loam containing 6.1% organic matter, a soil pH of 5.9, and P and K levels of 72 and 315 lb/A, respectively. A randomized complete block design with four replications and a plot size of 10x30 feet was used. All liquid herbicide formulations were applied broadcast with a motorized bicycle sprayer equipped with flat fan nozzles and calibrated to deliver 20 gallons/A at 30 psi. Granular formulations were applied broadcast using a Gandy Co. 'Orbit Air' spreader. Pioneer '3906' hybrid seed corn was planted at a seeding rate of 27,500 seeds/A on May 5. Both the liquid and granular formulations of herbicide were applied on May 7. The first rainfall after application, 0.65 inches, was received on May 13. Within 14 days of applying the preemergence herbicides, 1.10 inches of rainfall accumulated. All treatments were cultivated once on July 3.

The following weed species were present in the untreated control plots prior to cultivation: 106 giant foxtail, 25 redroot pigweed, 15 common lambsquarters, and 2 common ragweed plants/ft^2. Control of giant foxtail was similar for metolachlor 8E, 2.5 and 5.0 lb/A, and alachlor (4E) applied at the same rates. Alachlor provided slightly better control of redroot pigweed than metolachlor. Alachlor at 5.0 lb/A gave significantly better control of common lambsquarters than metolachlor at 5.0 lb/A. Neither herbicide offered acceptable control of common ragweed early in the season, however, the 5.0 lb/A rate of both herbicides reduced the presence of common ragweed at harvest. The performance of metolachlor 25G was similar to the 8E formulation. However, control of both giant foxtail and redroot pigweed were significantly better for the 8E or 25G formulations of metolachlor than for the 25 G-E formulation. CGA 180937 gave weed control very similar to metolachlor. The heavy weed pressure in this study is reflected in the grain yields. The weedy check produced only 74 bu/A of corn with the weed-free treatment yielding 161 bu/A. Treatments that failed to give adequate control of redroot pigweed, common lambsquarters and common ragweed resulted in yield decreases of 25 to 60 bu/A compared to the weed-free treatment. Very little early season corn injury was observed in this trial and there were no significant differences among treatments for this parameter. (MN Agr. Exp. Sta. Paper No. 2080. Misc. Journal Series, Univ. of MN, St. Paul, MN).

Table. A comparison of metolachlor formulations with alachlor and CGA-180937 for weed control in corn, 1986. (Lueschen and Hoverstad)

Herbicide	Rate lb/A	Formu-lation	% Injury 6/6	% Control[a] Gift 6/6	Gift 9/29	Rrpw 6/6	Rrpw 9/29	Colq 6/6	Colq 9/29	Corw 6/6	Corw 9/29	bu/A	% Grain H_2O
Metolachlor	2.5	8E	1	90	88	70	84	35	59	17	46	135	24.8
Metolachlor	5.0	8E	5	98	95	90	86	59	52	43	75	154	23.6
Metolachlor	2.5	25G	5	89	74	59	46	48	35	29	8	114	25.9
Metolachlor	5.0	25G	4	93	90	85	72	51	45	45	52	141	24.3
Metolachlor	2.5	25G-E	3	80	65	56	59	28	35	8	20	101	26.5
Metolachlor	5.0	25G-E	3	86	78	65	61	45	43	25	28	121	26.1
CGA-180937	2.5	7.8E	2	95	92	63	83	35	63	23	36	132	25.5
CGA-180937	5.0	7.8E	0	96	90	87	89	53	63	33	64	143	24.2
Alachlor	2.5	4E	4	93	85	95	89	45	52	38	54	143	24.6
Alachlor	5.0	4E	1	97	92	96	100	74	82	53	84	165	23.1
Alachlor + Hand-weeded	3.0	4E	0	100	100	100	100	100	100	100	100	161	23.2
Weedy Check	---	---	0	0	0	0	0	0	0	0	0	74	28.3
BLSD (0.05)			NS	13	9	14	13	14	16	16	26	20	1.2

[a]Visual ratings of % weed control were made on 6/6/86 and on 9/29/86.

1986 SOYBEAN BREEDING

James Orf, William Lueschen and Thomas Hoverstad

Objective: This project is designed to improve soybean production through developing superior genetic material. Each year the Southern Experiment Station serves as one of the major testing locations for material developed in this program. Evaluations conducted at Waseca include new experimental lines, preliminary yield tests, uniform regional trials, privately and publicly developed variety tests, a disease nursery and evaluation of early generation crosses. Data collected from these studies throughout Minnesota are used to provide growers and industry personnel with variety performance data. Results from these trials are published annually in "Varietal Trials of Farm Crops".

Procedures: All tests were designed as randomized complete blocks. The previous crop was oats. The site was fall chisel plowed after applying P and K fertilizer based on soil tests. Seed for each study was packaged for individual plots and planted with a cone-type planter. Weeds were controlled in all plots with Treflan (.75 lb/A PPI) plus Amiben (2.5 lb/A Pre). All 30-inch row plots were cultivated and all plots were handweeded to remove any escaped weeds. Publicly developed variety evaluations included three studies: 1) late-maturing varieties planted May 17, 2) medium-maturing varieties planted May 17, and 3) a range of maturities planted June 13. All public variety studies were planted in 10-inch row spacings. Privately developed varieties were tested in 10-inch rows and were planted on May 6. New experimental line tests, preliminary yield tests and uniform regional trials were all planted in 30-inch rows on May 7. A comparison of "old" and "new" late-maturing varieties was planted on May 6 in 30-inch rows. Harvested plot size for 30-inch rows was 5 (two 30-inch rows) x 8 feet. Harvested plot size for 10-inch rows was 4.2 (five 10-inch rows) x 8 feet. All plots were combined with a modified plot combine. An experiment involving six publicly developed soybean varieties planted over a range of dates was initiated in 1986. BSR 101, Hardin, Corsoy 79 and Sibley were evaluated in 10 and 30 inch; planted May 6, May 16, and May 24. For a June 9 and June 23 planting date, Simpson and Evans were substituted for BSR 101 and Corsoy 79.

Notes on maturity, plant type, lodging, diseases and other agronomic traits of early generation crosses were made on plots consisting of one 30-inch row 6 feet long. Information on these observations is not included in this report. Disease reactions on similar size plots were also evaluated on a site with poor internal drainage that has been in continuous soybeans for 15 consecutive years. No yield is collected on any of these very small plots.

Results: Medium-maturing variety yields ranged from 64.6 bu/A to 47.9 bu/A (Table 1). Hodgson 78 was the highest yielding variety in this test. Late-maturing varieties yielded from 67.2 bu/A to 46 bu/A, Vickery was the highest yielding late-maturing variety (Table 2). BSR 201 yielded 56.3 bu/A as the highest yielding variety in a variety trial planted on June 13, 1986 (Table 3). Private varieties tested in 1986 yielded from 62.6 bu/A to 22.2 bu/A (Table 4). Tables 5 - 7 include data on both Group I and Group II maturity varieties in a Uniform Regional Trial. Table 8 shows a yield advantage for 10-inch rows compared to 30-inch rows, especially in early situations. BSR 101 planted in 10-inch rows on May 6 was the highest yielding treatment in this study. Table 8 also shows how delayed planting can reduce soybean yield substantially. A comparison of "old" and "new" soybean varieties shows newer varieties have performed better than their predecessors (Table 9). Data collected at Waseca in 1986 and variety recommendations are published in "Varietal Trials of Farm Crops".

Table 1. Medium maturing soybean variety trial. Waseca 1986.

	DF	SS	MS	F
REP	2	2167.14	1083.57	27.07
TRT	14	1013.09	72.36	1.81
ERROR	28	1120.69	40.02	
TOTAL	44	4300.92		

CV = 11.0
LSD.05 = 10.6
YIELD MEAN = 57.7

RANKING BY YIELD

ENT	NSN	PEDIGREE		PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
4	HODGSON 78	HODGSON*7 X MERIT		R28	112.0	64.6	24	2.0	37	3.7	16.6	37.7	20.8
11	M81-27	11-68-49-26 X 11-70-294		R10	108.7	62.7	14	1.0	35	3.0	17.7	37.2	21.5
6	SIBLEY	M68-256 X HODGSON		R40	108.2	62.4	25	2.0	37	3.3	20.1	39.0	20.5
15	M81-571	11-70-484 X 11-70-128		R30	106.9	61.6	15	1.0	31	2.7	16.5	37.3	21.2
9	M74-12	EVANS X PETERSON 85		S30	106.7	61.6	11	2.0	35	2.3	17.6	39.1	20.5
10	M81-18	EVANS X 11-65-442		R20	106.5	61.4	10	1.0	35	2.0	16.8	38.1	21.8
14	M81-98	11-70-9 X 11-68-201		R50	105.5	60.8	15	1.0	35	3.0	16.1	36.6	21.5
1	DASSEL	EVANS X M66-18	RPS6	R35	99.9	57.6	14	1.0	35	3.3	18.1	38.5	21.3
7	SIMPSON	STEELE X HODGSON		R32	97.4	56.2	16	2.3	35	3.7	15.3	38.2	20.1
2	DAWSON	EVANS X 11-63-217Y		R22	95.5	55.1	10	1.0	31	2.3	15.0	37.5	20.6
5	OZZIE	WILKIN X 11-63-217Y		R20	95.3	55.0	7	1.0	32	2.3	16.1	39.3	19.8
13	M81-76	11-68-49-26 X 11-70-184		R30	93.1	53.7	11	1.0	37	2.7	20.7	40.0	20.8
8	SWIFT	11-54-240 X 11-54-139		S20	91.4	52.7	13	2.7	36	3.3	15.6	37.0	20.1
12	M81-70	EVANS X MAPLE ARROW	RPS6	R30	89.8	51.8	10	2.3	37	2.0	16.8	37.8	20.8
3	EVANS	MERIT X HARDSOY		R28	83.1	47.9	5	1.3	34	3.0	15.4	38.5	21.4

Table 2. Late maturing soybean variety trial. Waseca 1986.

	DF	SS	MS	F
REP	2	332.28	166.14	4.18
TRT	20	1631.20	81.56	2.05
ERROR	40	1589.03	39.73	
TOTAL	62	3552.52		

CV = 11.0
LSD.05 = 10.4
YIELD MEAN = 57.3

RANKING BY YIELD

ENT	NSN	PEDIGREE		PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
12	VICKERY	CORSOY*4 X (MACK X L65-1342 OR ANOKA)		R50	117.3	67.2	28	3.0	46	1.3	16.0	39.6	18.9
13	WEBER 84	WEBER*5 X CENTURY		R25	111.4	63.8	26	3.0	43	2.3	13.1	38.7	19.7
7	HARDIN	CORSOY*3 X CUTLER 71		R45	108.8	62.3	26	3.0	42	2.7	14.5	38.7	20.4
19	M81-382	11-70-127 X CENTURY		R30	107.1	61.3	20	2.0	43	3.0	21.9	41.2	20.2
9	HOYT	HARCOR X ELF	dt1	R40	106.5	61.0	34	2.0	29	1.7	13.0	39.9	17.9
15	M75-2	HOD*4 X (M69-141 X (CHIP X HIGAN))		R20	106.3	60.9	22	2.0	39	3.0	16.4	37.8	20.8
8	HODGSON 78	HODGSON*7 X MERIT		R28	105.7	60.5	24	2.0	40	3.7	17.9	38.6	21.6
11	SIBLEY	M68-256 X HODGSON		R40	104.8	60.0	25	2.3	41	2.7	19.4	38.5	21.1
6	HACK	L701-5436 X K1028		R45	101.8	58.3	33	2.0	43	1.7	18.0	38.8	19.8
20	M81-384	11-70-127 X CENTURY		R20	101.4	58.1	27	2.0	43	2.7	18.2	38.8	20.0
17	M81-380	11-70-127 X CENTURY		R20	100.1	57.3	19	2.0	40	3.0	18.8	39.6	20.6
18	M81-381	11-70-127 X CENTURY		R30	99.5	57.0	26	2.0	44	2.3	18.1	40.1	19.6
14	M74-498	Px20 X 554-10		R20	98.1	56.2	27	2.0	43	1.7	17.9	40.4	19.9
10	MIAMI	WELLS II*7 X (PI86972-1 X PI54615-1)		R50	97.8	56.0	27	2.0	44	1.7	17.7	41.4	19.2
16	M81-77	11-68-49-26 X 11-70-184		R40	97.7	55.9	25	2.7	38	3.0	19.9	39.4	20.4
2	BSR 201	PRIDE B216 X AX901-40-2		S50	97.4	55.8	32	2.7	42	2.0	15.9	39.8	18.8
21	M81-564	11-69-36 X WEBER		S20	96.7	55.3	22	2.3	37	3.7	11.6	36.9	19.2
1	BSR 101	L69U40016-4 X A76-304020		R42	91.8	52.6	28	2.0	42	2.3	17.3	38.1	19.6
4	CORSOY 79	CORSOY*6 X LEE 68	1C	R45	85.9	49.2	30	2.7	47	2.3	17.5	39.3	19.0
5	ELGIN	AP6(2YF)(F)CL		S38	83.4	47.8	29	2.3	37	1.7	17.4	38.0	18.8
3	CENTURY 84	CENTURY*5 X WILLIAMS 82		R32	80.4	46.0	32	2.0	46	2.0	19.2	40.9	16.9

Table 3. Soybean variety trial - mid June planting. Waseca 1986.

	DF	SS	MS	F
REP	2	834.40	417.20	7.50
TRT	14	1331.40	95.10	1.71
ERROR	28	1557.40	55.62	
TOTAL	44	3723.20		

CV = 15.4
LSD.05 = 12.5
YIELD MEAN = 48.6

RANKING BY YIELD

ENT	NSN	FEDIGREE	PHY-CHL		MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
15	BSR 201	PRIDE B216 X AX901-40-2		S50	115.9	56.3	40	2.0	34	1.7	14.3	39.8	17.9
4	DAWSON	EVANS X II-63-217Y		R22	113.1	54.9	27	1.3	31	1.7	12.6	39.9	18.2
14	BSR 101	L69U40016-4 X A76-304020		R42	111.0	53.9	38	1.7	35	1.7	14.5	38.8	18.2
11	SIBLEY	M68-256 X HODGSON		R40	110.5	53.7	32	1.7	33	1.3	16.7	39.9	18.3
6	EVANS	MERIT X HARDSOY		R28	108.6	52.7	25	1.0	28	2.3	16.0	38.8	19.2
7	HARDIN	CORSOY*3 X CUTLER 71		R45	108.3	52.6	32	1.7	33	1.3	13.0	39.1	17.4
2	CORSOY 79	CORSOY*6 X LEE 68	1C	R48	106.3	51.7	37	2.0	39	1.7	14.8	40.4	17.3
13	WEBER 84	WEBER*5 X CENTURY		R25	102.3	49.7	32	1.7	33	2.0	12.9	38.8	17.7
10	OZZIE	WILKIN X II-63-217Y		R20	97.0	47.1	25	1.0	29	1.7	14.1	40.7	18.6
3	DASSEL	EVANS X 11-66-18	RPS6	R35	95.0	46.1	29	1.0	27	2.0	15.3	41.0	17.6
8	HODGSON 78	HODESON*7 X MERIT		R28	92.4	44.9	29	1.7	32	1.3	15.5	40.1	18.6
12	SIMPSON	STEELE X HODGSON		R32	89.4	43.4	28	1.0	29	1.7	13.4	39.7	17.8
9	MCCALL	(ACME X CHIPPEWA) X HARK		S40	86.5	42.0	18	1.0	23	3.7	15.7	37.9	18.9
1	CLAY	CAPITAL X RENVILLE		S35	82.6	40.1	24	1.0	24	3.0	16.4	39.7	20.2
5	ELGIN	AP6(2YF)(F)CL		S38	81.3	39.5	45	1.3	28	2.0	16.7	39.6	17.5

Table 4. Public and private soybean variety trial. Waseca 1986.

	DF	SS	MS	F
REP	2	473.63	236.81	9.82
TRT	143	9059.88	63.36	2.63
ERROR	286	6897.50	24.12	
TOTAL	431	16431.00		

CV = 9.9
LSD.05 = 7.9
YIELD MEAN = 49.6

RANKING BY YIELD

ENT	NSN	PEDIGREE		PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
143	HOYT	OHIO A.E.S.		R40	126.1	62.6	31	1.0	27	0.0	0.0	0.0	0.0
101	S BRAND S-44A	SCHECHINGER SEED CO.		P S50	119.5	59.3	26	2.0	43	0.0	0.0	0.0	0.0
63	LATHAM 200	LATHAM BROS. FARM		P S10	116.3	57.7	25	2.0	38	0.0	0.0	0.0	0.0
28	EHRICH E-86	EHRICH SEED FARMS		P S20	115.4	57.2	24	1.7	39	0.0	0.0	0.0	0.0
118	RUNNER 3	TERRA		P R40	114.5	56.8	23	1.7	39	0.0	0.0	0.0	0.0
55	K1012	KRUGER SEED CO.		P S20	113.9	56.5	24	1.7	37	0.0	0.0	0.0	0.0
64	LATHAM 561	LATHAM BROS. FARM		B S20	113.5	56.3	27	2.0	41	0.0	0.0	0.0	0.0
76	MIDWEST OIL 1480	MIDWEST OILSEEDS INC.		P S30	113.1	56.1	25	1.7	37	0.0	0.0	0.0	0.0
91	GOLD HVST X170	J.C.ROBINSON SEED CO.		P S20	111.9	55.5	24	1.7	40	0.0	0.0	0.0	0.0
136	HARDIN	IOWA A.E.S.		R45	111.9	55.5	25	2.0	42	0.0	0.0	0.0	0.0
77	NK S 14-60	NORTHRUP KING CO.		P S30	111.7	55.4	23	2.0	40	0.0	0.0	0.0	0.0
57	DESOY 302-11	KRUGER SEED CO.		B R20	111.5	55.3	24	2.0	39	0.0	0.0	0.0	0.0
131	BSR 101	IOWA A.E.S.		R20	111.5	55.3	26	2.0	45	0.0	0.0	0.0	0.0
48	IS 622	INTERSTATE		P S40	110.7	54.9	25	1.7	39	0.0	0.0	0.0	0.0
24	DIAMOND D201	DIAMOND BRAND SEED		P M30	110.6	54.9	27	2.3	45	0.0	0.0	0.0	0.0
110	SRF 199P	SEXAUER		P R40	109.6	54.4	26	2.7	41	0.0	0.0	0.0	0.0
125	WIL'N BLEND 2145	WILSON HYBRIDS INC.		B M50	109.5	54.3	26	2.3	40	0.0	0.0	0.0	0.0
97	SOI EXP 255	SAND SEED SERVICES. INC.		P R50	109.3	54.2	26	2.3	41	0.0	0.0	0.0	0.0
14	DSR-171	DAIRYLAND SEED COMPANY INC.		P S40	109.0	54.1	25	2.3	45	0.0	0.0	0.0	0.0
37	GFS 105	GREEN FIELD		P R40	108.8	54.0	25	2.3	44	0.0	0.0	0.0	0.0
87	PROFISEED 1152	PROFISEED INC.		R30	108.6	53.9	26	2.0	41	0.0	0.0	0.0	0.0
71	RIVERSIDE 1405	LYNNVILLE SEED CO.		P R40	108.6	53.9	26	2.0	43	0.0	0.0	0.0	0.0
106	SEEDTEC 701	SEEDTEC		P 50	108.4	53.8	25	3.0	41	0.0	0.0	0.0	0.0
107	SEEDTEC 620-B	SEEDTEC		P 30	108.1	53.6	23	2.3	39	0.0	0.0	0.0	0.0
135	HACK	ILLINOIS A.E.S.		R45	108.0	53.6	28	2.0	40	0.0	0.0	0.0	0.0
100	S BRAND S-38A	SCHECHINGER SEED CO.		P 40	107.9	53.5	24	2.0	38	0.0	0.0	0.0	0.0
115	STINE 1850	STINE SEED FARM. INC.		P 50	107.7	53.4	23	2.0	40	0.0	0.0	0.0	0.0
80	NK S 23-12	NORTHRUP KING		P 50	107.0	53.1	25	1.7	41	0.0	0.0	0.0	0.0
36	FUNK 12283	FUNK SEEDS INT'L.	12213	P S30	106.6	52.9	25	1.7	38	0.0	0.0	0.0	0.0
20	DEKALB CX174	DEKALB - PFIZER GENETICS		P S20	106.6	52.9	26	2.0	41	0.0	0.0	0.0	0.0
104	SEEDEX 2810	SEEDEX		P 40	106.4	52.8	26	2.0	47	0.0	0.0	0.0	0.0
50	JACQUES J-231	JACQUES SEED CO. J-2386	E84100	P R30	106.3	52.7	26	2.0	42	0.0	0.0	0.0	0.0
69	LYNKS 8165	LYNKS SEEDS		P R30	106.2	52.7	24	1.7	39	0.0	0.0	0.0	0.0
42	JEWELL	HOFLER		P R50	105.6	52.4	26	2.0	43	0.0	0.0	0.0	0.0
78	NK S 15-50	NORTHRUP KING CO.		P R50	105.6	52.4	24	2.0	48	0.0	0.0	0.0	0.0
34	FUNK 63145	FUNK SEEDS INT'L.	12245	B R40	105.2	52.2	24	2.0	43	0.0	0.0	0.0	0.0
16	DST2203	DAIRYLAND SEED COMPANY INC.		P S20	105.2	52.2	28	1.7	42	0.0	0.0	0.0	0.0
49	IS 624	INTERSTATE		P R40	104.8	52.0	25	2.7	45	0.0	0.0	0.0	0.0
116	DECATHALON	TERRA		P S40	104.7	51.9	25	2.0	39	0.0	0.0	0.0	0.0
74	MIDWEST OIL 2500	MIDWEST OILSEEDS INC.		B M30	104.5	51.8	25	2.0	37	0.0	0.0	0.0	0.0
7	ASGROW A2187	ASGROW SEED CO.		P R20	104.3	51.7	26	2.0	44	0.0	0.0	0.0	0.0
113	SRF EXP266B	SRF		B R50	104.1	51.6	25	2.3	41	0.0	0.0	0.0	0.0
13	CSV 12A	CHALLENGER SEED LTD.		B M50	104.0	51.6	26	2.0	41	0.0	0.0	0.0	0.0
15	DST1207	DAIRYLAND SEED COMPANY INC.		P R50	104.0	51.6	24	2.0	41	0.0	0.0	0.0	0.0
90	GOLD HVST X198	J.C.ROBINSON SEED CO.		B S50	104.0	51.6	26	2.3	44	0.0	0.0	0.0	0.0
112	SRF 220P	SRF		P R50	103.9	51.6	28	2.3	47	0.0	0.0	0.0	0.0
79	NK S 23-03	NORTHRUP KING		P S30	103.9	51.5	27	2.0	44	0.0	0.0	0.0	0.0
120	THOMPSON T-12	THOMPSON FARMS SEEDS		P R50	103.9	51.5	26	2.7	43	0.0	0.0	0.0	0.0
114	STINE 2020	STINE SEED FARM. INC.		P 20	103.3	51.2	27	2.0	44	0.0	0.0	0.0	0.0

Table 4. cont.

ENT	NSN	PEDIGREE	PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
19	DEKALB CX226	DEKALB - PFIZER GENETICS	P S50	103.2	51.2	25	2.3	40	0.0	0.0	0.0	0.0
92	GOLD HVST H-1233	J.C.ROBINSIN SEED CO.	P S30	103.2	51.2	26	2.0	42	0.0	0.0	0.0	0.0
30	FARMACY ABEL	FARMACY SEED CO.	P R40	103.0	51.1	25	2.7	43	0.0	0.0	0.0	0.0
53	KB231	KALTENBERG SEED FARMS INC.	P S40	102.9	51.0	27	2.0	45	0.0	0.0	0.0	0.0
72	RIVERSIDE 4045	LYNNVILLE SEED CO.	P S50	102.8	51.0	26	2.3	40	0.0	0.0	0.0	0.0
83	PRIDE B203	PRIDE CO. INC.	P R50	102.7	50.9	26	2.7	45	0.0	0.0	0.0	0.0
94	LAKESIDE 104	ROSSBACH LAKESIDE SEEDS	B R20	102.6	50.9	23	3.0	43	0.0	0.0	0.0	0.0
85	PRIDE B236	PRIDE CO. INC.	P R50	102.6	50.9	27	2.0	43	0.0	0.0	0.0	0.0
47	HY-VIG EX 2900R	HY-VIGOR SEEDS. INC.	P S20	102.3	50.8	26	2.3	41	0.0	0.0	0.0	0.0
1	AGRIPRO AP1776	AGRIPRO SEEDS EX 31101	P R40	102.3	50.7	20	1.0	37	0.0	0.0	0.0	0.0
40	HOFFMAN 8501	HOFFMAN SEED FARMS INC.	B M30	102.1	50.6	27	2.7	43	0.0	0.0	0.0	0.0
70	LYNKS 8202	LYNKS SEEDS	P R40	101.9	50.6	26	2.0	41	0.0	0.0	0.0	0.0
102	S BRAND S-38B	SCHECHINGER SEED CO.	P 50	101.9	50.6	24	2.0	36	0.0	0.0	0.0	0.0
138	SIBLEY	MINNESOTA A.E.S.	R40	101.9	50.5	23	3.0	42	0.0	0.0	0.0	0.0
56	KRUGER KB220A	KRUGER SEED CO.	B M20	101.8	50.5	27	2.0	42	0.0	0.0	0.0	0.0
52	JACQUES EB5103	JACQUES SEED CO.	P R20	101.5	50.4	26	2.0	44	0.0	0.0	0.0	0.0
93	LAKESIDE 101	ROSSBACH LAKESIDE SEEDS	B R20	101.5	50.4	22	3.0	40	0.0	0.0	0.0	0.0
128	PRESCOTT 108	WILLETTE SEED FARM INC.	B R50	101.5	50.4	26	2.0	43	0.0	0.0	0.0	0.0
68	LATHAM 551	LATHAM SEED CO.	B S20	101.5	50.3	25	2.0	41	0.0	0.0	0.0	0.0
22	DIAMOND D180B	DIAMOND BRAND SEED	B R40	101.3	50.2	25	2.3	43	0.0	0.0	0.0	0.0
27	EHRICH E-84	EHRICH SEED FARMS	P R30	101.2	50.2	26	2.0	42	0.0	0.0	0.0	0.0
35	FUNK G3213	FUNK SEEDS INT'L. 12213	B M50	101.2	50.2	27	2.0	43	0.0	0.0	0.0	0.0
86	PROFISEED 1139	PROFISEED INC.	R40	101.0	50.1	25	3.0	44	0.0	0.0	0.0	0.0
122	THOMPSON T-30P	THOMPSON FARMS SEEDS	B 30	101.0	50.1	26	2.0	44	0.0	0.0	0.0	0.0
89	PROFISEED 6851	PROFISEED INC.	P 40	100.9	50.0	24	1.7	39	0.0	0.0	0.0	0.0
11	CENEX 8518	CENEX	P 40	100.8	50.0	25	1.7	41	0.0	0.0	0.0	0.0
65	LATHAM 401	LATHAM BROS. FARM	B S20	100.7	50.0	26	2.0	43	0.0	0.0	0.0	0.0
139	VICKERY	IOWA A.E.S.	R50	100.4	49.8	24	3.3	44	0.0	0.0	0.0	0.0
39	HOFFMAN DAWN	HOFFMAN SEED FARMS INC.	P R20	100.4	49.8	26	2.0	42	0.0	0.0	0.0	0.0
45	HY-VIG DERBY 9	HY-VIGOR SEEDS. INC.	P M50	100.1	49.7	25	3.0	42	0.0	0.0	0.0	0.0
10	CENEX 8017	CENEX	P R40	100.0	49.6	26	2.7	45	0.0	0.0	0.0	0.0
18	DEKALB CX264	DEKALB - PFIZER GENETICS	P S30	99.7	49.5	27	2.0	43	0.0	0.0	0.0	0.0
82	PRIDE B152	PRIDE CO. INC.	P R50	99.7	49.5	24	2.0	39	0.0	0.0	0.0	0.0
96	SOI 226	SAND SEED SERVICES. INC.	P S30	99.4	49.3	26	2.0	41	0.0	0.0	0.0	0.0
103	S BRAND S-40C	SCHECHINGER SEED CO.	B 30	99.2	49.2	26	2.0	41	0.0	0.0	0.0	0.0
26	MUSTANG 1280	DOMESTIC SEED AND SUPPLY INC.	B M50	99.1	49.2	26	2.0	45	0.0	0.0	0.0	0.0
132	BSR 201	IOWA A.E.S.	R50	99.0	49.1	26	2.3	41	0.0	0.0	0.0	0.0
58	DESOY 330	KRUGER SEED CO.	B M50	98.8	49.0	27	2.0	44	0.0	0.0	0.0	0.0
75	MIDWEST OIL 2620	MIDWEST OILSEEDS INC.	B M50	98.6	48.9	26	2.0	41	0.0	0.0	0.0	0.0
98	SOI 254	SAND SEED SERVICES. INC.	P R50	98.4	48.8	25	2.0	40	0.0	0.0	0.0	0.0
105	SEEDTEC 630	SEEDTEC	P 40	98.4	48.8	25	2.7	43	0.0	0.0	0.0	0.0
12	CSB 0158	CHALLENGER SEED LTD.	P S40	98.2	48.7	26	2.0	43	0.0	0.0	0.0	0.0
54	KB116	KALTENBERG SEED FARMS INC.	P S30	97.8	48.5	23	1.7	38	0.0	0.0	0.0	0.0
8	ASGROW A2522	ASGROW SEED CO.	P S30	97.7	48.5	28	2.3	47	0.0	0.0	0.0	0.0
5	ASGROW A1525	ASGROW SEED CO.	P R30	97.7	48.4	23	1.0	42	0.0	0.0	0.0	0.0
84	PRIDE 225 BRAND	PRIDE CO. INC.	B M50	97.6	48.4	26	2.0	43	0.0	0.0	0.0	0.0
32	FARMACY EVE	FARMACY SEED CO.	P R50	97.1	48.2	26	2.3	42	0.0	0.0	0.0	0.0
31	ENTERPRISE II	FARMACY SEED CO.	P S30	96.6	47.9	24	3.0	41	0.0	0.0	0.0	0.0
29	EHRICH E-85	EHRICH SEED FARMS	P R40	96.5	47.9	26	3.0	43	0.0	0.0	0.0	0.0

Table 4. cont.

ENT	NSN	PEDIGREE	PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
126	ZILLER EXP. 37	ZILLER SEED CO.	P S40	96.5	47.9	25	1.7	40	0.0	0.0	0.0	0.0
127	ZILLER EXP. 38	ZILLER SEED CO.	P S50	96.4	47.8	22	2.0	41	0.0	0.0	0.0	0.0
59	LOL EX 1700	LAND O' LAKES	B M30	96.0	47.6	23	2.3	41	0.0	0.0	0.0	0.0
129	PIONEER 1677	PIONEER	P S40	95.8	47.5	24	2.0	41	0.0	0.0	0.0	0.0
66	LATHAM 650	LATHAM SEED CO.	P S30	95.5	47.4	25	2.0	41	0.0	0.0	0.0	0.0
23	DIAMOND D195B	DIAMOND BRAND SEED	B S30	95.4	47.3	26	2.7	45	0.0	0.0	0.0	0.0
67	LATHAM 301	LATHAM SEED CO.	B R20	95.4	47.3	25	2.7	43	0.0	0.0	0.0	0.0
2	AGRIPRO AP200	AGRIPRO SEEDS	P R40	95.3	47.3	26	2.0	43	0.0	0.0	0.0	0.0
38	GFS 423	GREENFIELD	P R30	95.2	47.2	24	2.0	43	0.0	0.0	0.0	0.0
6	ASGROW A1937	ASGROW SEED CO.	P R40	94.7	47.0	22	2.0	44	0.0	0.0	0.0	0.0
123	THOMPSON T-25	THOMPSON FARMS SEEDS	P 30	94.6	46.9	26	2.0	41	0.0	0.0	0.0	0.0
60	LOL L 1771	LAND O' LAKES	P R50	94.4	46.8	22	2.0	40	0.0	0.0	0.0	0.0
111	SX 2010	SEXAUER	P R50	94.2	46.7	27	2.3	46	0.0	0.0	0.0	0.0
73	RIVERSIDE 4042	LYNNVILLE SEED CO.	B R40	94.0	46.6	26	2.3	46	0.0	0.0	0.0	0.0
46	HY-VIG 901	HY-VIGOR SEEDS. INC.	B R40	93.9	46.6	26	3.0	45	0.0	0.0	0.0	0.0
137	HODGSON 78	MINNESOTA A.E.S.	R28	93.9	46.6	18	2.0	39	0.0	0.0	0.0	0.0
9	CENEX 8212	CENEX	P R30	93.8	46.5	23	3.0	42	0.0	0.0	0.0	0.0
43	PEARL	HOFLER	P R50	93.8	46.5	25	2.0	41	0.0	0.0	0.0	0.0
41	HOFFMAN 8300	HOFFMAN SEED FARMS INC.	P S30	93.7	46.5	27	2.7	41	0.0	0.0	0.0	0.0
140	WEBER 84	IOWA A.E.S.	R25	93.7	46.5	24	3.0	43	0.0	0.0	0.0	0.0
133	CORSOY 79	ILLINOIS A.E.S.	R45	93.4	46.3	26	3.0	46	0.0	0.0	0.0	0.0
3	AGRIPRO HP20-20	AGRIPRO SEEDS	P R40	93.0	46.1	24	2.7	40	0.0	0.0	0.0	0.0
44	GEM	HOFLER	P S40	92.7	46.0	28	2.3	43	0.0	0.0	0.0	0.0
81	PS0021	PAYCO SEEDS INC.	P R40	92.6	46.0	26	2.0	41	0.0	0.0	0.0	0.0
130	PIONEER 9201	PIONEER	P S50	92.4	45.9	24	2.0	39	0.0	0.0	0.0	0.0
33	FUNK G3180	FUNK SEEDS INT'L. 12231	P S30	92.3	45.8	19	2.0	39	0.0	0.0	0.0	0.0
121	THOMPSON T-15	THOMPSON FARMS SEEDS	P R40	92.1	45.7	25	2.0	43	0.0	0.0	0.0	0.0
88	PROFISEED 6931	PROFISEED INC.	P R40	92.0	45.6	26	2.0	43	0.0	0.0	0.0	0.0
17	DST2204	DAIRYLAND SEED COMPANY INC.	P R30	91.9	45.6	26	2.0	45	0.0	0.0	0.0	0.0
4	AGRIPRO AP2190	AGRIPRO SEEDS EX 034	P R40	91.6	45.4	27	2.7	43	0.0	0.0	0.0	0.0
144	CENTURY 84	INDIANA A.E.S.	R32	91.6	45.4	26	2.0	44	0.0	0.0	0.0	0.0
51	JACQUES J-201	JACQUES SEED CO.	P R30	91.2	45.2	23	2.0	43	0.0	0.0	0.0	0.0
21	DIAMOND D140B	DIAMOND BRAND SEED	B M30	90.9	45.1	21	3.3	43	0.0	0.0	0.0	0.0
61	LOL L 1808	LAND O' LAKES	P M40	88.9	44.1	23	3.3	39	0.0	0.0	0.0	0.0
108	SX 1020	SEXAUER	P R30	88.5	43.9	24	2.0	46	0.0	0.0	0.0	0.0
117	RUNNER	TERRA	P R30	86.1	42.7	25	2.3	43	0.0	0.0	0.0	0.0
99	SOI 136	SAND SEED SERVICES. INC.	P R20	85.2	42.2	25	2.3	45	0.0	0.0	0.0	0.0
25	MUSTANG 1180	DOMESTIC SEED AND SUPPLY INC.	B M50	85.0	42.2	25	2.7	42	0.0	0.0	0.0	0.0
124	WIL'N BLEND 1650	WILSON HYBRIDS INC.	P R40	84.3	41.8	18	2.0	43	0.0	0.0	0.0	0.0
141	MIAMI	INDIANA A.E.S.	R50	84.0	41.7	26	2.0	45	0.0	0.0	0.0	0.0
62	LOL L 2330	LAND O' LAKES LL0023	P R40	83.4	41.4	27	2.0	43	0.0	0.0	0.0	0.0
109	SX 29	SEXAUER	P R40	83.2	41.3	26	2.0	44	0.0	0.0	0.0	0.0
95	LAKESIDE 107	ROSSBACH LAKESIDE SEEDS	B R40	82.2	40.8	26	2.0	45	0.0	0.0	0.0	0.0
119	HURDLE	TERRA	P R50	81.8	40.6	25	2.0	41	0.0	0.0	0.0	0.0
142	KELLER	INDIANA A.E.S.	R30	80.8	40.1	27	2.3	43	0.0	0.0	0.0	0.0
134	ELGIN	IOWA A.E.S.	S38	44.8	22.2	29	2.3	31	0.0	0.0	0.0	0.0

Table 5. Uniform Regional Trial - group I maturity. Waseca 1986.

	DF	SS	MS	F
REP	2	315.79	157.89	11.07
TRT	11	166.90	15.17	1.06
ERROR	22	313.71	14.26	
TOTAL	35	796.40		

CV = 7.0
LSD.05 = 6.4
YIELD MEAN = 53.7

RANKING BY YIELD

ENT	NSN	PEDIGREE	PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
6	CORSOY 79	CORSOY*6 X LEE 68	R40	107.8	57.8	26	2.3	43	2.3	14.2	0.0	0.0
12	W10186	SALUT 216 X AMURSKAJA 41	S30	105.0	56.3	14	1.0	41	2.7	14.7	37.0	20.9
4	HARDIN	CORSOY*3 X CUTLER 71	R45	104.7	56.2	23	2.0	42	3.0	14.6	37.3	21.7
3	ELGIN	AP6(2YF)(F)CL	S38	103.5	55.6	25	1.7	42	2.7	15.1	36.8	21.7
7	SIBLEY	M58-256 X HODGSON	R40	99.4	53.3	20	2.3	42	3.7	17.3	38.6	20.9
2	DAWSON	EVANS X II-63-217Y	R22	98.9	53.1	9	2.0	37	2.3	14.4	37.8	21.6
8	M81-77	II-66-49-26 X II-70-184	R40	98.3	52.8	19	2.0	39	3.3	17.7	39.4	20.7
10	M81-392	II-70-127 X CENTURY	R30	97.9	52.5	14	1.7	43	3.0	18.9	36.5	21.1
5	HODGSON 78	HODGSON*7 X MERIT	R28	97.9	52.5	14	1.7	42	2.7	14.3	0.0	0.0
1	BSR 101	L69U40016-4 X A76-304020	R42	96.3	51.6	27	1.0	43	3.3	15.4	37.0	21.2
11	M81-564	II-69-36 X WEBER	R20	95.2	51.1	19	2.0	41	3.0	11.2	37.5	21.4
9	M81-380	II-70-127 X CENTURY	R20	95.1	51.0	13	1.3	40	2.7	18.3	40.4	20.0

Table 6. Preliminary Uniform Regional Trial - group I maturity. Waseca 1986.

	DF	SS	MS	F
REP	1	295.33	295.33	15.02
TRT	27	671.94	24.89	1.27
ERROR	27	530.81	19.66	
TOTAL	55	1498.08		

CV = 8.7
LSD.05 = 9.1
YIELD MEAN = 50.7

RANKING BY YIELD

ENT	NSN	PEDIGREE	PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
16	A85-195005	A80-149008 X MIDWEST OILSEEDS 2050	40	113.7	57.6	27	1.0	43	2.3	14.6	38.6	21.1
25	82-808	11-71-52 X WELLS II	1C R50	108.2	54.8	20	1.0	42	3.0	16.2	37.5	21.1
11	A85-193023	A79-135010 X ASGROW A1937	40	108.1	54.8	25	2.0	40	2.7	15.0	37.2	21.8
6	A85-191033	PRIDE B203 X A79-135010	50	108.0	54.8	26	1.5	40	3.3	15.9	38.5	21.2
8	A85-192034	A80-344003 X ASGROW A1937	30	107.6	54.5	24	1.0	38	2.7	15.7	38.3	21.2
4	A85-191029	A80-245022 X A80-344003	40	107.4	54.4	26	1.5	41	3.0	13.7	39.5	19.5
18	A85-291010	MIDWEST OILSEEDS X ASGROW A1937	30	107.3	54.4	25	1.0	41	2.0	14.9	38.6	20.7
7	A85-192028	PRIDE B203 X MIDWEST OILSEEDS 3010	50	105.8	53.6	25	1.5	41	3.7	13.7	38.2	20.4
1	DAWSON	EVANS X 11-63-217Y	R22	103.7	52.5	11	1.5	35	2.0	14.1	36.2	21.9
5	A85-191030	PRIDE B203 X ASGROW A1937	40	102.9	52.1	23	1.5	42	3.0	14.4	37.1	21.3
2	ELGIN	AP6(2YT)(F)C1	S38	102.8	52.1	26	1.0	39	2.0	14.9	37.1	21.1
22	82-559	VICKERY X CENTURY	1C R40	102.7	52.1	13	1.0	36	2.7	16.0	39.6	19.9
10	A85-193020	ASGROW A1937 X TRI VALLEY CHARGER III	30	100.8	51.1	26	1.0	41	3.3	15.8	38.3	20.9
27	M74-498	Px20 X 554-10	R20	100.8	51.1	22	2.0	42	2.7	14.9	0.0	0.0
17	A85-195013	A79-334010 X A79-131010	40	100.6	51.0	26	2.0	40	2.3	15.6	38.4	20.4
21	82-118	11-74-69 X WELLS II	1C R20	98.8	50.1	18	1.0	41	3.0	13.6	37.4	21.7
26	82-946	11-74-69 X A77-112008	R50	98.2	49.8	18	1.5	40	3.3	16.6	39.2	20.1
9	A85-193012	A80-247007 X A80-143015	40	96.8	49.1	27	2.0	43	2.0	13.5	36.1	20.0
20	82-106	11-73-105 X VICKERY	1C R20	96.8	49.1	20	1.0	41	3.0	15.0	38.7	21.1
24	82-776	11-68-256 X 11-70-597	BSR-R R30	96.0	48.7	13	1.0	42	2.7	16.4	39.7	20.9
3	SIBLEY	M68-256 X HODGSON	R40	95.9	48.6	19	1.5	38	4.0	17.5	37.6	21.7
12	A85-193033	PRIDE B203 X A81-157024	50	94.6	48.0	24	1.5	42	3.0	14.2	39.0	20.7
23	82-772	11-68-256 X 11-70-597	BSR-R R20	93.8	47.5	14	1.0	43	3.3	16.9	40.9	20.0
13	A85-194007	HOFFLER CENSOY X A80-143015	20	92.9	47.1	27	1.5	41	2.0	14.9	37.7	20.3
19	BX HODGSON 1c Hm	HODGSON 3 X M75-2	20	91.5	46.4	13	1.0	38	2.7	12.9	37.3	21.4
14	A85-194010	HOFLER CENSOY X A80-143015	20	90.5	45.9	26	2.5	39	2.0	14.5	36.7	21.4
15	A85-194012	MRC CHEYENNE X A80-143015	30	88.0	44.6	27	2.0	41	2.3	12.9	38.4	19.6
28	M75-2	HOD*4 X [M69-141 X (CHIP X HIGAN)]	R20	85.8	43.5	14	2.0	38	2.0	14.2	0.0	0.0

Table 7. Uniform Regional Trial - group II maturity. Waseca 1986.

	DF	SS	MS	F
REP	2	312.19	156.09	5.39
TRT	20	573.64	28.68	0.99
ERROR	40	1158.14	28.95	
TOTAL	62	2043.97		

CV = 11.4
LSD.05 = 8.9
YIELD MEAN = 47.2

RANKING BY YIELD

ENT	NSN	PEDIGREE		PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
9	A84-284033	HW79015 X A80-247007		30	111.6	52.6	32	2.3	49	1.7	17.6	36.9	20.3
8	A83-273009	ASGROW A3127 X TRI-VALLEY CHARGER		S50	110.3	52.0	28	1.0	44	2.0	15.1	39.4	19.6
5	HOYT	HARCOR X ELF	dt1	R40	106.9	50.4	30	1.0	31	2.3	11.9	39.2	19.5
6	ZANE	CUMBERLAND X PELLA		X30	105.9	50.0	34	1.3	45	1.7	18.7	39.2	19.6
19	CORSOY 79	CORSOY*6 X LEE 68		R40	103.9	49.0	26	3.0	45	2.3	14.4	0.0	0.0
14	M81-384	II-70-127 X CENTURY		R20	103.1	48.6	25	2.0	40	2.7	16.9	37.5	21.2
20	6SR 101	L69U40-16-4 X A76-304020		R20	102.7	48.4	26	1.7	44	3.0	14.9	0.0	0.0
12	HC80-1756	L73U-632 X ELF	dt1	P30	101.7	48.0	29	1.0	31	1.7	14.6	40.1	18.1
1	HARDIN	CORSOY*3 X CUTLER 71		R45	101.3	47.8	22	2.3	43	3.3	13.9	36.6	21.4
18	82-951	II-74-69 X A77-112008		R40	101.0	47.6	25	1.3	46	3.0	17.1	0.0	0.0
16	82-650	WELLS X DESOTO		R50	100.0	47.1	26	1.3	42	2.3	15.7	0.0	0.0
10	C1678	HOBBIT X LAKOTA	dt1	M50	99.7	47.0	29	1.3	34	2.0	14.4	39.3	18.9
11	HC80-1742	UNION X GNOME	dt1	R40	99.7	47.0	29	1.0	31	1.7	15.4	40.4	18.1
21	PRESTON	SCHECHINGER S48 X LAND O'LAKES MAX		S40	99.7	47.0	28	1.7	45	2.0	16.6	39.4	19.3
3	ELGIN	AP6(2YT)(F)C1		S38	98.9	46.7	25	1.3	41	2.3	15.9	37.8	20.5
7	A83-172007	A77-211021 X MEPSCHMAN WASHINGTON V		R40	96.3	45.4	25	1.7	47	3.3	17.2	38.1	21.2
13	M81-381	II-70-127 X CENTURY		R30	94.5	44.5	23	1.0	45	3.3	16.3	38.5	20.8
15	82-605	II-70-484 X CENTURY		R40	94.1	44.4	23	1.0	43	3.7	16.8	0.0	0.0
17	82-854	II-73-129 X L74-3897		R50	93.9	44.3	24	1.7	43	3.7	19.9	0.0	0.0
4	ELGIN 8C	ELGIN*5 X WILLIAMS 82		R38	92.8	43.7	25	1.7	43	2.0	15.4	37.2	20.7
2	CENTURY 84	CENTURY*5 X WILLIAMS 82	1K	R32	82.0	38.7	25	1.0	46	2.3	17.8	40.0	20.3

Table 8. Effects of planting date on yield of publicly developed soybean varieties. Waseca 1986.

	DF	SS	MS	F
REP	3	758.56	252.85	11.94
TRT	39	19458.91	498.95	23.57
ERROR	117	2477.22	21.17	
TOTAL	159	22694.69		

CV = 10.2
LSD.05 = 6.4
YIELD MEAN = 45.1

RANKING BY YIELD

ENT	NSN			PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
16	BSR 101	10"	MAY 6		141.4	63.7	26	1.8	44	2.5	16.2	37.7	20.5
17	BSR 101	10"	MAY 16		136.1	61.3	26	1.3	44	2.2	16.2	38.3	19.6
27	HARDIN	10"	MAY 16		133.6	60.2	23	2.8	45	2.5	14.8	39.9	20.1
37	SIBLEY	10"	MAY 16		132.0	59.5	22	3.8	43	2.5	18.6	39.1	21.2
11	BSR 101	30"	MAY 6		129.2	58.2	24	1.0	43	2.8	16.3	38.1	17.9
12	BSR 101	30"	MAY 16		128.6	58.0	27	1.0	41	2.2	16.0	37.8	19.7
21	HARDIN	30"	MAY 6		127.2	57.3	21	2.3	42	2.5	15.7	37.0	20.9
26	HARDIN	10"	MAY 6		124.1	55.9	22	3.3	44	2.8	14.2	37.5	20.6
36	SIBLEY	10"	MAY 6		118.5	53.4	19	4.0	43	3.2	18.2	37.6	21.2
7	CORSOY 79	10"	MAY 16		116.2	52.4	27	2.5	47	2.5	14.7	38.7	18.4
13	BSR 101	30"	MAY 24		116.1	52.3	27	1.0	40	2.0	15.5	36.6	20.8
28	HARDIN	10"	MAY 24		115.5	52.1	25	2.0	44	2.2	13.9	38.5	20.4
22	HARDIN	30"	MAY 16		114.3	51.5	23	2.0	42	2.8	14.0	38.4	16.4
23	HARDIN	30"	MAY 24		113.5	51.2	23	2.0	42	2.5	14.5	38.7	19.9
2	CORSOY 79	30"	MAY 16		111.9	50.4	21	2.0	44	2.0	14.7	39.5	18.2
6	CORSOY 79	10"	MAY 6		109.3	49.2	23	2.8	45	2.5	14.3	39.8	18.2
1	CORSOY 79	30"	MAY 6		108.6	49.0	22	2.0	43	2.2	14.2	38.5	19.8
38	SIBLEY	10"	MAY 24		107.0	48.2	24	3.3	42	2.2	17.8	37.6	19.7
18	BSR 101	10"	MAY 24		106.7	48.1	27	1.3	41	2.0	15.7	37.9	18.5
31	SIBLEY	30"	MAY 6		104.8	47.2	19	2.8	38	2.8	18.6	36.2	21.0
3	CORSOY 79	30"	MAY 24		104.2	47.0	25	2.0	44	2.2	13.7	38.9	19.9
8	CORSOY 79	10"	MAY 24		103.6	46.7	26	2.0	46	2.3	13.8	39.4	18.6
33	SIBLEY	30"	MAY 24		103.4	46.6	23	2.3	38	2.8	18.2	38.1	20.7
32	SIBLEY	30"	MAY 16		102.2	46.0	21	2.8	40	3.0	19.1	37.8	21.4
29	HARDIN	10"	JUNE 9		98.3	44.3	31	1.8	36	2.0	11.5	38.5	19.3
14	EVANS	30"	JUNE 9		92.9	41.9	23	1.0	30	2.5	14.3	37.6	20.6
39	SIBLEY	10"	JUNE 9		88.9	40.1	28	1.3	33	2.0	14.5	39.3	19.4
24	HARDIN	30"	JUNE 9		88.4	39.8	31	1.0	35	2.2	11.8	37.9	20.0
34	SIBLEY	30"	JUNE 9		87.0	39.2	27	1.0	31	2.2	15.2	39.5	18.1
19	EVANS	10"	JUNE 9		81.3	36.6	23	1.0	28	2.5	14.9	38.0	19.5
4	SIMPSON	30"	JUNE 9		81.0	36.5	24	1.0	27	2.0	13.2	37.7	19.8
9	SIMPSON	10"	JUNE 9		78.7	35.5	24	1.0	26	2.0	12.4	37.8	20.1
40	SIBLEY	10"	JUNE 25		69.7	31.4	38	1.0	29	1.8	13.8	37.8	20.5
35	SIBLEY	30"	JUNE 25		68.5	30.9	38	1.0	31	2.0	13.4	39.0	19.5
15	EVANS	30"	JUNE 25		66.5	30.0	32	1.0	28	1.8	12.9	38.3	18.1
30	HARDIN	10"	JUNE 25		66.0	29.7	38	1.0	31	2.0	11.5	40.0	17.5
25	HARDIN	30"	JUNE 25		65.9	29.7	38	1.0	32	2.0	10.7	39.3	20.1
5	SIMPSON	30"	JUNE 25		59.4	26.8	32	1.0	24	1.0	11.9	39.4	17.6
20	EVANS	10"	JUNE 25		57.1	25.7	31	1.0	23	1.5	12.1	37.8	18.9
10	SIMPSON	10"	JUNE 25		42.1	19.0	32	1.0	22	1.2	11.1	38.6	19.4

Table 9. Yield of "old" vs "new" soybean varieties. Waseca 1986.

	DF	SS	MS	F
REP	2	200.01	100.00	8.67
TRT	20	2466.05	123.30	10.69
ERROR	40	461.44	11.54	
TOTAL	62	3127.50		

CV = 7.6
LSD.05 = 5.6
YIELD MEAN = 44.6

RANKING BY YIELD

ENT	NSN	PEDIGREE	PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
5	HARDIN	CORSOY*3 X CUTLER 71	R45	129.0	57.5	24	2.0	41	3.3	15.7	38.0	21.4
4	CORSOY 79	CORSOY*6 X LEE 68	R48	122.2	54.5	27	2.7	43	2.7	15.3	40.9	20.6
21	BSR 101	L69U40016-4 X A76-304020	R42	119.1	53.1	27	1.0	42	2.3	15.8	39.0	20.1
2	BSR 201	PRIDE B216 X AX901-40-2	S50	115.2	51.4	29	2.0	37	2.7	14.8	40.9	20.7
13	ELGIN	AP6 (2YT)(F)CL	S38	114.9	51.2	26	1.7	39	2.3	16.5	38.6	21.6
8	HODGSON 78	HODGSON*7 X MERIT	R28	108.4	48.3	20	2.0	39	2.7	14.2	37.9	22.3
9	SIBLEY	M68-256 X HODGSON	R40	105.1	46.9	21	2.0	40	3.0	18.9	38.0	22.6
11	WELLS II	WELLS*8 X ARKSOY	R30	102.2	45.6	25	1.3	47	2.7	17.1	41.0	22.0
12	WEBER	C1453 X SWIFT	S25	98.9	44.1	24	3.0	40	2.7	12.7	37.5	22.1
6	HARK	HAWKEYE X HAROSOY	R48	98.6	44.0	24	1.7	43	3.3	16.1	41.0	21.5
3	CHIPPEWA 64	[LINCOLN X (LIN. X RICH.)]X BLACKHAWK	R38	98.6	44.0	16	1.7	37	2.7	15.0	39.6	21.1
7	HAROSOY 63	(MANDARIN OTT.*2 X AK.HARROW)X BLACKH	R32	98.1	43.7	22	2.3	42	3.0	17.4	39.2	21.3
1	ANOKA	11-42-37 X KOREAN	S50	97.8	43.6	15	2.3	35	3.3	18.8	38.3	23.8
14	A-100	SEL. FROM FARMERS FIELD ST. PETER	S35	96.4	43.0	23	1.3	41	3.0	16.8	38.5	21.5
16	HABARO	INTRODUCTION FROM RUSSIA	R28	96.4	43.0	24	2.7	37	2.7	19.5	41.1	20.7
19	RENVILLE	LINCOLN*2 X RICHLAND	S50	90.6	40.4	16	1.7	39	2.0	17.4	39.2	21.2
18	MUKDEN	INTRODUCTION FROM MANCHURIA	R45	88.0	39.2	28	2.0	46	2.3	15.3	41.3	20.2
17	MANCHU	INTRODUCTION FROM MANCHURIA	S35	84.2	37.5	25	2.3	42	2.0	16.7	41.4	20.8
20	RICHLAND	SELECTION FROM MANCHURIAN INTRO.	S30	79.1	35.3	23	1.3	40	2.7	15.9	38.8	21.0
10	STEELE	BLACKHAWK X HAROSOY	R40	78.9	35.2	20	1.7	38	3.3	16.4	38.4	21.6
15	BLACKHAWK	MUKDEN X RICHLAND	R32	78.1	34.8	20	2.0	41	3.7	15.2	38.5	21.1

SOYBEAN SEED TREATMENT - 1986
WASECA, MINNESOTA

Ward C. Stienstra
Extension Plant Pathologist
Department of Plant Pathology
495 Borlaug Hall
1991 Upper Buford Circle
St. Paul, Minnesota 55108

This soybean seed treatment study with Hodgson 78 soybeans was planted with Certified and non-certified seed. Seeds were treated with 7 fungicides, either alone or in combination and an untreated check. The plot was planted on May 16 and harvested on October 16. Treflan and Amiben were used for weed control and the 1985 crop was oats. The seed treatments were selected to represent a wide range of products - old and new, currently registered for soybeans.

The data shows excellent germination and emergence on June 1, unifoliates fully expanded and first trifoliate just developing for all treatments and seed sources. Seedling emergence averaged 6 plants per foot of row and yield information is presented in table form. The application of seed treatments to good quality seed when planted into a well prepared seed bed did not affect early stand or yield. Variation in yields (treatments and seed sources) is not attributed to positive or negative effects of seed treatments.

Treatments	Stand	Yield
Certified Seed		
Vitavax 200 + Apron	5	43.9
Vitavax 200	5	51.1
Vitavax 34	6	47.4
Thiram	5	45.7
Apron	5	49.4
Captan	5	47.6
Captan + Apron	6	45.0
None	6	48.9
Bin Run Seed		
Vitavax 200 + Apron	6	49.8
Vitavax 200	6	49.3
Vitavax 34	5	50.1
Thiram	7	51.1
Apron	7	51.0
Captan	6	53.0
Captan + Apron	6	52.7
None	7	51.3

SOYBEAN PHYTOPHTHORA ROOT ROT - 1986
WASECA, MINNESOTA

Ward C. Stienstra
Extension Plant Pathologist
Department of Plant Pathology
495 Borlaug Hall
1991 Upper Buford Circle
St. Paul, Minnesota 55108

This soybean study of Phytophthora Root Rot and control with seed treatments Apron and Apron/Anchor and soil treatment with Ridomil was planted May 16 and harvested October 16. No disease was observed in 1986 and yield results reflect lack of disease. Early stand and final yields show no effect from disease. Phytophthora infection is favored with saturated soils following planting and in 1986 this condition did not develop.

Soybean Variety	Treatment	Stand	Yield
54-254			
	none	6	42.0
	Apron	5	41.2
	Apron/Anchor	7	41.3
	Ridomil	8	44.2
Corsoy			
	N-	6	52.4
	A	6	50.6
	AA	5	51.4
	R	5	49.8
Corsoy 79			
	N	7	54.5
	A	7	51.8
	AA	7	54.2
	R	8	57.9
Hardin			
	N	6	60.6
	A	6	57.1
	AA	7	57.9
	R	6	59.2
BSR101			
	N	7	56.7
	A	8	55.9
	AA	6	54.4
	R	6	55.2

SOYBEAN MANAGEMENT STUDY

William E. Lueschen, James H. Orf, Ward C. Stienstra
Gyles W. Randall and Thomas R. Hoverstad

Objective: The objective of this study was to evaluate the influence of tillage, soybean varieties, and seed treatments on performance of soybeans. This study was also conducted at Lamberton and Morris to evaluate the effects of different environments on these variables. This study will allow us to evaluate the interaction between the above factors.

Procedures: This study was conducted on a Webster clay loam soil containing 6 to 7% organic matter with the following chemical properties: pH=6.9; P=57 and K=285 lb/A. The initial tillage treatments were installed in the fall of 1985 after corn harvest. This site in previous years had uniform tillage with moldboard plowing following corn and chisel plowing following soybeans in a corn/corn/soybean rotation. The same tillage treatments will be maintained on the same plot each year for the duration of this study.

This study was designed as a randomized complete block experiment with four replications and a split- split plot arrangement of treatments. Tillage treatments were main plots that were 50 x 125 feet, eight varieties were subplots and sub-subplots were the three seed treatments (see Table 1 for treatment list). Fall primary tillage consisted of Paraplowing to a depth of 12 to 14 inches, chiseling to a depth of 7 to 8 inches and moldboard plowing to a depth of 8 to 9 inches. The ridges for the ridge-till system were formed in the previous year's corn crop. The corn stalks were chopped prior to fall chiseling and fall moldboard plowing but were not chopped for other tillage treatments. Spring tillage just prior to planting was one pass with a field cultivator for moldboard plowing and one pass with a finishing disk for the chisel plow treatments. Both tillage implements were equipped with a three-bar mulcher. No spring tillage was done on the no-till or Paraplow treatments.

The ridge-till system was planted with a J.D. 7100 planter equipped with a wide clearing sweep ahead of the planting units. During planting one to two inches of the tops of the ridges were removed. We experienced some planting problems because the stalks were not chopped. All other plots were planted with a J.D. 7100 planter equipped with a residue-cutting coulter ahead of the planting units. Seeds for all plots were counted and prepackaged for a seeding rate of 120,000 seeds/A. All plots were planted on May 21, 1986 using a cone planter attachment on the above described planters. On May 19, 1986, an application of glyphosate (Roundup) at 1 qt/A plus 0.5% surfactant was applied to the ridge-till, no-till and Paraplow treatments to remove existing weed competition. A preemergence application of alachlor (Lasso) plus chloramben (Amiben) at 3.5 + 3.0 lb/A was made to all treatments on May 22, 1986. The no-till and Paraplow treatments were not cultivated. The moldboard plow, chisel plow and ridge-till treatments were cultivated once in early July and the ridge-till treatments were ridged in mid-July.

Results: Very wet conditions existed in June with the accumulation of 7.89 inches of rainfall. Because of this, one replication received extensive damage from water ponding on the surface and was dropped from the analysis. The data presented in Table 1 are from three replications. Although we were unaware of it prior to planting, a poor seed lot of 'Elgin' soybeans was provided for this study. Therefore, the results with this variety were greatly affected by its poor seed quality. The analysis of variance (Table 2) is present with the variety Elgin included and with it removed from the analysis.

The moldboard plow treatments resulted in the tallest plants in July and also at maturity (Table 1). The ridge-till and no-till plants were the shortest. As expected there was considerable plant height variation among the eight varieties. Seed treatment did not affect plant height. None of the interactions were significant for plant height.

Lodging, which was not severe in this study, was influenced by tillage and variety but not by seed treatment (Table 1). Lodging was significantly greater for the ridge-till and chisel systems as compared to all other tillage systems. Lodging was similar for 'Corsoy 79', Asgrow 'A1937', 'Sibley', 'Hardin' and 'Hodgson 78' which had significantly greater lodging than 'BSR101', Elgin and Pioneer '1677' which also had similar lodging. Seed treatment did not affect lodging and none of the interactions were significant with this parameter.

Maturity was delayed one day with no-till compared to all other tillage systems which had similar maturity ratings (Table 1). As expected, varieties differed greatly with respect to maturity. Seed treatment did not affect this parameter. The tillage x seed treatment interaction was significant but the differences were very small and not meaningful.

Final plant population was lower than normal because we seeded this study at a reduced seeding rate (122,000/A) to maximize differences between treatments (Table 1). The ridge-till treatment had significantly fewer plants at maturity than any other tillage system. However, this difference (6,000 to 9,000 plants/A) probably was not sufficient to cause large yield differences. There were significant differences among varieties for this parameter, the most noticeable was Elgin which averaged only 38,000 plants/A at harvest. Averaged over all varieties, treatment with 'Captan' improved population 6,000 plants/A compared to the untreated control, this difference was significant. 'Apron' did not significantly affect plant population as compared to the untreated seed. There was a tillage x variety interaction for plant population which was the result of both Elgin and A1937 having lower populations on the ridge-till system than on other tillage systems. The seed treatment x tillage interaction was not significant.

Even though plant populations were generally less than 100,000 plants/A, yields were good (Table 1). The ridge-till system yielded an average of 6.4 bu/A less than the moldboard plow treatment. All other tillage systems had yields similar to the moldboard plow system. Although the ridge-till system was not significantly lower in yield than the no-till, chisel plow or Paraplow systems, there was a consistent trend for 4 to 5 bu/A lower yields. The lower yields with the ridge system probably were due to the relatively late ridging that covered up some of the lower nodes or may have pruned some of the roots. The ridge-till system was also more difficult to harvest and we may have experienced greater harvest losses.

As one would expect, there were significant differences among varieties for yield (Table 1). BSR101 and A1937 were the highest yielding varieties and Elgin was the lowest yielding. Where Elgin was included in the analyses (top of Table 2), seed treatment significantly affected yield. In this case, Captan-treated seed produced yields 2 bu/A higher than untreated seed and 1.6 bu/A higher than Apron-treated seed. The variety x seed treatment interaction where Elgin was included in the analysis resulted from both Elgin and Pioneer 1677 responding to both Captan and Apron seed treatment. In the case of Elgin seed treatment improved yield by 11 bu/A with Captan and 5 bu/A with Apron. Pioneer 1677 had 6 and 5 bu/A yield increases with Captan and Apron seed treatment, respectively, compared to the untreated seed of these varieties. No other varieties responded to seed treatment.

The variety x tillage interaction was significant for yield (Table 2). There was a lot of variation in varietal response to tillage treatment. Before any generalization can be made concerning this, more data is needed to see if consistent trends develop.

Summary: In the first year of this study, the major finding was that seed quality is extremely important. Where seed quality was high, seed treatment was not a major factor regardless of the tillage system. However, with the poor seed quality with Elgin, seed treatment greatly improved yields. Our data continue to indicate that soybean growers have a lot of latitude in choosing a tillage system for soybeans following corn. There does not appear to be a general need for seed treatment with highly reduced tillage systems.

We appreciate the support of the Minnesota Soybean Research and Promotion Council who provided partial funding for this study.

Table 1. Influence of tillage, soybean variety and seed treatment on soybean performance at Waseca, MN in 1986.

Tillage	Variety 1/	Seed Treatment	Plant Height 7/15	Plant Height 9/15	2/ Lodg.	3/ Mat.	Final Stand	Yield
			-inches-	-inches-	1-5	9/1=1	1000's/A	bu/A
Notill	Corsoy 79	Check	17	41	1.7	30	99	43.0
Notill	Corsoy 79	Captan	18	41	1.7	30	112	44.8
Notill	Corsoy 79	Apron	18	41	1.3	30	100	44.1
Notill	BSR 101	Check	17	35	1.0	30	79	47.2
Notill	BSR 101	Captan	15	34	1.0	30	91	42.3
Notill	BSR 101	Apron	16	35	1.0	30	93	47.1
Notill	A 1937	Check	16	33	1.3	25	84	48.3
Notill	A 1937	Captan	16	33	1.3	25	115	49.4
Notill	A 1937	Apron	16	33	1.3	25	112	47.8
Notill	Sibley	Check	17	34	1.3	25	100	43.9
Notill	Sibley	Captan	16	33	1.0	25	81	44.6
Notill	Sibley	Apron	17	35	1.3	25	93	42.3
Notill	Elgin	Check	13	28	1.0	34	26	38.1
Notill	Elgin	Captan	14	31	1.0	33	45	45.4
Notill	Elgin	Apron	13	30	1.0	33	24	41.5
Notill	Hardin	Check	17	37	1.7	26	85	40.2
Notill	Hardin	Captan	17	36	1.7	26	102	43.7
Notill	Hardin	Apron	19	36	1.7	26	94	43.8
Notill	P 1677	Check	15	35	1.3	28	80	42.1
Notill	P 1677	Captan	17	34	1.0	28	113	49.2
Notill	P 1677	Apron	17	34	1.3	28	98	46.9
Notill	Hodgson 78	Check	18	34	2.0	25	100	44.1
Notill	Hodgson 78	Captan	17	34	2.0	25	95	43.2
Notill	Hodgson 78	Apron	18	35	1.7	25	98	44.7
Ridge	Corsoy 79	Check	21	42	2.0	28	101	41.3
Ridge	Corsoy 79	Captan	21	42	2.0	28	116	46.2
Ridge	Corsoy 79	Apron	22	43	2.0	28	105	35.2
Ridge	BSR 101	Check	17	36	1.0	30	87	43.6
Ridge	BSR 101	Captan	18	34	1.0	30	93	45.0
Ridge	BSR 101	Apron	17	35	1.0	30	88	45.0
Ridge	A 1937	Check	19	35	1.7	24	78	44.3
Ridge	A 1937	Captan	18	36	1.7	24	78	42.0
Ridge	A 1937	Apron	18	34	1.7	24	59	43.9
Ridge	Sibley	Check	18	34	1.3	24	78	40.1
Ridge	Sibley	Captan	18	34	1.0	24	92	42.2
Ridge	Sibley	Apron	19	34	1.0	24	99	41.9
Ridge	Elgin	Check	11	26	1.0	35	9	21.1
Ridge	Elgin	Captan	11	28	1.0	35	37	34.8
Ridge	Elgin	Apron	12	27	1.0	35	21	33.0
Ridge	Hardin	Check	18	36	1.7	26	78	42.0
Ridge	Hardin	Captan	18	36	1.7	26	84	43.5
Ridge	Hardin	Apron	19	36	1.7	26	85	38.8
Ridge	P 1677	Check	17	34	1.0	25	96	41.9
Ridge	P 1677	Captan	18	34	1.3	25	89	44.3
Ridge	P 1677	Apron	18	34	1.0	25	100	42.2
Ridge	Hodgson 78	Check	17	33	1.3	24	87	37.9
Ridge	Hodgson 78	Captan	17	33	1.3	24	94	40.0
Ridge	Hodgson 78	Apron	18	34	1.3	24	91	40.7

Table 1. cont.

Moldboard	Corsoy 79	Check	23	45	2.0	30	116	50.8
Moldboard	Corsoy 79	Captan	23	43	2.0	30	110	42.4
Moldboard	Corsoy 79	Apron	24	45	2.0	30	104	45.4
Moldboard	BSR 101	Check	19	28	1.3	30	93	48.9
Moldboard	BSR 101	Captan	19	29	1.3	30	91	43.9
Moldboard	BSR 101	Apron	20	40	1.3	30	99	48.0
Moldboard	A 1937	Check	20	38	1.7	24	99	51.9
Moldboard	A 1937	Captan	19	38	1.7	24	102	48.1
Moldboard	A 1937	Apron	19	38	1.7	24	94	49.2
Moldboard	Sibley	Check	20	38	1.3	24	93	47.1
Moldboard	Sibley	Captan	20	39	1.7	24	81	45.9
Moldboard	Sibley	Apron	20	38	1.7	24	105	44.1
Moldboard	Elgin	Check	14	30	1.0	33	25	39.6
Moldboard	Elgin	Captan	14	32	1.0	33	62	47.3
Moldboard	Elgin	Apron	16	31	1.0	33	55	39.7
Moldboard	Hardin	Check	21	40	1.7	25	107	48.1
Moldboard	Hardin	Captan	22	41	1.7	25	89	46.7
Moldboard	Hardin	Apron	21	41	1.7	25	81	46.6
Moldboard	P 1677	Check	18	38	1.3	25	84	43.9
Moldboard	P 1677	Captan	20	38	1.3	25	94	50.1
Moldboard	P 1677	Apron	19	37	1.3	25	80	47.3
Moldboard	Hodgson 78	Check	20	39	1.3	23	104	47.4
Moldboard	Hodgson 78	Captan	21	38	1.3	23	104	47.6
Moldboard	Hodgson 78	Apron	20	38	1.3	23	93	47.1
Chisel	Corsoy 79	Check	20	43	2.0	28	100	39.7
Chisel	Corsoy 79	Captan	22	43	2.0	28	98	41.8
Chisel	Corsoy 79	Apron	22	44	2.0	28	110	47.1
Chisel	BSR 101	Check	17	37	1.0	31	100	45.4
Chisel	BSR 101	Captan	16	35	1.0	31	82	49.4
Chisel	BSR 101	Apron	17	36	1.0	31	93	47.7
Chisel	A 1937	Check	19	37	1.7	24	93	49.8
Chisel	A 1937	Captan	18	36	1.7	24	91	49.4
Chisel	A 1937	Apron	18	36	1.3	24	72	39.2
Chisel	Sibley	Check	17	35	1.7	25	96	41.6
Chisel	Sibley	Captan	18	36	1.7	25	100	45.6
Chisel	Sibley	Apron	17	34	1.3	25	103	46.7
Chisel	Elgin	Check	15	30	1.0	33	46	40.6
Chisel	Elgin	Captan	15	32	1.0	33	64	48.2
Chisel	Elgin	Apron	15	31	1.0	33	51	38.2
Chisel	Hardin	Check	18	38	1.7	26	92	48.5
Chisel	Hardin	Captan	19	39	1.7	26	98	48.2
Chisel	Hardin	Apron	19	38	1.7	26	76	43.8
Chisel	P 1677	Check	18	35	1.7	24	59	40.7
Chisel	P 1677	Captan	19	35	1.3	24	93	49.3
Chisel	P 1677	Apron	19	36	1.7	24	86	47.2
Chisel	Hodgson 78	Check	19	35	2.0	23	92	45.8
Chisel	Hodgson 78	Captan	19	35	2.0	23	94	47.5
Chisel	Hodgson 78	Apron	19	36	2.0	23	98	41.4
Paraplow	Corsoy 79	Check	21	42	2.0	29	105	39.9
Paraplow	Corsoy 79	Captan	22	43	2.0	29	101	45.7
Paraplow	Corsoy 79	Apron	22	43	2.0	29	109	40.2
Paraplow	BSR 101	Check	16	36	1.0	20	102	52.9
Paraplow	BSR 101	Captan	16	35	1.0	21	106	50.7
Paraplow	BSR 101	Apron	17	36	1.0	20	84	47.7
Paraplow	A 1937	Check	18	37	1.7	25	99	48.3
Paraplow	A 1937	Captan	18	37	1.7	25	80	49.1

Table 1. cont.

Paraplow	A 1937	Apron	19	37	1.3	25	85	48.8
Paraplow	Sibley	Check	18	35	2.0	24	91	49.4
Paraplow	Sibley	Captan	18	35	2.3	24	82	37.7
Paraplow	Sibley	Apron	18	36	2.0	24	108	37.6
Paraplow	Elgin	Check	13	29	1.3	33	31	26.6
Paraplow	Elgin	Captan	13	30	1.3	33	49	46.3
Paraplow	Elgin	Apron	13	30	1.3	33	30	39.0
Paraplow	Hardin	Check	18	36	1.7	27	93	49.7
Paraplow	Hardin	Captan	17	35	1.7	27	92	47.4
Paraplow	Hardin	Apron	17	35	1.7	27	79	48.9
Paraplow	P 1677	Check	18	35	2.0	25	80	38.8
Paraplow	P 1677	Captan	19	36	1.7	25	88	43.4
Paraplow	P 1677	Apron	17	36	2.0	25	95	44.3
Paraplow	Hodgson 78	Check	19	35	1.3	24	94	43.5
Paraplow	Hodgson 78	Captan	18	34	1.7	24	99	43.8
Paraplow	Hodgson 78	Apron	18	36	1.3	24	100	42.8

Means across varieties and seed treatments :

Tillage	Plant Height 7/15	9/15	Lodg.	Mat.	Final Stand	Yield
	-inches-		1-5	9/1=1	1000's/A	bu/A
Notill	16	35	1.4	28	88	44.5
Ridge	18	35	1.4	27	81	40.5
Moldboard	20	38	1.5	27	90	46.6
Chisel	18	36	1.6	27	87	45.1
Paraplow	18	36	1.6	27	87	44.3
BLSD(.05)	2	1	ns	1	7	5.2

Means across tillage and seed treatments :

Variety	Plant Height 7/15	9/15	Lodg.	Mat.	Final Stand	Yield
	-inches-		1-5	9/1=1	1000's/A	bu/A
Corsoy 79	21	43	1.9	29	106	42.8
BSR 101	17	36	1.1	30	92	47.0
A 1937	18	36	1.6	24	89	47.3
Sibley	18	35	1.5	24	93	43.0
Elgin	13	30	1.1	33	38	38.6
Hardin	19	37	1.7	26	89	45.3
P 1677	18	36	1.4	25	89	44.8
Hodgson 78	18	35	1.6	23	96	43.8
BLSD(.05)	1	1	0.2	1	5	1.6

Table 1. cont.

Means across tillage and variety :

Seed Treatment	Plant Height 7/15	Plant Height 9/15	Lodg.	Mat.	Final Stand	Yield
	-inches-		1-5	9/1=1	1000's/A	bu/A
Check	18	36	1.5	27	84	43.3
Captan	18	36	1.5	27	90	45.3
Apron	18	36	1.4	27	86	43.7
BLSD(.05)	ns	ns	ns	ns	3	1

1| Varieties : Asgrow A1937, Pioneer 1677; all other varieties are publicly developed varieties.

2| Lodg. : Lodging score; 1=erect 5=flat.

3| Mat. : Maturity; days past August 31 when 95% of the pods were brown.

Table 2. A summary of the statistical significance of parameters listed in Table 1.

Source of Variation	df	Plant Height 7/15	Plant Height 9/15	Lodg.	Mat.	Final Stand	Yield
Analysis with the variety Elgin included :							
		% Confidence Level					
Rep	2	99	99	98	>99	76	24
Tillage	4	97	>99	69	99	93	90
Rep x Till (error A)	8	---	---	---	---	---	---
Variety	7	>99	>99	>99	>99	>99	>99
Tillage x Variety	28	81	83	78	86	>99	>99
R x T x V (error B)	70	---	---	---	---	---	---
Seed Treatment	2	92	74	55	35	>99	>99
Till x Seedtrt	8	32	8	7	95	58	74
Var x Seedtrt	14	84	>99	5	28	>99	>99
Till x Var x Seedtrt	56	11	15	1	98	92	93
R x T x V x ST (error C)	160	---	---	---	---	---	---
		% CV					
		6.2	2.9	18	0.5	15	9.1
Analysis with the variety Elgin deleted :							
Rep	2	99	>99	98	>99	80	44
Tillage	4	97	>99	60	98	88	84
Rep x Till (error A)	8	---	---	---	---	---	---
Variety	6	>99	>99	>99	>99	>99	>99
Tillage x Variety	24	54	88	82	70	98	99
R x T x V (error B)	60	---	---	---	---	---	---
Seed Treatment	2	89	84	60	15	80	81
Till x Seedtrt	8	44	13	9	92	85	77
Var x Seedtrt	12	90	49	9	30	99	97
Till x Var x Seedtrt	48	21	36	4	99	94	89
R x T x V x ST (error C)	140	---	---	---	---	---	---
		% CV					
		5.9	2.8	18	0.5	13	8.3

Soybean Population and Interplant Study

D.R. Hicks, W.E. Lueschen, and J.H. Ford

The objective of this study was to determine the effect of plant population and interplanting after original stand was damaged on soybean yield. Plots were established by planting Corsoy 79 in 30-inch rows at three populations - 37,400; 75,000; and 150,000 plants per acre. Some plots were damaged with a flail chopper in early June and another group damaged in late June to simulate injury similar to that caused by hail. The flail chopper removed the top half of all plants. After injury on both dates, treatments were no interplant (leave damaged plants), interplant with variety with hila color different from Corsoy 79 (varieties given in yield tables), and replant with a pure stand of the interplant variety. After harvest, samples of seeds from interplanted plots were separated based on hila color to determine the contribution to yield by each variety. Interplanting occurred as close to the original rows as possible. Seeding rate of interplanting was 75,000 seeds per acre on all interplant plots. Replant plots were seeded with 150,000 seeds per acre.

Yield results are given in tables 1 and 2 for Waseca and Lamberton, respectively. Yields were lower at Lamberton when populations were less than 150,000 plants per acre. However, yields were not affected by the change in population at Waseca.

Damaged plants yielded lower than undamaged plants at both locations, all populations, and both dates of plant damaged except the 150,000 plant population at Lamberton. Damage in late June caused a greater reduction in yield than did damage in early June.

Interplanting did not have an effect on yield when the stand was 150,000 plants per acre except at Waseca on the late June damaged soybeans. At the lower populations, interplanting resulted in higher yields, especially at the 37,500 plants per acre. When interplanting occurred, each variety contributed equally to yield.

Replanting resulted in yields equal to those of interplanting at Waseca and lower yields at Lamberton, especially the June 25 replant date.

Table 1. Effect of plant population, plant damage, and interplanting on soybean yield, Waseca, 1986.

Treatment	Plant Population 37,500	75,000	150,000
	- - - - - - - -	-bu/a - - - - - - - -	
Original stand, Corsoy 79	53.6	54.9	53.3
Damaged 6/10, no interplant	40.3	44.0	45.0
Damaged 6/10, Elgin interplanted	47.4	47.3	44.9
Elgin planted alone 6/10*			44.2
Damaged 6/25, no interplant	24.0	19.3	15.8
Damaged 6/25, Hodgson 78 interplanted	30.5	32.2	25.9
Hodgson 78 planted alone 6/10*			24.5
McCall planted alone 6/10*			22.0

* Original stand of Corsoy 79 completely destroyed

Table 2. Effect of plant population, plant damage, and interplanting on soybean yield, Lamberton, 1986.

Treatment	Plant Population 37,500	75,000	150,000
	- - - - - - - -	-bu/a - - - - - - - -	
Original stand, Corsoy 79	38.2	41.6	43.4
Damaged 6/9, no interplant	34.8	38.2	45.4
Damaged A1937 interplanted	41.7	43.2	44.4
A1937 planted alone 6/9*			41.0
Damaged 6/25, no interplant	29.2	42.1	45.2
Damaged Hodgson 78 interplanted	34.4	36.0	42.5
Hodgson planted alone 6/9*			26.9

* Original stand of Corsoy 79 completely destroyed.

RESPONSE OF SOYBEANS TO FOLIAR APPLICATIONS OF ETHEPHON

William E. Lueschen and Thomas R. Hoverstad

Objectives: This study was designed to evaluate the effects of time and rate of ethephon (Cerone)[1/] application on agronomic characteristics and seed yield of two soybean varieties.

Procedures: This study was conducted in 1985 and 1986 at the Southern Experiment Station. The previous crops were corn removed for silage in 1985 and corn harvested for grain in 1986; following harvest the sites were chisel plowed to a depth of 6 to 8 inches. Spring tillage consisted of one field cultivation to incorporate Treflan (0.75 lb/A) one to two weeks prior to planting with a second field cultivation done just prior to planting. After planting a preemergence application of Amiben (2.5 lb/A) was made. Table 1 gives information on soil type, planting dates, treatment dates, and application dates.

Table 1. General information relating to 1985 and 1986 ethephon study for soybeans

			1985	1986
I.	Soil Related Information			
	Soil Type		Webster clay loam	Nicollet clay loam
	pH		6.1	6.6
	P (lb/A)		36	70
	K (lb/A)		296	242
II.	Planting Dates		May 22	May 23
III.	Treatment Parameters			

Date Applied		Soybean Stage[1/]	Temp. (F°)	Rel. Humidity(%)
1985	June 22	V2 to V3 (V2)	74	50
	July 2	V5 (V5)	80	40
	July 15	V7 to V9 (V8)	72	45
1986	June 23	V2 (V2)	79	50
	July 10	V6 (V5)	72	60
	July 18	V9 (V8)	92	50

[1/]The stages listed in the data tables are given in ( ) above.

These trials were designed as randomized complete block experiments with a split plot arrangement of treatments and four replications. Main plots were the two soybean varieties--'Corsoy 79' and Asgrow 'A1937'. Each subplot was 8.3 x 12 feet with a harvested area of 4.2 x 8 feet. All treatments were applied broadcast over-the-top of soybeans at the stages listed in Table 1.

[1/]Cerone is a trade name of Union Carbide Agricultural Products Company, Inc. The active ingredient is ethephon-(2-chloroethyl) phosphonic acid.

A spray volume of 20 gallons/A was used for all ethephon applications. The sprayer was equipped with 8002 nozzles and was operated at approximately 30 psi. No spray additives were applied with any of the treatments. A randomly selected 5-plant sample was taken only from Corsoy 79 when the plants were in approximately the R4 stage of development. These samples were dried, ground and submitted for nutrient analyses. Another randomly selected 5-plant sample was taken when soybeans were mature to determine the numbers of branches, pods, seeds and internodes as affected by treatment.

Results: In 1985, Corsoy 79 and A1937 had similar plant heights at maturity (Table 2). In 1986, Corsoy 79 was significantly taller than A1937. Ethephon significantly reduced plant height of both varieties each year. Height was reduced in a linear relationship as ethephon rate increased. In both years and with both varieties plant height was reduced at all three stages of application and the rate of ethephon x stage of application interaction was not significant. With each succeedingly later application of ethephon to soybeans, plant height was reduced in a stepwise fashion. There was one exception to this in 1986 when the V8 stage of ethephon application resulted in significantly taller plants than was observed for the V5 stage.

Soybean maturity was significantly influenced both years by soybean variety and rates and stages of ethephon application (Table 2). Corsoy 79 averaged about four days later than A1937. Ethephon applied at 0.50 lb/A significantly delayed maturity compared to other treatments, however, this delay was only one day. In both years applications at the V5 stage delayed maturity by one day compared to all other stages of application and the untreated control. The rate x stage of ethephon application interaction was not significant.

As with the other variables, lodging was influenced more by soybean variety than either rate or stage of ethephon treatment (Table 2). Significantly less lodging was observed with A1937 than with Corsoy 79 both years, however, lodging was not a serious limiting factor with either variety either year. There were no significant differences among ethephon rates for lodging either year, but in 1985 there was a consistent trend toward reduced lodging where ethephon was applied. The variety x ethephon rate interaction was not significant either year. In both 1985 and 1986, the least amount of lodging was observed when ethephon was applied at the V8 stage. There was a significant variety x stage of application interaction in 1985 which results from the fact that no lodging was observed with A1937 regardless of the treatment. Corsoy 79 exhibited reduced lodging with ethephon and lodging decreased as ethephon was applied at the later growth stages. The rate x stage of ethephon application was significant in 1986 for lodging. At the V2 stage of application, lodging averaged across both varieties was the same for all ethephon rates. Lodging was reduced where ethephon was applied at either 0.13 or 0.5 lb/A at the V5 stage of soybeans. The greatest and most consistent reduction in lodging occurred when ethephon was applied at the V8 stage.

In 1985, A1937 yielded an average of 5.0 bu/A better than Corsoy 79. However, in 1986 the yield of the two varieties was the same (Table 2). In 1985, there was a significant affect of rate of ethephon application (Table 2). The 0.13 and 0.25 lb/A rates increased soybean yields by 2.4 and 2.2 bu/A, respectively, when averaged over the two varieties. The 0.5 lb/A rate of ethephon did not affect yield. The variety x ethephon rate interaction was significant at the 84% level in 1985 since there was a better response to ethephon treatment with A1937 than with Corsoy 79. Neither variety responded to ethephon treatment in 1986. Neither year did we observe any interaction between variety x stage of application or rate x stage of application.

In both years Corsoy 79 had significantly more branching than was observed for A1937 (Table 3). The number of pods and seeds per plant were similar for both varieties. When averaged over both varieties in 1985, branching increased as the rate of ethephon increased (Table 3). A similar but nonsignificant trend was observed in 1986. In 1985 there was a significant variety x ethephon rate interaction for branching since A1937 exhibited increased branching as ethephon rate increased but Corsoy 79 exhibited little response to rate of application. A reduction in branching occurred in both years when ethephon was applied at the V2 stage. In 1985 there was a significant rate x stage of ethephon application interaction for branching. This was primarily the result of increased branching at the V8 stage with both the 0.25 and 0.50 lb/A rates compared to the 0.13 lb/A rate.

The number of pods and seeds per plant were not affected by ethephon rate (Table 3). There were no interactions between variety and ethephon rates for number of pods or seeds per plant. With Corsoy 79 in 1986 ethephon applied at 0.25 lb/A decreased the number of barren pods compared to the control and the 0.50 lb/A ethephon rate (Table 3). In both years the number of barren pods of Corsoy 79 increased as ethephon was applied at more advanced stages of soybean development.

The average length of internodes on Corsoy 79 was generally reduced with all rates of ethephon (Table 3). As ethephon was applied at later stages of soybean development, the internode length was significantly reduced. With the exception of the 0.13 lb/A ethephon rate, the greatest reduction in internode length occurred when soybeans were treated with ethephon at the V8 stage of development.

Data on nutrient analyses of whole plant samples of Corsoy 79 is given in Table 4. Nitrogen concentration in plant tissue was not affected by either time or rate of ethephon application either year. In 1985 the 0.25 and 0.50 lb/A rates of ethephon significantly increased calcium concentration in plant tissue; this was not true in 1986. In 1986 the V2 and V5 applications, averaged over all three ethephon rates, resulted in significantly higher concentrations of phosphorus in plant tissue than was observed for the V8 stage of treatment. The phosphorus concentration in the control treatment was similar to when ethephon was applied at the V2 and V5 stages. Potassium concentrations in 1985 were similar for the control and V8 stage applications and these treatments had significantly lower potassium levels than treatments applied at the V2 and V5 stages. Although there was a consistent trend toward higher potassium concentration for all stages of application when compared to the control, this difference was not significant. Although other nutrients occasionally showed response toward higher potassium concentration for all stages of application when compared to the control, this difference was not significant. Although other nutrients occasionally showed response to ethephon treatments, the results were not consistent. None of the interactions between stage and rates of ethephon applications were significant.

The results with ethephon in this study applied to soybeans at three growth stages indicate this compound reduced plant height and slightly delayed soybean maturity. Lodging was not reduced enough by ethephon in this study to be of practical significance. The level of lodging was not severe in this trial and if more lodging had occurred, the effects of ethephon may have been more pronounced. In 1985 there was a trend toward higher yields where ethephon was applied, especially with A1937. However, these results were not consistent over years. Based on these results, it would not appear that ethephon will consistently reduce lodging or improve soybean yields where lodging is not a serious problem.

Table 2. Effects of time and rate of ethephon application on plant height, maturity, lodging and yield of two soybean varieties in 1985 and 1986.

Variety	Ethephon Rate	Stage	Mature Plant Height 85	86	Maturity 85	86	Lodging 85	86	Yield 85	86
	(lb/a)		-(in)-		(9/1=1)		-(1-5)-		-(bu/a)-	
Corsoy 79	Check		37	46	43	28	2.0	2.2	39.1	44.5
Corsoy 79	0.13	V2	37	44	43	28	2.0	2.0	40.9	43.4
Corsoy 79	0.13	V5	36	41	43	29	1.5	2.5	41.9	45.0
Corsoy 79	0.13	V8	35	41	42	28	1.2	2.0	37.7	42.7
Corsoy 79	0.25	V2	37	42	43	28	2.0	2.5	40.9	44.2
Corsoy 79	0.25	V5	36	39	44	29	2.0	2.8	39.8	42.9
Corsoy 79	0.25	V8	34	40	43	29	1.0	2.0	40.5	43.4
Corsoy 79	0.50	V2	35	41	44	30	2.0	1.8	37.8	44.8
Corsoy 79	0.50	V5	35	36	44	31	1.2	3.2	39.8	41.4
Corsoy 79	0.50	V8	34	37	43	29	1.0	1.8	42.3	41.7
A 1937	Check		38	39	39	24	1.0	2.0	43.2	44.6
A 1937	0.13	V2	37	38	39	24	1.0	2.0	46.2	44.4
A 1937	0.13	V5	38	38	39	24	1.0	2.0	46.2	42.7
A 1937	0.13	V8	37	38	38	24	1.0	2.0	48.4	42.7
A 1937	0.25	V2	36	36	39	24	1.0	2.0	45.5	44.6
A 1937	0.25	V5	36	34	39	24	1.0	2.0	47.6	42.5
A 1937	0.25	V8	35	36	39	24	1.0	1.8	44.7	46.2
A 1937	0.50	V2	36	37	40	24	1.0	1.5	43.7	41.9
A 1937	0.50	V5	33	33	40	26	1.0	3.0	41.6	41.5
A 1937	0.50	V8	33	35	39	24	1.0	1.5	44.0	45.3

Average across rates and stages:

Variety	Mature Plant Height 85	86	Maturity 85	86	Lodging 85	86	Yield 85	86
	-(in)-		(9/1=1)		-(1-5)-		-(bu/a)-	
Corsoy 79	36	41	43	29	1.6	2.3	40.1	43.4
A 1937	36	36	39	24	1.0	2.0	45.1	43.6
	----- Level of significance (%) ----							
variety :	20	99	>99	>99	>99	97	>99	45
year x variety :	99		91		96		>99	

Table 2. cont.

Table 2. cont.

Average aross varieties and stages :

Ethephon Rate	Mature Plant Height 85	86	Maturity 85	86	Lodging 85	86	Yield 85	86
(lb/a)	-(in)-		(9/1=1)		-(1-5)-		-(bu/a)-	
Check	37	42	41	26	1.5	2.1	41.2	44.6
0.13	37	40	41	26	1.3	2.1	43.6	43.5
0.25	36	38	41	26	1.3	2.2	43.2	44.0
0.50	34	36	42	27	1.2	2.1	41.5	42.8
BLSD(.05)	1	1	1	1	ns	ns	2.1	ns
	----- Level of significance (%) ---							
year x rate :	81		29		27		25	
variety x rate:	89	81	67	47	66	56	84	10

Average aross varieties and rates :

Stage	Mature Plant Height 85	86	Maturity 85	86	Lodging 85	86	Yield 85	86
	-(in)-		(9/1=1)		-(1-5)-		-(bu/a)-	
Check	37	42	41	26	1.5	2.1	41.2	44.6
V2	36	40	41	26	1.5	2.0	42.5	43.9
V5	36	37	42	27	1.3	2.6	42.8	42.7
V8	35	38	41	26	1.0	1.9	42.9	43.7
BLSD(.05)	1	1	1	1	0.2	0.2	ns	ns
	----- Level of significance (%) ---							
year x stage :	99		85		>99		43	
variety x stage :	20	87	48	11	>99	56	10	68
rate x stage :	45	81	24	91	73	>99	50	12
var x rate x stage :	75	2	78	18	73	10	88	19

Table 3. Effects of time and rate of ethephon application on branching, number of pods, number of seeds, barren pods and internode length of two soybean varieties in 1985 and 1986.

Variety	Ethephon Rate	Ethephon Stage	Branches 85	Branches 86	Pods 85	Pods 86	Seeds 85	Seeds 86	Barren Pods[1/] 85	Barren Pods[1/] 86	Internode Length[1/] 85	Internode Length[1/] 86
	(lb/a)		(per plant)								(in)	
Corsoy 79	Check		1.8	1.8	34	45	73	85	4.2	3.2	2.6	2.6
Corsoy 79	0.13	V2	1.1	2.3	26	45	61	88	4.7	3.2	2.8	2.5
Corsoy 79	0.13	V5	2.4	2.4	32	37	72	71	5.8	2.9	2.6	2.4
Corsoy 79	0.13	V8	2.2	2.4	29	45	67	89	4.7	2.7	2.7	2.4
Corsoy 79	0.25	V2	1.6	2.0	30	40	70	83	5.0	2.1	2.6	2.5
Corsoy 79	0.25	V5	1.5	2.6	24	45	55	89	4.1	2.3	2.7	2.3
Corsoy 79	0.25	V8	4.1	2.9	37	42	80	78	9.3	3.3	2.3	2.0
Corsoy 79	0.50	V2	0.8	1.2	24	37	56	78	4.2	2.3	2.5	2.5
Corsoy 79	0.50	V5	2.2	3.3	35	41	69	79	6.4	3.9	2.2	2.4
Corsoy 79	0.50	V8	3.1	3.0	32	46	75	88	6.7	4.7	2.2	2.4
A 1937	Check		0.5	1.6	28	40	67	94	---	---	---	---
A 1937	0.13	V2	0.6	1.2	27	33	67	77	---	---	---	---
A 1937	0.13	V5	0.6	1.9	26	39	62	92	---	---	---	---
A 1937	0.13	V8	1.1	1.9	30	39	75	94	---	---	---	---
A 1937	0.25	V2	0.4	1.5	25	37	60	89	---	---	---	---
A 1937	0.25	V5	1.0	2.0	26	39	62	91	---	---	---	---
A 1937	0.25	V8	1.5	1.8	29	41	67	90	---	---	---	---
A 1937	0.50	V2	0.9	1.1	32	40	73	92	---	---	---	---
A 1937	0.50	V5	1.6	1.6	25	39	59	89	---	---	---	---
A 1937	0.50	V8	1.8	1.5	28	42	66	105	---	---	---	---

Average across rates and stages:

Variety	Branches 85	Branches 86	Pods 85	Pods 86	Seeds 85	Seeds 86	Barren Pods[1/] 85	Barren Pods[1/] 86	Internode Length[1/] 85	Internode Length[1/] 86
	(per plant)								(in)	
Corsoy 79	2.1	2.4	30	42	68	83	5.5	3.1	2.5	2.4
A 1937	1.0	1.6	27	39	66	91	---	---	---	---
	Level of Significance (%)									
variety :	97	99	68	74	27	73	---	---	---	---
year x variety :	51		22		76					

Table 3. cont.

Average aross varieties and stages :

Ethephon Rate	Branches 85	Branches 86	Pods 85	Pods 86	Seeds 85	Seeds 86	Barren Pods[1/] 85	Barren Pods[1/] 86	Internode Length[1/] 85	Internode Length[1/] 86
(lb/a)	(per plant)								(in)	
Check	1.2	1.7	31	43	70	89	4.2	3.2	2.6	2.6
0.13	1.3	2.0	28	39	67	85	5.1	2.9	2.7	2.4
0.25	1.7	2.1	28	41	66	87	6.1	2.6	2.5	2.3
0.50	1.7	2.0	29	41	66	89	5.8	3.6	2.3	2.4
BLSD(.05)	0.4	ns	ns	ns	ns	ns	ns	0.5	0.1	0.1
	Level of Significance (%)									
year x rate :	80		13		31		79		11	
variety x rate:	94	52	34	51	48	51	----	----	----	----

Average aross varieties and rates :

Stage	Branches 85	Branches 86	Pods 85	Pods 86	Seeds 85	Seeds 86	Barren Pods[1/] 85	Barren Pods[1/] 86	Internode Length[1/] 85	Internode Length[1/] 86
	(per plant)								(in)	
Check	1.2	1.7	31	43	70	89	4.2	3.2	2.6	2.6
V2	0.9	1.6	27	39	64	85	4.6	2.5	2.6	2.5
V5	1.6	2.3	28	40	63	85	5.4	3.0	2.5	2.4
V8	2.3	2.3	31	42	72	91	6.9	3.6	2.4	2.3
BLSD(.05)	0.3	0.3	3	4	6	ns	1.8	0.5	0.1	0.1
	Level of Significance (%)									
year x stage :	>99		5		16		63		>99	
variety x stage :	99	59	94	12	79	55	----	----	----	----
rate x stage :	99	74	81	39	43	67	96	50	99	64
var x rate x stage	98	91	99	90	98	75	----	----	----	----

[1/] **These parameters were evaluated only for Corsoy 79.**

Table 4. Effects of ethephon applied at three rates and three stages on plant nutrient content of Corsoy 79 soybeans in 1985 and 1986.

Variety	Ethephon Rate (lb/a)	Stage	N 85	N 86	P 85	P 86	K 85	K 86	CA 85	CA 86	MG 85	MG 86	AL 85	AL 86
			(ppm in whole plant)											
Corsoy 79	Check		2.59	3.17	2125	3236	18059	32864	16954	10596	5786	4391	48	70
Corsoy 79	0.13	V2	2.78	3.25	2199	3263	19047	34052	17306	10130	5625	4113	45	79
Corsoy 79	0.13	V5	2.41	3.26	2331	3384	19882	31782	16997	10750	5282	4299	46	88
Corsoy 79	0.13	V8	2.87	3.28	2167	3198	18335	31817	17892	10540	5575	4455	52	72
Corsoy 79	0.25	V2	2.81	3.23	2267	3281	19108	32765	17640	10572	5550	4360	47	87
Corsoy 79	0.25	V5	2.86	3.18	2227	3225	18880	31031	18850	10855	5592	4452	48	80
Corsoy 79	0.25	V8	2.99	3.05	2355	3183	18286	31254	18823	10491	5535	4487	55	83
Corsoy 79	0.50	V2	2.90	3.15	2336	3255	19546	32698	19873	10215	5606	4208	58	83
Corsoy 79	0.50	V5	2.48	3.22	2242	3261	18579	33628	19113	11282	5929	4367	59	82
Corsoy 79	0.50	V8	2.89	3.10	2312	3207	18372	33303	18496	10276	5605	4249	44	71

Variety	Ethephon Rate (lb/a)	Stage	FE 85	FE 86	NA 85	NA 86	MN 85	MN 86	ZN 85	ZN 86	CU 85	CU 86	B 85	B 86	PB 85	PB 86	NI 85	NI 86	CR 85	CR 86	CD 85	CD 86
			(ppm in whole plant)																			
Corsoy 79	Check		84	96	3.7	4.1	55	31	21	24	7	7	37	32	0.9	1.5	1.8	3.0	0.1	0.1	0.1	0.1
Corsoy 79	0.13	V2	83	101	0.9	5.1	58	32	22	26	7	7	38	33	1.0	1.3	1.8	2.6	0.2	0.1	0.1	0.2
Corsoy 79	0.13	V5	84	111	1.3	9.8	54	36	23	28	7	7	39	35	1.0	0.9	1.9	2.5	0.2	0.1	0.1	0.2
Corsoy 79	0.13	V8	89	95	1.6	5.0	54	30	23	24	7	7	37	32	1.0	1.1	1.4	2.4	0.1	0.1	0.1	0.1
Corsoy 79	0.25	V2	84	110	0.9	3.6	58	35	22	26	7	7	39	34	1.1	0.9	2.0	2.7	0.1	0.1	0.1	0.1
Corsoy 79	0.25	V5	86	102	1.0	4.5	60	33	23	25	7	7	40	33	1.1	1.7	1.8	2.5	0.2	0.1	0.1	0.1
Corsoy 79	0.25	V8	83	106	1.7	6.7	59	33	23	24	7	7	40	33	1.0	1.2	1.8	2.7	0.2	0.1	0.1	0.1
Corsoy 79	0.50	V2	96	106	0.9	4.0	60	35	23	24	7	7	40	33	1.3	1.3	2.1	2.5	0.1	0.1	0.1	0.1
Corsoy 79	0.50	V5	99	119	1.2	5.4	60	32	24	25	6	7	42	34	1.2	1.6	1.8	2.6	0.1	0.1	0.1	0.1
Corsoy 79	0.50	V8	86	96	1.2	6.2	59	31	22	25	7	7	38	32	1.1	1.0	1.7	2.7	0.2	0.1	0.1	0.1

Average across stages :

Ethephon Rate (lb/a)	N 85	N 86	P 85	P 86	K 85	K 86	CA 85	CA 86	MG 85	MG 86	AL 85	AL 86
	(ppm in whole plant)											
Check	2.59	3.17	2125	3236	18059	32864	16954	10596	5786	4391	46	70
0.13	2.69	3.26	2232	3281	19089	32566	17392	10473	5494	4289	48	80
0.25	2.85	3.16	2316	3229	18732	31683	18173	10639	5559	4388	50	83
0.50	2.76	3.16	2296	3241	18632	33209	18894	10564	5713	4274	54	79
BLSD(.05)	ns	ns	ns	ns	ns	ns	770	ns	ns	ns	ns	ns

Ethephon Rate (lb/a)	FE 85	FE 86	NA 85	NA 86	MN 85	MN 86	ZN 85	ZN 86	CU 85	CU 86	B 85	B 86	PB 85	PB 86	NI 85	NI 86	CR 85	CR 86	CD 85	CD 86
	(ppm in whole plant)																			
Check	84	96	3.7	4.1	55	31	21	24	7	7	37	32	0.9	1.5	1.8	3.0	0.1	0.1	0.1	0.1
0.13	85	102	1.3	6.9	55	33	23	26	7	7	38	33	1.0	1.1	1.7	2.5	0.2	0.1	0.1	0.2
0.25	84	106	1.2	4.9	59	34	23	25	7	7	40	33	1.1	1.3	1.9	2.6	0.2	0.1	0.1	0.1
0.50	94	107	1.1	5.2	60	33	23	25	7	7	40	33	1.2	1.3	1.9	2.6	0.1	0.1	0.1	0.1
BLSD(.05)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.1

Level of significance (%)

	N	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	PB	NI	CR	CD
year x rate :	74	79	55	99	72	54	27	73	61	58	45	72	18	2	1	84

Average across rates :

Stage	N 85	N 86	P 85	P 86	K 85	K 86	CA 85	CA 86	MG 85	MG 86	AL 85	AL 86
	(ppm in whole plant)											
Check	2.59	3.17	2125	3236	18059	32864	16954	10596	5786	4391	48	78
V2	2.83	3.21	2267	3266	19234	33182	18086	10306	5594	4289	50	83
V5	2.56	3.22	2298	3298	19114	32147	18056	10936	5601	4373	51	83
V8	2.88	3.15	2279	3196	18306	32125	18404	10436	5572	4370	50	75
BLSD(.05)	ns	ns	ns	86	973	ns	ns	317	ns	164	ns	ns

Stage	FE 85	FE 86	NA 85	NA 86	MN 85	MN 86	ZN 85	ZN 86	CU 85	CU 86	B 85	B 86	PB 85	PB 86	NI 85	NI 86	CR 85	CR 86	CD 85	CD 86
	(ppm in whole plant)																			
Check	84	96	3.7	4.1	55	31	21	24	7	7	37	32	0.9	1.5	1.8	3.0	0.1	0.1	0.1	0.1
V2	88	106	0.9	4.2	59	34	22	25	7	7	39	33	1.1	1.2	2.0	2.6	0.1	0.1	0.1	0.1
V5	90	111	1.2	6.6	58	34	23	26	7	7	40	34	1.1	1.4	1.8	2.5	0.2	0.1	0.1	0.1
V8	86	99	1.5	6.2	57	31	23	24	7	7	38	32	1.0	1.1	1.6	2.6	0.2	0.1	0.1	0.1
BLSD(.05)	ns	ns	0.6	ns	ns	2	ns	ns	ns	ns	ns	1	ns	ns	ns	ns	ns	ns	ns	ns

Level of significance (%)

	N 85	N 86	P 85	P 86	K 85	K 86	CA 85	CA 86	MG 85	MG 86	AL 85	AL 86	FE 85	FE 86	NA 85	NA 86
rate x stage :	40	14	45	62	46	29	67	74	50	53	94	36	89	73	18	71

	MN 85	MN 86	ZN 85	ZN 86	CU 85	CU 86	B 85	B 86	PB 85	PB 86	NI 85	NI 86	CR 85	CR 86	CD 85	CD 86
rate x stage :	18	92	16	47	5	88	21	54	1	91	32	17	69	31	8	74

	N	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	PB	NI	CR	CD
year x stage :	91	48	32	87	54	54	82	28	6	50	80	79	64	54	49	58
year x rate x stage :	38	19	53	57	36	48	44	66	72	51	39	15	79	17	75	66

EFFECTS OF FOLIAR APPLICATIONS OF RESPOND[a] ON PERFORMANCE OF TWO SOYBEAN VARIETIES

William E. Lueschen and Thomas R. Hoverstad
University of Minnesota
Southern Experiment Station
Waseca, Minnesota

Objectives: This study was designed to evaluate the effects of foliar applications of 'Respond' on agronomic traits and seed yield in soybeans. A second objective was to evaluate the interaction between 'Respond' and two soybean varieties.

Procedures: These studies were conducted on a Webster clay loam soil containing 5 to 6% organic matter. Soil test results from 1986 indicate the following soil chemical properties: pH=6.6; P=70 and K=242 lb/A. The previous crop was corn and following harvest in 1985 the site was chisel plowed. Spring tillage consisted of one field cultivation on May 5, 1986 to incorporate 0.75 lb/A Treflan and a second field cultivation just prior to planting. Seeds were prepackaged to plant 185,000 seeds/A and planting was done May 23, 1986 with a cone-type planter. A preemergence application of Amiben at 2.5 lb/A was applied on May 23, 1986. Two soybean varieties ('Corsoy 79' and Asgrow 'A1937') were main plots in a randomized complete block design with subplots consisting of Respond treatments. Each subplot consisted of ten 10-inch rows, 12 feet in length. Three foliar Respond treatments were included: an untreated check, 12 oz/A applied at the floral bud stage, and 12 oz/A applied at the R1 stage of soybeans. All Respond treatments were applied with a motorized bicycle sprayer calibrated to deliver 20 gpa at 32 psi using 8002 flat fan nozzles. Bud stage treatments were applied on July 10, 1986 when soybeans were in the V6 stage and were 18 inches tall, the temperature and relative humidity at treatment time were 72°F and 90%, respectively. R1 stage treatments were applied on July 18, 1986 when soybeans were in the R1 to R2 stage and were 25 inches tall; the temperature and relative humidity were 92°F and 50%, respectively.

Plant height was measured on October 8 when plants were mature. Maturity was recorded as days after August 31 when 95% of the soybean pods had turned brown. Plant populations were determined on October 8 by counting the number of plants in two 5-foot sections of row. Lodging was scored on October 8 using a 1 to 5 scale with 1=erect and 5=flat. Seed weight was measured as g/100 seeds from a seed sample taken at harvest. On July 25, 1986, five randomly selected plants were taken from each plot. These plants were dried, ground and analyzed for N content. Yield samples were taken October 9 after plots were end trimmed to 4.2 x 8 feet. The numbers of pods, barren pods, seeds, branches and internodes per plant and the internode length were determined from 5 randomly selected plants gathered on October 8.

---

[a]Respond is a trade name for a crop and soil supplement distributed by United Agri Products, Inc., 419-18th Street, Box 1286, Greeley, CO 80632. Respond consists of 0.0011% natural plant extracts having 7.6 mg/l of Vitamin B Complex compounds, and 3.4 mg/l of Purine-like and Adenine-like structures. It also contains 0.2% inorganic compounds.

Conclusions: Results of foliar Respond application on soybeans are shown in Table 1. Averaged across the Respond treatments, Asgrow A1937 yielded 2.2 bu/A more than Corsoy 79. A1937 was 4.6 inches shorter and matured 3 days earlier than Corsoy 79. Larger seeds and lower seed moisture at harvest were observed for A1937 than for Corsoy 79. There were more barren pods and branches per plant and greater per internode length for Corsoy 79 than A1937. There were fewer internodes per plant with Corsoy 79 than with A1937. The two varieties did not differ with respect to plant population, number of seeds per plant, or number of pods per plant, although A1937 averaged about four fewer pods per plant than Corsoy 79.

Averaged across both varieties, Respond significantly increased soybean yield 2.7 bu/A when applied at the bud stage but did not increase yield when applied at the R1 stage. Yield increases from Respond applied at the bud stage were 1.4 and 3.9 bu/A for Corsoy 79 and A1937, respectively. Corsoy 79 did not show any yield response to the R1 stage of Respond application, however, A1937 showed a trend toward higher yield (2.7 bu/A) at this stage of application. The overall variety x Respond interaction was not significant for yield, however. Although there was a significant reduction in internode length in soybeans due to Respond treatment, these differences were extremely small (.06 inches) and are probably not meaningful. No other agronomic traits were affected by Respond.

Based on two years (1985 and 1986) of research, our results indicate that the effects of foliar application of Respond on soybeans depends on the variety and the time of application. In 1985 when Respond was applied at 16 oz/A at the R1 or R2 stage and at 8 oz/A at both the R1 and R2 stages of soybeans, Corsoy 79 showed little effect. In 1986, 12 oz/A of Respond applied at the R1 stage also did not affect soybean yields; applications at the floral bud stage resulted in a slight positive yield effect (1.4 bu/A) compared to the untreated control. In both 1985 and 1986, we obtained positive yield effects when foliar applications of Respond were applied to A1937. In 1985, Respond applied to this variety at 16 oz/A at the R1 or R2 stages or 8 oz/A at both of these stages resulted in yields that ranged from 3.6 to 4.7 bu/A higher than the untreated control. In 1986, bud stage application of Respond appeared to be superior to applications made at R1. With A1937 bud stage applications of 12 oz/A of Respond increased yield by 3.9 bu/A while R1 applications increased yield by 2.7 bu/A compared to the untreated control. There is no clear explanation of these yield effects in the yield component data--number of seeds/plant and seed weight. However, there was a trend both years for slightly higher seed weights with A1937 where Respond was applied. This was not the case with Corsoy 79. Further research is needed to determine the effects of Respond on genetically diverse varieties and also to determine the proper stage of application.

Table 1. **Effects of foliar applications of Respond to two soybean varieties at Waseca, MN 1986.**

Variety	Respond	Plant Height	Maturity	Pop.	Lodging	Seed Weight	N	H2O	Yield
		(in.)	(9/1=1)	(plts/A)	(1-5)	(g/100)	(%)	(%)	(bu/A)
Corsoy 79	Check	44.0	27	140263	2.0	14.7	3.22	13.9	41.0
Corsoy 79	Bud-12oz.	44.5	27	180338	2.2	14.5	3.16	14.0	42.4
Corsoy 79	R1-12oz.	44.8	27	162914	1.8	14.2	3.20	14.1	40.3
Asgrow A1937	Check	39.2	24	154202	1.8	14.8	---	13.2	41.2
Asgrow A1937	Bud-12oz.	40.2	24	164657	1.8	15.2	---	13.4	45.1
Asgrow A1937	R1-12oz.	40.0	24	161689	2.0	15.0	---	13.0	43.9

Average across varieties :

Respond	Plant Height	Maturity	Pop.	Lodging	Seed Weight	N	H2O	Yield
	(in.)	(9/1=1)	(plts/A)	(1-5)	(g/100)	(%)	(%)	(bu/A)
Check	41.6	26	147233	1.9	14.8	1.61	13.6	41.1
Bud-12oz.	42.4	26	172498	2.0	14.9	1.58	13.7	43.8
R1-12oz.	42.4	26	162302	1.9	14.6	1.60	13.6	42.1
BLSD(.05)	ns	ns	ns	ns	ns	ns	ns	2.3

Average across respond treatment :

Variety	Plant Height	Maturity	Pop.	Lodging	Seed Weight	N	H2O	Yield
	(in.)	(9/1=1)	(plts/A)	(1-5)	(g/100)	(%)	(%)	(bu/A)
Corsoy 79	44.4	27	161172	2.0	14.5	3.19	14.0	41.2
Asgrow A1937	39.8	24	160183	1.9	15.0	---	13.2	43.4
Level of sign.	>99	>99	35	67	>99	12	>99	98
Variety x Respond : Level of sign.	14	14	59	81	87	---	72	70

Table 1. cont.

Variety	Respond	Pods	Barren Pods	Seeds	Branches	Internodes	Internode Length
		(#/plnt)	(#/plnt)	(#/plnt)	(#/plnt)	(#/plnt)	(in)
Corsoy 79	Check	46.0	3.0	87.5	2.7	15.6	2.59
Corsoy 79	Bud-12oz.	38.3	2.7	74.1	2.0	15.7	2.46
Corsoy 79	R1-12oz.	39.5	2.6	76.0	2.2	15.0	2.53
Asgrow 1937	Check	34.0	0.7	78.1	1.3	16.6	2.23
Asgrow 1937	Bud-12oz.	39.0	1.7	86.5	1.7	16.4	2.23
Asgrow 1937	R1-12oz.	38.1	1.3	79.4	1.6	15.5	2.34

Average across varieties :

Respond	Pods	Barren Pods	Seeds	Branches	Internodes	Internode Length
	(#/plnt)	(#/plnt)	(#/plnt)	(#/plnt)	(#/plnt)	(in)
Check	40.0	1.9	82.8	2.0	16.1	2.41
Bud-12oz.	38.7	2.2	80.3	1.9	16.1	2.35
R1-12oz.	38.8	2.0	77.7	1.9	15.3	2.44
BLSD(.05)	ns	ns	ns	ns	ns	0.09

Average across respond treatment :

Variety	Pods	Barren Pods	Seeds	Branches	Internodes	Internode Length
	(#/plnt)	(#/plnt)	(#/plnt)	(#/plnt)	(#/plnt)	(in)
Corsoy 79	41.3	2.8	79.2	2.3	15.4	2.53
Asgrow 1937	37.0	1.2	81.3	1.5	16.2	2.27
Level of sign.	86	99	34	94	98	99
Variety x Respond : Level of sign.	91	64	86	86	10	70

Influence of soil type, ethalfluralin, and trifluralin on the performance of four soybean varieties in 1986. Lueschen, William E., Thomas R. Hoverstad and James H. Orf. This study was conducted near Waseca, MN to investigate the possible interactions between four soybean genotypes, ethalfluralin and trifluralin applied at normal and excessive use rates and two soil types. The characteristics of the two soil types chosen are as follows:

Soil Type	Organic Matter	Sand	Silt	Clay	pH	P	K
	--%--	-----------%	--------			--lb/A--	
Clarion Clay Loam	4.3	34.5	35.0	30.5	6.0	63	306
Webster Clay Loam	6.4	29.9	37.0	33.1	6.4	65	338

Within each soil type a randomized complete block experiment with four replications and a split-plot arrangement of treatments was used. Herbicide treatments listed in the accompanying table were main plots and subplots were the four soybean varieties with an individual plot size of 10x12 feet. The seed for each row of each plot was counted and packaged for a seeding rate of 150,000 viable seeds/A prior to planting. Planting was done on May 20 with a cone-type seeding mechanism mounted on a commercial planter and the planting depth was approximately 1.5 inches. The ethalfluralin and trifluralin were applied on May 19 and incorporated twice with a field cultivator set to till to a depth of 4 to 5 inches. This tillage was done in the same direction because of the small plot size and the need to prevent dilution of the herbicide within a plot. Our control treatment was a preemergence application of alachlor at 3.0 lb/A applied on May 22. Bentazon at 1.0 lb/A plus 1.3% oil concentrate was applied to all treatments for broadleaf weed control. All herbicides were applied at a total spray volume of 20 gallons/A at 30 psi. This study was cultivated on July 3 and hand-weeded throughout the season to maintain a weed-free condition. Prior to emergence of any soybeans a 5-foot section of row was staked in each plot. This area was used to make stand counts throughout the season. Rainfall during the first week after planting totalled 0.77 inches and an additional 0.91 inches was received the following week. During the 30-day period following planting 8.09 inches of rainfall was received.

Soil type significantly affected most parameters. Soybean stands were better and the plants were taller on the Webster soil as compared to the Clarion soil. However, when averaged across all varieties and herbicide treatments there was no significant yield difference between the two soil types. When averaged across varieties and soil types, the fastest emergence was observed with alachlor at 3.0 lb/A preemergence. Significant delays in emergence of soybeans, decreased stands, and reduced yields were evident for the 2.62 lb/A rate of ethalfluralin and the 2.0 lb/A rate of trifluralin. The soil type x herbicide treatment interaction was significant for soybean injury, stand counts taken on all dates except June 2, and for plant height on June 17 and October 1. Crop injury was similar for the alachlor treatment on both soil types but both ethalfluralin and trifluralin caused more early season injury and plant height reduction on the Clarion soil than was observed on the Webster soil. However, the soil type x herbicide interaction was not significant for yield. The herbicide treatment x variety interaction was significant for crop injury, stand counts taken after June 4, and plant height on July 7 but was not significant for yield. Stands for all varieties were relatively similar for the alachlor treatment but for all rates of ethalfluralin, 'AP200' had a lower plant population than the other varieties. This was not the case for either rate of trifluralin. Based on these results, soil type and soybean genotype are important factors in determining soybean response to ethalfluralin and trifluralin for agronomic characteristics other than yield. Excessive rates of these compounds were the primary factor contributing to soybean injury, stand loss, and reduced yields. (MN Agr. Exp. Sta. Paper No. 2075. Misc. Journal Series. Univ. of MN, St. Paul, MN).

Table. Influence of soil type, ethalfluralin, and trifluralin on the performance of four soybean varieties in 1986. (Lueschen, Hoverstad and Orf)

Herbicide[a]	lb/A	Variety[b]	% Injury 6/7	Plants/5 Feet of Row 5/30	6/2	6/4	6/6	6/9	6/16	10/1	Height(inches) 6/17	7/7	10/1	Mat.[c]	bu/A
Clarion soil type															
Alachlor	3.0	A1937	5	0	17	31	32	35	39	33	5.6	15.8	37.5	26	52.9
Alachlor	3.0	AP200	1	3	26	36	36	39	41	38	6.2	18.5	42.2	28	54.5
Alachlor	3.0	Hardin	6	6	32	37	37	39	41	38	6.1	18.5	41.0	26	55.4
Alachlor	3.0	S14-60	3	5	27	33	35	37	40	36	6.4	18.0	36.8	24	56.0
Ethalfluralin	1.13	A1937	23	3	18	21	30	32	37	32	5.1	16.8	37.5	25	54.7
Ethalfluralin	1.13	AP200	45	1	10	16	18	21	24	20	4.8	14.8	37.8	28	53.3
Ethalfluralin	1.13	Hardin	22	2	14	28	32	38	41	34	5.0	16.5	39.0	26	49.6
Ethalfluralin	1.13	S14-60	19	2	12	22	30	34	38	32	5.1	16.2	36.0	25	52.2
Ethalfluralin	1.31	A1937	28	1	15	24	28	31	36	32	5.2	16.5	38.0	25	57.1
Ethalfluralin	1.31	AP200	49	1	5	8	10	16	22	17	4.6	14.2	37.8	28	47.8
Ethalfluralin	1.31	Hardin	30	0	16	30	32	34	39	34	5.2	15.8	39.3	27	48.7
Ethalfluralin	1.31	S14-60	28	2	14	23	26	34	34	31	5.4	15.5	34.8	26	53.1
Ethalfluralin	2.62	A1937	58	0	6	10	14	20	24	21	4.3	13.2	35.5	26	47.5
Ethalfluralin	2.62	AP200	71	0	2	7	10	12	15	11	3.8	11.2	31.8	28	27.1
Ethalfluralin	2.62	Hardin	60	0	5	13	18	24	30	20	4.4	13.8	34.8	26	43.0
Ethalfluralin	2.62	S14-60	58	3	7	10	13	19	24	20	4.5	11.2	30.2	27	42.7
Trifluralin	1.0	A1937	12	1	15	32	35	38	40	36	5.1	15.2	37.8	25	52.4
Trifluralin	1.0	AP200	16	1	15	27	31	32	35	32	5.5	18.8	41.5	28	59.1
Trifluralin	1.0	Hardin	19	0	14	26	30	33	33	30	5.1	17.5	41.0	27	55.1
Trifluralin	1.0	S14-60	19	1	14	27	30	32	36	31	5.4	16.5	36.5	25	52.1
Trifluralin	2.0	A1937	54	0	2	4	6	9	13	12	4.3	12.5	34.0	26	40.2
Trifluralin	2.0	AP200	42	1	3	13	14	17	21	18	4.8	14.5	36.8	27	48.0
Trifluralin	2.0	Hardin	60	1	3	10	12	14	16	14	4.4	13.0	35.0	27	40.1
Trifluralin	2.0	S14-60	56	0	3	12	14	19	22	17	4.4	12.5	32.8	26	42.6
Webster soil type															
Alachlor	3.0	A1937	5	18	35	38	42	42	41	40	6.9	19.0	40.5	26	58.4
Alachlor	3.0	AP200	4	14	34	36	38	39	39	37	6.6	20.0	44.3	28	47.6
Alachlor	3.0	Hardin	3	15	36	40	41	41	41	39	6.9	19.3	41.8	27	54.0
Alachlor	3.0	S14-60	1	27	38	40	41	41	41	38	7.0	19.3	38.0	24	56.3
Ethalfluralin	1.13	A1937	10	10	30	38	42	42	44	41	6.6	19.3	41.0	24	58.8
Ethalfluralin	1.13	AP200	15	12	28	37	38	40	40	37	6.1	19.5	44.3	28	51.6
Ethalfluralin	1.13	Hardin	13	18	35	42	43	43	44	41	6.5	20.3	42.0	26	55.2
Ethalfluralin	1.13	S14-60	6	27	35	42	43	43	44	40	7.0	18.5	36.8	23	49.8
Ethalfluralin	1.31	A1937	29	3	23	32	38	39	42	36	5.3	16.0	40.3	25	56.4
Ethalfluralin	1.31	AP200	33	4	14	29	30	33	38	32	5.6	16.3	41.0	27	49.7
Ethalfluralin	1.31	Hardin	20	13	32	39	40	40	43	38	6.0	18.8	42.3	26	56.2
Ethalfluralin	1.31	S14-60	16	7	25	34	38	39	40	36	6.1	17.5	37.8	23	53.5
Ethalfluralin	2.62	A1937	40	0	9	21	30	34	40	33	5.1	15.5	37.3	26	52.1
Ethalfluralin	2.62	AP200	50	0	10	22	27	31	37	29	5.0	14.8	39.3	29	49.4
Ethalfluralin	2.62	Hardin	45	3	20	34	39	40	40	33	5.3	14.3	39.3	26	53.8
Ethalfluralin	2.62	S14-60	48	4	10	19	28	34	38	30	4.8	13.3	33.5	25	46.5
Trifluralin	1.0	A1937	4	12	34	41	42	42	45	42	6.5	19.0	43.0	24	57.2
Trifluralin	1.0	AP200	19	15	28	31	33	34	36	33	6.1	18.5	41.0	28	51.4
Trifluralin	1.0	Hardin	15	21	35	38	38	40	41	39	6.4	20.0	44.3	26	58.1
Trifluralin	1.0	S14-60	14	12	28	32	35	36	39	32	6.0	18.5	38.0	24	54.4
Trifluralin	2.0	A1937	21	7	26	33	36	38	41	38	6.3	17.5	40.3	24	52.7
Trifluralin	2.0	AP200	21	4	22	31	35	36	39	34	6.3	18.0	43.5	30	46.6
Trifluralin	2.0	Hardin	33	6	22	28	30	34	35	30	5.6	16.8	40.5	27	50.5
Trifluralin	2.0	S14-60	29	4	17	26	29	32	35	31	5.5	16.0	35.5	25	48.7
Means for soil type:		Clarion	33	1	12	21	24	27	31	27	5.0	15.3	36.9	26	49.4
		Webster	20	11	26	33	36	38	40	36	6.1	17.7	40.2	26	52.9
% Significance Level			98	100	100	100	100	100	100	100	100	100	100	82	78
Means for herbicide treatments:															
Alachlor	3.0		3	11	31	36	38	39	40	37	6.5	18.5	40.3	26	54.4
Ethalfluralin	1.13		19	9	23	30	34	37	39	35	5.8	17.7	39.3	26	53.1
Ethalfluralin	1.31		29	4	18	27	30	33	37	32	5.4	16.3	38.9	26	52.8
Ethalfluralin	2.62		54	1	8	17	22	27	31	24	4.6	13.4	35.2	26	45.3
Trifluralin	1.0		15	8	23	32	34	36	38	34	5.8	18.0	40.4	26	55.0
Trifluralin	2.0		40	3	12	20	22	25	28	24	5.2	15.1	37.3	26	46.2
BLSD (0.05)			7	5	7	5	4	4	4	4	0.3	1.1	0.9	1	4.8
Means for soybean varieties:															
A1937			24	5	19	27	31	34	37	33	5.5	16.4	38.4	25	53.4
AP200			31	5	16	24	27	29	32	28	5.4	16.6	40.3	28	48.6
Hardin			27	7	22	30	32	35	37	32	5.6	17.0	40.0	26	51.7
S14-60			25	8	19	27	30	33	36	31	5.6	16.1	35.6	25	50.7
BLSD (0.05)			4	2	3	2	2	2	2	2	NS	0.7	0.7	1	2.4
Interactions - % significance level:															
Soil type x herbicide			98	97	49	96	99	100	100	99	98	75	99	20	81
Soil type x variety			12	90	43	21	47	83	94	84	47	13	97	99	89
Herbicide x variety			100	78	83	99	100	100	100	100	92	95	92	69	82
Soil type x herbicide x variety			49	92	65	60	60	80	92	86	72	83	58	20	96

[a]Alachlor 4MT applied preemergence; ethalfluralin 3EC and trifluralin 4EC were applied and incorporated twice with a field cultivator. Bentazon at 1.0 lb/A plus 1.3% crop oil concentrate was applied to all treatments.

[b]Varieties: Asgrow A1937, Agripro AP200, Hardin and Northrup King S14-60.

[c]Days past August 31 when 95% of the pods were brown.

Influence of planting depth and ethalfluralin on response of four soybean varieties, 1986. Lueschen, William E., Thomas R. Hoverstad and James H. Orf. This study was conducted near Waseca, MN to evaluate the influence of two planting depths (1.5 and 3.0 inches) and 2.62 lb/A of ethalfluralin on the agronomic performance of four soybean varieties. A randomized complete block design with a split-split plot arrangement of treatments with an individual plot size of 10x12 feet was used. The main plots were two herbicide treatments: either 3.0 lb/A of alachlor applied preemergence May 22, or 2.62 lb/A of ethalfluralin, twice the maximum label recommendation for soybeans, applied May 19 and incorporated twice with a field cultivator set to till to a depth of 4 to 5 inches. Subplots were the two planting depths and sub-subplots were four soybean varieties--'Asgrow A1937', 'Agripro AP200', 'Hardin' and 'Northrup King S14-60.' The soil type was a Nicollet clay loam containing 4.5% organic matter, 35.1% sand, 34.0% silt and 30.9% clay. The soil pH was 6.1 and soil test P and K levels were 62 and 364 lb/A, respectively. Seed was prepackaged for a seeding rate of 150,000 viable seeds/A and planting was done on May 20 with a cone-type seeder mechanism mounted on a commercial planter. Prior to the emergence of any soybeans, a 5-foot section of row was staked in each plot. This area was used to make emergence counts throughout the season. When the soybeans were in the second trifoliolate leaf stage, we uniformly applied bentazon at 1.0 lb/A plus oil concentrate at 1.3% for broadleaf weed control. The plots were cultivated once on July 3 and hand-weeded to maintain a weed-free condition. During the first week following planting, 0.77 inches of precipitation was received and an additional 0.91 inches accumulated the next week.

When comparing the 2.62 lb/A of ethalfluralin to 3.0 lb/A of alachlor, significant differences were observed for all parameters evaluated. There was greater early injury, reduced soybean stands, reduced plant height, and reduced yield with the ethalfluralin treatments compared to the alachlor treatment. Planting depth did not affect early injury ratings but there was a consistent trend toward reduced stands where soybeans were planted 3.0 inches deep compared to 1.5 inches deep. The interaction that was consistently significant was the soybean variety x herbicide treatment. This interaction was significant for early injury, most plant population counts and for plant height taken on July 17 and October 1 but was not significant for yield. The varieties A1937 and AP200 consistently had fewer emerged plants than either Hardin for S14-60. When alachlor was used, AP200 was the tallest of the four varieties, however, this variety was similar in height to the other varieties where ethalfluralin at 2.62 lb/A was applied. Planting 3.0 inches deep significantly reduced soybean yields by 4.1 bu/A compared to planting 1.5 inches deep. The 2.62 lb/A of ethalfluralin reduced yields by 11.3 bu/A compared to the alachlor treatment. However, neither the soybean variety x herbicide treatment nor the planting depth x herbicide treatment interactions were significant. (MN Agr. Exp. Sta. Paper No. _____. Misc. Journal Series, Univ. of MN, St. Paul, MN).

Table. Influence of planting depth and ethalfluralin on response of four soybean varieties, 1986. (Lueschen, Hoverstad, and Orf).

Variety	Planting Depth (inches)	Ethalfluralin[a] Rate lb/A	% Injury 6/17	Plants/5 feet of Row							Height (inches)			Mat.[b]	bu/A
				5/30	6/2	6/4	6/6	6/9	6/16	10/1	6/17	7/7	10/1		
Asgrow A1937	1.5	0	4	13	34	36	38	40	40	36	6.4	18.8	40.3	24	53.2
Agripro AP200	1.5	0	0	11	36	37	39	40	41	38	6.6	20.3	44.5	27	50.8
Hardin	1.5	0	1	11	30	32	36	36	37	33	6.5	19.2	41.0	26	58.3
Northrup King S14-60	1.5	0	0	24	34	34	36	38	39	35	6.9	19.8	35.8	24	51.1
Asgrow A1937	3.0	0	0	1	19	30	32	36	37	33	6.5	17.5	39.5	24	51.0
Agripro AP200	3.0	0	4	2	24	32	34	36	38	35	6.5	19.8	41.8	26	41.9
Hardin	3.0	0	4	1	25	31	33	36	38	34	6.3	18.5	40.8	26	51.8
Northrup King S14-60	3.0	0	1	4	28	36	38	39	40	37	4.8	17.8	37.8	24	52.4
Asgrow A1937	1.5	2.62	59	1	10	16	21	30	34	28	4.2	12.8	34.3	26	45.7
Agripro AP200	1.5	2.62	74	0	1	5	10	13	18	15	3.4	12.8	33.8	28	37.3
Hardin	1.5	2.62	64	0	14	16	26	34	36	28	3.8	12.2	34.8	26	39.4
Northrup King S14-60	1.5	2.62	46	2	12	20	26	36	38	30	6.5	13.2	31.0	24	45.8
Asgrow A1937	3.0	2.62	67	0	4	9	10	16	22	21	3.6	9.8	32.5	27	38.0
Agripro AP200	3.0	2.62	70	0	4	9	11	15	19	18	3.4	12.8	33.5	28	34.0
Hardin	3.0	2.62	69	1	9	16	21	25	28	24	3.8	11.0	33.5	27	37.4
Northrup King S14-60	3.0	2.62	56	0	11	18	23	28	31	24	4.5	12.8	32.0	25	42.2
Means for Varieties															
Asgrow A1937			32	4	17	23	25	30	33	30	5.2	14.7	36.6	25	47.0
Agripro AP200			37	3	16	21	23	26	29	26	5.1	16.4	38.1	27	41.0
Hardin			34	3	20	24	29	33	35	30	5.1	15.2	37.5	26	46.7
Northrup King S14-60			26	8	21	27	31	35	37	32	5.6	15.9	34.1	24	47.9
BLSD (0.05)			4	2	NS	5	4	4	4	5	0.3	1.6	1.2	1	5.0
Means for Herbicide															
Alachlor 3 lb/A Pre			2	8	29	34	36	38	39	35	6.5	18.9	40.2	25	51.3
Ethalfluralin 2.62 lb/A PPI			63	1	8	14	18	24	28	24	4.0	12.2	33.0	26	40.0
% Significance Level			100	100	99	99	97	97	96	99	100	100	99	96	97
Planting Depth															
1.5 inches			31	8	21	25	29	33	35	30	5.3	16.1	36.8	26	47.7
3.0 inches			34	1	16	23	25	29	32	28	5.2	15.0	36.4	26	43.6
% Significance Level			59	100	99	55	74	91	95	91	47	99	50	57	98
Interactions (% Significance Level)															
Variety x Planting Depth			36	99	67	69	73	84	64	32	48	42	84	73	26
Variety x Herbicide			100	100	89	96	99	99	100	99	96	36	99	53	72
Herbicide x Planting Depth			44	100	95	20	19	79	83	80	06	17	09	86	02
Variety x Planting Depth x Herbicide			86	89	61	55	51	89	76	73	77	34	76	31	52

[a]The 0 lb/A ethalfluralin treatment received 3.0 lb/A of alachlor preemergence.
[b]Days past August 31 when 95% of the pods were brown.

Response of sixteen soybean varieties to ethalfluralin at Waseca, MN, 1986. Lueschen, William E., Thomas R. Hoverstad and James H. Orf. This study was conducted near Waseca, MN to evaluate the response of 16 soybean varieties to four levels of ethalfluralin. A randomized complete block design with a split-plot arrangement of treatments with an individual plot size of 10x12 feet was used. The main plots were four ethalfluralin rates (0, 1.13, 1.31 and 2.62 lb/A) and subplots were 16 soybean varieties. The ethalfluralin was applied and incorporated twice on May 19 with a field cultivator set to till 4 to 5 inches deep. The plots not treated with ethalfluralin received 3.0 lb/A of alachlor preemergence on May 22. The following table lists the varieties included. The soil type was a Webster clay loam containing 6.4% organic matter, 29.9% sand, 37.0% silt and 33.1% clay. The soil pH was 6.4 and the soil test P and K levels were 65 and 338 lb/A, respectively. Seed was prepackaged for a seeding rate of 150,000 viable seeds/A and planting was done on May 20 with a cone-type seeder mechanism mounted on a commercial planter. Prior to emergence of any soybeans, a 5-foot section of row was staked in each plot. This area was used to make stand counts throughout the season. When the soybeans were in the second trifoliolate leaf stage, a uniform application of bentazon at 1.0 lb/A plus oil concentrate at 1.3% was applied for broadleaf weed control. This trial was cultivated once on July 3 and maintained in a weed-free condition by hand-weeding. During the first week following planting, 0.77 inches of rainfall was received and an additional 0.91 inches accumulated the following week.

Significant early soybean injury and plant height reductions were observed with all levels of ethalfluralin as compared to the alachlor control. The variety x herbicide treatment interaction was not significant for early injury. At maturity only the 2.62 lb/A rate of ethalfluralin resulted in significantly shorter plants than the alachlor treatment. There was a significant interaction between soybean varieties and herbicide treatment for stand counts made after June 4. Northrup King 'S2596' had the greatest stand loss among all varieties where 2.62 lb/A of ethalfluralin was applied. Other varieties suffering significant stand loss with the 2.62 lb/A rate of ethalfluralin were Asgrow 'A2187' and 'A1937', 'Weber 84', Agripro 'AP 200', and Northrup King 'S14-60'. When averaged over all 16 varieties, there were no significant yield effects among any of the herbicide treatments but there was a trend toward lower yields where 2.62 lb/A of ethalfluralin was applied. The variety x herbicide interaction was not significant for yield.

Although differences among soybean varieties with respect to ethalfluralin application was observed, stand reductions and yield reductions were not observed for labelled rates of application. Over-application would appear to be the primary reason for reduced stands and lower yields where ethalfluralin is used for weed control in soybeans. (MN Agr. Exp. Sta. Paper No. 2077. Misc. Journal Series. Univ. of MN, St. Paul, MN).

Table. Response of sixteen soybean varieties to ethalfluralin and trifluralin at Waseca, MN, 1986 (Lueschen, Hoverstad and Orf)

Variety	Ethal-fluralin[a] lb/A	% Injury 6/17	Plants/5 Feet of Row 5/30	6/2	6/4	6/6	6/9	6/16	10/1	Height (inches) 6/17	7/7	10/1	Mat.[b]	bu/A
Asgrow A2187	0	6	27	39	39	40	41	43	42	7.1	19.8	43.2	26	49.4
Corsoy 79	0	3	26	38	43	43	43	44	42	7.0	19.8	42.2	28	47.8
Dekalb CX155	0	1	24	39	40	40	43	42	40	7.3	20.0	43.5	28	50.2
Dekalb CX174	0	6	15	34	37	38	39	39	34	6.9	18.3	39.8	28	50.7
Hardin	0	3	15	36	40	41	41	41	39	6.9	19.3	41.8	27	54.0
Pioneer 1677	0	6	22	34	36	38	38	38	36	6.8	19.3	40.8	26	49.7
Asgrow A1937	0	5	18	35	38	42	42	41	40	6.9	19.0	40.5	26	58.4
BSR 201	0	6	16	32	34	36	37	38	36	6.1	17.0	39.8	33	54.4
Hodgson 78	0	2	20	35	40	41	43	44	40	7.0	19.3	39.8	23	53.1
Pioneer 1981	0	0	13	35	37	40	41	42	39	7.1	21.0	43.0	24	48.9
Weber 84	0	14	18	31	34	35	36	38	35	6.0	18.0	44.0	28	50.4
Agripro 200	0	4	14	34	36	38	39	39	37	6.6	20.0	44.2	28	47.6
Agripro 240	0	6	12	30	34	37	38	40	37	6.7	17.3	39.0	31	45.4
Elgin	0	5	15	36	38	41	41	42	40	6.8	18.0	37.3	27	51.8
Northrup King S14-60	0	1	27	38	40	41	41	41	38	7.0	19.3	38.0	24	56.3
Northrup King S2596	0	2	18	36	40	42	42	42	41	6.9	19.0	38.0	28	52.6
Asgrow A2187	1.13	23	5	24	33	38	40	42	39	6.0	17.8	41.3	28	48.4
Corsoy 79	1.13	12	17	37	39	42	43	42	42	6.2	19.5	45.8	29	48.9
Dekalb CX155	1.13	14	20	30	36	39	40	42	39	6.4	18.8	42.8	27	48.3
Dekalb CX174	1.13	9	8	27	34	36	37	37	36	6.8	18.8	41.2	28	54.5
Hardin	1.13	12	19	35	42	43	43	44	41	6.5	20.3	42.0	26	55.2
Pioneer 1677	1.13	16	14	29	36	38	38	40	38	6.4	18.0	39.8	25	50.0
Asgrow A1937	1.13	10	10	30	38	42	42	44	41	6.6	19.3	41.0	24	58.9
BSR 201	1.13	16	8	22	34	36	38	38	35	6.5	18.5	38.5	23	49.5
Hodgson 78	1.13	14	7	24	35	39	39	42	35	6.5	18.5	38.5	23	49.5
Pioneer 1981	1.13	8	13	36	41	42	44	44	42	6.6	20.0	42.5	25	48.0
Weber 84	1.13	28	11	24	30	33	34	37	33	5.6	18.3	42.5	28	49.0
Agripro 200	1.13	15	12	28	37	38	40	40	37	6.1	19.5	42.3	28	51.6
Agripro 240	1.13	10	18	33	35	34	35	38	38	6.4	17.0	39.3	31	45.6
Elgin	1.13	14	9	22	32	37	38	38	33	6.2	17.3	38.5	27	49.7
Northrup King S14-60	1.13	6	27	35	42	43	43	44	40	7.0	18.5	36.8	23	49.8
Northrup King S2596	1.13	14	7	27	36	38	39	41	38	6.1	17.0	36.8	30	50.2
Asgrow A2187	1.31	22	8	26	35	37	37	41	37	5.8	15.3	41.3	27	50.6
Corsoy 79	1.31	21	9	26	40	43	43	46	42	5.6	18.0	46.0	30	45.9
Dekalb CX155	1.31	25	16	35	37	40	42	44	40	5.6	18.5	42.8	28	49.6
Dekalb CX174	1.31	14	10	29	37	38	38	40	38	6.4	18.0	41.0	28	53.8
Hardin	1.31	20	13	32	39	40	40	43	38	6.0	18.8	42.2	27	56.2
Pioneer 1677	1.31	24	11	28	33	34	35	37	34	5.8	16.5	38.5	26	51.4
Asgrow A1937	1.31	29	3	23	32	38	39	42	36	5.2	16.0	40.3	25	56.4
BSR 201	1.31	16	8	22	31	33	34	36	33	5.6	15.8	39.3	33	50.5
Hodgson 78	1.31	14	13	33	38	38	39	40	38	6.3	18.3	38.8	23	51.7
Pioneer 1981	1.31	8	10	29	37	38	38	40	37	6.8	19.0	43.5	25	52.5
Weber 84	1.31	30	14	22	30	33	34	37	33	5.2	16.8	42.8	27	45.0
Agripro 200	1.31	32	4	14	26	30	33	38	32	5.6	16.3	41.0	27	49.7
Agripro 240	1.31	28	4	16	29	31	32	36	33	5.1	14.5	38.3	31	47.9
Elgin	1.31	12	17	31	37	40	40	43	38	6.5	17.5	37.8	27	50.6
Northrup King S14-60	1.31	16	7	25	34	38	39	40	36	6.1	17.5	37.8	23	53.5
Northrup King S2596	1.31	16	5	26	36	37	39	40	36	5.8	16.3	36.8	28	48.9
Asgrow A2187	2.62	61	0	9	21	23	27	32	28	4.4	13.5	36.5	28	45.0
Corsoy 79	2.62	37	4	16	29	34	38	39	34	5.4	16.0	45.5	29	51.5
Dekalb CX155	2.62	36	0	13	28	38	39	40	36	5.4	15.8	41.5	26	45.1
Dekalb CX174	2.62	34	4	19	28	32	37	38	33	5.4	15.8	38.5	28	51.7
Hardin	2.62	45	3	20	34	39	40	40	32	5.2	14.3	39.3	26	53.8
Pioneer 1677	2.62	48	10	22	33	36	38	42	36	5.0	14.0	36.2	27	50.2
Asgrow A1937	2.62	40	0	9	21	29	34	40	33	5.1	15.5	37.2	26	52.1
BSR 201	2.62	45	3	17	28	32	34	36	32	4.6	13.5	38.2	33	50.0
Hodgson 78	2.62	39	0	12	26	36	37	40	33	5.4	16.5	37.5	22	47.5
Pioneer 1981	2.62	36	6	24	33	35	40	39	34	5.5	16.0	40.8	26	51.5
Weber 84	2.62	52	3	8	20	25	26	31	27	4.6	14.3	39.5	27	43.0
Agripro 200	2.62	50	0	10	22	27	31	37	29	5.0	14.8	39.2	28	49.4
Agripro 240	2.62	39	4	24	32	36	38	42	37	5.0	13.8	36.8	32	47.1
Elgin	2.62	41	5	17	28	33	36	38	32	5.2	15.3	35.0	28	47.4
Northrup King S14-60	2.62	48	4	10	19	28	34	38	30	4.8	13.3	33.5	25	46.5
Northrup King S2596	2.62	58	0	4	11	13	19	22	20	4.6	12.8	32.2	31	46.8

Table continued (Lueschen, Hoverstad and Orf)

Variety	Ethal-fluralin[a] lb/A	% Injury 6/17	Plants/5 Feet of Row 5/30	6/2	6/4	6/6	6/9	6/16	10/1	Height (inches) 6/17	7/7	10/1	Mat.[b]	bu/A
Means for Ethalfluralin Treatments:														
	0	4	18.8	35	38	40	40	41	38	6.8	19.0	40.9	27	51.3
	1.13	14	12.7	29	36	39	40	41	38	6.3	18.4	40.8	27	50.4
	1.31	20	9.4	26	34	37	38	40	36	5.8	17.0	40.5	27	50.9
	2.62	44	2.9	15	26	31	34	37	32	5.0	14.7	38.0	28	48.7
BLSD (0.05)		6	3.3	4	4	4	3	3	3	0.3	1.2	1.7	NS	NS
Means for Varieties:														
Asgrow A2187		28	10	24	32	35	36	40	36	5.8	16.6	40.5	27	48.4
Corsoy 79		18	14	29	39	40	42	43	40	6.0	18.3	44.9	29	48.6
Dekalb CX155		19	15	29	35	39	41	42	38	6.1	18.3	42.6	27	48.3
Dekalb CX174		16	9	27	34	36	38	38	35	6.3	17.7	40.1	28	52.7
Hardin		20	12	31	39	40	41	42	38	6.1	18.1	41.3	26	54.8
Pioneer 1677		23	14	28	34	36	38	39	36	6.0	16.9	38.8	26	50.3
Asgrow A1937		21	7	24	32	38	39	42	37	6.0	17.4	39.8	25	56.4
BSR 201		21	9	23	32	34	36	37	34	5.5	15.6	39.2	33	51.2
Hodgson 78		17	10	26	35	39	40	42	37	6.3	18.1	38.6	23	50.5
Pioneer 1981		13	11	31	37	39	41	41	38	6.5	18.9	42.4	25	50.2
Weber 84		31	11	21	29	31	32	36	32	5.4	16.8	42.2	27	46.8
Agripro 200		25	8	22	30	33	36	39	34	5.8	17.6	42.2	28	49.6
Agripro 240		21	9	26	32	35	36	39	36	5.8	15.6	38.3	31	46.5
Elgin		18	11	27	34	38	39	40	36	6.2	17.0	37.1	27	49.9
Northrup King S14-60		18	16	27	34	38	39	41	36	6.2	17.1	36.5	24	51.5
Northrup King S2596		23	8	23	30	33	35	36	34	5.8	16.3	35.9	29	49.6
BLSD (0.05)		6	8	8	5	4	3	3	3	0.3	0.9	1.2	1	3.6
% Significance level for Ethalfluralin x Variety:														
		85	73	75	92	100	100	98	96	92	80	100	66	08

[a]The 0 lb/A rate of ethalfluralin received 3.0 lb/A of alachlor preemergence. The ethalfluralin was incorporated twice with a field cultivator set to till 4 to 5 inches deep.

[b]Days past August 31 when 95% of the pods were brown.

Herbicide performance in soybeans at Waseca, MN - 1986. Gunsolus, Jeffrey L. and William E. Lueschen. The purpose of this experiment was to evaluate various herbicides and herbicide combinations for weed control efficacy and soybean tolerance. Oats were grown in 1985 and the plot area was chisel plowed in the fall of 1985 and field cultivated in the spring of 1986. No fertilizer was applied. On May 20 preplanting herbicide applications were incorporated to a depth of 2 to 3 inches by either one pass with a field cultivator or two passes with a field cultivator with the second pass at right angles to the first. The soil was a Webster clay loam with 6.6% organic matter, pH 6.3, and an adequate moisture content. All herbicides were applied with a motorized bicycle-wheeled sprayer using 20 gpa, 30 psi, 3 mph, and 8002 flat-fan nozzles. Environmental conditions at preplanting application were wind 5 mph, relative humidity 40%, and air temperature 67 F. The first rain after application was 0.05 inch May 25 with rainfall of 0.77 and 0.00 inches during the first and second weeks after treatment. On May 20 'Hardin' soybeans were planted 1.5 inches deep at 150,000 seeds/A at a soil temperature of 66 F. A randomized complete block design with four replications was used. Plots were 10 by 30 ft and contained four 30-inch rows. Preemergence treatments were applied May 20 with wind 5 mph, relative humidity 50%, and an air temperature of 64 F. Soil moisture and rainfall patterns were the same as for preplanting herbicide applications. Postemergence treatments were applied June 14 to 4 to 5 inch soybeans in the V-1 stage. Broadleaf weeds were 0.5 to 3 inches and in the two to four leaf stage. Giant foxtail was 1.0 to 3.0 inches and in the one to three leaf stage. Soil moisture was adequate, the wind was 3 mph, relative humidity 70%, and air temperature was 71 F. First rain was 0.06 inch June 14 with rainfall of 4.01 and 2.61 inches the first and second weeks after treatment. Sequential postemergence treatments were applied June 19 to 5 to 6 inch soybeans in the V-2 stage. Broadleaf weeds were 2 to 4 inches and in the four to eight leaf stage. Giant foxtail was 4 to 5 inches and in the four to five leaf stage. Soil moisture was adequate, the wind was 10 mph, relative humidity 60%, and air temperature 93 F. First rain was 0.03 inch June 19 with rainfall of 4.92 and 0.34 inches the first and second weeks after treatment. Weed densities/m^2 were 370 giant foxtail, 110 redroot pigweed, 150 common lambsquarters, and 8 velvetleaf. Weed control, crop injury, and stand reduction evaluations were taken visually June 14 for preplanting incorporated and preemergence treatments. Visual weed control evaluations for postemergence treatments were taken July 6; visual crop injury and stand reduction evaluations were taken June 19. All plots were cultivated July 6. Yield data were obtained from 25 ft of the center two rows on October 7 and are presented in the table, corrected for 13% moisture. AC 263,499 gave very effective full season grass and broadleaf control and little visible effect on soybeans with preplanting incorporated and preemergence applications. However, AC 263,499 applied postemergence gave highly effective control only on redroot pigweed. Addition of both crop oil concentrate and fertilizer solutions to bentazon + acifluorfen increased the crop injury to soybeans significantly. (Minn. Agric. Exp. Stat., Paper No. 2084 Misc. Jour. Series, University of Minnesota, St. Paul)

Table. Herbicide performance in soybeans at Waseca, MN-1986. (Gunsolus and Lueschen)

Treatment[ab]	Rate[a] lb/A	Soybeans bu/A	Soybeans Inj. ind.	Soybeans % kill	% Weed Control Gift	% Weed Control Colq	% Weed Control Rrpw	% Weed Control Vele
Preplanting Incorporation-2X (May 20)								
AC 263,499	0.063	47	3	0	97	100	100	96
AC 263,499	0.094	47	3	0	98	100	100	94
FMC-57020	0.5	48	0	0	74	72	36	87
FMC-57020	1.0	42	1	0	84	86	51	93
Trifluralin	0.75	43	3	0	95	94	95	76
Preplanting Incorporation-1X (May 20)								
Ethafluralin + FMC-57020	0.75 + 0.5	48	0	0	94	88	90	84
Trifluralin + FMC-57020	0.75 + 0.5	45	0	0	91	84	84	81
Preplanting Incorporation-1X (May 20) + Preemergence (May 20)								
(Ethafluralin) + (FMC-57020)	(0.75) + (0.5)	42	3	0	93	95	94	88
(Trifluralin) + (FMC-57020)	(0.75) + (0.5)	47	3	0	93	91	93	80
(Metribuzin + Trifluralin) + (Metribuzin)	(0.38 + 0.75) + (0.25)	47	0	0	87	92	89	86
(Cinmethylin + Metribuzin) + (Cinmethylin + Metribuzin)	(0.75 + 0.25) + (0.75 + 0.25)	48	5	0	89	88	79	76
(Cinmethylin) + (Cinmethylin + Metribuzin)	(0.75) + (0.75 + 0.5)	45	3	0	91	86	73	69
(Cinmethylin + AC 263,499) + (Cinmethylin + AC 263,499)	(0.75 + 0.03) + (0.75 + 0.03)	48	3	0	99	99	100	97
Check - cultivated	—	49	NA[c]	NA	NA	NA	NA	NA
LSD(0.05)		NS	NS	NS	8	8	19	14
Preemergence (May 20)								
AC 263,499	0.063	50	0	0	94	98	100	94
AC 263,499	0.094	48	3	0	97	99	100	97
FMC-57020	0.5	45	0	0	63	53	34	81
FMC-57020	1.0	46	0	0	74	59	50	90
FMC-57020 + Metribuzin	1.0 + 0.5	44	0	0	88	76	56	90
FMC-57020 + Chloramben	1.0 + 2.7	45	5	1	99	100	100	99
Chloramben	2.7	41	8	0	99	100	100	95
Cinmethylin	1.5	45	0	0	88	34	25	35
Cinmethylin + Metribuzin	1.5 + 0.5	47	0	0	81	58	54	48
Metribuzin + Metolachlor	0.5 + 2.25	47	0	0	85	52	70	45
[Metolachlor + Metribuzin]	2.25 + 0.5	48	0	0	85	64	73	48
[Metolachlor + Metribuzin] + FMC-57020	2.25 + 0.5 + 0.25	45	0	0	86	79	76	81
Alachlor-MT	3.0	48	1	0	93	53	81	35
Preemergence (May 20) + Postemergence (June 14)								
(Cinmethylin) + (Imazaquin + Bentazon + COC[d])	(1.5) + (0.063 + 0.75 + 1.25%)	45	9	0	80	91	91	94
(Cinmethylin) + (Imazaquin + Bentazon + COC)	(1.5) + (0.094 + 0.75 + 1.25%)	42	8	0	80	95	96	98
(Cinmethylin) + (Bentazon + COC)	(1.5) + (0.75 + 1.25%)	50	6	0	78	96	74	100
(Cinmethylin) + (Acifluorfen + X-77)	(1.5) + (0.5 + 0.13%)	47	23	0	83	93	98	76
(Cinmethylin) + (Bentazon + Acifluorfen + COC)	(1.5) + (0.75 + 0.25 + 1.25%)	38	23	0	79	98	100	99
(Cinmethylin) + (AC 263,499 + X-77)	(1.5) + (0.063 + 0.25%)	45	5	0	81	71	74	66
(Cinmethylin) + (Lactofen + COC)	(1.5) + (0.2 + 0.31%)	44	33	0	76	80	100	96
(FMC-57020) + (AC 263,499 + X-77)	(0.5) + (0.063 + 0.25%)	47	7	0	79	67	68	83
(FMC-57020) + (Acifluorfen + X-77)	(1.0) + (0.38 + 0.13%)	48	20	0	79	89	80	76
Check - cultivated	—	45	NA	NA	NA	NA	NA	NA
Check - weed free	—	45	0	0	100	100	100	100
LSD(0.05)		NS	3	NS	6	12	15	14
Postemergence (June 14)								
AC 263,499 + X-77	0.063 + 0.25%	48	0	0	64	70	99	76
AC 263,499 + X-77	0.094 + 0.25%	46	0	0	69	68	99	72
Postemergence (June 14) + Postemergence (June 19)								
(Bentazon) + (Sethoxydim + COC)	(0.75) + (0.2 + 1.25%)	47	0	0	99	46	30	75
(Bentazon + COC) + (Fluazifop-P + COC)	(0.75 + 1.25%) + (0.19 + 1.25%)	42	4	0	93	91	33	93
(Bentazon + 28% N[e]) + (DPX-Y6202 + COC)	(0.75 + 5.0%) + (0.12 + 1.25%)	45	2	0	99	86	18	97
(Bentazon + 28% N + COC) + (Haloxyfop + COC)	(0.75 + 5.0% + 1.25%) + (0.12 + 1.25%)	45	5	0	100	94	16	97
(Bentazon + Acifluorfen + COC) + (Sethoxydim + COC)	(0.75 + 0.25 + 1.25%) + (0.2 + 1.25%)	45	14	0	96	89	84	84
(Bentazon + Acifluorfen + 10-34-0[e]) + (Sethoxydim + COC)	(0.75 + 0.25 + 1.25%) + (0.2 + 1.25%)	44	10	0	97	79	78	93
(Bentazon + Acifluorfen + 28% N) + (Sethoxydim + COC)	(0.75 + 0.125 + 5.0%) + (0.2 + 1.25%)	41	9	0	98	85	79	95
(Bentazon + Acifluorfen + 10-34-0 + COC) + (Sethoxydim + COC)	(0.75 + 0.25 + 1.25% + 1.25%) + (0.2 + 1.25%)	36	29	0	95	83	86	91
(Bentazon + Acifluorfen + 28% N + COC) + (Sethoxydim + COC)	(0.75 + 0.125 + 5.0% + 1.25%) + (0.2 + 1.25%)	46	25	0	96	84	85	89
(DPX-M6316) + (DPX-Y6202 + COC)	(0.008) + (0.12 + 1.25%)	46	0	0	100	16	99	65

Continued

Table. Continued. (Gunsolus and Lueschen)

Treatment[ab]	Rate[a] lb/A	Soybeans bu/A	Soybeans Inj. ind.	Soybeans % kill	% Weed Control Gift	% Weed Control Colq	% Weed Control Rrpw	% Weed Control Vele
(DPX-M6316) + (Haloxyfop + COC)	(0.016) + (0.12 + 1.25%)	46	0	0	98	45	99	80
(DPX-M6316) + (Fenoxaprop + COC)	(0.032) + (0.15 + 1.25%)	46	0	0	98	63	100	86
(DPX-M6316 + X-77) + (Fluazifop-P + COC)	(0.004 + 0.25%) + (0.19 + 1.25%)	47	0	0	88	89	100	69
(DPX-M6316 + 10-34-0) + (Fluazifop-P + COC)	(0.008 + 1.25%) + (0.19 + 1.25%)	44	0	0	89	35	99	84
(DPX-M6316 + 10-34-0) + (Fenoxaprop + COC)	(0.016 + 1.25%) + (0.15 + 1.25%)	46	0	0	99	43	99	89
(DPX-M6316 + 28% N) + (Haloxyfop + COC)	(0.008 + 5.0%) + (0.12 + 1.25%)	39	0	0	100	13	99	86
(DPX-M6316 + 28% N) + (DPX-Y6202 + COC)	(0.016 + 5.0%) + (0.12 + 1.25%)	45	0	0	99	46	100	95
(Bentazon + Lactofen + COC) + (Sethoxydim + COC)	(0.5 + 0.15 + 0.625%) + (0.2 + 1.25%)	38	19	0	97	80	99	95
(Bentazon + Lactofen + COC) + (Fluazifop-P + COC)	(0.38 + 0.15 + 0.625%) + (0.19 + 1.25%)	45	21	0	82	64	99	94
Check - cultivated	---	46	NA	NA	NA	NA	NA	NA
LSD(0.05)		NS	2	NS	4	8	11	8

[a] Treatment(s) and rate(s) in parenthesis represent a single application.
[b] Herbicide combinations in brackets [] represent a premix.
[c] NA = data not available.
[d] COC = crop oil concentrate = Agicide Activator.
[e] Fertilizer solutions.

Soybean injury as influenced by postemergence acifluorfen, bentazon, and lactofen applied with several herbicide additives, 1986. Lueschen, William E. and Thomas R. Hoverstad. This study was conducted near Waseca, MN to evaluate the influence of eight spray additive treatments with acifluorfen, acifluorfen plus bentazon, bentazon and lactofen on injury of weed-free soybeans. The accompanying table gives the herbicide rates and additive rates. The study was conducted as a factorial experiment in a randomized complete block design with four replications and a plot size of 10x12 feet. Data were analyzed as a factorial with six herbicide treatments and eight additives. The site for this research was a Nicollet clay loam soil containing 4.8% organic matter, a pH of 6.7 and soil test P and K levels of 76 and 307 lb/A, respectively. 'Hardin' soybeans were planted May 23 in 30-inch wide rows at a seeding rate of 150,000 seeds/A. Just prior to planting 0.75 lb/A of trifluralin was applied and incorporated twice with a field cultivator. After planting a preemergence application of chloramben at 2.5 lb/A was made. All plots were also hand-weeded to remove any escaped weeds. Postemergence herbicide treatments were applied on June 20 with a motorized bicycle sprayer calibrated to deliver 20 gallons/A at 30 psi; the soybeans were in the second trifoliolate leaf stage and were 5 inches tall. Air temperatures ranged from 83 to 91°F with 60% relative humidity during the time the postemergence treatments were being applied. Also, during this period the sky was clear but became partly cloudy late in the afternoon of June 20. Two hours after the last herbicide treatments were applied, rain commenced and accumulated to 2.46 inches within eight hours of applying the final treatments. The herbicides were applied in the order in which the treatments are listed in the table, i.e. additives without any herbicides were applied first and the lactofen treatments were applied last. Within 32 hours of applying the treatments, 4.64 inches of rainfall was received. The ammonium sulfate (AMS) was a spray grade material, Sulf N-45 supplied by Allied Chemical Corp. The 10-34-0 and 28% N solution were fertilizer grade materials. The surfactant was a nonionic surfactant, AG-98, and the oil concentrate was an 80% paraffin based petroleum oil. All additives except AMS were added on a volume/volume basis.

When averaged across all additive treatments, the most severe soybean injury was observed with lactofen at 0.20 lb/A followed in decreasing order of severity by acifluorfen at 0.50 lb/A, acifluorfen at 0.25 lb/A, and acifluorfen at 0.25 lb/A plus bentazon at 0.75 lb/A. Very little injury was observed with bentazon applied alone regardless of the additive. The additive treatment causing the most severe crop injury was oil concentrate at 0.63% in combination with 28% N solution at 1.25%. Oil concentrate at either 0.63% or 1.25% and 28% N solution at 5.0% also caused significant soybean injury. These additives were especially injurious to soybeans when applied with lactofen at 0.20 lb/A, and acifluorfen at 0.25 or 0.50 lb/A. With acifluorfen at 0.25 lb/A plus bentazon at 0.75 lb/A, the only additive that resulted in a high degree of early soybean injury was oil concentrate at 0.63% combined with 28% N solution at 1.25%. Where severe injury was observed, plant heights were reduced throughout the season. When averaged across additive treatments, lactofen was the only herbicide treatment that yielded significantly less than the control. Yield reduction with 0.50 lb/A of acifluorfen approached significance. (MN Agr. Exp. Sta. Paper No. 2076. Misc. Journal Series. Univ. of MN, St. Paul, MN).

Table. Soybean injury as influenced by postemergence acifluorfen, bentazon and lactofen applied with several herbicide additives, 1986. (Lueschen and Hoverstad)

Herbicide(s)[a]	Rate lb/A	Additive % (lb)[b]	% Injury[c] 6/23	6/26	6/27	7/2	Plant Height (inches) 7/2	7/17	10/6	bu/A	H_2O
None	----	None	0	0	0	0	9.8	23.8	35.8	44.4	15.7
None	----	AMS (2.5)	0	0	0	0	10.5	24.5	37.2	46.0	16.1
None	----	10-34-0 1.25	0	0	3	0	10.5	24.5	36.2	44.5	16.2
None	----	28%N 5.0	0	0	1	0	10.0	23.8	37.0	47.6	15.6
None	----	Surfactant 0.13	0	0	0	0	9.8	23.2	35.2	43.6	15.8
None	----	O.C. 0.63	0	0	0	0	10.5	24.8	36.5	47.4	16.2
None	----	O.C. 1.25	0	0	3	0	10.5	24.5	37.2	46.8	15.8
None	----	O.C.+28%N 0.63+1.25	1	0	0	0	10.8	25.2	36.8	46.0	15.9
Acifluorfen	0.25	None	0	0	1	0	10.3	24.8	36.5	45.6	15.8
Acifluorfen	0.25	AMS (2.5)	8	6	11	2	10.0	22.2	36.2	44.7	15.7
Acifluorfen	0.25	10-34-0 1.25	5	3	6	1	10.3	24.0	36.2	46.4	15.6
Acifluorfen	0.25	28%N 5.0	10	9	8	1	9.5	22.2	35.5	46.6	15.5
Acifluorfen	0.25	Surfactant 0.13	3	2	3	0	10.3	24.5	36.0	46.0	15.8
Acifluorfen	0.25	O.C. 0.63	12	7	8	1	10.0	23.2	36.0	46.2	15.6
Acifluorfen	0.25	O.C. 1.25	18	10	15	3	9.0	22.2	35.8	43.4	16.0
Acifluorfen	0.25	O.C.+28%N 0.63+1.25	22	16	19	2	9.3	20.5	35.0	42.5	15.8
Acifluorfen	0.50	None	2	0	1	0	10.5	24.0	38.2	46.0	15.8
Acifluorfen	0.50	AMS (2.5)	12	9	12	2	10.0	23.2	36.8	48.0	15.8
Acifluorfen	0.50	10-34-0 1.25	8	10	12	2	10.0	23.5	36.0	46.6	15.9
Acifluorfen	0.50	28%N 5.0	20	12	16	4	9.3	21.8	35.5	44.6	15.5
Acifluorfen	0.50	Surfactant 0.13	4	3	6	0	10.5	24.5	37.2	43.5	15.8
Acifluorfen	0.50	O.C. 0.63	14	10	13	2	9.5	22.2	35.0	42.1	15.6
Acifluorfen	0.50	O.C. 1.25	19	16	18	5	9.3	21.2	35.2	43.1	15.9
Acifluorfen	0.50	O.C.+28%N 0.63+1.25	32	28	29	20	8.0	18.2	32.8	40.4	15.5
Acifluorfen+Bentazon	0.25+0.75	None	3	0	2	0	10.0	24.2	36.8	47.6	15.8
Acifluorfen+Bentazon	0.25+0.75	AMS (2.5)	6	5	8	2	9.5	23.8	36.2	42.9	15.6
Acifluorfen+Bentazon	0.25+0.75	10-34-0 1.25	6	4	7	0	9.5	22.8	37.0	46.9	15.7
Acifluorfen+Bentazon	0.25+0.75	28%N 5.0	7	4	8	0	9.5	23.5	36.5	47.3	15.7
Acifluorfen+Bentazon	0.25+0.75	Surfactant 0.13	4	2	6	0	10.3	24.0	36.8	46.4	16.0
Acifluorfen+Bentazon	0.25+0.75	O.C. 0.63	7	4	5	1	9.8	23.5	36.0	46.5	15.8
Acifluorfen+Bentazon	0.25+0.75	O.C. 1.25	7	6	8	2	9.8	22.8	36.0	44.0	16.0
Acifluorfen+Bentazon	0.25+0.75	O.C.+28%N 0.63+1.25	24	20	20	4	9.0	20.8	34.5	43.1	15.1
Bentazon	0.75	None	0	0	0	0	11.0	26.0	37.8	47.2	16.1
Bentazon	0.75	AMS (2.5)	1	0	0	0	10.5	24.5	36.5	45.8	15.7
Bentazon	0.75	10-34-0 1.25	0	0	1	0	10.3	24.5	36.0	46.0	16.0
Bentazon	0.75	28%N 5.0	0	0	3	1	10.5	23.8	35.8	48.1	15.7
Bentazon	0.75	Surfactant 0.13	0	0	0	0	10.5	24.2	36.5	45.4	15.8
Bentazon	0.75	O.C. 0.63	1	0	0	0	10.0	23.2	36.2	46.6	15.8
Bentazon	0.75	O.C. 1.25	0	0	0	0	10.8	25.2	36.5	47.3	15.9
Bentazon	0.75	O.C.+28%N 0.63+1.25	2	2	2	0	10.5	24.2	36.5	45.7	16.0
Lactofen	0.20	None	8	12	16	1	9.8	22.5	35.8	43.8	15.8
Lactofen	0.20	AMS (2.5)	16	15	20	4	9.0	21.5	36.0	42.2	15.8
Lactofen	0.20	10-34-0 1.25	16	14	20	4	9.3	22.2	35.8	44.6	15.6
Lactofen	0.20	28%N 5.0	20	19	18	5	9.5	22.0	36.0	43.2	15.8
Lactofen	0.20	Surfactant 0.13	20	16	18	4	9.8	22.8	36.2	40.8	15.8
Lactofen	0.20	O.C. 0.63	28	21	24	11	8.5	19.2	34.5	40.0	15.6
Lactofen	0.20	O.C. 1.25	34	29	30	15	8.0	18.5	34.5	42.0	15.4
Lactofen	0.20	O.C.+28%N 0.63+1.25	36	28	29	11	8.8	19.5	33.2	43.0	15.9
Additive Means:		None	2	2	3	0	10.2	24.2	36.8	45.8	15.8
		AMS (2.5)	7	6	9	2	9.9	23.2	36.5	45.0	15.8
		10-34-0 1.25	6	5	8	1	10.0	23.5	36.2	45.8	15.8
		28%N 5.0	10	7	9	2	9.7	22.8	36.0	46.2	15.6
		Surfactant 0.13	5	4	6	1	10.1	23.9	36.3	44.3	15.9
		O.C. 0.63	10	7	8	3	9.7	22.7	35.7	44.8	15.8
		O.C. 1.25	13	10	12	4	9.5	22.4	35.9	44.4	15.8
		O.C.+28%N 0.63+1.25	20	16	16	16	9.4	21.4	34.8	43.4	15.8
BLSD (0.05) for additives			2	2	2	1	0.4	0.6	0.8	2.6	NS
Herbicide Means:		None	0	0	1	0	10.3	24.3	36.5	45.8	15.9
		Acifluorfen 0.25	10	7	9	1	9.8	23.0	35.9	45.2	15.7
		Acifluorfen 0.50	14	11	13	4	9.6	22.3	35.8	44.3	15.8
		Acifluorfen + Bentazon	8	6	8	1	9.6	23.2	36.2	45.6	15.8
		Bentazon	1	0	1	0	10.5	24.4	36.5	46.5	15.9
		Lactofen	22	19	22	7	9.1	21.0	35.2	42.4	15.7
BLSD (0.05) for herbicide treatments			2	1	1	1	0.3	0.5	0.7	1.9	0.6
Herbicide x Additive (% significance level)			100	100	100	100	100	100	95	30	08

[a]Herbicide formulations: Acifluorfen 2L, Bentazon 4S, and Lactofen 2L. Herbicides were applied in the order listed in the table. Two hours after the lactofen treatments were applied, rainfall commenced.

[b]Additives: AMS = spray grade ammonium sulfate; 10-34-0 = liquid fertilizer; 28%N = 28% nitrogen solution; surfactant = nonionic, Ag-98; and O.C. = 80% paraffin based petroleum oil.

[c]Visual estimates of soybean injury - leaf necrosis and stunting.

Weed control in no-till soybeans, 1986. Lueschen, William E. and Thomas R. Hoverstad. This study was designed to evaluate early preplant (EPP), preemergence (PRE) and postemergence treatments for weed control in no-till soybean production. The soil type was a Webster clay loam containing 7.2% organic matter, a pH of 7.6 and soil test P and K levels of 56 and 445 lb/A, respectively. This site has been in a no tillage corn-soybean rotation for the past three years. A randomized complete block design with four replications and a plot size of 7.5x30 feet was used. With the exception of the burndown treatments, all herbicides were applied with a motorized bicycle sprayer equipped with flat fan nozzles calibrated to deliver 20 gallons/A at 30 psi. The burndown treatments were applied with a total spray volume of 10 gallons/A. 'Hardin' soybeans were planted with a no-till planter on May 22 in 10-inch wide rows at a seeding rate of 175,000 seeds/A. The following table gives dates of herbicide application and climatic conditions.

Treatment	Date Applied	Temperature(°F)		Rainfall (inches)	
		Max.	Min.	1st Week	2nd Week
Early Preplant	April 22	57	35	1.67	0.10
Burndown	May 22	71	49	0.77	0.91
Preemergence	May 23	66	44	0.77	0.91
Postemergence					
Bentazon+Acifluorfen	June 12	81	61	1.61	4.64
Sethoxydim	June 19	92	71	4.64	0.62

When the bentazon plus acifluorfen was applied, the soybeans were in the unifoliolate to first trifoliolate leaf stage and broadleaf weeds were 0.5 to 2.0 inches tall and had one to four true leaves present. When the sethoxydim was applied postemergence, the soybeans were in the second trifoliolate leaf stage and the giant foxtail was 3 to 4 inches tall with two to four leaves present. In the untreated controls, there were an average of five giant foxtail, one redroot pigweed, three common lambsquarters and five velvetleaf plants/ft^2. These weed populations were sufficient to reduce yields in the weedy checks to 15.6 bu/A compared to 50.9 bu/A for the hand-weeded treatment.

When comparing the EPP treatments with the same herbicides applied as either a split application with one compound applied EPP and the other applied PRE or the same treatment applied PRE following a burndown treatment of glyphosate, there was generally better weed control with the EPP plus PRE and the burndown plus PRE treatments. Glyphosate at 0.38 lb/A gave excellent burndown whether applied alone with 0.5% surfactant and ammonium sulfate (AMS) at 2.5 lb/A or if it was combined with 2,4-D amine and AMS. Sethoxydim at 0.10 lb/A applied in combination with 2,4-D ester and oil concentrate also gave excellent burndown of all weed species. Velvetleaf control with post-emergence bentazon plus acifluorfen was good to excellent in late June but ranged from 61 to 83% at harvest. There were several cases where FMC 57020 did not give consistently good performance on velvetleaf, especially where it was applied EPP and PRE in combination with metribuzin. Metribuzin did not provide good control of broadleaf weeds, especially when applied PRE following cinmethylin EPP. Significant differences in early soybean injury were observed among treatments. This injury was primarily in the form of stunting. Treatments giving the highest degree of injury were AC 263,499 at 0.10 lb/A PRE and the total postemergence systems following burndown treatments. (MN Agr. Exp. Sta. Paper No. 2074. Misc. Journal Series, Univ. of MN, St. Paul, MN).

Table. Weed control in no-till soybeans, 1986. (Lueschen and Hoverstad)

Treatment[a]	lb/A	% Injury 6/26	% Control[b] Gift 5/29	Gift 6/26	Gift 9/29	Colq 5/29	Colq 6/26	Colq 9/29	Rrpw 5/29	Rrpw 6/26	Rrpw 9/29	Vele 5/29	Vele 6/26	Vele 9/29	bu/A
Early Preplant applied April 22															
AC 263,499	0.10	3	99	84	81	100	95	94	100	100	100	88	85	99	44.1
AC 263,499 + FMC 57020	0.06+1.0	3	100	93	91	100	92	90	100	100	98	99	90	98	48.8
AC 263,499 + Cinmethylin	0.06+1.0	10	100	73	70	100	82	94	100	100	99	96	84	98	40.8
AC 263,499 + Pendimethalin	0.06+1.5	3	100	89	78	100	88	84	100	100	98	92	82	92	42.2
FMC 57020 + Pendimethalin	1.25+1.5	2	100	95	91	100	84	76	100	96	98	99	80	82	45.7
Early Preplant applied April 22 - (Preemergence applied May 23)															
FMC 57020-(AC 263,499)	1.0-(0.06)	9	100	99	98	100	100	100	100	99	100	100	98	99	52.0
FMC 57020-(Metribuzin)	1.25-(0.50)	1	100	96	91	100	85	78	100	91	86	100	94	91	48.6
FMC 57020+Metribuzin-(Metribuzin)	1.25+0.38-(0.38)	1	100	98	96	100	98	99	100	100	96	99	98	91	48.3
FMC 57020+Metribuzin-(FMC 57020+Metribuzin)	0.75+0.38-(0.50+0.38)	1	100	95	94	100	86	95	100	100	100	95	87	78	43.7
FMC 57020-Chloramben	0.75-(2.5)	6	100	96	94	100	93	86	100	99	93	100	92	82	48.5
FMC 57020-Chloramben	1.0-(2.5)	9	100	97	94	100	89	78	100	100	100	100	98	86	46.2
AC 263,499-Chloramben	0.10-(2.5)	14	100	98	94	100	98	100	100	100	100	97	96	99	45.7
Cinmethylin-AC 263,499	1.0-(0.06)	14	100	97	97	100	100	100	99	99	100	84	88	80	44.3
Cinmethylin-Metribuzin	1.5-(0.50)	4	100	69	55	100	66	48	100	82	62	94	65	38	25.1
Metolachlor+Metribuzin-(Metolachlor+Metribuzin)	2.0+0.38-(1.0+0.38)	5	100	92	88	100	89	85	100	95	86	100	81	49	40.0
Alachlor+Metribuzin-(Alachlor+Metribuzin)	2.5+0.38-(1.5+0.38)	11	100	96	92	100	95	98	100	100	100	98	80	60	37.8
Pendimethalin-(AC 263,499)	1.5-(0.06)	15	100	100	99	100	100	100	100	100	100	93	88	88	42.2
Pendimethalin-(FMC 57020)	1.5-(1.25)	4	100	96	93	100	89	80	100	92	91	91	74	66	44.2
Pendimethalin+Metribuzin-(Metribuzin)	1.5+0.38-(0.38)	8	100	81	72	100	95	90	100	98	91	99	85	55	37.2
Burndown Glyphosate 0.38 lb/A + Surfactant 0.5% + AMS 2.5 applied May 22 - following by these preemergence treatments applied May 23															
FMC 57020+Chloramben	1.0+2.5	9	98	98	97	100	92	95	100	100	98	90	95	91	51.0
FMC 57020+Metribuzin	1.0+0.5	4	99	96	90	100	90	82	100	92	89	80	81	74	45.8
FMC 57020+AC 263,499	1.0+0.06	12	98	99	98	100	100	100	100	100	100	80	97	100	49.5
AC 263,499	0.10	23	98	100	98	100	100	100	100	100	100	88	98	100	43.8
AC 263,499+Cinmethylin	0.06+1.0	15	100	100	99	100	100	100	100	100	100	92	98	100	49.9
Alachlor+Chloramben	4.0+2.5	18	99	100	96	100	95	91	100	100	100	94	90	75	45.8
Chloramben+Metolachlor	2.5+3.0	15	100	98	96	100	94	92	100	100	98	88	94	76	47.3
Burndown Sethoxydim 0.10 + 2,4-D ester 0.50 + O.C. 1.3% applied May 22 - Acifluorfen 0.25 + Bentazon 0.75 + O.C. 1.3% applied June 12 - Sethoxydim 0.20 + O.C. 1.3% applied June 19		23	75	98	98	88	97	97	95	100	93	90	96	83	43.9
Burndown Glyphosate 0.38 + 2,4-D amine + AMS applied May 22 - Acifluorfen 0.25 + Bentazon 0.75 + O.C. 1.3% applied June 12 - Sethoxydim 0.20 + O.C. 1.3% applied June 19		24	98	100	97	100	99	94	100	99	94	88	88	61	42.8
Weedy Check		0	0	0	0	0	0	0	0	0	0	0	0	0	15.6
Hand-Weeded - (Glyphosate 0.38 + Alachlor 2.5 + Chloramben 2.5 + AMS 2.5 + Hand-weeded)		18	83	99	100	99	100	100	100	100	100	60	100	100	50.9
BLSD (0.05)		7	7	6	9	8	9	14	5	7	9	14	9	20	7.0

[a]Herbicide Formulations: AC 263,499 1.92AS; Acifluorfen 2L; Alachlor 4MT; Bentazon 4S; Cinmethylin 7EC; Chloramben 75DS; FMC 57020 6EC; Glyphosate 3AE; Metolachlor 8EC; Metribuzin 75DF; Pendimethalin 4EC; Sethoxydim 1.53EC; 2,4-D amine 3.8AE and 2,4-D ester 3.8AE; AMS=spray grade ammonium sulfate; O.C.=80% paraffin base petroleum oil concentrate; Surfactant=nonionic surfactant (Ag 98).

[b]Visual estimates of weed control taken 5/29/86, 6/26/86 and 9/29/86.

Influence of additives with bentazon and bentazon plus acifluorfen on weed control in soybeans, 1986. Lueschen, William E. and Thomas R. Hoverstad. The objective of this study was to evaluate the effects of several herbicide additives on the broadleaf weed control in soybeans with bentazon or a tank mixture of bentazon plus acifluorfen. This study was conducted on a Webster clay loam soil having 6.3% organic matter, a soil pH of 6.3, and soil test P and K levels of 56 and 298 lb/A, respectively. The study was designed as a randomized complete block with four replications and a plot size of 10x30 feet. 'Hardin' soybeans were planted on May 22 in 30-inch wide rows at a planting rate of 150,000 seeds/A. Sethoxydim at 0.3 lb/A was applied without any spray additive on June 6 and this treatment was repeated on June 26. This provided excellent grass control so we could evaluate the broadleaf weed control without interference from grassy weeds and without the possible confounding effects that an additive may have had. All herbicide treatments were applied with a motorized bicycle sprayer equipped with flat fan nozzles and calibrated to deliver 20 gallons/A at 30 psi. The broadleaf herbicide treatments were applied as tank mixtures on June 17. The maximum temperature on this date was 81°F and the minimum temperature was 58°F. The sky was clear to partly cloudy. Due to mechanical problems with the sprayer, the treatments in this study were applied over a 7-hour period. Approximately eight hours after beginning to spray this study, heavy rainfall commenced. Most treatments had been applied for three to four hours before the rain began; however, the bentazon at 0.5 lb/A plus acifluorfen at 0.13 lb/A plus AMS plus oil concentrate treatment was applied only one hour prior to commencement of rain. Within 12 hours after application of all herbicides, 1.30 inches of rainfall accumulated. The weed-free treatment received alachlor at 2.5 lb/A plus chloramben at 2.5 lb/A as a preemergence treatment and was hand-weeded throughout the season. The broadleaf weedy check was treated with sethoxydim as described above. All plots were cultivated once on July 3. The liquid 10-34-0 and 28% N solutions were fertilizer grade materials. The ammonium sulfate (AMS) was a dry, crystalline spray grade material, Sulf-N 45 from Allied Corporation.

Both herbicide treatments and additives significantly affected soybean injury and weed control ratings. Regardless of the additive, soybean leaf necrosis was very low with bentazon at 0.5 lb/A when applied alone. When acifluorfen was applied as a tank mixture with bentazon, the 0.25 lb/A rate of acifluorfen generally gave more soybean injury than the 0.13 lb/A rate. Oil concentrate or a combination of 28% N plus oil concentrate resulted in the greatest crop injury. With the bentazon treatment, additives did not influence control of redroot pigweed or ladysthumb; however, common lambsquarter control with bentazon was improved where oil concentrate was used alone or in combination with 28% N or AMS. The best control of velvetleaf with bentazon was obtained where either 28% N or AMS was used as the sole additive or when one of these additives was combined with oil concentrate. For the bentazon plus acifluorfen treatments, oil concentrate, 10-34-0 and AMS were generally less effective additives than either 28% N or a combination of oil concentrate with either 28% N or AMS. These results were especially true for redroot pigweed and velvetleaf. Yield differences among treatments generally were not significant, however, the poor control of redroot pigweed with bentazon is reflected in soybean yield. (MN Agr. Exp. Sta. Paper No. 2079. Misc. Journal Series, Univ. of MN, St. Paul, MN).

Table. Influence of additives on broadleaf weed control in soybeans with bentazon and bentazon plus acifluorfen, 1986. (Lueschen and Hoverstad)

Herbicide Treatment[a] Rate (lb/A)	Additive Treatment[b] Kind	Additive Treatment[b] Qt/A(lb/A)	% Injury 6/27	% Control Gift 6/27	Gift 9/26	Rrpw 6/27	Rrpw 9/26	Colq 6/27	Colq 9/26	Vele 6/27	Vele 9/26	Lath 6/27	Lath 9/26	bu/A
Bentazon														
0.5	None	None	0	79	100	61	64	64	80	61	56	98	95	40.6
0.5	OC	0.5	0	79	100	59	65	65	92	70	79	100	100	43.4
0.5	OC	1.0	0	82	100	55	59	80	91	65	74	95	96	41.4
0.5	28%N	1.0	0	80	100	54	45	70	72	88	89	100	95	40.0
0.5	28%N	4.0	0	83	100	61	62	75	92	96	100	99	100	43.8
0.5	28%N + OC	1.0 + 0.5	2	84	100	51	49	92	100	89	96	100	100	42.4
0.5	28%N + OC	4.0 + 0.5	1	80	100	60	52	95	99	95	95	100	100	41.6
0.5	AMS	(2.5)	1	83	100	55	52	68	78	85	91	100	99	43.6
0.5	AMS + OC	(2.5) + 0.5	1	81	100	63	56	95	99	100	94	100	100	42.9
Bentazon + Aciflurofen														
0.5 + 0.13	None	None	0	79	100	70	71	70	86	74	81	94	92	43.8
0.5 + 0.13	OC	0.5	1	81	100	71	71	79	94	78	70	99	99	43.4
0.5 + 0.13	10-34-0	1.0	1	81	100	68	78	80	90	69	76	98	98	44.2
0.5 + 0.13	28%N	1.0	2	83	100	81	93	82	96	92	91	100	100	45.5
0.5 + 0.13	28%N	4.0	1	83	100	88	96	79	76	92	95	100	100	47.6
0.5 + 0.13	28%N + OC	1.0 + 0.5	14	88	100	81	84	90	99	95	100	98	100	45.8
0.5 + 0.13	28%N + OC	4.0 + 0.5	22	92	100	92	92	91	94	98	91	98	100	43.6
0.5 + 0.13	AMS	(2.5)	1	81	100	55	73	81	99	77	82	90	96	41.4
0.5 + 0.13[c]	AMS + OC	(2.5) + 0.5	11	83	100	51	45	76	90	73	69	96	96	37.8
Bentazon + Aciflurofen														
0.5 + 0.25	None	None	0	83	100	78	89	86	100	65	85	91	95	44.5
0.5 + 0.25	OC	0.5	10	88	100	85	86	88	96	84	72	96	98	42.6
0.5 + 0.25	10-34-0	1.0	2	82	100	80	83	84	95	95	89	98	96	45.8
0.5 + 0.25	28%N	1.0	15	90	100	91	94	91	91	86	90	100	100	44.8
0.5 + 0.25	28%N	4.0	10	86	100	96	93	86	92	100	100	100	100	46.0
0.5 + 0.25	28%N + OC	1.0 + 0.5	24	92	100	94	91	94	97	95	95	100	100	45.6
0.5 + 0.25	28%N + OC	4.0 + 0.5	26	94	100	99	100	95	100	100	98	98	100	42.9
0.5 + 0.25	AMS	(2.5)	4	83	100	79	91	89	92	80	81	99	100	43.5
0.5 + 0.25	AMS + OC	(2.5) + 0.5	24	93	100	99	98	97	95	98	94	93	100	42.6
Broadleaf Weedy Check			1	80	100	0	0	0	0	0	0	0	0	38.7
Weed-Free			0	100	100	100	100	100	100	100	100	100	100	46.8
BLSD (0.05)				3	NS	15	16	17	21	22	21	12	6	5.1

[a]All treatments received an application of 0.3 lb/A sethoxydim on 6/6/86 without any additive. This treatment was repeated on 6/26/86. All treatments were applied on 6/17/86.
[b]OC=Crop Oil Concentrate 80% paraffin base petroleum oil, 28%N=28%N solution fertilizer, AMS=ammonium sulfate, 10-34-0=liquid fertilizer.
[c]This treatment was applied one hour before rainfall commenced.

Influence of tillage on efficacy of postemergence grass herbicides for quackgrass control in soybeans at Waseca, MN - 1986. Don Wyse

	Treatment	Rate	Tillage	Quackgrass control-DAT 30	100	365	Soybean yield	
		(lb/a)		(%)	(%)	(%)	(bu/a)	(kg/ha)
1	No treatment	----	C	0	0		43	2929
2	Glyphosate F	0.75	C	62	86		43	2894
3	Glyphosate S	0.50	C	92	89		41	2785
4	Glyphosate S	0.75	C	91	93		44	3007
5	Sethoxydim	0.25	C	90	89		45	3038
6	Sethoxydim	0.13 + 0.13	C	87	93		43	2937
7	Fluazifop	0.25	C	82	91		42	2855
8	Fluazifop	0.13 + 0.13	C	82	94		45	3026
9	Haloxyfop	0.13	C	95	97		47	3175
10	Haloxyfop	0.06 + 0.06	C	90	93		41	2800
11	DPX Y6202	0.13	C	95	96		44	2968
12	DPX Y6202	0.06 + 0.06	C	93	97		44	2995
13	No treatment	----	R	0	0		38	2562
14	Glyphosate	0.75	R	58	82		43	2913
15	Glyphosate	0.50	R	92	93		43	2886
16	Glyphosate	0.75	R	95	94		41	2788
17	Sethoxydim	0.25	R	80	86		40	2726
18	Sethoxydim	0.13 + 0.13	R	62	89		40	2707
19	Fluazifop	0.25	R	84	85		40	2738
20	Fluazifop	0.13 + 0.13	R	80	89		40	2738
21	Haloxyfop	0.13	R	85	87		42	2839
22	Haloxyfop	0.06 + 0.06	R	83	83		39	2671
23	DPX Y6202	0.13	R	89	91		42	2812
24	DPX Y6202	0.06 + 0.06	R	91	91		42	2851
25	No treatment	----	N	0	0		37	2539
26	Glyphosate	0.75	N	63	79		42	2863
27	Glyphosate	0.50	N	90	81		42	2851
28	Glyphosate	0.75	N	91	89		41	2800
29	Sethoxydim	0.25	N	85	91		44	2948
30	Sethoxydim	0.13 + 0.13	N	76	86		40	2738
31	Fluazifop	0.25	N	86	91		42	2851
32	Fluazifop	0.13 + 0.13	N	74	89		44	2964
33	Haloxyfop	0.13	N	91	90		44	2987
34	Haloxyfop	0.06 + 0.06	N	86	87		42	2866
35	DPX Y6202	0.13	N	89	90		44	2964
36	DPX Y6202	0.06 + 0.06	N	89	87		43	2937
	LSD 0.05			7	9		3	202

C-conventional tillage, fall moldboard plow, spring disk. R-ridge tillage. N-no tillage.

Area planted to corn 1985. Ridged 7-2-85. Plot size 15' x 35'. Fall (F) glyphosate treatment made 10-12-85. Spring (S) glyphosate treatment 5-20-86, temperature 65, wind NW 10 mph, quackgrass 8", 4-5 lvs. Glyphosate treatments received oil and applied at a carrier rate of 8.7 gal/a. Postemergence treatments applied 6-20-86, temperature 70, wind SW 5 mph, received 1 qt/a crop oil concentrate, soybeans 7", second trifoliate, quackgrass 9", 4-5 lvs, repeat applications 7-9-85 temperature 80, wind calm soybeans fourth trifoliate, 12", quackgrass regrowth noted. Quackgrass shoot populations in untreated plots were counted in fall of 1986: conventional tillage, $60/m^2$; ridge tillage, $277/m^2$; no tillage, $226/m^2$. Herbicides were applied with a tractor mounted sprayer. Quackgrass control ratings are an average of three reps based on visual ratings on a 0-100% scale.

Cinmethylin for weed control in soybeans, 1986. Lueschen, William E. and Thomas R. Hoverstad. This study was conducted near Waseca, MN to evaluate cinmethylin applied alone or in tank mixtures with AC 263,499, chloramben, or metribuzin for weed control in soybeans. The soil type was a Webster clay loam containing 7.5% organic matter, a soil pH of 6.9, and soil test P and K levels of 72 and 353 lb/A, respectively. The study was conducted as a randomized complete block design with four replications and a plot size of 10x30 feet. 'Hardin' soybeans were planted on May 22 in 30-inch wide rows at a seeding rate of 150,000 seeds/A. Preemergence treatments were applied on May 23 to a dry soil surface using a motorized bicycle sprayer calibrated to deliver 20 gallons/A at 30 psi. During the week following application of preemergence herbicides, 0.77 inches of precipitation was received and an additional 0.91 inches was received during the second week following preemergence herbicide application. Postemergence bentazon was applied on June 12 when the soybeans were in the unifoliolate to first trifoliolate leaf stage and broadleaf weeds were 1 to 3 inches tall. In the weedy check plots prior to cultivation, there were 108 giant foxtail, 3 redroot pigweed, 2 common lambsquarters and 0.5 velvetleaf plants/ft^2. All treatments were cultivated once.

Cinmethylin applied alone provided very little control of any of the broadleaf weeds. The 0.75 and 1.13 lb/A rate of cinmethylin gave poor giant foxtail control; the 1.50 lb/A rate gave approximately 80% control of this species early in the season and at harvest. The addition of 0.5 lb/A of metribuzin to either 1.13 or 1.50 lb/A of cinmethylin did not improve control of giant foxtail. Control of common lambsquarters and ladysthumb was improved with the addition of metribuzin but control of redroot pigweed and velvetleaf were not adequate for the tank mixture of cinmethylin and metribuzin.
AC 263,499 applied as a tank mixture with either 0.75, 1.13 or 1.50 lb/A of

cinmethylin resulted in excellent control of all species in this trial. Chloramben at 2.5 lb/A plus cinmethylin at 1.13 lb/A also gave excellent control of all weed species for the entire season. There was no crop injury or stand loss as a result of any of the treatments. (MN Agr. Exp. Sta. Paper No. 2078. Misc. Journal Series. Univ. of MN, St. Paul, MN).

Table. Cinmethylin for weed control in soybeans, 1986. (Lueschen and Hoverstad)

		% Control									
		Gift		Rrpw		Colq		Vele		Lath	
Treatment[a]	lb/A	6/12	9/26	6/12	9/26	6/12	9/26	6/12	9/26	9/26	bu/A
Cinmethylin	0.75	59	36	30	53	50	70	35	45	65	34.6
Cinmethylin	1.13	66	48	36	40	40	64	37	30	50	35.2
Cinmethylin	1.50	80	76	35	28	50	64	50	50	60	42.1
Cinmethylin + AC 263,499	0.75 + 0.09	93	98	100	100	100	100	92	100	100	47.5
Cinmethylin + AC 263,499	1.13 + 0.09	93	98	100	100	100	100	94	99	100	45.5
Cinmethylin + AC 263,499	1.50 + 0.09	93	99	100	100	100	100	93	100	100	50.7
Cinmethylin + AC 263,499	1.50 + 0.07	93	97	100	100	99	100	89	100	100	49.1
Cinmethylin + AC 263,499	1.50 + 0.05	87	98	100	100	99	100	93	100	100	51.8
Cinmethylin + Metribuzin	1.13 + 0.50	65	59	53	58	81	84	35	53	80	43.2
Cinmethylin + Metribuzin	1.13 + 0.50	78	74	55	60	76	86	49	60	93	44.8
Cinmethylin + Chloramben	1.13 + 2.5	98	97	100	100	97	99	91	100	100	47.5
Alachlor + Chloramben + Handweeded	3.0 + 2.5	98	100	100	100	100	100	85	100	100	50.1
Alachlor - (Bentazon + O.C.)[b]	3.0 - (1 + 1 qt)	79	56	89	100	92	100	98	100	100	40.5
Weedy Check		0	0	0	0	0	0	0	0	0	20.3
BLSD (0.05)		14	19	17	15	22	14	20	23	14	7.8

[a]Herbicide formulations: alachlor 4MT; AC 263,499 1.92 AS; bentazon 4S; cinmethylin 7E; chloramben 75DS and metribuzin 75DF. Oil concentrate was 80% paraffin based petroleum oil.

[b]Bentazon + oil applied postemergence.

<u>A comparison between flat fan and air-assist nozzles for weed control in soybeans, 1986</u>. Lueschen, William E. and Thomas R. Hoverstad. This study was conducted near Waseca, MN to evaluate weed control in soybeans with herbicides applied with flat fan nozzle tips as compared to air-assist nozzles. The site was a Webster clay loam soil containing 7.4% organic matter, a pH of 6.9, and soil test P and K levels of 90 and 396 lb/A, respectively. This study was conducted as a randomized complete block design with four replications and a plot size of 10x55 feet. 'Evans' soybeans were planted on May 24 in 30-inch wide rows at a seeding rate of 150,000 seeds/A. All herbicides applied with flat fan nozzles, Spraying Systems 8003, were applied with a tractor-mounted sprayer calibrated to deliver 20 gallons/A when operated at 30 psi. The air-assist nozzles, Spraying Systems Co. Airjet nozzles, were operated to deliver 5 gallons/A with 40 psi on the fluid line and 7.5 psi on the air line. Preemergence treatments were applied May 24 to a dry soil surface. During the first week following application of preemergence treatments 0.77 inches of precipitation accumulated followed by an additional 0.91 inches during the second week. Two dates of application of bentazon were evaluated: June 12 and June 19. The sethoxydim treatments were applied either on June 19 or June 20. The following table gives crop and weed stages and weather parameters for all herbicide application.

Date	Stage[a]	Weed Leaf Stage (inches)	Temp. (F°) Max.	Temp. (F°) Min.	Relative Humidity (%)	Sky	Hours to Rainfall
May 24	---	---	72	51	55	P Cloudy	24
June 12	0-1	2-4(1-2)	81	61	50	Clear	24
June 19	2	4-6(3-4)	92	71	60	Clear	24
June 20	2	4-6(3-4)	91	66	65	Clear	8

[a]Numbers refer to the number of fully-expanded trifoliolate leaves on the soybeans.

All treatments were cultivated once on July 3. In the weedy check plots prior to cultivation, there were 61 giant foxtail, 4 common lambsquarters, and 6 redroot pigweed plants/ft^2. There was a light, scattered population of velvetleaf.

Control of giant foxtail with alachlor at 2.0 lb/A preemergence was very poor with both systems of application and there were no differences observed between methods of application. However, with alachlor at 3.0 lb/A the flat fan nozzles provided better control of giant foxtail than the air-assist system. Applying alachlor at either 2.0 or 3.0 lb/A preemergence followed by bentazon at 1 lb/A plus oil concentrate at 1 qt/A provided generally better control of redroot pigweed with the flat fan nozzles as compared to the air-assist nozzles. With these herbicide treatments, control of common lambsquarters and velvetleaf were similar for both systems. Sethoxydim at either 0.1 or 0.2 lb/A plus oil concentrate at 1 qt/A provided equivalent control of giant foxtail with both types of nozzles. However, where bentazon at either 0.5 or 1.0 lb/A was applied alone for control of redroot pigweed, there was an advantage for the flat fan system as compared to the air-assist nozzles. Control of all broadleaf weed species was better with bentazon at 0.75 lb/A plus acifluorfen at 0.25 lb/A with 0.5 qt/A oil concentrate using the flat fan nozzles as compared to the air-assist nozzles. Although the spray patterns appeared uniform with the air-assist treatments, and drift was not a significant problem because of low wind velocities, these nozzles generally provide somewhat poorer weed control than was obtained with flat fan nozzles. (MN Agr. Exp. Sta. Paper No. 2081. Misc. Journal Series. Univ. of MN, St. Paul, MN).

Table. A comparison between flat fan nozzles and air-assist nozzles for weed control in soybeans, 1986. (Lueschen and Hoverstad.

Herbicide[a]	Rate lb/A(Qt/A)	Nozzle Type[b]	% Injury 6/27	% Control[c] Gift 6/27	Gift 9/26	Rrpw 6/27	Rrpw 9/26	Colq 6/27	Colq 9/26	Vele 6/27	Vele 9/26	bu/A
Alachlor PRE May 24 - Bentazon + O.C. June 12												
	2-1 + (1)	Air-Assist	0	54	34	79	92	95	96	100	99	26.8
	2-1 + (1)	Flat Fan	0	59	28	92	95	91	100	98	100	26.1
	3-1 + (1)	Air-Assist	2	52	36	84	89	93	94	96	98	24.7
	3-1 + (1)	Flat Fan	2	79	56	89	99	93	100	98	100	34.7
Bentazon + O.C. June 12 - Sethoxydim + O.C. June 19												
	0.5+(1) - 0.1+(1)	Air-Assist	1	75	91	66	49	89	85	95	85	38.9
	0.5+(1) - 0.1+(1)	Flat Fan	1	76	87	83	69	89	88	98	92	38.9
	1.0+(1) - 0.2+(1)	Air-Assist	1	79	92	73	55	94	76	94	86	40.6
	1.0+(1) - 0.2+(1)	Flat Fan	4	79	94	90	75	94	93	97	94	39.9
Bentazon + O.C. June 19 - Sethoxydim + O.C. June 20												
	1.0+(1) - 0.2+(1)	Air-Assist	0	79	93	35	30	45	58	71	58	36.4
	1.0+(1) - 0.2+(1)	Flat Fan	1	79	94	61	32	79	55	88	59	38.7
Bentazon + Acifluorfen + O.C. June 19 - Sethoxydim + O.C. June 20												
	0.75+0.25+(0.5) - 0.2+(1)	Air Assist	9	81	88	78	74	75	49	79	50	40.5
	0.75+0.25+(0.5) - 0.2+(1)	Flat Fan	11	75	83	92	84	85	71	95	79	42.0
Weed-Free - Alachlor 3.0 lb/A + Chloramben 2.5 lb/A PRE + Hand-weeded			0	100	100	100	100	100	100	100	100	39.2
Weedy Check			0	0	0	0	0	0	0	0	0	16.1
BLSD (0.05)			4	18	15	10	14	7	10	8	15	4.4

[a]Herbicide formulations: Alachlor 4MT, Acifluorfen 2L; Bentazon 4S; and Sethoxydim 1.52E.

[b]Flat fan nozzles were Spraying Systems Co. 8003 tips calibrated to deliver 20 gallons/A at 30 psi. The air-assist nozzles were Spraying Systems Co. 'Airjet' nozzles calibrated to deliver 5 gallons/A with 7.5 psi on the air line and 40 psi on the fluid line.

[c]Visual estimates of percent weed control on June 27, 1986 and September 26, 1986.

CEREAL RUST DEVELOPMENT ON SMALL GRAIN

Alan Roelfs, David Long and Thomas Hoverstad

Time is a very important factor in rust epidemic development. The longer the disease has to develop the greater the resulting loss in yield. In Minnesota, the rust epidemic nearly always terminates in early to mid-August due to wheat maturity. Late planting results in only a few more days of crop growth in August. Thus, the time available for an epidemic is controlled by the date the rust first appears in the crop. Often the inoculum must be blown in from the southern or central Great Plains. Thus the onset of the epidemic is the first time that viable virulent inoculum arrives when conditions are favorable for infection and wheat plants are present in the field. The onset data varies from year to year and location to location. A seven day earlier onset wth a moderate epidemic will result in an additional 15 percent increase in disease severity and result in perhaps a 7 percent loss in yield. Thus, you can see the importance in knowing both the average date of disease onset for your area and the onset date for the current year (Table 1). Another variable is the amount of infection that occurs from that initial input of inoculum. In most years the initial infection results in approximately 1 lesion per 40 foot of row, which is about the lowest level a trained observer can detect. Doubling the number of initial infections is equivalent to a 4 day earlier onset.

Table 1 Average date of wheat leaf and stem rust onset on susceptible trap plots at six Minnesota locations during the period of 1978 through 1986.

	Stem Rust		Leaf Rust	
Location	Mean	1986	Mean	1986
Waseca	6/28	6/26	6/21	6/12
Rosemount	7/04	6/20	6/19	6/20
Lamberton	7/05	6/09	6/12	6/09
Morris	7/12	-	6/21	6/12
Staples	7/13	7/11	7/08	7/17
Crookston	7/17	7/17	7/13	7/17

Leaf and perhaps stem rust can survive the winter in Minnesota on winter wheat where adequate cover exists to protect the wheat from dying back to the crown. The rust usually survives the winter as non-sporulating mycelium resulting from infections occurring late in the fall. Over-wintering of rust results in a local source of inoculum that is available on a daily basis and generally results in a very early disease onset.

To avoid losses due to the rusts a grower should select a resistant cultivar whenever possible. Winter wheat should be planted in fields free of volunteer wheat and away from areas of volunteer wheat. Spring wheat should not be planted adjacent to fields of winter wheat. Fields should be monitored twice weekly in June and early July for the rusts. If yields are expected to be above 40 bushel per acre and rust appears a week or more prior to the mean date of appearance spraying may be economical. Note that in the case of leaf rust that cultivars with adult plant resistance may have significant leaf rust on the lower leaves and still have adequate flag leaf resistant to prevent major yield losses. Spraying must be done early as for each pustule seen there are probably (depending on past weather conditions) 10 latent infections.

1986 OAT BREEDING

Deon D. Stuthman, William E. Lueschen and Thomas R. Hoverstad

Objective: The development of improved oat varieties was the object of this study. Oat varieties grown at Waseca are evaluated for maturity, height, lodging, disease resistance and grain yield. Results from this study are published in "Varietal Trials of Farm Crops".

Procedures: Three studies, a varietal trial, an early maturity advanced yield nursery, and a recurrent selection parents yield nursery are in trial. All plots were planted on April 10. The previous crop was soybeans and the site was fall chisel plowed. 30 lb N/A was applied in the spring and incorporated with a field cultivator just prior to planting. Seed was packaged for planting individual plots at a rate of 80 lb/A using a cone-type planter. Plot size was 4 (four 12-inch rows) x 12 feet. All plots were trimmed to a length of 8 feet for harvest. Bromoxynil (.25 lb/A) plus MCPA (.25 lb/A) was applied when oats were in the 4-leaf stage. All plots were also hand-weeded to remove any escaped weeds. The oat variety trial included 40 varieties in a randomized complete block design with three replications. The variety trial was harvested with a modified plot combine. The early advanced yield nursery included six named varieties and 40 experimental lines in the advanced stages of testing. The recurrent selection parents yield nursery included 36 oat lines used as recurrent selection parents.

Results: Yield results of the variety trial are presented in Table 1. Agronomic characteristics of these varieties are presented in Table 2. Although 40 varieties were entered in this trial, data on 11 named varieties appear. The remaining varieties are in the experimental stages of development. Yields at Waseca in 1984-86 ranged from 82 to 114 bu/A. Data on the advanced yield nursery and the recurrent selection parents nursery are not included in this report since most of the material are experimental lines still in testing. Oat variety recommendations including information from this study are published in "Varietal Trials of Farm Crops". Recommended varieties for Minnesota are: Moore, Ogle, Preston, Proat, Starter and Steele.

OTHER VARIETIES

Iowa Early Multiline Blend (E73, E74, E76, and E77)—Early, low yield, medium height, good lodging resistance, high test weight and groat percent, medium protein percent, yellow seed. Heterogeneous crown rust reaction, susceptible to smut. The recurrent parent is CI 7970. Developed at Iowa Agricultural Experiment Station and originally released in 1968.

Lancer—Early-medium maturity, medium yield and height, good lodging resistance, high test weight, groat percent and protein percent, white seed. Susceptible to crown rust, smut and red leaf. Selected at South Dakota Agricultural Experiment Station from a cross between Neal and Clintland 64. Released in 1979.

Lang—Early, high yield, short, good lodging resistance, medium test weight and groat percent, low protein percent, yellow seed. Susceptible to crown rust and smut. Tolerant to red leaf. Selected at Illinois Agricultural Experiment Station from a cross of Tyler and Orbit. Released in 1976.

Lyon—Medium-late maturity, medium yield, tall, poor lodging resistance, medium test weight and groat percent, medium protein percent, white seed. Some resistance to crown rust, resistant to smut, susceptible to red leaf. Selected at Minnesota Agricultural Experiment Station from a cross between Lodi and Portage. Released in 1977.

Noble—Early-medium maturity, medium yield and height, good lodging resistance, medium test weight, groat percent and protein percent, yellow seed. Susceptible to crown rust, resistant to smut, some tolerance to red leaf. Selected at Purdue Agricultural Experiment Station from a cross involving many lines. Released in 1973. Seed sale regulated by U.S. Variety Protection Act.

Pierce—Late, high yielding, tall, fair lodging resistance, high test weight, medium groat percent and protein percent, white seed. Resistant to crown rust and smut. Selected at North Dakota Agricultural Experiment Station from a cross between Hudson and Dal. Released in 1983.

Rodney—Late, medium yield, tall, poor lodging resistance, medium test weight, white seed. Some resistance to crown rust, susceptible to smut. Selected by Agriculture Canada, Winnipeg, from a cross involving several lines. Licensed in 1952.

Webster—Early, medium yield and height, good lodging resistance, high test weight and groat percent, medium protein percent, yellow seed. Resistant to crown rust and smut. Selected at Iowa Agricultural Experiment Station as a multi-line with Lang as recurrent parent. Released in 1984.

Table 1. Yield of oat varieties in bushels per acre, 1984-86

Variety	Rosemount	Waseca	Lamberton	Morris	Crookston	Grand Rapids	Average 6 locations	Roseau	Stephen[1]
Webster	93	96	96	95	110	71	94	—	—
Starter	95	101	108	107	112	77	100	96[2]	64
Preston	88	82	96	96	105	75	90	85	69
Don[2]	92	114	133	141	125	104	118	—	78
Ogle	94	98	87	87	122	98	98	103	96
Lyon	74	89	75	86	107	70	83	99	83
Hazel[2]	96	101	114	137	127	86	110	—	104
Steele	105	107	94	129	127	102	111	112	102
Moore	92	99	96	98	126	81	99	100	96
Proat	92	93	90	116	116	95	100	94[2]	87
LSD 5%	8.3	8.2	11.4	7.9	9.8	6.9	3.5	10.8	12.2

[1]1984-85 and 86. [2]1985-1986.

Table 2. Characteristics of oat varieties, 1984-86[a]

Variety	Heading (date)	Height (inches)	Lodging (score)[b]	Seeds/ pound (number)	Test weight/ bushel (pounds)	Groat (percent)	Protein percent groat	Protein percent seed	Protein/ acre (pounds)	Reactions to disease[c] crown rust	Reactions to disease[c] smut
Webster	6-21	35	2.2	15970	40	75	16.5	12.3	369	MR	S
Starter	6-21	35	1.7	15958	42	76	18.1	13.7	436	S-MS	R
Preston	6-22	36	2.0	17475	41	75	19 9	15.0	432	MS	R
Don[d]	6-23	35	2.5	14476	43	76	15.5	11.8	443	HR-R	R
Ogle	6-25	37	2.0	17886	37	75	14.7	11.1	347	S	S
Lyon	6-26	42	2.5	15949	37	73	17.1	12.5	337	S-MS	HR
Hazel[d]	6-27	35	2.1	14655	41	78	17.4	13.5	477	HR	S
Steele	6-27	43	2.0	14868	41	76	17.2	13.0	457	HR	MS
Moore	6-28	41	2.3	18922	38	74	15.7	11.7	368	R-MR	MS
Proat	6-29	39	2.2	16095	41	75	19.2	14.3	460	MS	R

[a]Does not include Stephen and Roseau. [b]1 = erect, 5 = flat. [c]HR = highly resistant, R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible. [d]1985-86.

DATE OF PLANTING RESPONSE OF TWELVE HARD RED SPRING WHEAT VARIETIES IN MINNESOTA

William E. Lueschen, J. Harlan Ford and Thomas R. Hoverstad

Objectives: These studies were conducted to evaluate the effects of planting date on performance of Hard Red Spring Wheat in Southern Minnesota. A second objective was to determine if spring wheat varieties responded differently to planting date.

Procedures: These studies were conducted at Waseca and Lamberton, Minnesota from 1983 to 1986. Our objective was to evaluate five planting dates between April 1 and May 31. Weather conditions limited planting dates at both locations and in most years. Table 1 gives the actual planting dates for both locations. These studies were designed as randomized complete blocks with four replications and a split-plot arrangement of treatments. Main plots were planting dates and subplots were the twelve varieties. Individual plots were four 12-inch rows x 18 feet at Waseca, and four 10-inch rows x 15 feet at Lamberton. These studies were located on a Webster silty clay loam soil at Lamberton and a Nicollet clay loam soil at Waseca. These soils contained 4 to 5 percent organic matter. Fall P and K fertilizer applications were made according to soil test recommendations to maintain these nutrients at a high level in the soil. After fertilizer applications, the sites were fall chisel plowed. At Waseca 80 lb N/A as urea was applied just before the first planting date each year and incorporated once with a field cultivator. Each year the previous crop at Waseca was soybeans. At Lamberton, the previous crop was sorghum-sudangrass and nitrogen rates varied with years. Nitrogen was fall applied as urea at the rates of 100, 150, 80 and 150 lb N/A in 1983, 1984, 1985 and 1986, respectively.

Seeding rate was 28 seeds/ft^2 for all planting dates and varieties. Seeds of each variety were counted and packaged before planting with a cone-type seeder.

At both locations, bromoxynil plus MCPA (0.25+0.25 lb/A) was applied for broadleaf weed control. At Lamberton, 0.75 lb/A of Hoelon was applied for control of giant foxtail in tank mixture with the broadleaf herbicides. Herbicide applications were made at the appropriation stage of wheat development for each date of planting.

Each date of planting was harvested when all varieties within a planting date were mature and dry enough to combine harvest. Prior to harvesting, approximately one foot was removed from each end of the plots to eliminate border effects. All four rows were harvested for grain yield using a modified small plot combine. A subsample of grain from each plot was saved after weighing to determine test weight and percent protein content.

Results: Planting date had a dramatic effect on wheat yield at both locations (Figures 1-3). When the yield data from both locations and all years were subject to a regression analysis, the results indicate an 0.73 bu/A per day decline in yield for each day planting was delayed beyond our earliest planting date, April 9 (Figure 1). The relationships between grain yield and planting date were similar for both locations (Figures 2 and 3). There was some year-to-year variation in yield response to planting date at both locations. Although varieties were affected somewhat differently by planting date, all varieties exhibited a decline in yield as planting date was delayed (Tables 2-6). There was no variety that consistently performed better than another at later planting dates. Therefore, it would appear that selecting the variety with the highest yield potential is preferred regardless of the planting date. With few exceptions, Wheaton was consistently one of the highest yielding varieties at both locations. This variety has a relatively high yield potential over a range of planting dates.

Protein content of wheat was affected by variety and to a lesser extent planting date at both locations (Table 7). There was a trend for higher grain protein with later planting dates. This is not surprising since there is normally an inverse relationship between grain yield and protein content.

Data on plant height, lodging and test weight were collected at Waseca from 1984 through 1986 (Tables 8-10). Plant height was significantly reduced by delayed planting. Planting in late April or early May resulted in plants that were up to 3 inches shorter than the same variety planted in mid-April. Delaying planting until mid-May reduced plant height by 1 to 4 inches compared to mid-April plantings. Lodging, scored on a 1 to 9 scale where 1=erect and 9=flat, was similar for mid-April and early May planting but was increased significantly when planting was delayed until late May. Lodging scores were very low in these trials with the highest rating reaching only 3.1.

Test weight was reduced as planting was delayed. When averaged across the twelve varieties, test weight was reduced about 2 lb/bu where planting was delayed until late April to early May. It was reduced nearly 5 lb/bu by delaying planting until mid-May. The number of days from planting to heading decreased as planting was delayed (Table 11). The number of days from planting to heading ranged from 60 to 68 days, 53 to 58 days, and 48 to 53 days for the mid-April, late April or early May and the late May plantings, respectively.

Based on these studies, spring wheat should be planted as soon as soil conditions are fit in the spring. Planting before March 25 would increase the risk of freeze damage which could reduce yields. However, in Minnesota, planting this early is seldom possible. Since spring wheat responds to planting date, it is to the grower's advantage to plant as early as possible to capitalize upon the higher yields afforded by early planting with no increase in production costs. In fact, production cost may be less with early planting since wheat will be more competitive and may reduce the need for chemical weed control.

Table 1. Actual planting dates for Waseca and Lamberton, MN, 1983-1986.

Waseca				Lamberton			
1983	1984	1985	1986	1983	1984	1985	1986
4/27	4/17	4/16	4/19	4/29	4/18	4/11	4/11
5/11	5/10	4/26	4/23	----	5/9	5/3	4/25
----	5/17	5/9	5/9	5/12	5/18	5/13	5/12
5/25	5/31	5/24	5/19	5/25	5/30	5/28	5/28
----	6/7	6/6	6/2	6/9	----	6/10	6/9

Table 2. Effects of planting date on yield of twelve spring wheat varieties at Waseca and Lamberton Minnesota in 1983.

	Lamberton Planting Date					Waseca Planting Date			
Variety	4/29	5/12	5/25	6/9	Avg.	4/27	5/11	5/25	Avg.
	(bu/a)								
Butte	41.6	50.6	36.7	16.0	36.2	35.9	34.2	29.5	33.2
Oslo	49.6	49.3	38.9	14.5	38.1	37.7	30.1	24.4	30.7
Centa	41.7	45.7	37.8	20.1	36.3	33.4	29.9	29.5	30.9
Era	46.5	56.1	37.2	17.7	39.4	34.9	37.9	29.8	34.2
Solar	54.1	55.5	40.6	18.4	42.2	31.9	35.5	27.1	31.5
Wheaton	54.4	55.9	47.0	18.8	44.0	35.7	39.6	30.0	35.1
Len	34.5	41.7	36.9	17.7	32.7	26.5	34.2	28.2	29.6
Olaf	52.9	43.6	30.5	15.4	35.6	21.6	35.5	25.1	27.4
Marshall	50.0	55.7	34.4	17.2	39.3	39.4	40.2	30.1	36.6
Alex	35.6	48.8	34.0	11.7	32.5	25.8	34.2	29.6	29.9
PR 2369	46.4	55.7	40.1	18.4	40.2	38.6	33.8	29.4	33.9
James	40.0	39.8	31.4	23.2	33.6	34.3	33.8	36.2	34.8
Average	45.6	49.9	37.1	17.4	37.5	33.0	34.9	29.1	32.3
BLSD(.05) Variety					2.6				2.8
Planting Date					3.1				3.0
Variety x Planting Date Sign. Level (%)					99				99

Table 3. Effects of planting date on yield of twelve spring wheat varieties at Waseca and Lamberton Minnesota in 1984.

	Lamberton Planting Date					Waseca Planting Date					
Variety	4/18	5/9	5/18	5/30	Avg.	4/17	5/10	5/17	5/31	6/7	Avg.
	(bu/a)										
Butte	37.2	40.2	35.0	11.7	31.0	61.9	41.2	33.2	11.0	6.6	30.8
Oslo	49.9	52.8	47.6	22.1	43.1	62.0	47.2	39.0	23.1	17.0	37.7
Centa	50.0	49.8	37.6	12.1	37.4	60.5	36.2	26.3	14.6	8.6	29.2
Era	65.0	58.7	39.8	11.6	43.8	64.4	38.1	27.2	15.2	14.5	31.9
Solar	66.4	62.3	41.7	12.0	45.6	59.6	37.8	26.2	17.4	13.2	30.8
Wheaton	61.1	62.3	52.2	21.2	49.2	74.2	49.9	40.7	22.6	20.8	41.6
Len	60.0	51.8	40.2	16.4	42.1	62.0	45.8	35.6	15.5	12.2	34.2
Olaf	65.4	52.5	37.9	15.4	42.8	65.2	35.4	26.0	13.4	9.6	29.9
Marshall	67.5	56.0	40.5	15.5	44.9	67.6	43.7	37.4	20.0	16.6	37.1
Alex	55.6	55.3	40.4	19.0	42.6	65.5	47.8	39.0	26.5	24.8	40.7
PR 2369	65.2	60.6	48.7	15.9	47.6	67.7	40.4	22.4	10.8	10.4	30.3
James	43.8	38.9	34.4	15.0	33.0	62.3	38.5	36.6	18.6	14.9	34.2
Average	57.3	53.4	41.3	15.7	41.9	64.4	41.8	32.5	17.4	14.1	34.0
BLSD(.05) Variety					3.2						2.2
Planting Date					7.1						5.7
Variety x Planting Date Sign. Level (%)					99						99

Table 4. Effects of planting date on yield of twelve spring wheat varieties at Waseca and Lamberton Minnesota in 1985.

	Lamberton						Waseca					
	Planting Date						Planting Date					
Variety	4/11	5/3	5/13	5/28	6/10	Avg.	4/16	4/26	5/9	5/24	6/6	Avg.
	(bu/a)											
Butte	70.5	47.2	41.9	26.1	20.3	41.2	73.2	54.9	50.3	40.8	16.8	47.2
Oslo	94.6	42.2	53.1	33.7	21.7	49.1	71.1	58.3	48.6	41.6	25.9	49.1
Centa	75.4	53.5	48.1	32.2	21.7	46.2	68.5	57.5	50.2	38.2	17.6	46.4
Era	82.6	49.6	55.9	41.9	21.7	50.3	79.4	66.9	47.2	39.7	25.7	51.8
Solar	69.4	53.1	57.1	39.0	20.0	47.7	83.1	68.3	44.9	35.7	29.6	52.3
Wheaton	99.2	50.6	59.6	34.6	25.7	53.9	84.9	67.6	49.9	33.5	28.3	52.8
Len	81.2	48.7	49.2	38.8	18.3	47.2	73.4	60.0	51.3	40.3	24.7	49.9
Olaf	74.6	43.3	40.7	25.4	16.2	40.0	72.0	58.4	46.3	29.4	16.4	44.5
Marshall	72.2	48.0	45.8	35.5	30.3	46.4	72.2	62.3	43.7	30.6	30.1	47.8
Alex	71.9	57.1	56.7	36.4	26.0	49.6	78.2	61.7	51.4	49.8	30.2	54.3
PR 2369	89.5	51.1	56.8	41.8	26.6	53.2	76.7	65.7	53.8	37.6	33.7	53.5
James	78.2	39.8	40.1	32.1	22.2	42.5	72.1	60.5	45.2	41.0	24.6	48.7
Average	79.9	48.7	50.4	34.8	22.6	47.3	75.4	61.8	48.6	38.2	25.3	49.9
BLSD(.05) Variety						4.2						2.3
Planting Date						4.4						2.7
Variety x Planting Date Sign. Level (%)						99						99

Table 5. Effects of planting date on yield of twelve spring wheat varieties at Waseca and Lamberton Minnesota in 1986.

	Lamberton						Waseca					
	Planting Date						Planting Date					
Variety	4/11	4/25	5/12	5/28	6/9	Avg.	4/9	4/23	5/6	5/19	6/2	Avg.
	(bu/a)											
Butte	44.3	36.3	26.3	10.7	6.1	24.7	44.1	37.5	28.0	12.7	2.8	25.0
Oslo	49.8	31.8	35.1	12.0	9.5	27.6	51.2	34.9	29.4	18.4	9.8	28.7
Centa	44.5	33.7	32.4	16.1	8.6	27.1	41.9	34.6	25.3	14.5	5.1	24.3
Era	44.3	31.2	21.5	19.0	8.3	24.9	43.2	28.2	26.1	14.0	14.0	25.1
Solar	41.1	33.3	23.1	15.9	11.8	25.0	39.4	28.9	26.5	12.3	12.1	23.8
Wheaton	54.0	43.4	32.4	15.6	11.7	31.4	57.4	39.0	31.4	13.0	16.0	31.4
Len	40.7	34.4	25.6	16.8	9.1	25.3	41.4	31.7	25.9	11.2	7.4	23.5
Olaf	40.2	31.0	20.3	13.6	6.2	22.3	38.3	26.6	22.1	9.2	5.0	20.2
Marshall	40.8	37.2	26.8	23.1	13.4	28.3	38.7	31.7	29.8	19.4	19.5	27.8
Alex	39.2	28.1	27.1	13.5	7.0	23.0	40.3	29.3	21.5	13.6	11.8	23.3
PR 2369	47.2	35.0	36.2	18.2	10.7	29.5	49.2	33.8	28.6	16.7	17.3	29.1
James	35.4	27.0	24.5	16.6	9.5	22.6	43.0	32.4	25.5	13.7	10.6	25.0
Average	43.5	33.5	27.6	15.9	9.3	26.0	44.0	32.4	26.7	14.1	11.0	25.6
BLSD(.05) Variety						2.3						1.6
Planting Date						3.5						3.1
Variety x Planting Date Sign. Level (%)						99						99

Table 6. Effects of planting date on yield of twelve spring spring varieties at Waseca and Lamberton from 1983-1986.

Variety	Planting Date[a] I (April 9-29)	II (April 23 - May 12)	III (May 6-25)	Avg.
	------------------(bu/a)------------------			
Butte	51.1	42.8	35.1	43.0
Oslo	58.1	43.5	39.5	47.0
Centa	52.0	42.6	35.9	43.5
Era	57.5	45.9	35.6	46.3
Solar	55.6	46.8	35.9	46.1
Wheaton	65.1	51.0	42.9	53.0
Len	52.5	43.4	36.6	44.2
Olaf	53.7	40.8	31.1	41.9
Marshall	56.0	46.9	36.0	46.3
Alex	51.5	45.3	37.5	44.8
PR 2369	60.0	47.0	39.5	48.8
James	51.1	38.8	34.2	41.4
Average	55.4	44.6	36.7	45.5
BLSD(.05) Variety				1.2
Planting Date				1.4
Variety x Planting Date Sign. Level (%)				99

[a] Planting date I ranged from April 9 - April 29 depending on year and location. Likewise, planting date II ranged from April 23 - May 12, and planting date III from May 6 - May 25.

Table 7. Effects of planting date on percent protein of twelve spring wheat varieties at Lamberton and Waseca from 1983-1985.

Lamberton

Variety	1983 4/29	1983 5/12	1983 5/25	1983 6/9	1984 4/18	1984 5/9	1984 5/18	1984 5/30	1985 4/11	1985 5/3	1985 5/13	1985 5/28	1985 6/10
	(%)				(%)				(%)				
Butte	15.2	15.4	15.1	15.3	15.4	15.2	14.8	16.0	13.8	13.8	14.1	13.5	13.9
Oslo	14.5	14.3	14.4	15.0	15.3	15.4	14.5	16.8	13.0	13.7	13.6	13.5	13.9
Centa	15.6	15.5	15.3	15.1	15.8	16.3	16.0	16.5	14.2	13.9	14.0	13.4	14.2
Era	14.9	14.1	15.1	14.8	14.0	14.6	15.1	17.2	13.3	13.2	13.2	13.3	14.0
Solar	15.1	14.4	14.9	15.0	13.6	13.6	14.8	16.7	13.3	13.1	13.2	13.5	14.0
Wheaton	14.4	14.5	14.6	15.4	14.5	15.1	14.9	16.9	12.3	13.8	13.3	13.6	14.4
Len	16.1	15.6	16.2	15.8	16.5	17.1	17.8	18.6	14.6	15.1	14.8	15.0	14.9
Olaf	14.5	15.1	15.1	15.0	16.0	16.3	16.6	17.9	13.5	14.1	13.9	13.9	14.4
Marshall	14.6	14.7	14.6	14.8	14.9	15.6	15.4	17.1	12.5	13.5	13.3	13.3	13.5
Alex	16.9	16.2	16.3	16.3	15.0	16.8	16.5	18.7	15.0	15.0	14.8	15.0	15.3
PR 2369	15.3	15.2	15.7	16.2	15.9	16.1	15.4	17.5	13.8	14.3	14.1	13.7	14.2
James	15.7	15.9	15.1	15.6	15.9	16.7	16.8	16.9	14.3	14.3	14.6	13.9	14.8
Average	15.2	15.1	15.2	15.4	15.2	15.7	15.7	17.2	13.6	14.0	13.9	13.8	14.3

Waseca

Variety	1983 4/27	1983 5/11	1983 5/25	1984 4/18	1984 5/10	1984 5/17	1984 5/31	1984 6/7	1985 4/10	1985 5/9	1985 5/24	1985 6/6
	(%)			(%)								
Butte	14.2	14.8	13.7	15.7	16.2	16.0	16.3	16.6	13.8	13.1	13.0	15.1
Oslo	13.8	14.6	13.9	15.1	15.5	15.3	17.2	16.9	13.3	13.2	13.8	13.9
Centa	15.0	15.0	14.2	16.5	16.2	17.1	16.6	17.6	14.1	13.2	13.2	13.5
Era	13.8	13.8	14.2	14.9	15.9	16.3	16.9	17.0	12.6	12.7	13.2	13.5
Solar	13.7	13.7	13.9	14.9	15.6	16.0	17.4	16.7	12.5	12.7	12.6	13.1
Wheaton	13.5	14.1	13.7	15.1	15.7	16.3	17.3	17.3	13.1	12.9	13.2	13.4
Len	16.6	15.7	15.6	17.3	17.6	17.6	18.6	18.4	14.4	13.9	14.8	14.8
Olaf	16.4	15.4	15.3	16.6	16.9	17.0	18.3	17.5	13.8	13.6	13.9	14.3
Marshall	14.4	14.2	13.8	15.0	15.7	15.6	17.3	16.6	13.3	12.7	13.1	13.2
Alex	16.2	15.3	15.3	16.8	17.4	17.3	18.3	17.7	14.5	14.0	14.3	13.8
PR 2369	14.1	15.0	14.5	15.8	15.5	15.7	17.4	17.4	13.9	13.6	13.8	14.1
James	14.4	15.2	14.4	15.6	16.3	16.5	17.1	17.4	14.8	13.8	14.1	14.1
Average	14.7	14.7	14.4	15.8	16.2	16.4	17.4	17.3	13.7	13.3	13.6	13.9

Table 8. Effects of planting date on plant height of twelve spring wheat varieties at Waseca from 1984-1986.

Variety	Planting Date[a] I (April 9-27)	II (April 23 - May 11)	III (May 6-25)	Avg.
	(in)			
Butte	36.5	36.4	35.4	36.1
Oslo	28.5	29.8	27.2	28.5
Centa	37.2	36.9	34.7	36.3
Era	32.2	30.7	27.8	30.2
Solar	32.0	30.8	27.9	30.2
Wheaton	30.6	29.6	27.6	29.3
Len	32.4	31.7	29.6	31.2
Olaf	33.5	32.6	30.2	32.1
Marshall	31.1	30.4	27.6	29.7
Alex	40.2	38.5	37.1	38.6
PR 2369	32.4	31.6	29.8	31.3
James	35.6	32.9	32.8	33.8
Average	33.5	32.7	30.6	32.3
BLSD(.05) Variety				0.5
Planting Date				0.4
Variety x Planting Date Sign. Level (%)				99

Table 9. Effects of planting date on lodging of twelve spring wheat varieties at Waseca from 1984-1986.

Variety	Planting Date[a] I (April 9-27)	II (April 23 - May 11)	III (May 6-25)	Avg.
	(1-9)			
Butte	2.7	2.1	2.7	2.5
Oslo	1.6	1.4	2.2	1.7
Centa	3.1	2.9	3.2	3.1
Era	1.7	1.7	3.1	2.2
Solar	1.7	1.3	2.9	2.0
Wheaton	1.8	1.3	2.8	2.0
Len	1.3	1.0	1.8	1.4
Olaf	1.2	1.5	1.9	1.5
Marshall	1.0	1.1	1.8	1.3
Alex	1.7	1.9	2.8	2.1
PR 2369	1.9	2.4	3.2	2.5
James	1.5	1.6	2.2	1.8
Average	1.8	1.7	2.6	2.0
BLSD(.05) Variety				0.3
Planting Date				0.3
Variety x Planting Date Sign. Level (%)				99

[a] Planting date I ranged from April 9 - April 27 depending on year. Likewise, planting date II ranged from April 23 - May 11, and planting date III from May 6 - May 25.

Table 10. Effects of planting date on test weight of twelve spring wheat varieties at Waseca from 1984-1986.

Variety	Planting Date[a] I (April 9-27)	II (April 23 - May 11)	III (May 6-25)	Avg.
	(lb./bu)			
Butte	59.6	57.4	53.3	56.8
Oslo	58.2	55.8	53.1	55.7
Centa	60.3	58.1	54.9	57.8
Era	56.2	54.9	52.1	54.4
Solar	55.9	55.0	52.1	54.3
Wheaton	58.9	55.5	52.3	55.6
Len	56.9	55.8	54.6	55.8
Olaf	57.3	55.2	53.1	55.2
Marshall	59.0	56.3	54.6	56.6
Alex	57.6	56.3	54.3	56.1
PR 2369	59.8	57.6	53.7	57.0
James	56.7	55.3	51.4	54.5
Average	58.0	56.1	53.3	55.8

BLSD(.05) Variety 0.6
Planting Date 0.6
Variety x Planting Date
Sign. Level (%) 99

Table 11. Effects of planting date on heading date of twelve spring wheat varieties at Waseca and Lamberton from. 1983 - 1986.

Variety	Planting Date I (April 9-29)	II (April 23 - May 12)	III (May 6-25)	Avg.
	(days from planting)			
Butte	60	53	48	54
Oslo	60	53	49	54
Centa	60	53	48	54
Era	67	58	53	59
Solar	68	58	53	60
Wheaton	64	55	50	56
Len	65	57	51	58
Olaf	65	57	52	58
Marshall	65	57	52	58
Alex	66	57	51	58
PR 2369	64	56	51	57
James	61	53	48	54
Average	64	56	51	57

BLSD(.05) Variety 1
Planting Date 1
Variety x Planting Date
Sign. Level (%) 99

* Planting date I ranged from April 9 - April 29 depending on year and location. Likewise, planting date II ranged from April 23 - May 12, and planting date III from May 6 - May 25.

Figure 1.

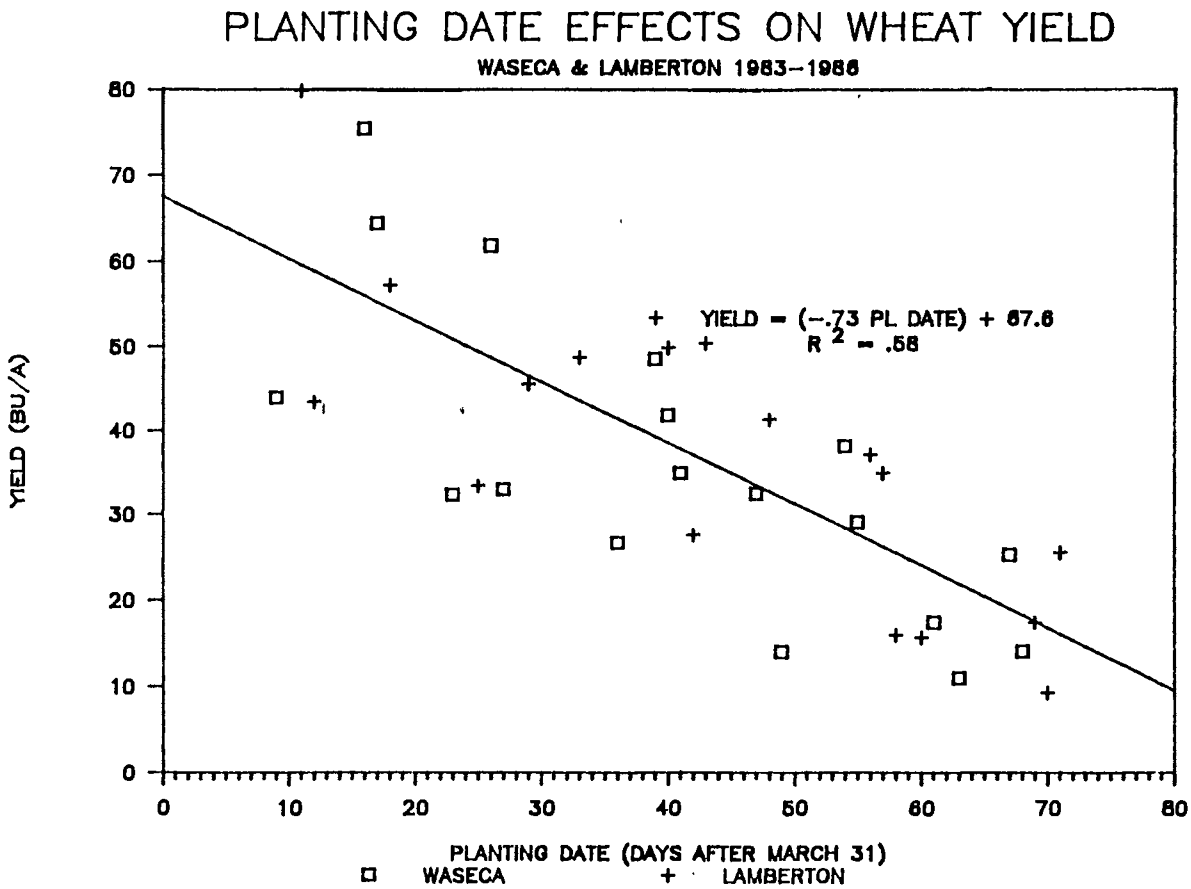

PLANTING DATE EFFECTS ON WHEAT YIELD
WASECA & LAMBERTON 1983–1986
YIELD = (–.73 PL DATE) + 67.6
R 2 = .58
YIELD (BU/A)
0
10
20
30
40
50
60
70
80
PLANTING DATE (DAYS AFTER MARCH 31)
WASECA
LAMBERTON

Figure 2.

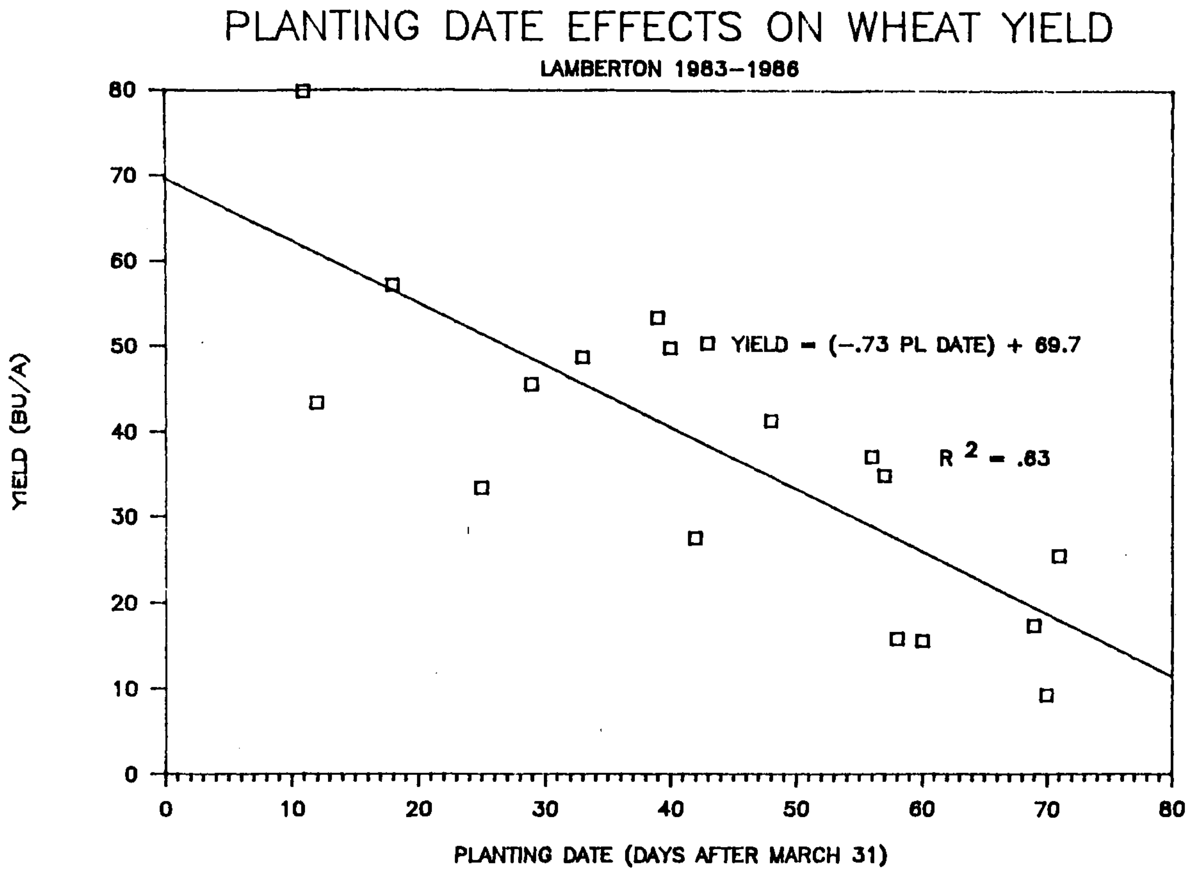
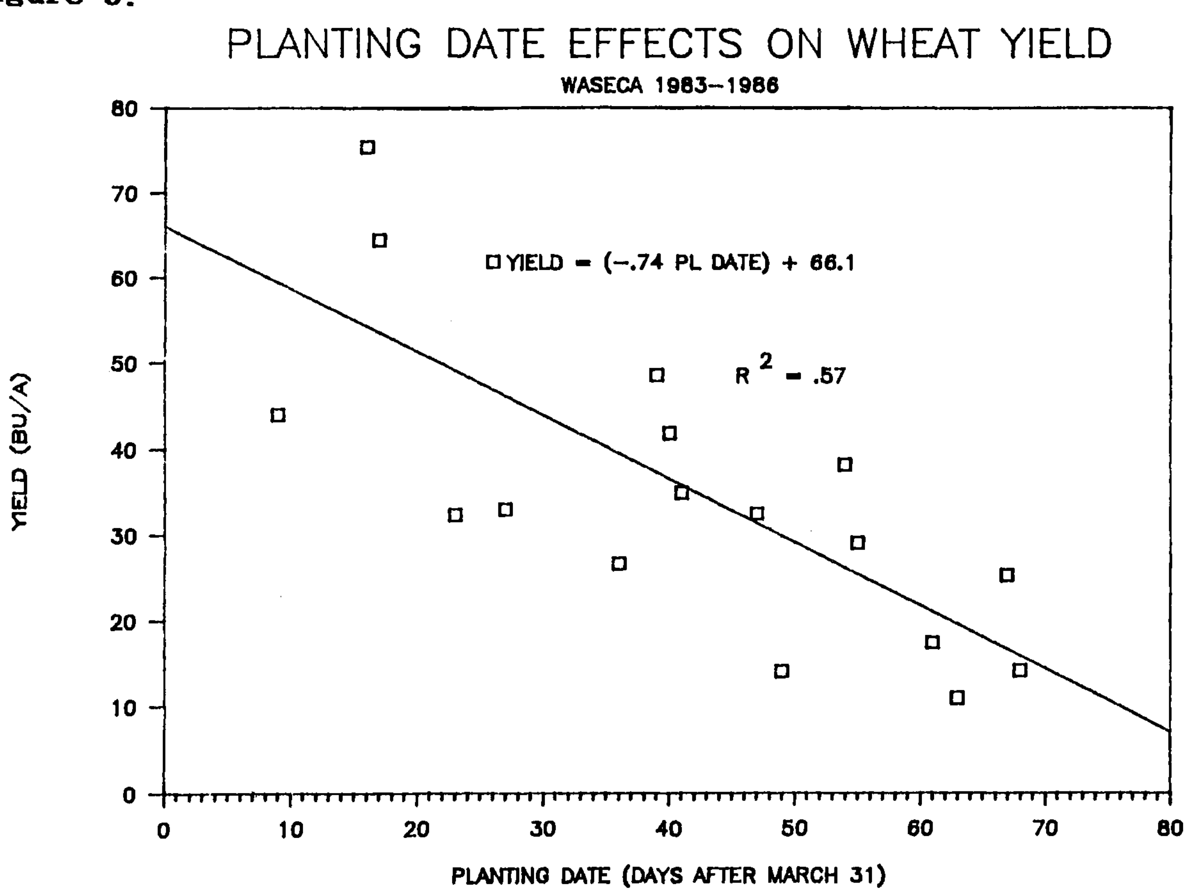


Figure 3.



Summary of Hard Red Spring Wheat Variety Trial

Spring wheat can perform eratically at this station because of the increased possibility of early season high temperatures. However, over a three year period yields are normally quite high. Test weight can be quite variable as well. If spring wheat is to be grown in the Waseca area, it should be planted in April. If April seeding is not possible, other crops should be considered. Diseases can be a problem, but many varieties have adequate resistance to leaf and stem rust. Recommendation among publicly released varieties only is made. Privately released varieties are tested and data reported in the same trials as publicly released varieties but no recommendations are made. No implications should be drawn from the lack of recommendation in privately released varieties, since this is done only to remain impartial and to provide date to allow choice.

Waseca Hard Red Spring Wheat Yield Trial 1984-86.

Variety	Grain yield (bu/A)	Test[1/] weight (lb/bu)	Plant[1/] height (inches)	Heading[1/] date (June)	Wheat[1/] protein (%)	Lodging[1/] score (1-9)
Public Varieties						
Era	56	60	31	29	12.5	2.0
Guard	65	61	31	24	13.3	2.0
Len	57	60	31	27	14.1	1.6
Marshall	63	61	30	28	12.8	1.6
Stoa	67	60	37	25	13.8	2.0
Wheaton	68	59	30	26	12.6	2.2
Butte	56	61	34	23	13.7	2.7
Chris	44	60	38	28	14.8	4.2
Olaf	55	60	32	27	14.1	1.7
Private Varieties						
Apex 83	60	60	30	23	13.0	2.0
A99AR	63	60	40	28	13.2	2.8
Buckshot	61	60	32	27	13.2	1.9
Celtic	63	61	32	25	13.6	2.0
Challenger	60	61	30	23	12.9	2.0
Erik	70	60	32	29	12.7	1.8
Leif	64	61	34	26	12.8	2.0
Norak	58	60	30	28	12.8	2.0
Norseman	64	59	30	27	13.3	1.2
Oslo	60	59	29	23	12.6	1.7
Solar	59	60	31	29	12.5	2.1
Success	61	60	34	30	12.6	2.3
Tammy	64	59	32	28	13.3	2.0
Walera	54	60	30	30	12.5	2.0
2369	63	61	31	26	13.0	2.2
Mean	61					
LSD 5%	9					

1/ State Average

Northern Regional Winter Wheat Nursery

The Northern Regional Winter Wheat Nursery is grown each year at the Waseca station to evaluate new selections and hybrids of hard red winter wheat. Breeding programs from Nebraska, Montana, North Dakota, South Dakota, Nickerson American Plant Breeder, Hybritech and Rohm-Haas enter their most promising materials which are evaluated in many sites in over nine states and one canadian province. These data are taken and returned to the coordinator, C.J. Peterson, at Nebraska for compliation, printing and distribution. In 1986, very high winter wheat yields were obtained, with the best performing materials two hybrids from Rohm-Haas and selections from Nebraska. Since winterhardiness was not a problem in 1985-86 because of early and heavy snow, less hardy materials will often be higher yielding than more winterhardy materials. Only one year's data are provided because of the large change in entries from year to year. Thus, the Waseca station provides a valuable service to wheat breeders in other states by providing valuable information for selection.

NORTHERN REGIONAL WINTER WHEAT 87 1986

PLOT_SIZE_IN_SQFT: 36 DATE_SEEDED: 9/24/85 LOCATION: WASECA

VARIETY OR STATE NO.	YIELD BU/AC	TWT LB/BU	HD JAN1	HT IN	LD
RH853514	81.2	59.7	150	41	3.0
NE82656	79.3	58.4	156	37	3.3
RH852515	69.5	59.3	152	40	4.7
NE82658	65.7	58.0	157	35	3.3
NE851182	63.1	54.6	156	38	3.0
NE82651	61.9	57.4	155	40	4.3
NE82652	58.2	56.8	157	36	2.7
COLT	57.9	56.9	158	32	2.0
SD76598-7	57.8	58.0	156	42	5.0
XNH1337	55.6	53.9	156	41	3.7
NA-HW81-459	55.4	59.5	153	36	2.3
SD76463-16	55.3	58.2	158	43	6.0
SD82102	55.0	57.7	156	43	5.7
SD82114	54.0	57.2	156	41	6.7
RH846835	51.7	56.1	151	35	2.0
XNH1342	51.5	56.2	157	43	2.7
SD82195	51.2	58.2	157	41	3.0
SD82144	50.7	55.8	155	40	6.3
MT8039	49.1	53.4	156	38	1.3
ND8002	48.1	56.1	158	45	4.3
SD791117	47.6	54.6	155	41	6.3
SD79892	45.3	54.7	158	42	3.7
MT80302	45.0	56.3	157	36	3.0
ND8095	44.0	57.9	157	45	2.3
XNH1228	43.6	48.5	157	39	3.0
ND8061	42.7	55.2	157	40	2.7
MT80122	36.3	51.7	158	37	2.7
MT7877	31.8	52.1	159	29	2.0
WARRIOR	31.3	51.4	157	43	4.7
KHARKOF	22.7	49.8	158	44	6.0
MEANS:	52.1	55.8	156	39	3.7

TESTS	YIELD	TWT	HD	HT	LD
LSD:	11.4	2.9	1.8	2.8	1.8
CV:	13.4	3.2	0.7	4.3	29.2
F-Trts:	10.2	7.6	11.5	14.9	5.8

Alfalfa Variety Yield Trials

D.K. Barnes, USDA-ARS and D.M. Smith, Department of Agronomy & Plant Genetics

Three variety trials were present on the Waseca Station during 1986. These included trials seeded in 1982 (35 entries), 1984 (40 entries) and 1986 (51 entries). The increasing number of entries in each successive trial reflects the increasing numbers of alfalfa varieties being released. Most new alfalfa varieties are presently being developed by private industry. The policy is to include all new alfalfa varieties that are eligible for certification or approved for Plant Variety Protection in yield trials at each branch station. Those varieties sold in Minnesota each year are described in Varietal Trials of Farm Crops (Minnesota Report 24).

The 1986 average alfalfa yields were about 6.4 tons hay (15% moisture) acre for the 1982 trial and 8.1 tons hay/acre for the 1984 trial. The yield of the best variety was 7.5 and 8.9 tons hay/acre for the 1982 and 1984 trials, respectively. Both trials were harvested on a four harvest management with harvests about 5/30, 6/26, 7/29 and 9/4. The 1982 trial will be terminated because four harvest years following the seeding year have been completed. The 1984 trial will be harvested again in 1987 and 1988. Excellent stand establishment was obtained in the 1986 trial and yields will be taken for four years beginning in 1987.

NOT FOR PUBLICATION WITHOUT PERMISSION

Table 8. Five Year Forage Yields From 1982 Alfalfa Variety Yield Trial, Waseca, Mn.*

	Forage Yields (Tons DM/A)										
					1986						
Entry	1982	1983	1984	1985	5/30	6/26	7/29	9/4	Season Total	5 Year Total	% Vernal
Advantage	2.46	5.34	5.36	4.87	1.97	1.27	1.32	1.15	5.71	23.74	106
Apollo II	2.15	5.23	5.28	4.71	1.87	1.17	1.34	1.13	5.51	22.88	102
Armor	2.42	5.31	5.39	5.23	1.99	1.32	1.43	1.17	5.91	24.25	108
C/W 61	2.62	5.13	5.30	4.77	1.81	1.17	1.29	1.11	5.38	23.19	103
Defender	2.24	5.22	5.33	4.41	1.85	1.17	1.19	1.03	5.24	22.44	100
DK 135	2.32	5.27	5.51	4.77	1.86	1.29	1.35	1.13	5.63	23.49	105
Duke	2.23	5.04	5.26	4.76	1.90	1.27	1.40	1.12	5.69	22.98	102
Epic	2.36	4.91	5.34	4.92	2.04	1.25	1.49	1.27	6.05	23.58	105
Expo	2.24	4.89	5.35	4.77	1.96	1.23	1.40	1.18	5.77	23.01	103
G 2815	2.22	4.97	5.24	4.50	1.95	1.25	1.38	1.17	5.75	22.68	101
G 7730	2.36	4.95	5.33	4.84	1.93	1.16	1.29	1.05	5.43	22.91	102
Glory	2.51	5.07	5.40	4.73	1.92	1.14	1.20	1.09	5.35	23.06	103
Jubilee	2.46	5.45	5.36	5.03	2.00	1.27	1.39	1.26	5.92	24.22	108
Mercury	2.35	5.15	5.35	4.83	1.94	1.28	1.38	1.15	5.75	23.42	104
MnBIC7N2CL	2.27	4.15	5.05	2.42	1.64	0.91	1.19	0.98	4.72	18.61	83
MnVWCYCLE1	2.42	5.28	5.43	4.54	1.77	1.26	1.32	1.14	5.49	23.16	103
Oneida	2.34	5.70	5.44	5.14	2.21	1.47	1.46	1.21	6.35	24.96	111
Polar II	2.12	5.02	5.08	4.39	1.84	1.15	1.38	1.07	5.44	22.05	98
Prowler	2.34	4.80	4.48	4.41	2.19	0.98	1.24	0.87	5.28	21.31	95
Raidor	2.45	5.03	5.03	4.08	1.56	0.89	1.02	0.84	4.31	20.88	93
Saranac	2.34	4.94	5.01	4.20	1.81	1.18	1.29	1.01	5.29	21.78	97
Saranac AR	2.28	5.03	5.24	3.98	1.61	0.97	1.17	1.03	4.78	21.31	95
Spectrum	2.43	5.34	5.31	5.04	2.03	1.25	1.40	1.27	5.95	24.07	107
SX-418	2.53	5.07	5.36	4.31	1.75	1.06	1.29	1.13	5.23	22.50	100
Thunder	2.20	5.31	5.35	5.04	2.05	1.19	1.29	1.13	5.66	23.55	105
Trumpetor	2.46	5.30	5.52	4.92	1.91	1.21	1.33	1.22	5.67	23.87	106
Vancor	2.45	5.06	5.27	4.97	1.97	1.24	1.44	1.00	5.65	23.40	104
VERNAL **	2.25	4.78	4.93	4.67	2.20	1.24	1.33	1.04	5.81	22.44	100
Vernema	2.21	5.17	5.44	4.94	1.85	1.17	1.26	1.06	5.34	23.10	103
WL 313	1.96	5.12	5.42	5.04	2.27	1.56	1.47	1.24	6.54	24.08	107
WL 315	1.97	5.02	5.64	5.13	2.05	1.40	1.42	1.10	5.97	23.73	106
WL 316	2.12	5.14	5.47	4.68	1.78	1.29	1.35	1.14	5.56	22.98	102
123	2.13	4.71	4.96	4.92	1.89	1.21	1.23	1.10	5.43	22.14	99
130	2.45	5.27	5.41	4.49	1.90	1.24	1.39	1.17	5.70	23.32	104
526	2.28	5.14	5.58	5.50	2.15	1.36	1.42	1.19	6.12	24.61	110
LSD .05	.28	.41	.30	.43	.20	.17	.16	.18	.52		
CV %	8.68	5.79	4.03	6.56	7.29	9.79	8.47	11.37	6.59		

*Seeded 5-5-82, 1# Balan/A, 50 viable seed/sq. ft., 6' x 20' plots with 4 replicates.
**Average of 2 plots/replication.

Table 9. Two Year Forage Yields From 1984 Alfalfa Variety Yield Trial, Waseca, Mn.*

Entry	Forage Yield (Tons DM/A) 1985	1986 5/29	1986 6/25	1986 7/28	1986 9/3	Season Total	2 Year Total	% Vernal	Score***
Advantage	5.55	2.06	1.57	1.64	1.18	6.45	12.00	98	5.0
Apollo II	5.30	2.07	1.73	1.78	1.16	6.74	12.04	99	4.5
Armor	5.59	2.31	1.80	1.78	1.28	7.17	12.76	104	3.8
Baker	5.51	2.07	1.48	1.63	1.11	6.29	11.80	97	5.7
Big Ten	5.52	2.28	1.72	1.74	1.27	7.01	12.53	103	4.2
Challanger	5.47	2.30	1.83	1.66	1.15	6.94	12.41	102	4.0
Cimarron	5.76	2.21	1.84	1.70	1.28	7.03	12.79	105	4.7
Decathlon	5.47	2.42	1.78	1.66	1.14	7.00	12.47	102	3.0
DK 135	5.29	2.17	1.72	1.73	1.24	6.86	12.15	99	4.2
Drummor	5.42	2.26	1.63	1.64	1.16	6.69	12.11	99	5.2
Eagle	5.33	2.38	1.86	1.74	1.19	7.17	12.50	102	2.2
Endure	5.61	2.36	1.82	1.80	1.33	7.31	12.92	106	2.5
Epic	5.35	2.16	1.74	1.80	1.25	6.95	12.30	101	3.5
Excalibur	5.75	2.07	1.58	1.63	1.18	6.46	12.21	100	5.5
G 2818	5.26	2.38	1.89	1.88	1.21	7.36	12.62	103	2.7
Magnum	5.38	2.40	1.80	1.89	1.30	7.39	12.77	105	2.5
Maverick	5.14	2.44	1.48	1.71	1.09	6.72	11.86	97	4.0
Maxim	5.55	2.23	1.77	1.64	1.19	6.83	12.38	101	4.2
Mich 80-16Pca3	5.69	2.28	1.82	1.75	1.34	7.19	12.88	105	4.0
Mn CargoX(10X7)	4.85	1.92	1.74	1.79	1.22	6.67	11.52	94	6.2
Mn GR N2	5.60	2.39	1.92	1.83	1.29	7.43	13.03	107	2.0
Mn GR N4	5.67	2.39	1.96	1.90	1.38	7.63	13.30	109	1.0
Mn SWCompX(10X7)	5.51	2.27	1.90	1.83	1.23	7.23	12.74	104	4.2
Oneida	5.41	2.33	1.87	1.88	1.25	7.33	12.74	104	3.0
Preserve	5.34	2.09	1.61	1.63	1.21	6.54	11.88	97	4.7
Saranac AR	5.29	2.26	1.74	1.64	1.13	6.77	12.06	99	5.0
Shenandoah	5.71	2.37	1.87	1.77	1.30	7.31	13.02	107	4.0
Spectrum	5.79	2.38	1.81	1.79	1.25	7.23	13.02	107	2.7
Spredor 2	4.92	2.14	1.41	1.55	0.94	6.04	10.96	90	3.2
Trumpetor	5.48	2.26	1.72	1.72	1.20	6.90	12.38	101	4.7
VERNAL **	5.45	2.24	1.65	1.69	1.18	6.76	12.21	100	2.7
WL 219	5.60	2.45	1.92	1.91	1.33	7.61	13.21	108	3.2
WL 316	5.51	2.31	1.92	1.83	1.28	7.34	12.85	105	2.5
WL 320	5.87	2.23	1.95	1.86	1.31	7.35	13.22	108	4.0
WL So. Special	5.54	2.20	2.02	1.95	1.42	7.59	13.13	107	4.0
Wrangler	5.44	2.46	1.66	1.70	1.19	7.01	12.45	102	3.5
120	5.48	2.45	1.74	1.73	1.28	7.20	12.68	104	4.6
130	5.36	2.23	1.76	1.75	1.17	6.91	12.27	100	3.8
532	5.70	2.58	1.91	1.88	1.35	7.72	13.42	110	1.5
555	5.72	2.25	1.81	1.87	1.45	7.38	13.10	107	4.5
LSD .05	.41	.30	.17	.15	.14	.55			1.4
CV %	5.43	9.45	7.13	6.31	8.02	5.64			27.6

*Seeded 4-25-84, 1# Treflan/A, 50 viable seed/sq. ft., 6' x 20' plots with 4 replicates.
**Average of 2 plots/replication.
***General appearance 5-7-86. Scored 1-9, 1=excellent, 9=poor stand, unthrifty plants.

Alternative Forage Crops

W.E. Lueschen and C.C. Sheaffer

Objective: To determine the yield and quality of alternative annual forage crops.

Procedure: Multiple- (tyfon, alfalfa, red clover, alsike clover, sudangrass, sorghum x sudangrass cross) and single-cut forage crops (field pea, soybean, cow pea, lupine, and oat-field pea mix) were established in May. Multiple-cut forages were cut three times. Non-legumes were fertilized with 150 lb. nitrogen per acre.

Results: Yield and quality of alternative forages are shown in Tables 1 and 2. Forages differed significantly in yield and quality. Multiple-cut sudangrass or sorghum x sudangrass crosses were the highest yielding while lupines were the lowest yielding. Forage crude protein concentration was greatest for multiple-cut alfalfa, clovers, and tyfon, while tyfon had the highest concentration of digestible dry matter.

Summary and Conclusion: In selection of alternative forage crops, potential costs of production and use must be considered:
Warm season annual grasses such as sudangrass provided high forage yields but required nitrogen fertilizer (a cash cost) and were lower in overall forage quality than other alternatives. They are not suitable for rations where high levels of animal performance are desired. Mixing soybeans with a warm season grass will increase quality at the first harvest following seeding, but nitrogen fertilization will be required to maintain yields at subsequent harvests.

Lupine, a relatively new legume used for grain production, was very low yielding and did not appear adapted to the soil at Waseca. Soybeans were superior to lupine as an annual forage legume. If used for hay, both soybeans and lupine may be slow drying due to steminess.

Red clover and alfalfa will provide high yields of quality forage on an annual or perennial basis. They also offer greatest potential to contribute nitrogen to subsequent crops in rotation through incorporation of roots or herbage.

Tyfon, a cross between Chinese cabbage and turnip, produced high yields of high quality forage. Nitrogen fertilization was required. Tyfon is best suited for livestock grazing due to its low stature.

Table 1. Yield of alternative forages.

Treatments	Forage Dry Matter Yields (T/A)			
	Hvst 1	Hvst 2	Hvst 3	Total
Typhon	1.5	1.6	1.0	4.1
Alfalfa (Impact)	1.2	1.2	1.2	3.6
Red Clover (Arlington)	0.9	1.7	1.3	3.9
Alsike Clover (Common)	0.4	1.4	0.6	2.4
Sudangrass (Trudan 8)	1.7	2.7	1.8	6.2
Sudangrass (Monarch)	1.4	3.0	1.7	6.1
Sorghum x Sudangrass (SSX643)	1.8	2.4	2.1	6.3
(Soybean) + (SSX643)	1.8	1.6	1.7	5.1
Field Pea (Procon)	1.7			1.7
Blue Lupine (Kiev)	1.2			1.2
White Lupine (Ultra)	1.2			1.2
Soybean (Corsoy 79)	3.4			3.4
Soybean (Forrest)	3.9			3.9
Field Pea (Procon) + (Starter Oats)	3.3			3.3
LSD (0.05)	0.5	0.4	0.4	0.7

Table 2. Forage quality of alternative forages.

Treatments	Nutrient Concentrations (%)					
	Hvst 1		Hvst 2		Hvst 3	
	CP	DDM	CP	DDM	CP	DDM
Typhon	15.3	86.2	17.9	85.2	17.5	81.8
Alfalfa (Impact)	21.7	71.8	16.0	69.2	22.1	62.5
Red Clover (Arlington)	24.9	70.6	18.9	72.0	22.9	69.4
Alsike Clover (Common)	--[+]	--	18.3	74.9	26.8	69.8
Sudangrass (Trudan 8)	--	--	11.3	65.0	10.4	58.0
Sudangrass (Monarch)	--	--	12.2	60.8	10.8	58.6
Sorghum x Sudangrass (SSX643)	13.9	67.9	10.7	63.6	9.4	56.6
(Soybean) + (SSX643)	18.2	67.9	9.3	61.8	9.5	57.6
Field pea (Procon)	15.1	67.8				
Blue Lupine (Kiev)	12.3	68.1				
White Lupine (Ultra)	12.4	71.3				
Soybean (Corsoy 79)	17.0	62.5				
Soybean (Forrest)	13.2	61.6				
Field Pea (Procon) + (Starter Oats)	11.1	48.9				
LSD (0.05)	1.3	2.6	1.2	3.6	1.9	2.9

[+]data not available

EFFECTS OF FOLIAR APPLICATIONS OF RESPOND[a] ON ALFALFA PERFORMANCE IN 1986

William E. Lueschen and Thomas R. Hoverstad

Objectives: This study was designed to evaluate the agronomic effects of foliar applications of 'Respond' to alfalfa.

Procedures: This study was conducted at the Southern Experiment Station on a Nicollet clay loam soil containing 6% to 7% organic matter. Two alfalfa varieties, 'Blazer' and Dekalb '120', were established in 1984. Blazer was seeded alone. Dekalb 120 was seeded with Marathon oats and blended with a 25% mixture of orchardgrass. Soil test results from Blazer in 1986 indicate the following soil chemical properties: pH=6.4, P=41, and K=251. Soil test results from Dekalb 120 indicate pH=6.4, P=53 and K=298. To evaluate the effects of a single application of Respond before the first cutting of alfalfa, Respond was applied May 2 when the alfalfa was 8 to 10 inches tall. To evaluate the effects of sequential Respond applications, Respond was applied May 2 followed by an application after cut one and repeated after cut two. Treatment dates are listed in Table 1.

Table 1. Treatment dates, alfalfa height, and weather conditions at treatment time for Respond applications to alfalfa.

Treatment	Date	Alfalfa Height	Temp. (F°)	Relative Humidity
Before cut one	May 2	8 to 10 inches	48	55%
After cut one	June 5	3 to 4 inches	62	86%
After cut two	July 8	2 to 3 inches	74	80%

Each respond application was at 24 oz/A broadcast over-the-top using 8002 flat fan nozzles calibrated to deliver 20 gallons per acre at 32 psi. Individual plot size was 10 feet x 22 feet. Harvested plot size was 3 feet x 22 feet. Yield measurements were taken with a modified flail mower weighing fresh cut alfalfa and drying a sample to determine moisture content at harvest. Cutting dates were: May 28, June 30 and August 5. Alfalfa was in the bud stage at each cutting date.

Discussion: Table 2 shows the effects of foliar applications of Respond to alfalfa. Respond applied at 24 oz/A before cut one, or at 24 oz/A before cut one followed by sequential applications following cut one and cut two did not significantly increase forage yield for either variety. Season total yields were 5.51 tons/A, 5.57 tons/A and 5.55 tons/A for the check, single and sequential Respond applications, respectively. There was no yield advantage for Respond on any of the individual harvest dates. Dekalb 120 yielded 2 tons/A more than Blazer; season total yield for Dekalb 120 was 6.58 tons/A while Blazer yielded 4.51 tons/A. This difference was evident at cut one and cut three where Dekalb 120 yielded approximately 1 ton/A more than Blazer on each of these cuttings.

[a]Respond is a trade name for a crop and soil supplement distributed by United Agri Products, Inc., 419-18th St., Box 1286, Greeley, CO 80632. Respond consists of 0.0011% natural plant extracts having 6.7 mg/l of vitamin B complex compounds, and 3.4 mg/l of Purine-like and Adenine-like structures. It also contains 0.2% inorganic compounds.

Conclusion: In this study where Respond was applied to existing alfalfa stands of Dekalb 120 and Blazer, there was no yield increase from either a single application of Respond before the first cutting or from sequential applications before cut one, after cut one and after cut two. Based on this study, it does not appear that Respond has potential for improving alfalfa yield.

Table 2. The effects of foliar applications of Respond on alfalfa yield.

Variety	Respond	Time of Application	Forage Yield May 28	June 30	Aug. 8	Total
			(TDM/A)			
Blazer	check	---	1.42	2.25	0.86	4.53
Blazer	24 oz	May 2	1.23	2.23	0.94	4.40
Blazer	24 oz + 24 oz + 24 oz	May 2+June 5+July 8	1.44	2.17	0.98	4.59
DeKalb 120	check	---	2.66	1.99	1.84	6.49
DeKalb 120	24 oz	May 2	2.98	2.00	1.75	6.73
DeKalb 120	24 oz + 24 oz + 24 oz	May 2+June 5+July 8	2.70	1.99	1.82	6.51

Average for Respond treatment :

Respond	Time of Application	Forage Yield May 28	June 30	Aug. 8	Total
		(TDM/A)			
check	---	2.04	2.12	1.35	5.51
24 oz	May 2	2.11	2.12	1.35	5.57
24 oz + 24 oz + 24 oz	May 2+June 5+July 8	2.07	2.08	1.40	5.55
	BLSD(.05)	ns	ns	ns	ns

Average for variety :

Variety	Forage Yield May 28	June 30	Aug. 8	Total
	(TDM/A)			
Blazer	1.36	2.22	0.93	4.51
DeKalb 120	2.78	1.99	1.80	6.58
	Level of Significance			
	99	83	99	99
	Level of Significance			
Variety x Respond treatment :	93	20	58	58

Swine

PERFORMANCE OF BARROWS AND GILTS FED DIFFERENT PROTEIN (LYSINE) LEVELS FROM 110 TO 230 LB BODY WEIGHT

Hugh Chester-Jones, Jim Pettigrew, Steve Cornelius and Ron Moser

Introduction

It has been well established that barrows and gilts differ in their lysine requirements to maintain optimum growth rate, feed efficiency and carcass quality. There is, however, a large variation in the suggested lysine requirements for barrows and gilts reported in the literature, to the extent that the precise lysine requirements have yet to be clearly defined. There is now the need in the pork industry to continually refine production techniques to satisfy the lean pork market requirements. Differentiating the requirement differences for protein (lysine) between barrows and gilts more precisely will enable producers to optimize growth rate and feed efficiency to ensure that the best return in terms of carcass quality is achieved.

Objectives

The study reported herein is part of a collaborative effort by the North Central Region (NCR-42) committee with the objectives to determine the protein (lysine) requirements of barrows and gilts from 110 to 230 lb weight. Similar studies were concurrently conducted at experiment stations throughout the North Central Region.

Experimental Procedure

The study was conducted at the Southern Experiment Station in Waseca. One hundred sixty crossbred pigs (80 barrows and 80 gilts) were randomly assigned to two replications (two pens of 10 pigs/pen) of 4 treatments for each sex (16 pens total). The study was initiated at an average pen weight of approximately 110 lb and continued until each pen averaged 230 lb, when all pigs were marketed and carcass data collected. The four treatments consisted of 16, 15, 14 or 13% crude protein levels in typical corn-soy diets fed similarly to barrow and gilts. The composition of the treatment diets is shown in Table 1.

All pigs were housed in 15' x 5'4" concrete floored finishing pens. All diets were fed ad libitum through self-fed feeders. Pigs had access to fresh water at all times. Pigs were weighed initially and at biweekly intervals throughout the study. Feed intakes were determined on the same schedule on a pen basis. Carcass data collected on all animals included hot carcass weight, backfat (10th rib) and loin eye area (10th rib). Percent muscle was calculated from these data using the NPPC formula: 81.4 + (.06 x hot carcass weight) + (2 x loin eye area) - (14.9 x 10th rib backfat depth)/160. Criteria for evaluation of the protein (lysine) requirements were performance data and carcass information.

TABLE 1. COMPOSITION OF DIETS, PERCENT AS FED[a]

Protein, %	16	15	14	13
Lysine, %	.80	.73	.66	.58
Corn, ground	76.64	79.33	82.02	84.71
Soybean meal (46%)	20.76	18.07	15.38	12.69
Dicalcium phosphate	1.10	1.10	1.10	1.10
Limestone	.90	.90	.90	.90
Salt	.25	.25	.25	.25
Vitamin premix[b]	.30	.30	.30	.30
Trace mineral premix[c]	.05	.05	.05	.05

[a] Based on 8.5% crude protein and .25% lysine in corn and 45.7% crude protein and 2.93% lysine in soybean meal.

[b] Provided per lb of premix: 500,000 IU vitamin A; 50,000 IU vitamin D_3; 1664 IU vitamin E; 327 mg vitamin K; 500 mg riboflavin; 3000 mg niacin; 2000 mg D-pantothenic acid and 2000 mg vitamin B_{12}.

[c] Provided in complete diet: 70 ppm zinc; 55 ppm iron; 30 ppm manganese; 5 ppm copper; 0.6 ppm iodine; 0.1 ppm selenium.

Results and Discussion

Gilts fed 13% dietary protein (.58% lysine) had a lower ($p < .05$) average daily gain than any other treatment group (Table 2). The other treatments did not differ. Daily feed intake was quite variable. Average values for gilts tended to be lower than values for barrows, especially at the lower protein levels. Overall there were no marked differences in feed/gain ratio between gilts and barrows.

Effects of protein level on some carcass characteristics is shown in Table 3. There were no real differences in average hot carcass weights between barrows and gilts. The depth of backfat in barrows remained constant across dietary protein levels. As dietary protein level increased, the backfat depth in the gilts tended to decrease. Gilts fed 15 and 16% dietary protein had lower ($p < .05$) backfat depths than gilts fed 13 and 14% protein. The average loin eye area (LEA) was higher (p .05) in gilts fed 14 or 15% protein than all other treatment groups regardless of sex. Gilts fed 13 and 16% protein had larger ($p < .05$) LEA than all the barrow treatments. Values for LEA for barrows were similar for all dietary protein levels, the highest value being in barrows fed 16% protein. Percent muscle was higher ($p < .05$) for gilts fed 14, 15 or 16% protein than for barrows or for gilts fed only 13% protein.

Summary and Conclusions

A study was conducted with 160 crossbred pigs (80 barrows and 80 gilts) from 110 to 230 lb market weight to determine protein requirements of barrows and gilts. Dietary protein (lysine) levels of 13 (.58), 14 (.66), 15 (.73) or 16 (.80)% were incorporated in typical corn-soy diets. Gilts fed 13% protein had the lowest ($p < .05$) average daily gain of all treatment groups. Barrows

fed 13, 14 or 15% protein gained at a similar rate of gilts fed 14, 15 or 16% protein. There were no marked differences in feed/gain ratio between barrows and gilts across protein level. Backfat depth in barrows was constant across dietary protein level. Gilts fed 15 and 16% protein had lower ($p < .05$) backfat depths than gilts fed 13 and 14% protein. Loin eye area (LEA) was larger in gilts than barrows. Gilts fed 14 or 15% protein had highest LEA. Gilts fed 14, 15 or 16% protein had a higher ($p < .05$) percent muscle than gilts fed 13% protein and all barrows regardless of dietary protein. The study indicated that there are response differences between protein (lysine) levels when fed to barrows vs. gilts.

Farmer Recommendations

The results from this study indicate that indeed differences do occur in protein (lysine) requirement levels for barrows vs gilts which may require a refinement in our management practices. However, a confident recommendation for producers cannot be made until all the studies conducted in the North Central Region have been summarized.

TABLE 2. EFFECT OF PROTEIN LEVEL ON PERFORMANCE OF BARROWS (B) AND GILTS (G)[a]

	Protein level, % as fed								
	13		14		15		16		
Item	B	G	B	G	B	G	B	G	$S\bar{x}$
Av. gain/day, lb	1.79^{b}	1.55^{c}	1.86^{b}	1.73^{b}	1.80^{b}	1.79^{b}	1.94^{b}	1.87^{b}	.36
Av. feed/day, lb	6.20^{bc}	5.42^{d}	6.72^{b}	5.69^{bc}	6.40^{bc}	5.74^{bc}	6.36^{bc}	6.08^{bc}	1.05
Feed/gain ratio	3.49	3.50	3.64	3.35	3.57	3.22	3.28	3.27	.56

[a] Av. of 2 replicates per treatment (2 pens of 10 pigs)

[bcd] Means without similar superscripts differ ($p<.05$)

TABLE 3. EFFECT OF PROTEIN LEVEL ON CARCASS CHARACTERISTICS OF BARROWS (B) AND GILTS (G)[a]

	Protein level, % as fed								
	13		14		15		16		
Item	B	G	B	G	B	G	B	G	$S_{\bar{x}}$
Hot carcass wt, lb.	170.10	164.45	166.25	168.10	167.45	168.55	169.70	164.60	
Backfat, in. (10th rib)	1.06[b]	1.01[bc]	1.05[b]	.87[cd]	1.05[b]	.81[d]	1.07[b]	.84[d]	.16
Loin eye area, sq in (10th rib)	5.17[e]	5.58[cd]	5.16[e]	5.94[b]	5.23[e]	5.92[b]	5.33[de]	5.73[bc]	.33
Muscle, %	53.90[c]	54.65[c]	53.78[c]	56.54[b]	53.90[c]	57.10[b]	53.98[c]	56.39[b]	1.68

[a] Av. of 2 replications per treatment (2 pens of 10 pigs)

[bcde] Means without similar superscripts differ ($p<.05$)

Swine

THE INFLUENCE OF REDUCED LITTER SIZE ON BODY COMPOSITION AND SUBSEQUENT REPRODUCTION PERFORMANCE IN PRIMIPAROUS SOWS

Brian Knudson, Ron Moser, Sayed Kandelgy, Steve Cornelius,
Hugh Chester-Jones, Harley Hanke, Larry Clark and Jim Pettigrew

Introduction

Failure of second-litter sows to farrow a "normal" litter size has recently emerged a problem for swine producers. Typically, litter size increases one piglet from the first to the second litter. However, recent retrospective herd analyses have established that second-litter sows farrow fewer piglets than expected unless the weaning to estrus interval was longer than 12 days. To circumvent this dilemma, Australian researchers recommend first-litter sows should not be mated before 12 days postweaning. These practices enable producers to maximize the number of piglets produced/sow during the first two parities. Perhaps this unique relationship between litter size and rebreeding interval is due to body fat.

The classical study by Whittemore et al. (1980) first suggested that anestrus in sows occurred because of inadequate maternal fat stores. During two successive reproductive cycles, a gradual reduction in estimated fat stores occurred although body weight increased. The reduction in estimated fat stores was linked to extended weaning to estrous intervals. Body fat has also been hypothesized to be involved in size of second litter.

French researchers have reported that the second litter size fluctuates relative to the size of the first litter. Researchers showed a decrease in the second litter size corresponded to a large (11 or more) first litter, while an increase in the second litter size occurred when the size of the first litter was low or average. Therefore, if a management program could be developed to buffer the stress associated with the first litter on the sow, swine producers could maximize number of piglets produced per sow for two parities. Preliminary findings of this study were reported in the 1985 Southern Experiment Station Annual Report.

Objectives

The objectives of this study were to determine the effect of reduced litter size on primiparous sow's subsequent:

a) Body condition (body fat percentage) and weight loss
b) Weaning-to-estrus interval and
c) Litter size for those returning to estrus within 14 days

Experimental Procedues

One hundred twenty-eight Yorkshire x Landrace gilts from the University of Minnesota experiment stations (Morris and Waseca) were paired by body weight prior to farrowing and randomly allotted to nurse 11 piglets/litter or 7 piglets/litter. Litter size was adjusted within 3 days after farrowing. Weight, subcutaneous backfat thickness and body composition were used to evaluate the condition of the sow. Weight of sow was recorded at day 112 of gestation (parity 0), post-farrowing (within 24 hrs), weaning, estrus, day 112 of gestation (parity 1) and post-farrowing (within 24 hrs). Subcutaneous backfat thickness was measured by ultrasound at the tenth rib. Measurements were recorded prior to farrowing and on day 8 post-weaning. Body composition of each sow was determined on day 8 postweaning by the dilution of deuterium oxide (Knudson, 1986).

Sows were fed *ad libitum* a 15% corn-soybean meal diet during gestation and lactation. Feed intake was recorded only during lactation.

After weaning, sows were heat-checked daily with a boar for 70 days. If sows returned to estrus by day 70 or failed to maintain pregnancy, they were removed from the study. All sows were mated at least twice to the same boar at estrus.

Litter performance was recorded for the first and second parity. The number of live piglets, stillborn and mummified festuses were recorded for both parities. Birth weights of live piglets and stillborns were recorded. The number of piglets weaned as well as weaning weights were recorded from parity one.

Results and Discussion

Weight changes during parity 1 are summarized in Table 1. Similar weight losses occurred for both treatments at farrowing (-41.1 vs -40.8 lb) and 8 days following weaning (-26.6 vs 23.6 lb). However, weight change for sows that nursed 11 piglets/litter was greater ($p < .001$) during lactation and less ($p < .04$) during rebreeding interval. Total weight change from farrowing to estrus was comparable for both treatments (-76.5 vs -74.6 lb). Change in subcutaneous backfat thickness was similar for both treatments (-0.24 vs -0.29). Body composition data is summarized in Table 3. Weight of empty body water, protein and ash was unaffected ($p > .29$) by treatment, while weight of empty body fat was lower ($p < .09$) for sows that nursed 11 piglets/litter (98.1 vs 103.1 lb). The body composition data along with weight changes indicate sows that nurse large litters lose more weight during lactation and have smaller body fat reserves than do sows that suckle small litters. This finding is not surprising.

TABLE 1. WEIGHT CHANGES OF SOWS

Item	Treatments 7	11
1. Farrowing (lb) (Day 112 gestation - post-farrowing)	-41.1	-40.8
2. Lactation (lb) *** (Weaning - post-farrowing)	-38.4	-55.0
3. Post-weaning (lb) (Weaning - Day 8 post-farrowing)	-26.6	-23.6
4. Estrus (lb) *** (Estrus - weaning)	-38.1	-19.6
5. Gestation (parity 1) (lb) (Day 112 gestation - weaning)	110.2	111.5

*** $p < .001$

TABLE 2. SOW LACTATION PERFORMANCE

Item	Treatments 7	11
1. No. of observations	64	64
2. Age at parity 1 (days)	374.5	380.7
3. Lactation length (days)	28.2	28.1
4. Lactation feed intake (lb)*	253.6	269.7
5. Backfat change (in.)	-.24	-.29
6. No. of piglets weaned ***	6.89	10.59

*** $p < .001$
* $p < .05$

TABLE 3. BODY COMPOSITION

Item	Treatments 7	11
1. Water (lb)	174.2	170.5
2. Protein (lb)	54.5	53.1
3. Fat (lb) ¶	103.1	98.1
4. Ash	18.7	18.2

¶ $p < .09$

Return to estrus performance is summarized in Table 4. No difference existed between treatments ($p > .17$) for days return to estrus. Number of sows which did not return to estrus within 70 days was greater for sows that nursed 7 piglets/litter (3 vs 2) although total number of sows that did not farrow a second litter was unaffected by treatments (14 vs 14). Days return to estrus was unaffected by weight of empty body protein or fat. The correlation between days return to estrus and weight of empty body fat was -.004. This finding does not agree with other reports that contend body fat is related to estrous activity. This disagreement may lie in the methodology for body fat determination.

TABLE 4. RETURN TO ESTRUS PERFORMANCE

Item	Treatments 7	11
1. Days return to estrus	8.2	11.3
2. Return performance (%)		
0 - 7 days	61.9	51.6
8 - 14	22.2	32.8
15 - 21	4.8	0.0
22 - 69	6.4	12.5
Nonreturn	4.8	3.1

One hundred sows completed two parities. Litter performance is summarized in Table 5. Parity 2 performance, adjusted for parity one, differed for total born (9.5 vs 10.8; $p < .04$) and stillborn (.2 vs .7; $p < .08$) although no difference occurred for born alive (9.2 vs 9.9; $p < .05$). Litter size at parity 2 was not affected by quantity of body fat ($p > .44$).

TABLE 5. LITTER PERFORMANCE

Item	Treatments 7	11
Parity 2		
1. No of observations	50	50
2. Born alive	9.93	9.16
3. Stillborn ¶	.69	.23
4. Mummified fetuses	.18	.13
5. Total born*	10.80	9.51
6. Average birth weight (lb)	3.51	3.48

¶ $p < .09$
* $p < .05$

Results of this study do not support the hypothesis that body fat is related to estrous activity. Changes in body reserves were not studied in this experiment. Perhaps estrous activity is more closely related to the sow's metabolic state than a level of maternal body stores. That is, a sow in an anabolic state during lactation may initiate ovarian function quicker than a sow in a catabolic state regardless of quantity of body fat.

Number of piglets suckled during parity one did not affect the number of piglets born alive in parity two. However, numeric differences did occur.

Summary and Conclusions

The influence of parity one (P1) litter size on body composition and subsequent reproductive performance was evaluated. One hundred twenty-eight Yorkshire x Landrace gilts were paired by body weight and randomly allotted to nurse 11 pigs/litter (C) or 7 pigs/litter (T). Litter size was adjusted within 3 d after parturition. Weight change for C sows was greater ($p < .001$) during P1 lactation (-55.0 vs -38.4 lb) and less ($p < .04$) during rebreeding interval (-19.6 vs -38.1 lb). Feed intake (269.6 vs 253.5 lb; $p < .04$) and number of pigs weaned (10.6 vs 6.9; $p < .001$) were greater for C sows. Average P1 weaning weight of piglets (15.4 vs 18.4 lb; $p < .001$) was greater for T sows. Body composition was determined by dilution of deuterium oxide 8 d after first litter was weaned. Weight of empty body fat (EBF) was lower (98.1 vs 103.1 lb; $p < .09$) for C sows. Weight of empty body water, protein (EBP) and ash were unaffected ($p > .29$) by treatment. No difference existed between treatments (11.3 vs 8.5 d; $p > .17$) for days return to extrus (DRE). EBF and EBP did not affect DRE ($p > .52$). Number of sows which did not return to estrus within 70 d was greater for T sows (3 vs 2), although nunber of sows that did not farrow a second litter was unaffected by treatment (14 vs 14). Parity 2 (P2) performance, adjusted for P1, differed for total born (9.5 vs 10.8; $p < .04$) and stillborn (.2 vs .7; $p < .08$) although no difference occurred for born alive (9.2 vs 9.9; $p > .15$). Litter size at P2 was not affected by EBF ($p > .44$). These results do not demonstrate that number of pigs suckled during P1 affects the number of pigs born alive in parity 2 or DRE. Moreover, EBF of sows 8 d after P1 is not related to DRE or P2 performance.

Farmer Recommendation

Further investigation in this area is warranted to conclusively determine if reducing parity one litter size increases the number of piglets born alive in parity two. This will allow a conclusive recommendation to be made to producers.

References

Knudson, B. J. 1986. Estimators of in vivo body composition in sows following weaning. M.S. Thesis. University of Minnesota, St. Paul.

Whittemore, C. T., M. F. Franklin and B. S. Pearce. 1980. Fat changes in breeding sows. Anim. Prod. 31:183-190.

Dairy

IMPROVING CATTLE THROUGH BREEDING WITH SPECIAL EMPHASIS ON SELECTION FOR a) MILK YIELD AND b) LBS PROTEIN OUTLINE OF A NEW BREEDING PROJECT

Les Hansen, Charles Young,
Hugh Chester-Jones and David Ziegler

Introduction

Since 1964 the dairy herd at the Southern Experiment Station has been established as two distinct genetic based herds with the overall objectives of measuring the direct response to single trait selection for milk yield and possible correlated responses. The criteria for evaluation of each cow from the genetic lines over the years have included milk yield, milk composition (fat and protein), physical characteristics, milking ability (rate of milk flow and milking time), reproductive performance, herd health care costs and income over feed costs. The control herd is now well recognized as a true control population because genetically the herd has remained at a stand still. The average milk production per cow has been maintained at approximately 14,000 lbs with 3.7% fat and 3.4% protein. The selection herd has improved average milk production per cow by 2-3% per year and now averages approximately 20,000 lbs with 3.5% fat and 3.1% protein. This project indicated that selection on the basis of PD-milk is extremely effective and few problems result from such selection in terms of physical characteristics and reproductive performance. The decline in percentages of fat and protein has resulted in the recommendation that bulls should be selected on the basis of PD$. A slightly higher health cost ($11 per lactation) for selection cows mainly due to mammary care has suggested that high PD-milk bulls that rate poorly for mammary traits should not be considered for selection.

The uniqueness of the control herd base and the existing divergent selection line in the Southern Experiment Station herd has created the possibility of implementing nutritional and physiological supporting research studies designed to further the understanding of why the differences occur and the ability to describe interactions between genetics, physiology and nutrition, especially as related to dairy heifer replacements. However, the dairy industry in Minnesota is becoming increasingly interested in the protein component of milk production. It was, therefore, decided to build on the existing genetics base and create another divergent line based on single trait selection for milk protein. The new herd will be based on selection for lbs protein with a minimum genetic transmittance level in the bulls of 3.15%. This third divergent genetic herd will be an additional experimental unit which again can be utilized for important supporting research studies.

Objectives

The objectives of the new breeding project will be to evaluate the response to selection for milk yield and protein using similar criteria as described for the initial 1964 project. (Detailed update summary in 1985 Annual Report Part III, pp 270-275.)

Implementation

The implementation of the study began in November, 1986. The present selection herd will be carefully divided based on lineage. Four top PD-milk bulls and four top PD-protein bulls will be selected each year with a minimum repeatability of 60%. The same bulls will not be used for the milk selection herd and the protein selection herd in any given year. The maximum number of cows for all three herds will be 30.

The challenge of the new project is to maintain the true control herd population. As much of the semen taken from the original 20 bulls used for the control herd is in short supply, there is a need to collect semen from at least 2 bull calves sired by each of the 20 control bulls over a 5-year period. The bull calves will be kept as intact males until 9-10 months old at the Southern Experiment Station. They will be collected and the semen frozen for a subsequent rotational breeding scheme as before.

To build the new protein herd will take 3-5 years but the herd will represent an exciting new era for dairy science in terms of genetics selection and will create many opportunities to further our understanding of new dairy technology available to the producer.

Dairy Beef

PERFORMANCE OF HOLSTEIN STEER CALVES FED DIFFERENT FORMS OF SUPPLEMENTAL NITROGEN IN STARTER DIETS

Hugh Chester-Jones, Marshall Stern, Ken Miller
Steve Plegge and David Ziegler

Introduction

Holstein steer calves used for dairy-beef production utilize soybean meal very efficiently as the main nitrogen source in starter diets. In addition previous work at the Southern Experiment Station has shown that various combinations of soybean meal and urea or urea alone can be effective as supplemental nitrogen sources. There is now continued interest in the use of higher by-pass protein sources in diets fed to Holstein steers. The process of extruding soybeans produces a less degradable protein than traditional soybean meal. The trials reported herein were designed to evaluate the nutritional value of incorporating various forms of soybeans in starter diets fed to growing Holstein steers in comparision to urea and a combination of urea and a higher by-pass nitrogen source.

Objectives

The different forms of soybeans and urea used in this study represented differing available nitrogen sources. The objectives of the study were to:

1. Evaluate the utilization of various forms of nitrogen source by growing Holstein steers.
2. Examine the effect of high by-pass protein on performance of the growing Holstein steer.
3. Examine the effect of the addition of urea to a high by-pass protein on performance of the growing Holstein steer.
4. Compare the utilization of non-protein nitrogen with other protein sources by the growing Holstein steer.

Experimental Procedure

Three groups of 48 Holstein steer calves (avg. initial wt, 110 lb) were used in three consecutive trials over a two-year period. All calves had been weaned at 4 weeks of age when consuming at least 2 lb of dry feed then assigned to treatment groups. In each trial calves were randomly assigned to 5 treatment groups among 8 pens (6 animals per pen). The main effects were different nitrogen sources, the treatments being: 1 - urea; 2 - soybean meal (SBM); 3 - raw soybeans (RSB); 4 - extruded soybeans (ExSB); and 5 - extruded soybeans and urea (ExSB + urea). The experiment was designed to achieve a total of 5 replicates of each treatment over the two-year period except treatment 5 which was replicated 4 times (Table 1).

The composition of the starter diets is shown in Table 2. All diets were isonitrogenous formulated to supply approximately 14% crude protein as fed basis. Steer calves were full fed all diets by daily adjustment of feed to achieve ad libitum intake. Feed refusals were weighed and recorded. All calves were weighed initially and every 14 days during the study.

Calves were full fed the starter diets until the average pen weight was 400 lb. After 400 lbs all calves, regardless of previous treatment, were fed similarly. From 400 to 700 lbs calves were full fed 4 parts corn silage to 1 part ground corn (as fed basis) plus 1 lb/head protein supplement mixed daily in the feed bunk with other dietary ingredients. From 700 to 1050 lbs calves were full fed 1 part corn silage to 1 part ground corn (as fed basis) plus 1 lb protein supplement. Composition of the supplements used is reported in Table 3. The feeding period was terminated when each pen weighed approximately 1050 lbs when a final weight was taken on each steer after feed and water were withheld for 16 hours. Initial and final weights taken during the starter period were full weights adjusted for a 4% shrinkage to give a meaningful comparison to the terminal trial weight for all treatment groups.

At the initiation of each trial all calves were implanted with Ralgro and re-implanted according to manufacturer's directions. Steers were also routinely vaccinated for bovine viral diarrhea (BVD), infectious bovine rhinotracheitis (IBR) and parainfluenza (PI_3). During the two year trial period at least one calf per group was removed from the study for reasons unrelated to treatment.

Results and Discussion

Daily gain, daily feed intake, pounds of feed required per 100 lb of grain and days on feed were not different ($P > .05$) when calves were fed starter diets containing soybean meal, extruded soybeans or extruded soybeans plus urea (Table 4.) Calves fed urea or raw soybeans in their starter diets had lower daily gains ($P < .05$) and were on feed longer ($P < .05$) than those fed other nitrogen sources. Daily feed intake of calves fed raw soybeans was the lowest ($P < .05$) compared to other nitrogen sources. Calves fed urea in the starter diet were the least efficient ($P < .05$) in terms of pounds of feed required per 100 lb of gain.

Nitrogen source fed in the starter diets did not influence ($P > .05$) steer performance during the growing-finishing period when all calves were fed similarly (Table 5). Daily gain and days on feed averaged for the entire feeding period reflected differences between the calf groups seen during the starter period (Table 6).

TABLE 1. EXPERIMENTAL DESIGN

Calf groups[a]	Pen							
Period	1	2	3	4	5	6	7	8
1	U	SBM	RS	ES	ES+U	SBM	RS	ES+U
2	ES	U	SBM	RS	ES	ES+U	U	RS
3	SBM	RS	ES	U	SBM	ES	ES+U	U

U = urea, SBM = soybean meal; RS = raw soybeans; ES = extruded soybeans, and ES+U = extruded soybeans and urea.

[a] 1 = August 1983; 2 = April 1984; 3 = August 1984

TABLE 2. COMPOSITION OF DIETS

Ingredient	Urea	Soybean meal	Raw soybeans	Extruded soybeans	Extruded soybeans & urea
	% as fed				
Ground corn	84	74.55	69.85	69.85	71.93
Ground alfalfa	10.2	10.2	10.2	10.2	10.2
Soybean meal	-----	11.7	-----	-----	-----
Raw soybeans	-----	-----	16.4	-----	-----
Extruded soybeans	-----	-----	-----	16.4	14.0
Urea	1.6	-----	-----	-----	.22
Dicalcium phos.	1.3	1.1	1.1	1.1	1.2
Limestone	.9	1.1	1.1	1.1	1.1
Potassium chloride	.4	-----	-----	-----	-----
Trace mineral salt	.45	.45	.45	.45	.45
Gypsum	.25	-----	-----	-----	-----
Vitamin premix[a]	.9	.9	.9	.9	.9

[a] To provide 1500 IU Vitamin A and 120 IU Vitamin D per lb.

TABLE 3. COMPOSITION OF SUPPLEMENTS[a] USED FOR GROWING-FINISHING PERIOD

Ingredient	Amount, lb/ton grower 400-700 lbs	finisher 700-1050 lbs
Ground corn	1064	970
Urea	348	432
Dicalcium phosphate	342	148
Limestone	36	240
Trace mineralized salt	150	150
Vitamin-Monensin-Sulfur premix[b]	60	60

[a] Supplements fed daily at 1 lb/head

[b] To provide per lb supplement: 20,000 IU Vitamin A, 2000 IU Vitamin D, .004 lb sulfur, 200 mg monensin (grower) and 300 mg monensin (finisher).

TABLE 4. PERFORMANCE OF HOLSTEIN STEER CALVES FED DIFFERENT FORMS OF SUPPLEMENT NITROGEN IN DIETS TO 400 LB.

Item	Nitrogen source: Urea	SBM	RSB	ExSB	ExSB + Urea	Sx
No. of calves	28	27	30	29	22	
Initial wt, lb[a]	107	111	111	110	109	
Final wt, lb[a]	399	390	395	392	392	
Daily gain, lb	2.21[c]	2.39[b]	2.13[c]	2.35[b]	2.48[b]	.14
Days on feed	132[b]	118[c]	133[b]	121[c]	115[c]	7.41
Daily feed, lb as fed	7.73[b]	7.66[b]	7.05[c]	7.55[b,c]	7.96[b]	.56
Feed/100 lb gain, lb as fed	350[b]	320[c]	331[c]	322[c]	322[c]	19.25

[a] Full weight adjusted for 4% shrink

[b,c] Means with unlike superscripts differ ($P < .05$)

TABLE 5. INFLUENCE OF STARTER DIET NITROGEN SOURCE ON PERFORMANCE OF HOLSTEIN STEERS DURING THE GROWING AND FINISHING PERIOD

	Starter diet nitrogen source				
Item	Urea	SBM	RSB	ExSB	ExSb + Urea
No. of steers	28	27	30	29	22
Initial wt, lb[a]	399	390	395	392	392
Final wt, lb[b]	1032	1020	1016	1012	1014
Daily gain, lb	2.73	2.71	2.67	2.71	2.75
Days on feed	233	233	233	226	227
Daily feed, lb as fed					
Supplement	1.00	1.01	1.00	1.00	1.02
Corn grain	9.65	9.31	9.44	9.51	9.36
Corn silage	18.63	18.45	18.49	18.96	18.49
Total	29.28	28.77	28.93	28.47	28.87
Feed/100 lb of gain, lb as fed					
Supplement	37	37	38	37	36
Corn grain	354	344	354	351	340
Corn silage	682	681	693	700	672
Total	1073	1062	1085	1088	1048

[a] Full weight adjusted for 4% shrink
[b] Obtained after withholding feed and water 16 hours.

TABLE 6. INFLUENCE OF STARTER DIET NITROGEN SOURCE ON PERFORMANCE OF HOLSTEIN STEERS DURING ENTIRE FEEDING PERIOD.

	Starter diet nitrogen source					
Item	Urea	SBM	RSB	ExSB	ExSB + Urea	Sx
No. of steers	28	27	30	29	22	
Initial wt, lb[a]	107	111	111	110	109	
Final wt, lb[b]	1032	1020	1016	1012	1014	
Daily gain, lb	3.53[d,c]	2.60[c,d]	2.47[e]	2.60[c,d]	2.65[c]	.08
Days on feed	365[c]	351[c,d]	367[c,d]	347[d]	342[d]	17.92

[a] Full weight adjusted for 4% shrink
[b] Obtained after withholding feed and water 16 hours
[c,d,e] Means with unlike superscripts differ ($P < .05$).

Summary and Conclusions

Three groups of 48 Holstein steer calves (avg. initial wt. 110 lb) were used in three consecutive trials over a two-year period to evaluate the utilization of either urea, soybean meal, raw soybeans, extruded soybeans or extruded soybeans plus urea as the main nitrogen sources in starter diets. The influence of starter diet nitrogen source on the performance of the steers over the growing-finishing period was also investigated. Daily gain, daily feed intake, pounds of feed required per 100 lb gain and days on feed

were not different (P > .05) in calves fed starter diets containing extruded soybeans, extruded soybeans plus ureea and soybean meal. Supplementing starter diets with raw soybeans or urea resulted in a lower (P < .05) calf performance that the other nitrogen sources. Calves fed urea were least efficient (P < .05) in terms of pounds of feed required per 100 lb gain.
There was a trend for a response in extruded soybeans plus urea fed steers as they outgained those fed soybean meal, extruded beans, urea and raw soybeans by 3.6, 5.2, 10.9 and 14.1%, respectively. Nitrogen source fed in starter diets did not influence (P > .05) steer performance during the growing-finishing period when all calves were fed similarly. Daily gain and days on feed averaged for the entire feeding period from weaning to 1050 lbs reflected the same differences between the treatment groups as seen during the starter period.

Under the conditions implemented in these trials it appears that there was no marked benefit of feeding a higher by-pass nitrogen source with or without urea in starter diets fed to growing Holstein steers. These trials confirmed that young growing Holsteins can utilize urea as the main nitrogen source in starter diets but not as effectively as plant protein sources.

Farmer Recommendation

Under the conditions implemented in this study, it would appear that the choice of supplemental protein to be used in starter diets fed to growing Holstein steers should be based on consideration by the market price of the soybean meal versus extruded soybeans with or without urea.

Dairy Beef

FERMENTATION CHARACTERISTICS OF SWEET CORN PROCESSING WASTE ENSILED AT DIFFERENT MOISTURE LEVELS WITH AND WITHOUT ADDITIVES

Hugh Chester-Jones, Don Otterby, Jay Meiske, Marshall Stern, Steve Plegge and David Ziegler

Introduction and importance to the industry

The processing of sweet corn results in a waste residue that typically contains 90% husk and leaf, 8% cob and 2% kernel plus washed corn screenings that contain 5% solids. The combined dry matter of the waste is usually 20% or less. In SE Minnesota over 400,000 tons of sweet corn waste silage is produced each year from the 19 food processors. The waste is typically stacked after being chopped and squeezed under pressure to produce an ensiled product available for use by farmers. However, the high moisture content of the silage limits its efficient use by livestock producers. In addition the supply of silage available far exceeds the demand. The disposal problem is an annual concern for the processors each season. The questions that need to be addressed are: a) how can sweet corn waste silage be disposed of more efficiently?, b) how can the quality of ensiled waste be improved and what is the typical quality of chopped and squeezed silage today?, c) what are the most efficient feeding systems for livestock producers to utilize the waste silage?, and d) are there alternative uses for the waste silage other than feeding to ensure efficient disposal of the product?

Early feeding trials conducted by the University of Minnesota in 1970 evaluated sweet corn processing waste as a livestock feed. The waste was not chopped or squeezed. When fed to cattle the processing waste silage (dry matter 23%), had an energy value that was slightly higher than regular corn silage but lower than whole plant sweet corn silage on a dry matter basis. The amount of dry matter per 100 lb gain was similar for cattle fed processing waste silage and those fed regular corn silage. The high water content reduced the rate of gain in cattle fed processing waste silage and, therefore, the actual feeding value on a wet basis was estimated as 77.4% of regular corn silage and whole plant sweet corn silage. Sixteen years later the product is presented as a better quality product as it has been chopped but the moisture problem has not been alleviated.

Objectives

Further investigations into the waste problem were indicated and the impetus to conduct new work was given by General Foods who constructed their own chop and squeeze system for the first time in 1986. Thanks to a grant from General Foods in Waseca, preliminary studies were initiated in September, 1986. The initial objectives were to simulate, through a small silo study, larger scale ensiling processes to investigate the fermentation characteristics of sweet corn processing waste ensiled alone or with additives.

Experimental Procedures

Sweet corn processing waste that had been chopped then squeezed at 200 psi in a pressure plate chamber was taken directly from the General Foods plant in

Waseca and ensiled in 5-gallon plastic buckets under pressure (1000 psi) using a hydraulic press. The fermentation characteristics of the following were investigated: a) Processing Waste (PW) ensiled alone, b) PW plus 5% corn, c) PW plus .75% urea, d) PW plus bacterial innoculant, e) PW plus 2% propionic acid, and f) PW plus extra squeeze (1500 psi) ensiled alone. Silos were opened at intervals over a 35-day period (days 1, 3, 5, 7, 14, 21 and 35). Each treatment had 3 silos per time period. Samples of each silage were taken initially and at each day of opening then frozen for subsequent analysis.

On day 35 an aerobic stability study was implemented by monitoring daily temperature changes with thermocouples for 14 days. This would give an indication of storage stability of each silage when exposed to ambient temperature after being removed from the silage stack.

Analysis: All silage samples will be analyzed for: dry matter, pH, protein, acetic acid, propionic acid, butyric acid, lactic acid, soluble carbohydrates, acid detergent fiber and acid detergent insoluble nitrogen.

Preliminary Results and Discussion

Only very preliminary results are available to date from the small silo study. Table 1 lists the average dry matter and pH changes by treatment for the 35 day small silo study.

The variability in dry matter percentages are a reflection on the method of treatment application. A disappointment was the continued low dry matter of the extra squeeze treatment. This may have been a reflection on mechanics of the ensiling procedure with the hydraulic press. Another concern was the low initial pH in all treatments (the effect of propionic acid was expected). Although the pH readings of all treatments except propionic acid did drop on average over the 35 days, the initial low readings meant that any treatment effects were perhaps nullified. A true picture of the comparative fermentation characteristics will be forthcoming upon completion of all the analysis.

TABLE 1. SMALL SILO STUDY - ENSILING CHARACTERISTICS: DRY MATTER AND pH CHANGES AVERAGED BY TREATMENT FOR 35 DAYS

Treatment	Av. dry matter, %	Initial pH	Final pH
PW ensiled alone	13.80	4.24	3.53
PW + 5% corn	16.58	4.30	3.52
PW + .75% urea	14.60	4.42	3.45
PW + innoculant	13.64	4.29	3.57
PW + propionic acid	17.56	3.51	3.64
PW + extra squeeze	16.45	4.50	3.56

On day 35 a comparative silage sample was taken from the General Foods stack at a 2-foot depth. The dry matter was 15.65 and pH 4.10 after being in the stack about one week. This indicated that final pH readings and dry matters of the small-silo silages were a good approximation of conditions in the large silage stack.

Because of the concern about the low initial pH readings of the small silos, further pre-ensiled processing waste samples were taken directly from the squeeze chamber towards the end of the corn pack. Readings for pH were between 6 and 7. Reasons for this discrepancy in silage quality is unknown but warrants further investigation. Samples of the squeezed effluent were also taken from beneath the squeeze chamber at the plant. The pH averaged 6.5. These samples will be analyzed to give an idea of the nutrient loss due to the squeezing process.

The results from the aerobic stability trial are shown in Table 2.

TABLE 2. AEROBIC STABILITY TRIAL

Treatment	Initial temp. F	Peak temp. F	Days to peak	Temp. day 14	Comments on stability after 2 wks.
PW alone	46	107	7	61	Smells bitter; brown color
PW + corn	46	96	4	63	Moldy, rotten; worse than 1
PW + urea	46	102	6	65	Discolored; rotten, same as 2
PW + innoc.	49	106	6	64	Similar to 6; moldy, not as bad as 1, 2
PW + Ext. Squ.	48	105	7	59	Slight mold and brown
PW + Prop. Ac.	48	70	8	59	Stable

The aerobic stability study indicated that propionic acid added at 2% (wet weight basis) to processing waste is a good preservative. It was difficult to evaluate a real treatment effect on stability of the other treatments. There was an indication that extra squeezing can improve the stability of the silage. This emphasizes a need to further reduce the moisture of the processing waste.

Conclusion

A concurrent feeding trial is underway that is evaluating different levels of processing waste silage fed in growing diets to the Holstein steers (see Part II). This study and the final results from the small silo study will allow a critical evaluation of the quality of the processing waste. Future strategies for a feeding systems approach for producers, together with recommendations for the processors, will be planned after all the results are summarized before the 1987 corn pack.

Dairy Beef

UTILIZATION OF BEET PULP IN DIETS FED TO GROWING HOLSTEIN STEERS

Marshall Stern, Hugh Chester-Jones, Jim Linn,
Steve Plegge and David Ziegler

Introduction

The incorporation of by-product feedstuffs into diets for growing Holstein steers creates the opportunity to refine feeding systems for dairy-beef production. In addition interest continues in the use of by-pass protein sources for growing Holstein Steers. Beet pulp, a by-product of the sugar refining industry, is an excellent digestible energy source and offers some by-pass protein. Optimum levels of beet pulp that can be utilized in growing cattle diets need to be clarified to allow for an economic evaluation of its use in relation to traditional feed sources. The study reported herein is a progress report of trials conducted to evaluate the utilization of up to 30% beet pulp incorporated into starter/grower diets as replacement for corn. In addition a comparison was made of soybean meal vs alcohol treated soybeans as the main nitrogen sources, the latter being higher by-pass proteins.

Objectives

Recent results from Marshall Stern's animal science laboratory on the St. Paul campus, using laboratory fermenters, suggest that dried beet pulp may provide an adequate source of energy for microbial synthesis and also some by-pass protein. In addition, treatment of soybeans with alcohol has increased the by-pass value of soybean protein. Therefore, the objectives of this study were to: Determine the efficiency of growth in growing Holstein steers when fed: 1) beet pulp vs corn as an energy source, and 2) alcohol treated soybeans vs soybean meal as a protein source.

Experimental Procedures

Three groups of 42 male Holstein calves (av. initial wt 124 lb) were used in three consecutive trials over a two-year period. In each trial calves were weaned at 4 weeks of age and blocked by weight and age, then randomly allotted to six treatments and assigned to six pens for group feeding. Initially after weaning each treatment group of calves were assigned to a block of individual stalls for the first 14 days of the experiment then transferred to pens for group feeding. During this initial period calves were castrated and dehorned. The study was a complete randomized block design with a 3 x 2 factorial arrangement of treatments. Main effects were energy source (beet pulp vs. corn) and protein source (alcohol treated soybeans or soybean meal). The composition of the starter diets fed are shown in Tables 1 and 2. All diets were isonitrogenous formulated to supply 14.5% crude protein (approximately) on an as fed basis.

TABLE 1. COMPOSITION OF STARTER DIET[a] WITH SOYBEAN MEAL AS THE MAIN PROTEIN SOURCE.

Ingredient	Level of Beet Pulp, % As Fed		
	0	15	30
Ground Corn	75.03	60.47	45.60
Alfalfa Pellets	11.6	11.6	11.7
Sugar Beet Pulp	0	14.7	29.6
Soybean Meal	10.1	10.1	10.2
Alc. Trt. Soybeans	-----	-----	-----
Urea	.22	.22	.22
Dicalc, Phos.	.57	.75	.75
Limestone	1.0	.68	.45
Trace Min. Salt	.48	.48	.48
Vitamin Premix	1.0	1.0	1.0

[a] As fed basis

TABLE 2. COMPOSITION OF STARTER DIET[a] WITH ALCOHOL TREATED SOYBEANS AS THE MAIN PROTEIN SOURCE.

Ingredient	Level of Beet Pulp, % As Fed		
	0	15	30
Ground Corn	75.73	61.17	46.34
Alfalfa Pellets	11.6	11.6	11.7
Sugar Beet Pulp	0	14.7	29.5
Soybean Meal	-----	-----	-----
Alc. Trt. Soybeans	9.4	9.4	9.5
Urea	.22	.22	.22
Dicalc. Phos.	.57	.75	.85
Limestone	1.0	.68	.41
Trace Min. Salt	.48	.48	.48
Vitamin Premix	1.0	1.0	1.0

[a] As fed basis

Steer calves were full fed all diets daily. Daily feed intake data were recorded on an individual basis for the first 14 days and on a group pen basis for the remainder of the study. Feed refusals were weighed and recorded. Calves were full fed the starter diets until the average pen weight was approximately 350 lbs. After 350 lb each starter diet was readjusted for mineral requirements and self-fed until the average pen weight was 730 lbs.

All calves were weighed on two consecutive days initially and every 14 days throughout the feeding period. More frequent weighings were taken as each pen approached the 350 or 730 end point weights, respectively. Initial and final weights during the starter period to 350 lbs were full weights and the final weight at the end of the growing period (730 lbs) was taken after feed and water were withheld for 16 hours. All calves were implanted with Ralgro at weaning and re-implanted every 70 days. Fresh water was available at all times. Seven calves per pen were group fed up to 350 lbs but this was reduced to 6 calves per pen for the remainder of the feeding period. Steers were routinely vaccinated for IBR, PI_3 and BVD and de-wormed with Ivermectin before being moved to the feedlot. During the two-year trial period, 5 animals were removed from the study for reasons unrelated to treatment.

Results and Discussion

Calves fed 0 and 15% beet pulp (BP) with soybean meal (SBM) and those fed 15% BP with alcohol treated soybeans (ATSB) had similar rates of gain to 350 lbs (Table 3). The least effective diet in terms of rate of gain to 350 lbs was 30% BP with SBM followed by 0% and 30% BP with ATSB, respectively. Calves utilized the SBM diets more efficiently than the ATSB diets up to 350 lbs. These calves fed 0% BP with SBM had the lowest feed/gain followed by calves fed 15% or 30% BP with SBM.

TABLE 3. PERFORMANCE OF HOLSTEIN STEER CALVES FED DIFFERENT LEVELS OF BEET PULP WITH DIFFERENT SUPPLEMENTAL NITROGEN FORMS TO 350 LBS[a].

	Nitrogen Source					
	Soybean meal			Alcohol treated soybeans		
	Level of beet pulp (%, as fed)					
Item	0	15	30	0	15	30
No. of calves	21	20	21	20	21	21
Initial wt, lb[b]	122	125	122	126	123	123
Final wt, lb[c]	354	351	353	350	356	351
Daily gain, lb	2.39	2.35	2.14	2.18	2.33	2.26
Days on feed	97	96	108	103	100	101
Daily feed, lb as fed	7.32	7.50	6.84	7.10	7.74	7.35
Feed/100 lb gain, lb as fed	306	319	320	326	332	325

[a] Results are raw means, statistical analysis has not been completed
[b] Av. of 2 full consecutive weights
[c] Full pen weight

Performance summarized for the feeding period from weaning to 700 lbs indicated that calves fed 0% BP with SBM gained faster and more efficiently than any of the other treatment groups (Table 4). Calves fed 15% BP with SBM gained faster but were less efficient than calves fed 0% BP with ATSB. Calves fed the ATSB diets gained at a very similar rate irrespective of BP levels but tended to utilize their diets less efficiently as BP level increased. Calves fed the SBM diets with 15 or 30% BP utilized their diets similarly in terms of feed/gain, being more efficient than the equivalent BP diets with ATSB.

TABLE 4. PERFORMANCE OF HOLSTEIN STEER CALVES FED DIFFERENT LEVELS OF BEET PULP WITH DIFFERENT SUPPLEMENTAL NITROGEN FORMS FROM WEANING TO 700 LBS[a].

	Nitrogen Source					
	Soybean meal			Alcohol treated soybeans		
	Level of beet pulp (%, as fed)					
Item	0	15	30	0	15	30
No. of calves	17	18	18	17	18	17
Initial wt, lb[b]	122	125	122	126	123	123
Final wt, lb[c]	703	695	702	704	699	700
Daily gain, lb	2.75	2.65	2.51	2.58	2.58	2.52
Days on feed	211	215	231	224	223	229
Daily feed, lb as fed	8.36	9.06	8.56	8.19	9.00	9.19
Feed/100 lb gain, lb as fed	304	342	341	317	349	365

[a] Results are raw means, statistical analysis has not been completed
[b] Av. of 2 full consecutive weights
[c] Obtained after withholding water and feed for 16 hours

Conclusion

The results of the study indicate that the addition of up to 15% BP to starter/grower diets fed to Holstein steers is quite effective. The addition of 30% BP to the diets did cause a decrease in average daily gain and days on feed. The use of ATSB as a higher by-pass protein source than SBM did not enhance performance of calves compared to those fed diets with SBM. In this study the ATSB was a finely ground material which may have caused some problems with utilization especially with the younger calves to 350 lbs. Overall the diet with 0% BP with SBM appeared to result in the best performance.

Farmer Recommendation

Under the conditions implemented in this study, the use of beet pulp in starter/grower diets for Holstein steers should be based on an economic comparision to corn or equivalent concentrate feed. Nutritionally, beet pulp appeared to be a good substitute for corn up to 15% of the diet with soybean meal as the main nitrogen source. There was no benefit of feeding a higher by-pass protein as the main nitrogen source in this study.

SYSTEMIC AND CONTACT FUNGICIDE EVALUATION FOR CONTROL OF COMMON LEAF RUST IN SWEET CORN

Vincent Fritz, James Groth
Richard Zeyen, James Hebel
Southern Experiment Station
Waseca, Minnesota

IMPORTANCE

An entire spectrum of cultural management strategies are and will be changing to meet production efficiency levels necessary for farm survival in today's agricultural industry. Specific areas which are repeatedly scrutinized for expenditure cuts are fertilization and pest control.

The use of systemic pesticides may not only give a grower extended control when compared to a contact pesticide, but also cut labor costs by reducing the number of applications necessary for the desired level of control.

Leaf rust (fungal disease) in sweet corn is a major concern in the sweet corn processing industry in Minnesota. Contact fungicides presently used are applied a multiple number of times which result in exorbitant labor costs and offer only marginal control.

OBJECTIVES

1) to determine control potential of various systemic fungicides.

2) to determine if there are any adverse effects on yield, quality, or harvest date from using systemic fungicides.

MATERIALS AND METHODS

Variety:	Jubilee
Planting date:	May 19
Population:	22,000/acre
Experimental Design:	Randomized complete block with four reps
Fungicides:	Systhane (Rohm and Haas)
	Manzate 200 (Dupont)
	Bayleton (Mobay)
	Bay WHG 1608 (Mobay)
	Tilt (Ciba-Geigy)
	Control (untreated)

PARAMETERS MEASURED

Four leaf samples of leaf area infected (leaf area meter)
- -flag
- -secondary
- -opposite/above ear
- -opposite/below ear

Husked and unhusked yield
Yield recovery (c-o-c and cut)
Moisture content at harvest
Harvest date
Time to 80% silk
Treatment date and growth stage of plant at treatment

Fungicide treatments were first applied on July 18. Date of 80% tassel was July 15. All plots were harvested when kernel moisture content measured 73-74% (August 12).

RESULTS AND DISCUSSION

In general, the use of systemic fungicides did not offer any additional margin of control of rust when compared to the contact fungicide, Manzate, or the control (Fig. 1). This may have been due to the earliness of planting. A late season planting will be conducted in 1987 to increase disease pressure for improved fungicide evaluation. Yield fractions were not significantly effected in plants receiving systemic fungicide treatments when compared to the control (Figs. 2 and 3). Maturity was not significantly effected by the use of systemic fungicides.

(Note: None of the systemic fungicides are presently labeled for sweet corn.)

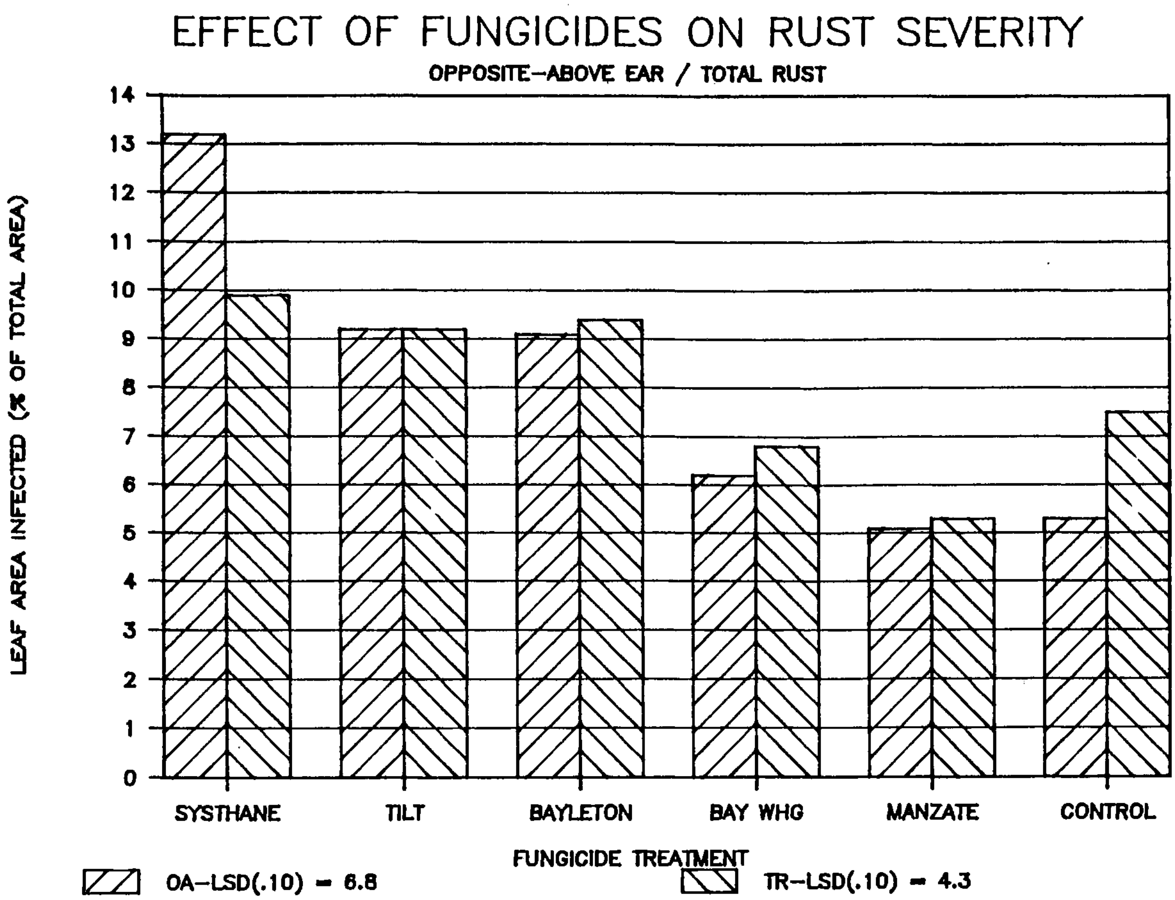


Fig. 1 The effect of fungicide treatment on rust severity. (OA = leaves opposite/above ear; TR = average severity reading of four leaf locations/plant.)

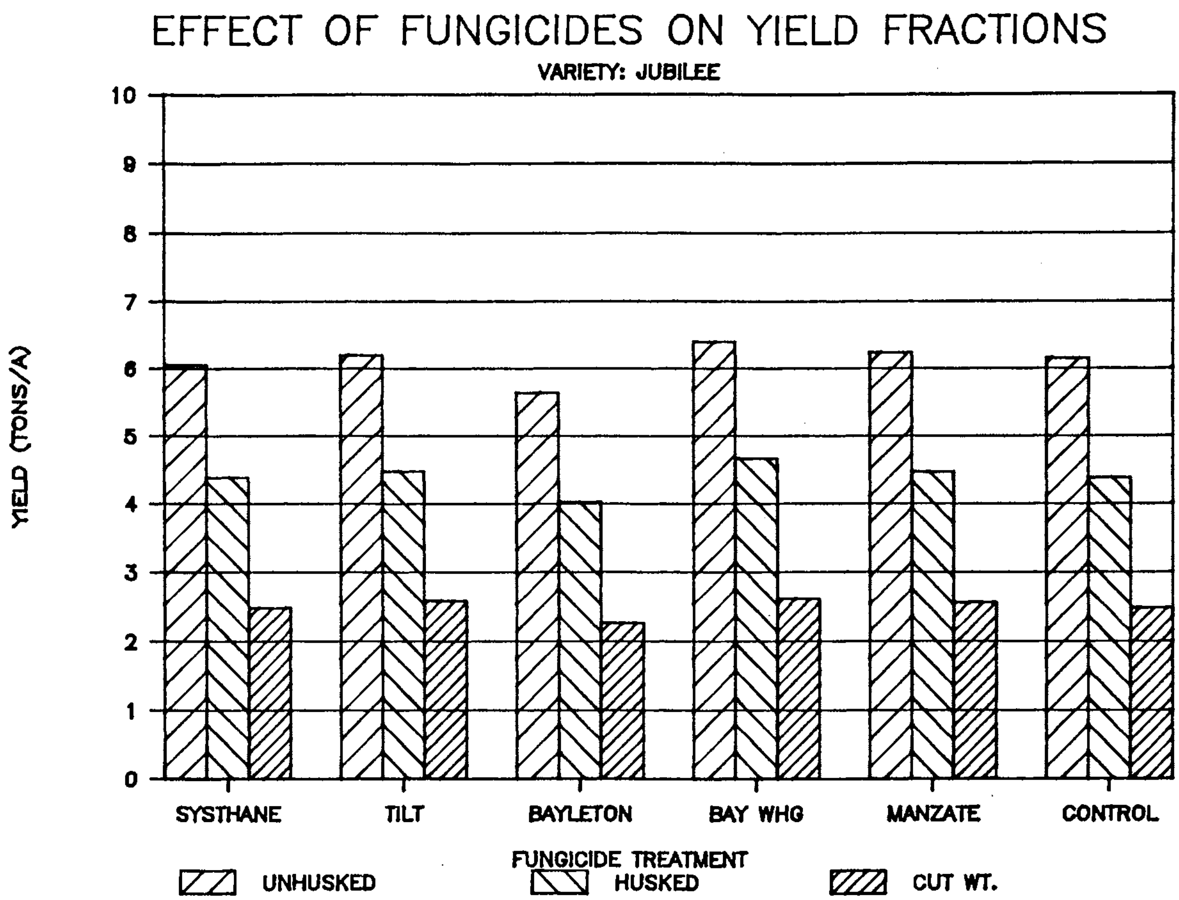


Fig. 2. The effect of fungicide treatment on unhusked, husked, and cut weight yield factor.

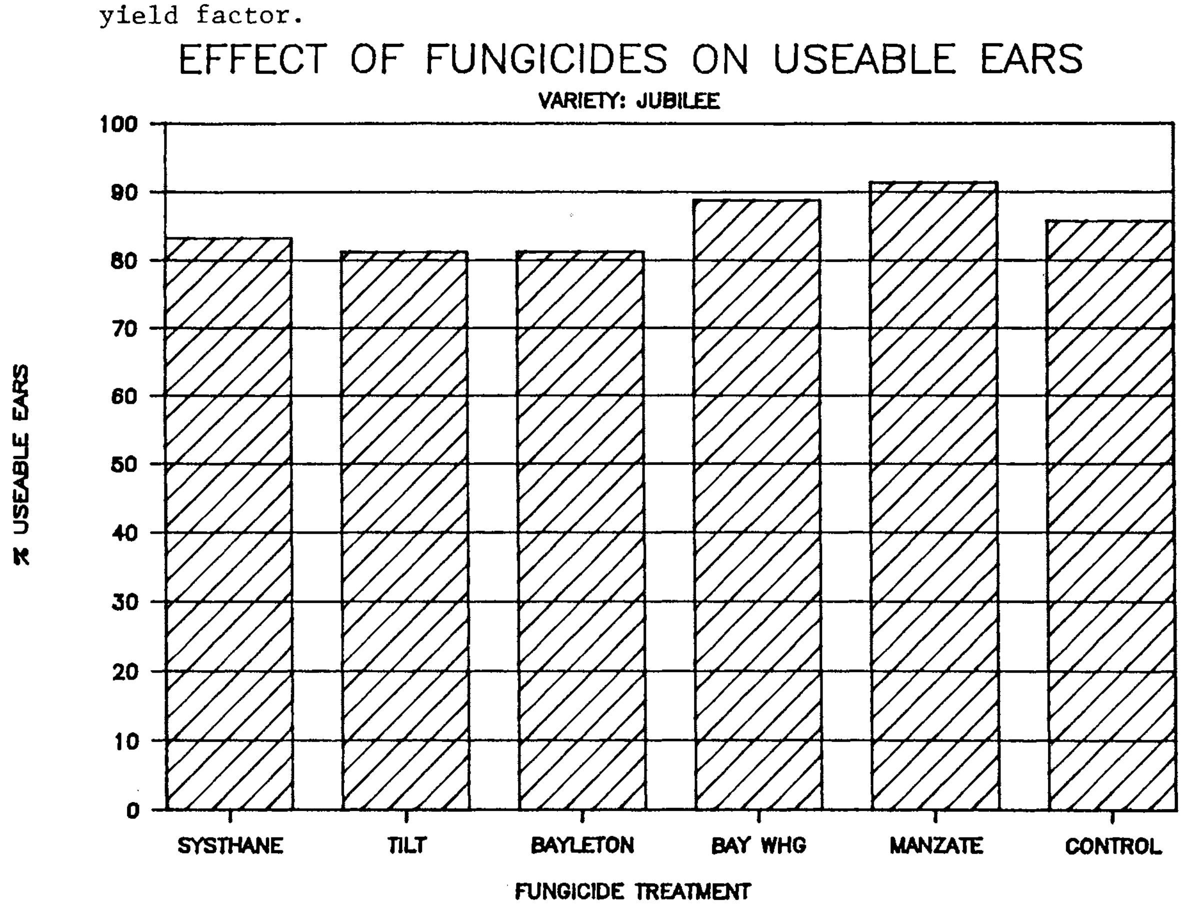


Fig. 3. The effect of fungicide treatment on % useable ears.

BROMOXYNIL EFFECTS ON SWEET CORN

Vincent Fritz and James Hebel
University of Minnesota
Southern Experiment Station
Waseca, Minnesota 56093

This study was conducted near Waseca, MN to determine the effects of postemergence application of bromoxynil on horticultural characteristics of sweet corn varieties. The soil type was a Webster clay loam containing 6.3% organic matter, a soil ph of 6.0, and soil test P and K levels of 65 and 256 lb/A, respectively. The experiment was a 15 x 2 factorial arranged in a randomized complete block design with four replications and a plot size of 10x30 feet. Fifteen varieties of sweet corn were planted at a seeding rate of 48,000/A on May 23 in 30-inch wide rows. At the two leaf stage, all treatments were thinned to 24,000 plants/A. Alachlor and cyanazine were applied preemergence at a rate of 4.0 and 2.0 lb/A, respectively. Precipitation during the two week period following preemergence herbicide application was 1.68 inches. Bromoxynil at 0.5 lb/A was applied at the three to four leaf stage. Two dates of application, June 17 or June 20, were necessary due to significant differences in varietal vigor. Maximum/minimum air temperatures were 74/52 °F on June 17 and 92/71 °F on June 20. During the week following application, 6.97 inches of precipitation was received; however, the herbicide had been applied for about 10 hours before rain commenced. All herbicide treatments were applied using a bicycle sprayer equipped with flat fan nozzles and calibrated to deliver 20 gallons/A at 30 psi. All treatments were cultivated once and maintained in a weed-free condition throughout the season.

Five days after bromoxynil applications, leaf injury ratings were taken on five randomly selected plants from plot rows that were not harvested. Leaves three through six were removed and visually evaluated for percent leaf area damaged by bromoxynil. Plots were monitored for kernel moisture content and harvested as each variety reached 73 to 74% moisture. All samples were mechanically husked and cut.

In general, greater yields were obtained from plots treated with bromoxynil even though significant leaf injury was apparent. Significantly higher unhusked yields were observed from bromoxynil treated plants as compared to untreated plants. Smaller but significantly higher husked and cut corn yields were also observed from bromoxynil treatments. Overall performance of the four commercial inbred lines was especially poor. 'Reward' and 'Sweetie' were the commercially named varieties most sensitive to leaf injury from bromoxynil. (MN Agr. Exp. Sta. Paper No. 2094. Misc. Journal Series. Univ. of MN, St. Paul, MN).

Table. Bromoxynil effects on injury, yield, and quality of several sweet corn varieties, 1986. (Fritz and Hebel)

Variety	Sweet Corn Type[a]	Bromoxynil Trt	Leaf Number 3	4	5	6	Days to Harvest	Unhusked Yield	Husked Yield	Cut Corn Yield	Total Ears/A	Usable Ears/A	Ear Length	Ear Dia.	Plant Height	Ear Height
			---% injury----					--------Tons/A--------			1000's	--%---	-----------Inches-----------			
Miracle	Se	+	29	32	26	18	82	6.5	4.1	2.2	20.04	63	18.1	1.6	71.5	22.0
Crisp 'n' Sweet 710	Sh_2	+	36	40	22	13	84	6.0	3.9	1.9	19.51	69	19.6	1.7	78.5	26.5
Excellency	Su	+	36	35	18	13	85	4.9	3.2	1.4	19.49	61	19.3	1.7	77.4	28.5
Commander	Su	+	27	35	29	17	89	3.9	2.6	1.2	15.14	49	19.5	1.7	89.6	32.1
Jubilee	Su	+	39	32	23	14	82	5.2	4.0	1.9	21.45	70	18.5	1.6	86.3	30.0
Reward	Su	+	45	41	32	19	74	5.3	3.9	1.9	19.49	35	20.0	1.7	72.7	20.7
Arrestor	Su	+	30	31	27	18	85	5.1	3.4	1.3	15.90	70	20.2	1.7	85.4	29.0
Prevailer	Su	+	35	40	31	19	84	6.0	4.6	2.5	21.56	54	18.4	1.9	81.8	25.3
Sweetie	SH_2	+	42	47	27	17	89	6.0	4.2	2.4	20,91	78	18.0	1.7	81.7	27.4
Reliance	Su	+	29	30	21	12	82	4.5	3.8	2.1	19.82	75	18.1	1.6	74.3	23.0
Stylepak	Su	+	34	31	24	15	84	3.3	2.3	0.8	14.70	45	19.7	1.6	76.9	27.1
Crookham 54851T	--	+	46	49	35	20	87	2.4	1.1	0.2	15.68	4	14.7	1.3	65.0	25.9
39724	--	+	39	37	22	13	87	2.5	1.2	0.3	16.00	0	16.3	1.3	70.3	25.3
53806X	--	+	26	28	15	8	80	1.4	0.8	0.3	9.15	21	13.5	1.3	45.1	6.9
50768T	--	+	39	47	29	18	95	2.4	1.5	0.6	16.11	8	14.0	1.5	56.4	21.0
Variety Means LSD (0.05)			8	4	5	3										
Miracle	Se	-					82	4.7	3.1	1.7	20.47	61	16.5	1.6	72.0	23.8
Crisp 'n' Sweet 710	SH_2	-					82	3.9	3.3	1.6	15.35	53	16.4	1.6	81.0	27.7
Excellency	Su	-					85	4.7	2.8	1.5	16.33	66	18.2	1.7	82.2	31.8
Commander	Su	-					89	3.4	2.2	1.1	14.37	35	18.2	1.6	86.6	32.9
Jubilee	Su	-					82	4.3	3.4	1.6	19.49	68	18.4	1.6	80.8	28.9
Reward	Su	-					74	4.5	3.2	1.6	18.84	26	19.0	1.7	72.8	21.9
Arrestor	Su	-					85	3.8	2.5	0.9	14.81	61	20.2	1.7	88.6	34.5
Prevailer	Su	-					84	4.8	3.8	1.9	19.71	49	19.3	1.8	81.4	24.8
Sweetie	SH_2	-					85	4.7	3.3	1.3	19.82	66	18.0	1.6	82.6	30.9
Reliance	Su	-					80	4.5	3.7	2.1	18.73	87	18.6	1.6	76.7	24.9
Stylepak	Su	-					84	3.9	2.5	1.1	16.11	46	18.9	1.7	79.0	29.4
Crookham 54851T	--	-					87	1.5	0.8	0.2	10.78	1	15.2	1.3	65.9	27.4
39724	--	-					95	2.1	1.4	0.4	13.83	20	14.2	1.5	65.1	23.9
53806X	--	-					82	1.7	1.0	0.4	12.52	6	13.2	1.5	46.9	8.5
50768T	--	-					95	1.7	1.2	0.4	12.30	11	13.8	1.5	56.9	23.9
Variety Means																
Miracle							82	5.2	3.6	2.0	20.25	62	17.3	1.6	71.8	22.9
Crisp 'n' Sweet 710							83	4.6	3.6	1.7	17.42	61	18.0	1.7	79.8	27.1
Excellency							85	4.8	3.0	1.4	17.91	64	18.7	1.7	79.8	30.2
Commander							89	3.6	2.4	1.1	14.76	42	18.9	1.7	88.1	32.5
Jubilee							82	4.8	3.7	1.7	20.47	69	18.4	1.6	83.5	29.4
Reward							74	4.9	3.5	1.7	19.17	30	19.5	1.7	72.8	21.3
Arrestor							85	4.4	2.9	1.1	15.35	65	20.2	1.7	87.0	31.7
Prevailer							84	5.4	4.2	2.2	20.64	52	18.8	1.9	81.6	25.0
Sweetie							87	5.4	3.8	1.9	20.36	72	18.0	1.7	82.2	29.2
Reliance							81	4.5	3.7	2.1	19.28	81	18.4	1.6	75.5	23.9
Stylepak							85	3.6	2.4	1.0	15.41	46	19.3	1.6	77.9	28.3
Crookham 54851T							87	1.9	1.0	0.2	13.23	2	14.9	1.3	65.4	26.7
Crookham 39724							91	2.3	1.3	0.3	14.92	6	15.2	1.4	67.7	24.6
Crookham 53806X							81	1.6	0.9	0.3	10.84	12	13.3	1.4	46.0	7.7
Crookham 50768T							95	2.0	1.3	0.5	14.21	9	13.9	1.5	56.7	22.4
Variety Means LSD (0.05)							1	1.2	0.9	0.5	3.98	5	1.7	0.1	5.2	3.1
Bromoxynil Means																
Plus Bromoxynil							84.6	4.2	3.0	1.4	17.68	44	17.8	1.6	74.2	24.7
Minus Bromoxynil							84.7	3.6	2.5	1.1	16.23	42	17.2	1.6	74.6	26.3
Bromoxynil Means (% Sig.)							99.9	99.9	99.9	99.8	99.30	58.7	99.7	70.9	41.9	99.9
(Variety x Bromoxynil Trt (% Sig.)							99.9	35.9	29.9	91.6	67.8	97.0	92.2	96.9	74.4	77.4

[a]Normal Sugar (Su), Sugary Enhancer (Se), Shrunken (SH_2).

CERONE EFFECTS ON SWEET CORN

Vincent Fritz and James Hebel
University of Minnesota
Southern Experiment Station
Waseca, Minnesota 56093

IMPORTANCE

The increasing genetic development of high sugar sweet corn varieties (SH_2) has earned increased interest by processors in Minnesota. However, a number of inadequacies need to be compensated for before a significant increase in production occurs. One characteristic associated with high sugar sweet corn hydrids is their susceptibility to lodging. Severe lodging can adversely affect harvesting operations and decrease yield recovery.

OBJECTIVES

The use of Cerone (ethylene), a growth regulator, will be evaluated for its effectiveness in reducing lodging and its effect on subsequent yield and quality.

MATERIALS AND METHODS

Cerone was applied to several cultivars at the rate of .25 lb. a.i./A:

Su	Se	SH_2
Jubilee	Miracle	Sweetie
Commander		Crisp n Sweet 710
Reward		
Stylepak		

PARAMETERS MEASURED

- -tassel length at application
- -time to maturity
- -plant height (close to harvest)
- -ear height (close to harvest)
- -% kernel moisture
- -husked weight
- -% usable c-o-c
- -cut corn recovery
- -ear length
- -% lodging

Seeds of the various cultivars were planted on May 23 to a population of 27,000/A. After emergence, the plots were thinned to 24,000/A. Lasso (alachlor) and Bladex (cyanizine) at 2.5 and 2 lb. a.i./A were applied preemergence for weed control. All plots were also cultivated once. Urea was applied preplant at a rate of 140 lb. N/A. The average tassel length at application exceeded the target length of 10 cm due to an extended rain delay (Table 1). The experimental plot design was a randomized complete block with 4 replicates. Experimental plots were comprised of 4 rows, each 25 feet long. At maturity (73% kernel moisture), a 100 sq. ft. area was harvested.

RESULTS AND DISCUSSION

Cerone significantly reduced plant and ear height in all cultivars represented (Fig. 1). Differences in maturity was not due to Cerone, but rather reflects cultivar variation (Fig. 2). Upon evaluating the effects on various yield fractions, it became obvious that the magnitude of the response to Cerone varied between cultivars, especially husked weight (Fig. 3). Generally, Cerone treated plants yielded more total ears/A than untreated plants with the one exception being 'Jubilee', which showed the opposite response (Fig. 4). The number of useable ears for corn-on-the-cob freezing was also affected by a cerone x cultivar interaction (Fig. 5). 'Reward' was the only cultivar that did not significantly respond to Cerone treatment. Cut weight recovery was also effected by the use of Cerone in some cultivars. 'Jubilee' and 'Reward' yielded lower when treated with Cerone compared to the untreated plants (Fig. 6). This response may have resulted from reduced total ear yield and/or reduced kernel depth. The cultivar 'Crisp n Sweet 710' when treated with Cerone, yielded a higher cut weight than untreated plants. This might have been expected due to the significant increase in total ear yield when 'Crisp n Sweet 710' was treated. Ear length was not affected in treated plants when compared to the control. Lodging was not observed in any of the experimental plots. The overall lack of response to Cerone application in the cultivar 'Reward' was probably due to the delay in timing of application (loss of sensitivity to Cerone).

SUMMARY

The use of Cerone (ethylene) significantly reduced plant and ear height in several sweet corn cultivars. This may be of some benefit in reducing lodging, particularly the high sugar types (Se and SH_2). However, its effect on yield fractions significantly varied between cultivars. Further investigation is needed to better pinpoint timing and rate of application. In addition, a 'universal' definition of timing of application is needed. These efforts should be focussed on the high sugar cultivars.

Table 1. Average tassel length at time of cerone application

Variety	Tassel Length (cm)
Jubilee (Su)	19.7
Commander (Su)	15.5
Stylepak (Su)	22.0
Reward (Su)	32.3
Miracle (Se)	22.1
Sweetie (SH_2)	15.0
Crisp n Sweet 710 (SH_2)	16.6

(Note: Cerone is not currently labeled for sweet corn.)

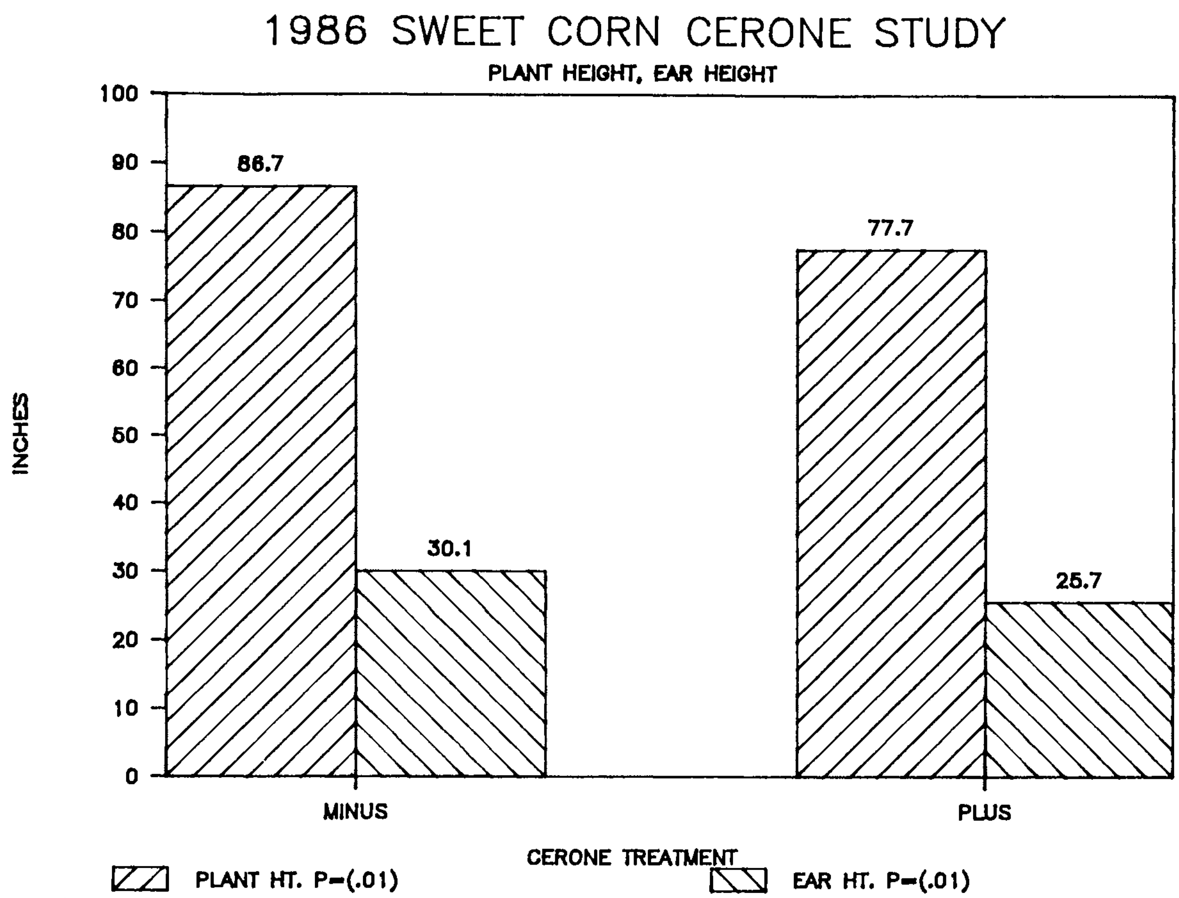


Fig. 1. Effects of Cerone on plant and ear height averaged over all cultivars.

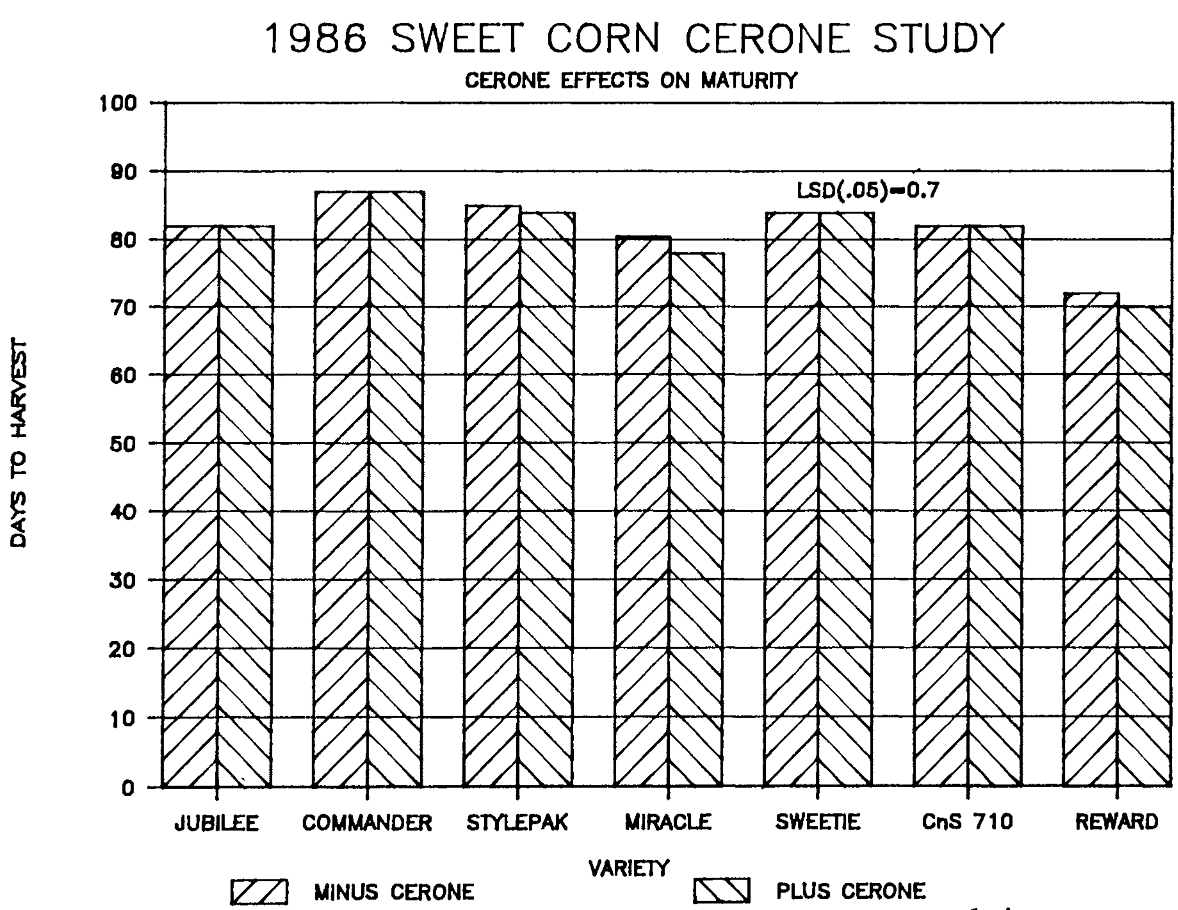


Fig. 2. Effect of Cerone on maturity of several sweet corn cultivars.

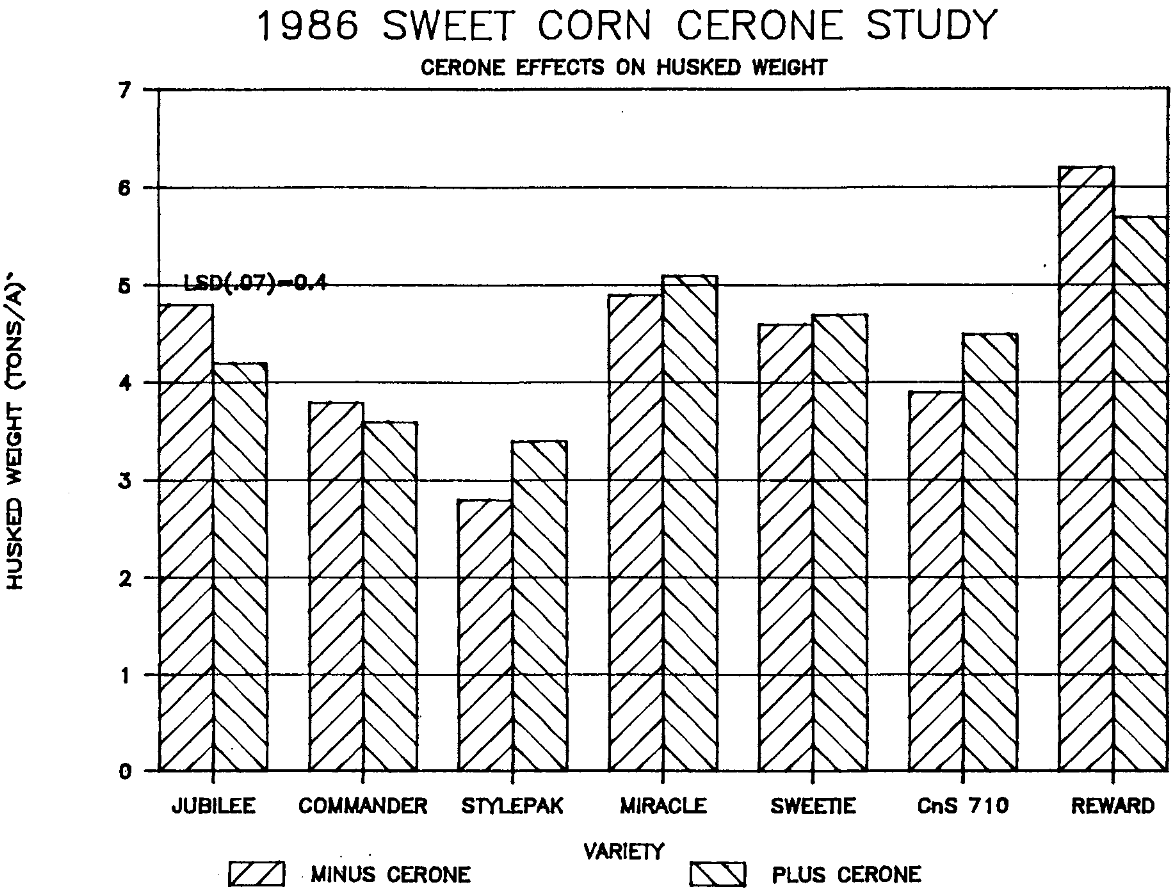


Fig. 3. Effect of Cerone on husked weight.

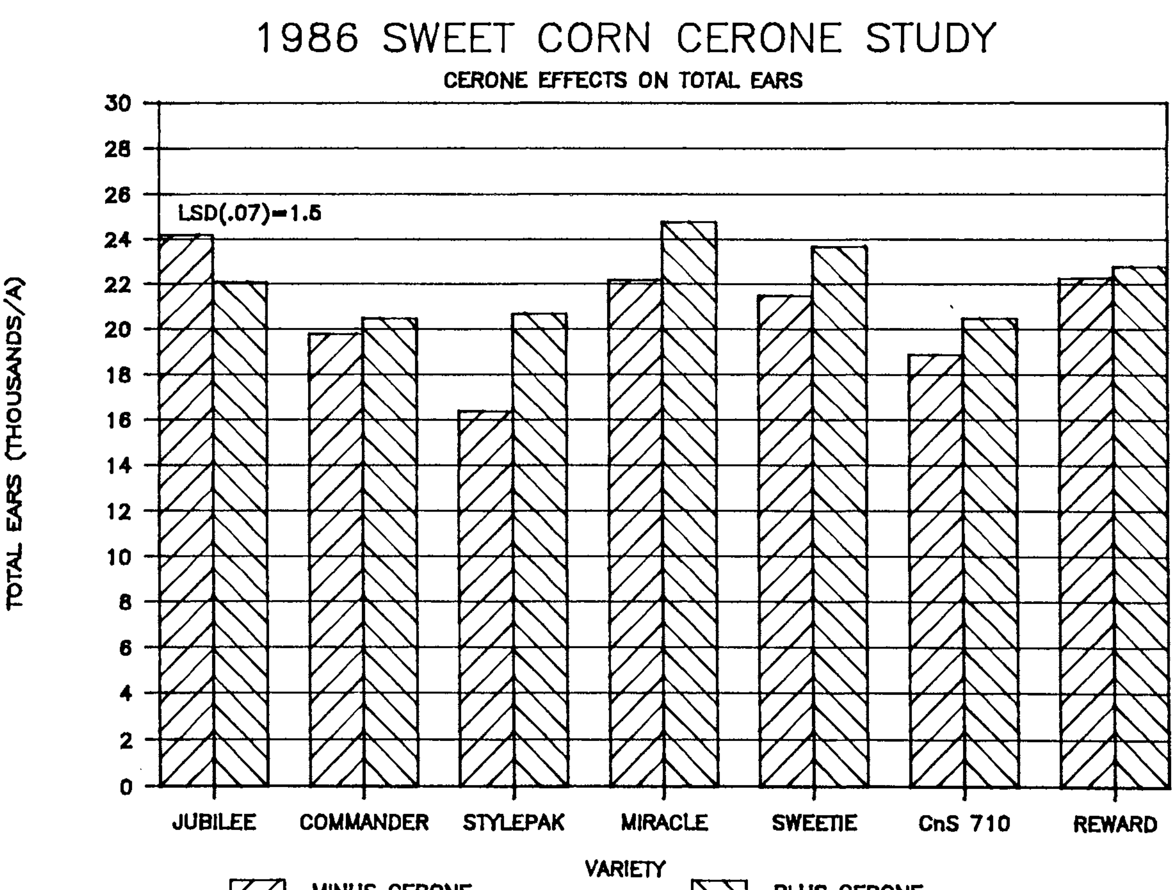


Fig. 4. Effect of Cerone on total ear production.

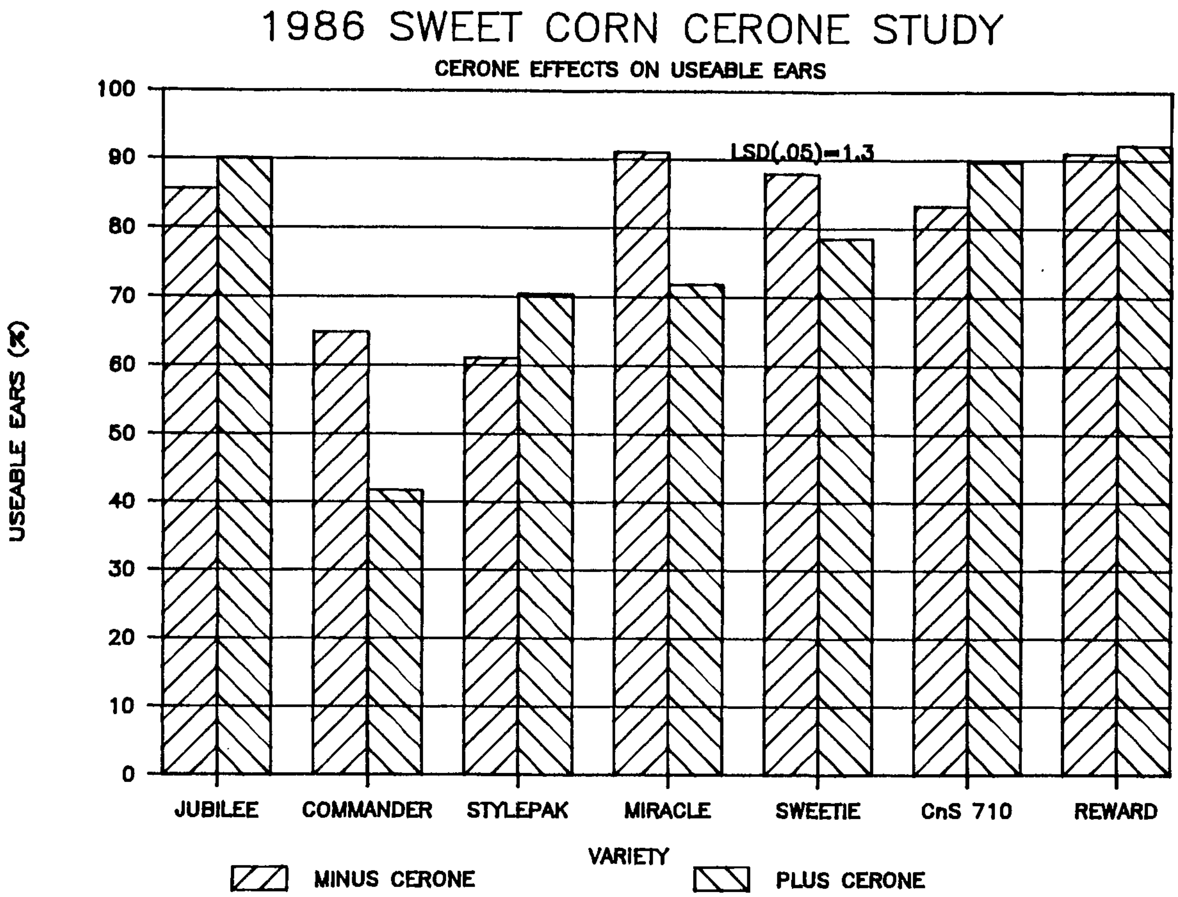


Fig. 5. Effect of Cerone on % useable ears.

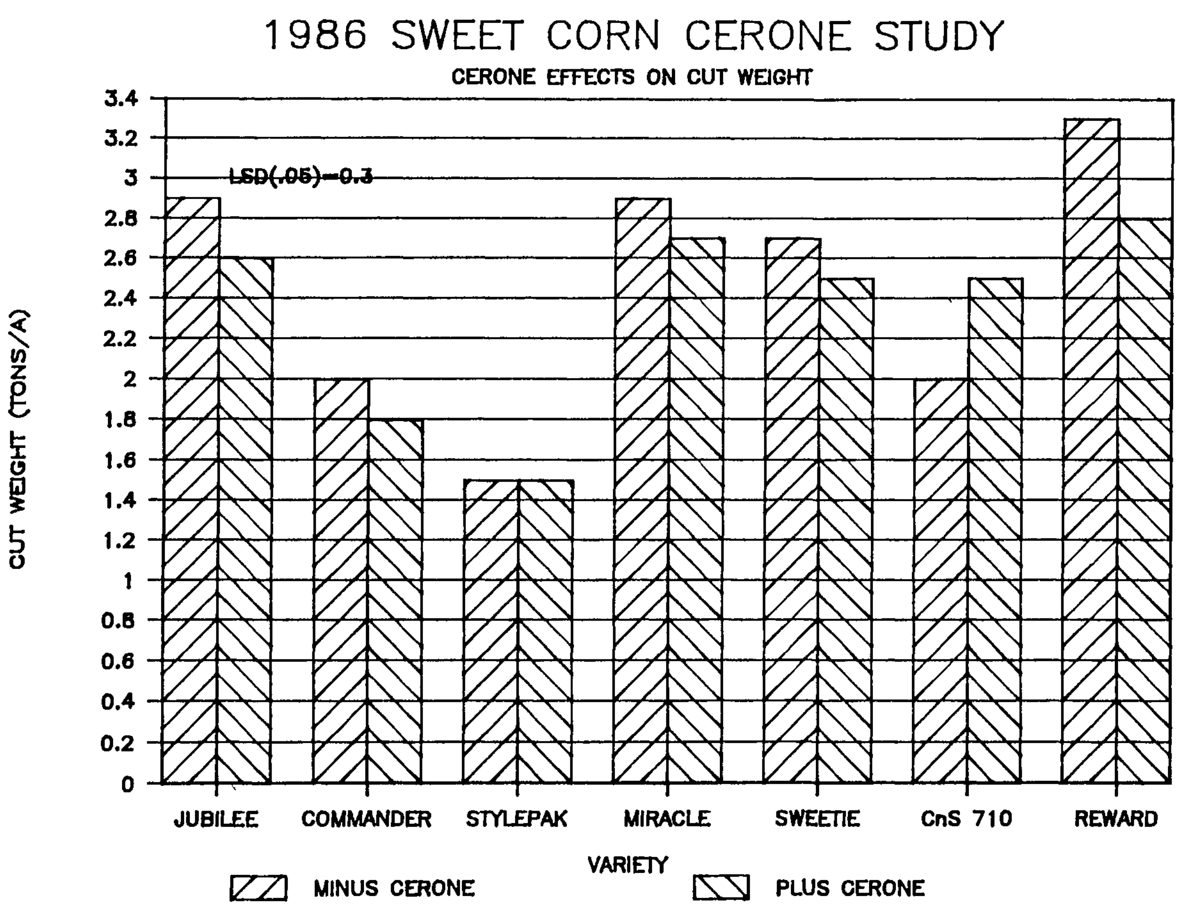


Fig. 6. Effect of Cerone on cut weight recovery.

Planting Date, Nitrogen Fertilizer, and Plant Population Interactions in Processing Sweet Corn - A preliminary report

C. Rosen and V. Fritz

Objective: To determine the response of processing sweet corn to nitrogen fertilizer and plant population at various planting dates.

Procedures:

Site: Waseca, MN Nicollet-Webster clay loam
pH - 6.6, P - 54 lb/A, K - 337 lb/A

Treatments: Fertilizer - 0, 60, 120, 180 lb. N/A as urea broadcast and incorporated 2 days before planting.

Plant Populations - 17,000, 22,000, 27,000 plants/A. Planted at 30,000 plants/A and then thinned.

Planting Dates - May 8, May 22, June 5, June 19.

Previous Crop: Corn

Hybrid: Jubilee

Harvest Dates: August 5, August 13, August 27, September 9.

Results:

Although the experiment was set up with 4 replications, 3 of the 4 replications were flooded out on June 20 and 21. As illustrated in Figure 1 over 6 inches of rain fell between June 15 and June 21. Data presented are based on only one replication.

Sweet corn response to N and plant populations averaged over dates is presented in Figures 2-4. Unhusked yields, cut corn yields, and usable cars increased with N application. The largest increase was from the 0 to 60 lb. increment with only modest increases from 60 to 180 lb. N/A. Cut corn yields were generally highest at the low plant populations and depressed at high plant populations. The results are more complex than this because planting date had an effect on response to N and plant population. Figures 5-7 illustrate N response to planting date averaged over populations. Yields were generally depressed at the first two planting dates compared to the last two dates. this was probably due to greater denitrification at the first two planting dates compared to the second two planting dates. Even though increasing N rate increased yields, all plants were N stressed as measured by ear leaf N at silking (Figure 8). The critical value for N at this time is about 2.6 - 2.8% N. Most values were below this range at all planting dates with lowest levels occurring at the first two planting dates.

Response of sweet corn to plant populations and planting date averaged over N rates is illustrated in Figures 9-11. At the first two planting dates were N stress was greatest, lower plant populations were favored. In contrast, by the second two planting dates, N stress was not as great and higher plant populations increased yields. This was especially evident for number of usable ears (COC eligible) per acre.

In summary, this experiment will have to be repeated because of flooding problems; however, some interpretations based on the data collected this year are as follows:

1. Sweet corn responded to N at all planting dates and plant populations.

2. Because of excessive rainfall and poor drainage, denitrification occurred causing N stress at all planting dates and N rates. Stress was greatest at the earlier planting dates and lower N rates.

3. Response to N rate and plant populations was highly dependent on planting date which in turn was dependent on climatic conditions during the season.

4. Unhusked yields did not always correlate well with cut corn yields or number of usable ears.

5. Due to greater N stress, lower plant populations at the earlier planting dates resulted in higher cut corn yields and usable ears.

6. At the later planting dates N stress was not as great and higher plant populations resulted in greater number of usable ears/A.

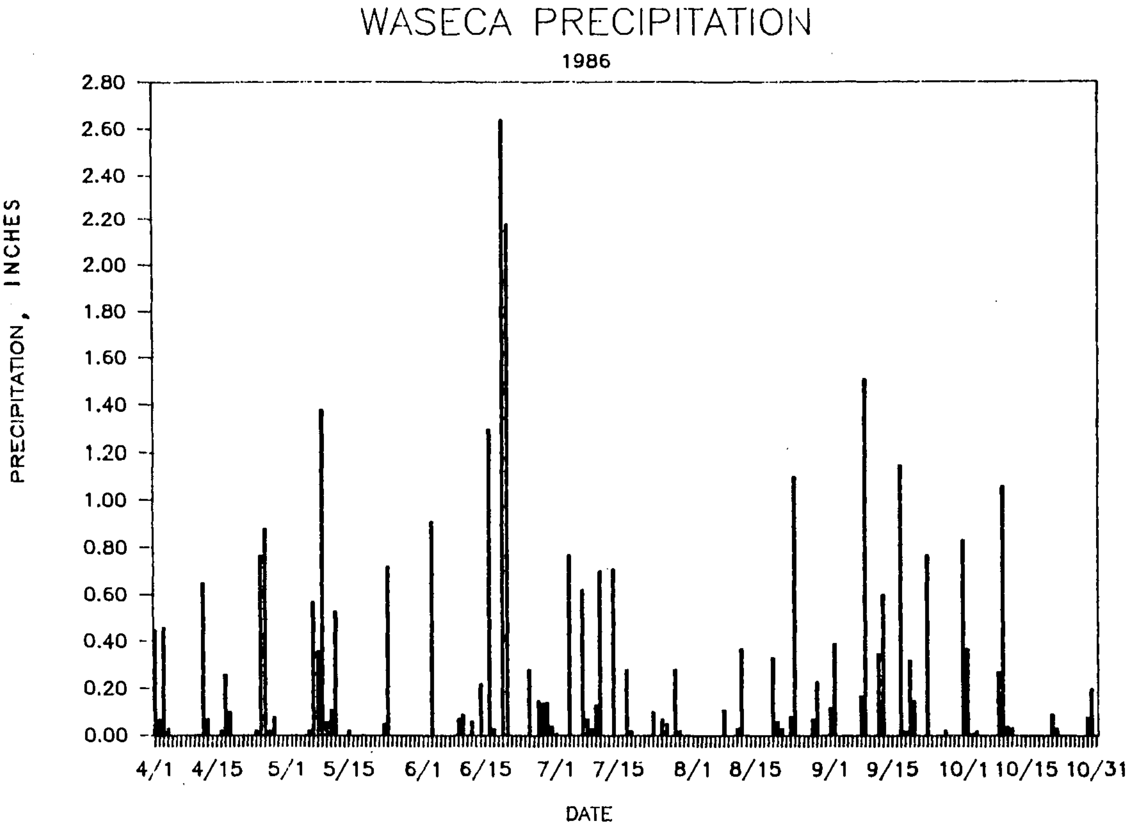


Figure 1. Daily precipitation at the Southern Experiment Station, 1986.

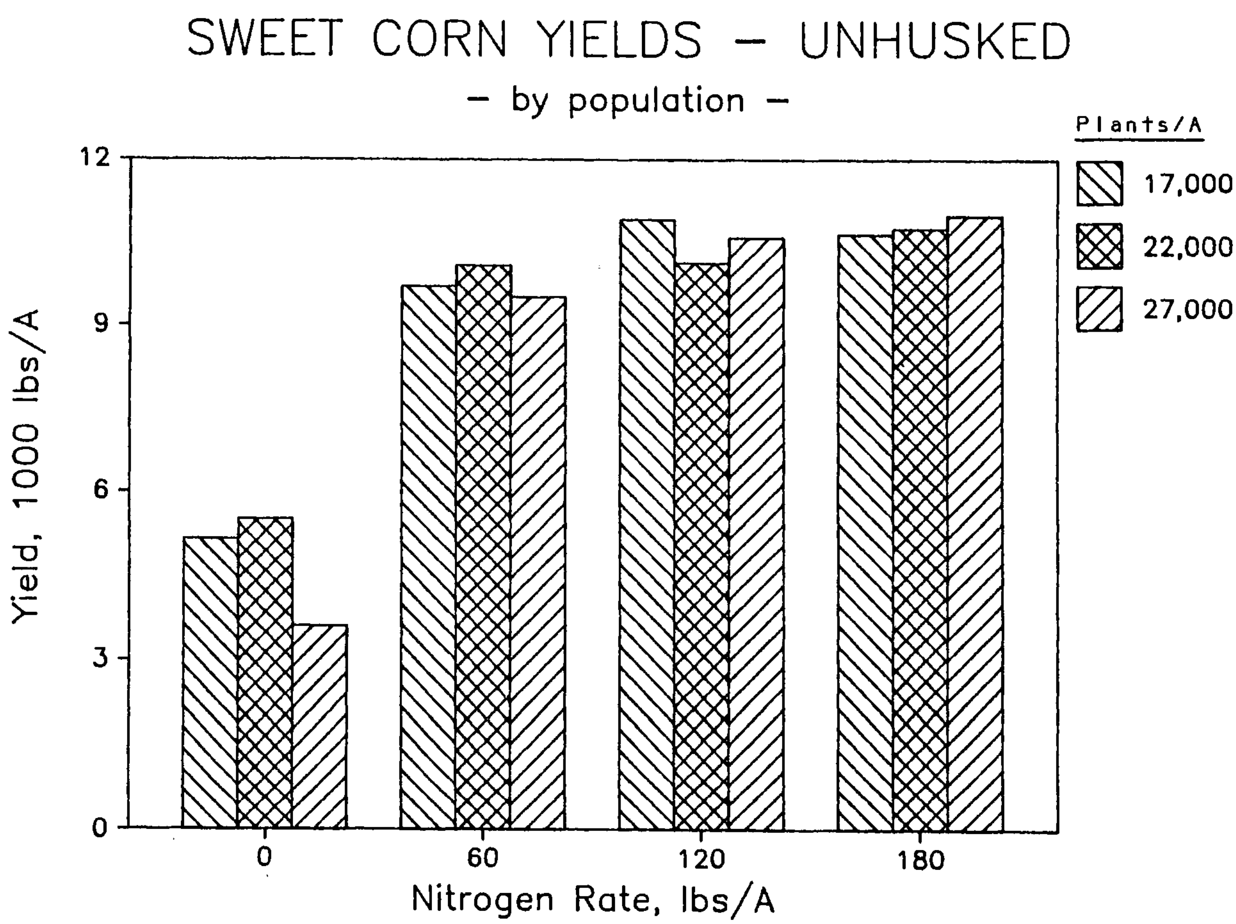


Figure 2. Influence of N rate and plant population on unhusked yields, averaged over planting dates.

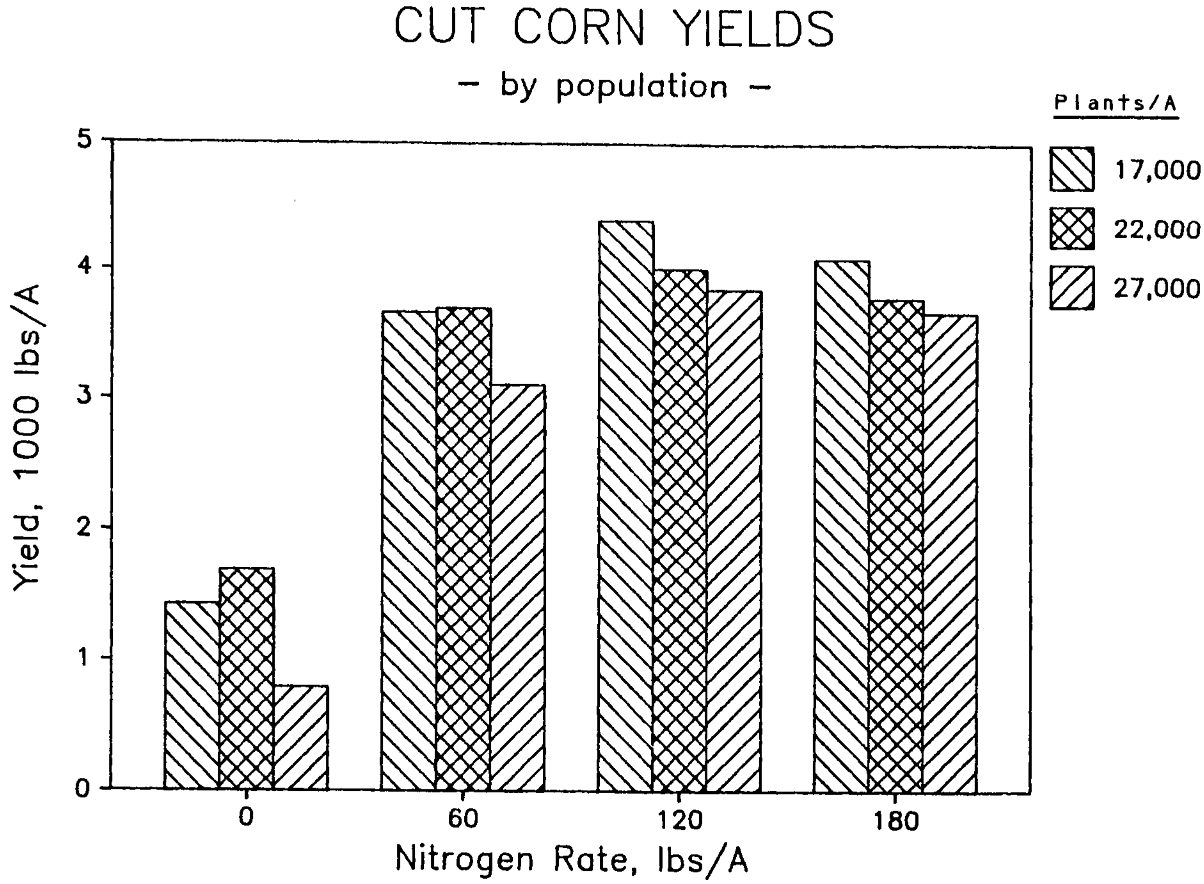


Figure 3. Influence of N rate and plant population on cut corn yields, averaged over planting dates.

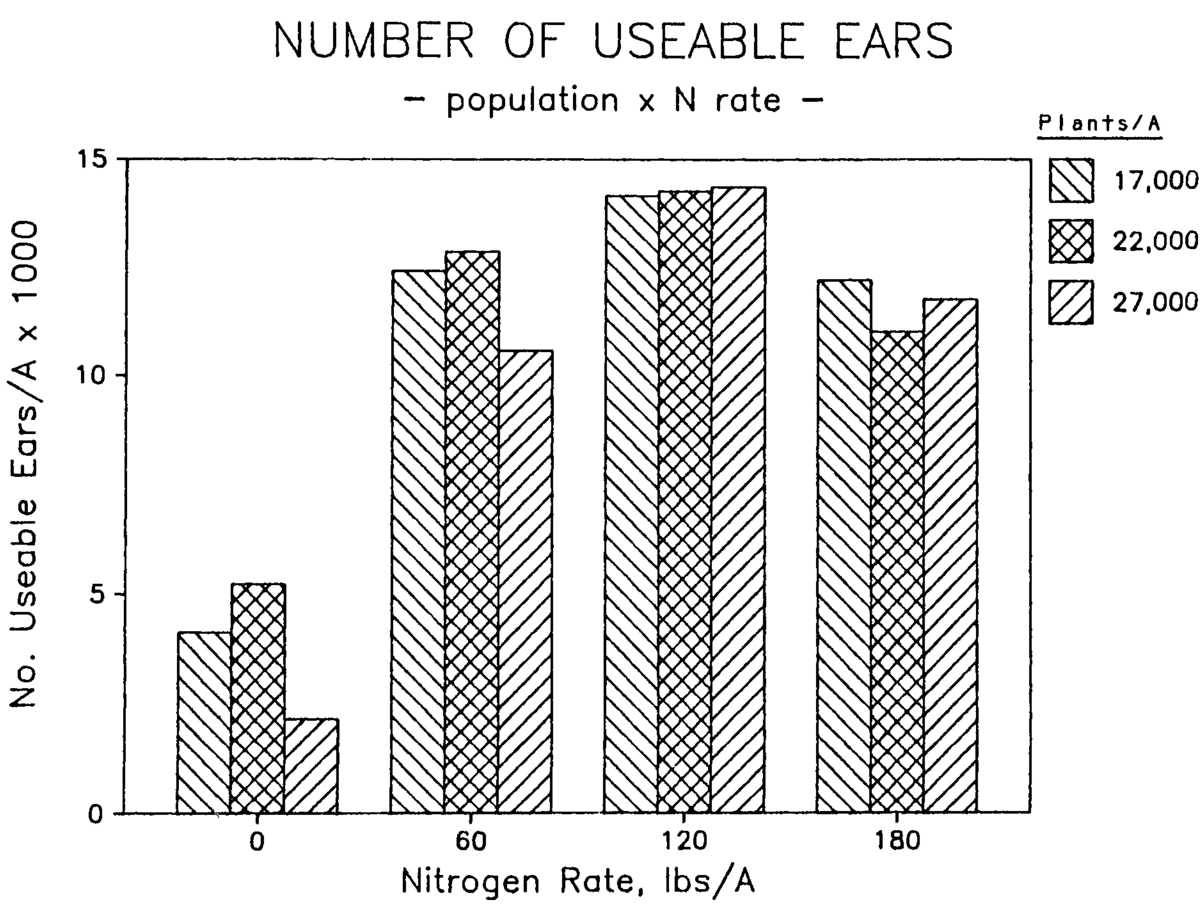


Figure 4. Influence of N rate and plant population on number of usable ears/A, averaged over planting dates.

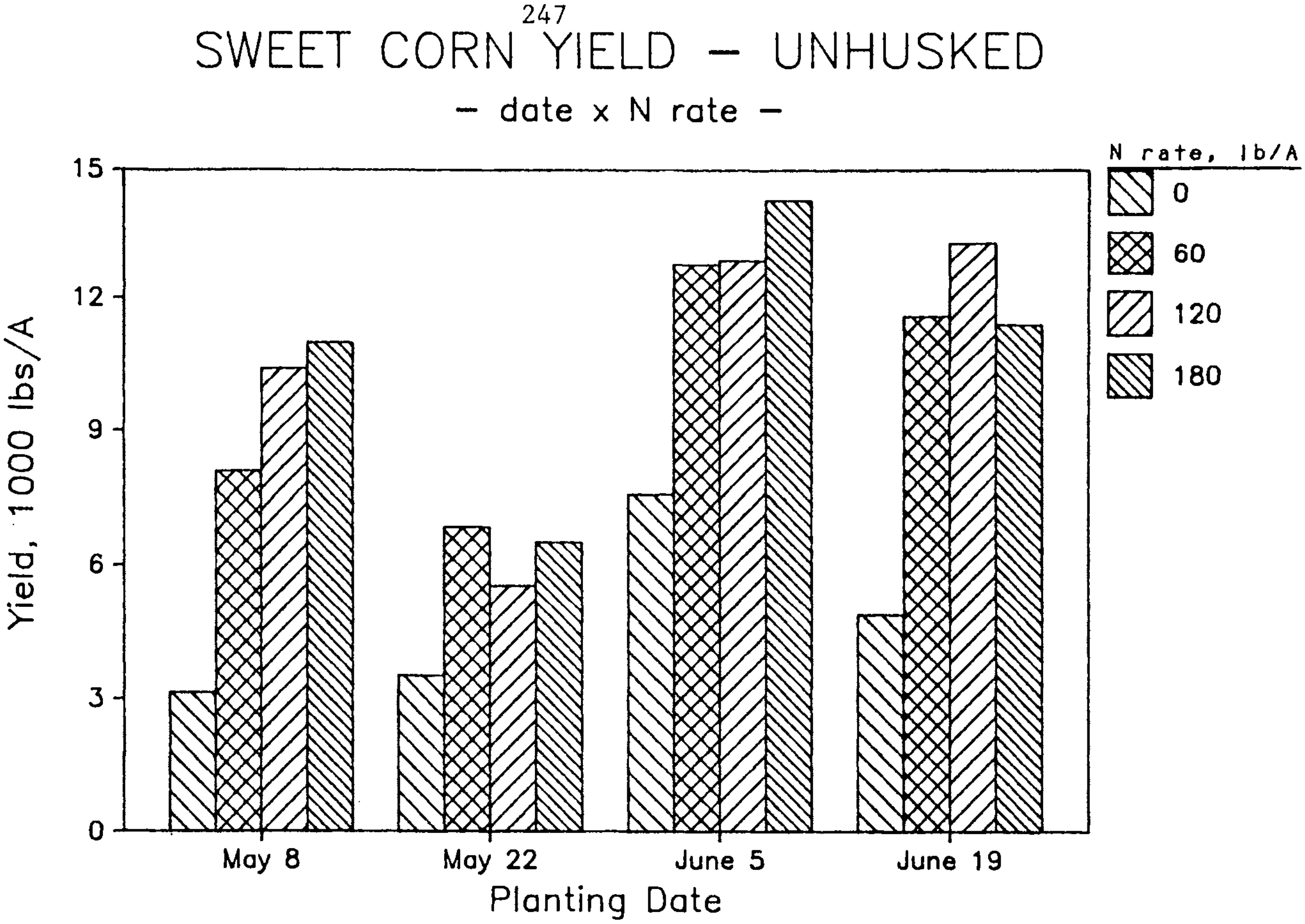


Figure 5. Influence of planting date and N rate on unhusked yields, averaged over plant populations.

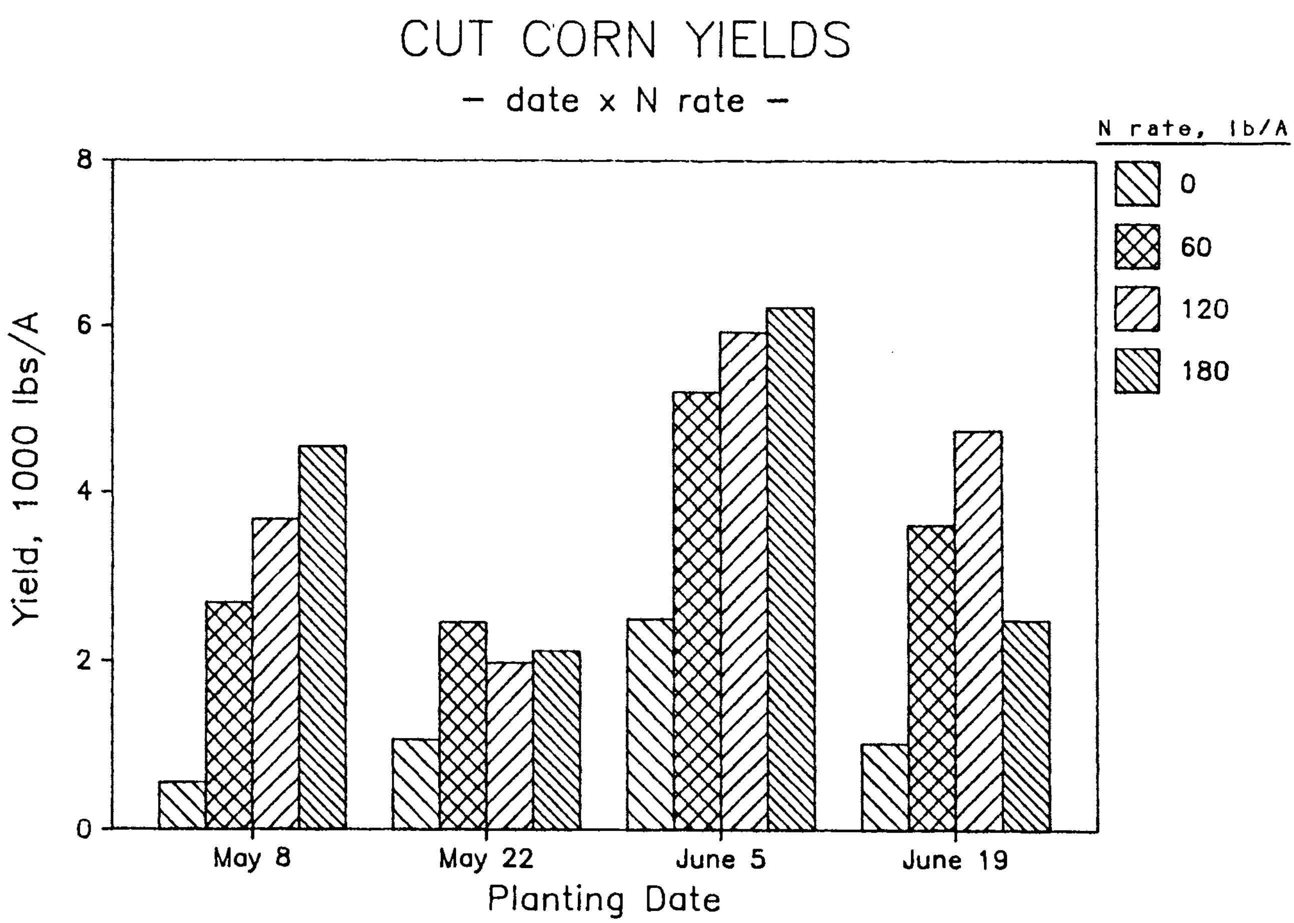


Figure 6. Influence of planting date and N rate on cut corn yields, averaged over plant populations.

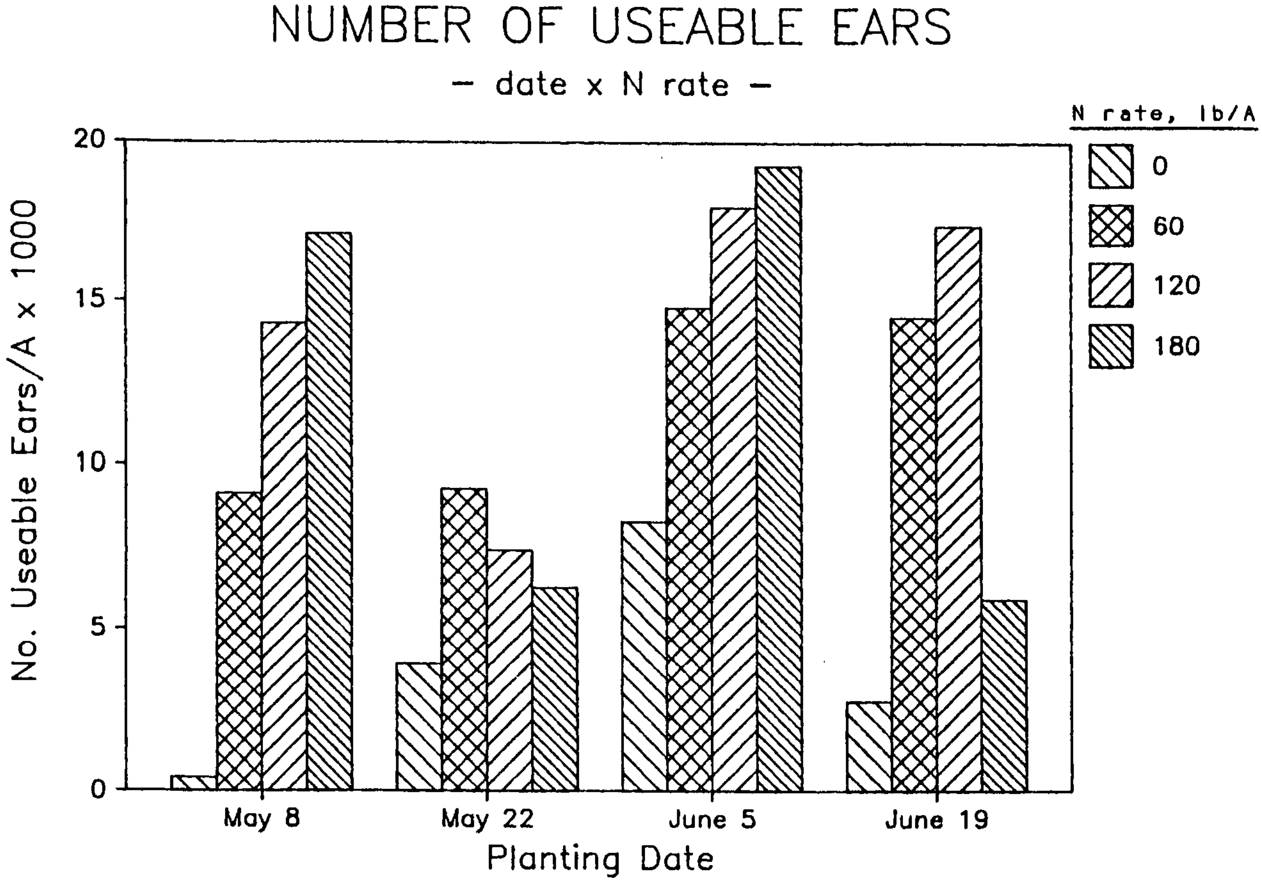


Figure 7. Influence of planting date and N rate on number of usable ears/A, averaged over plant populations.

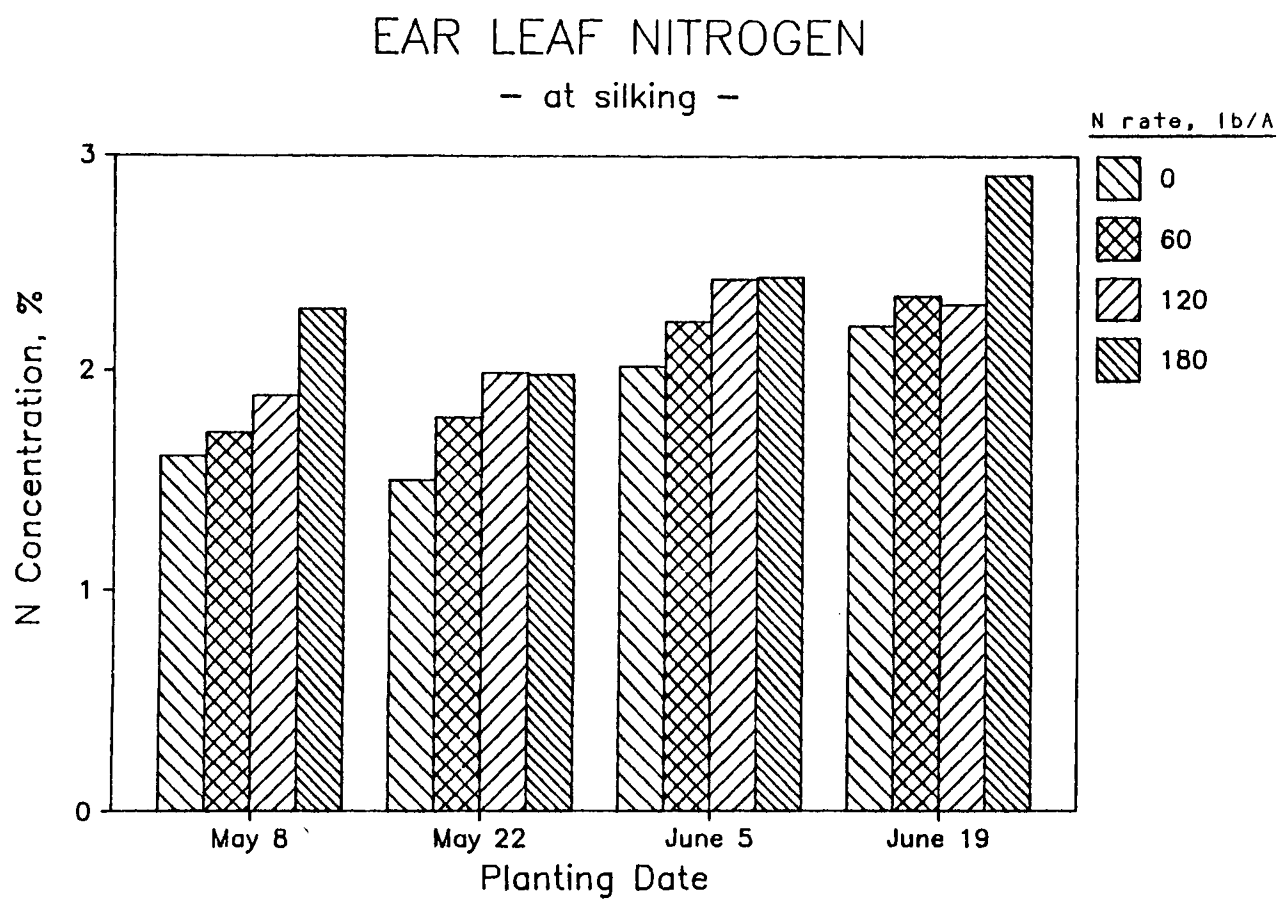


Figure 8. Influence of planting date and N rate on ear leaf N concentration at silking.

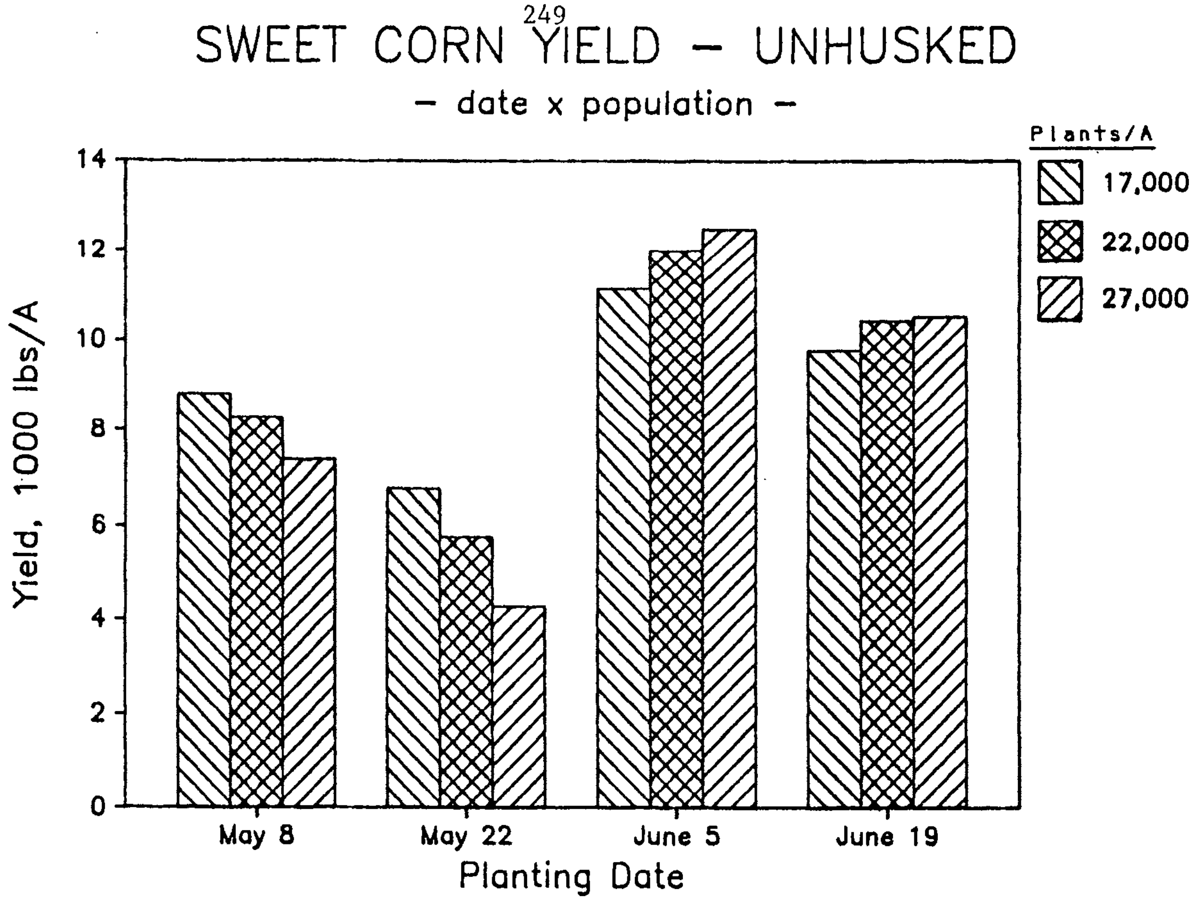


Figure 9. Influence of planting date and plant populations on unhusked yields, averaged over N rates.

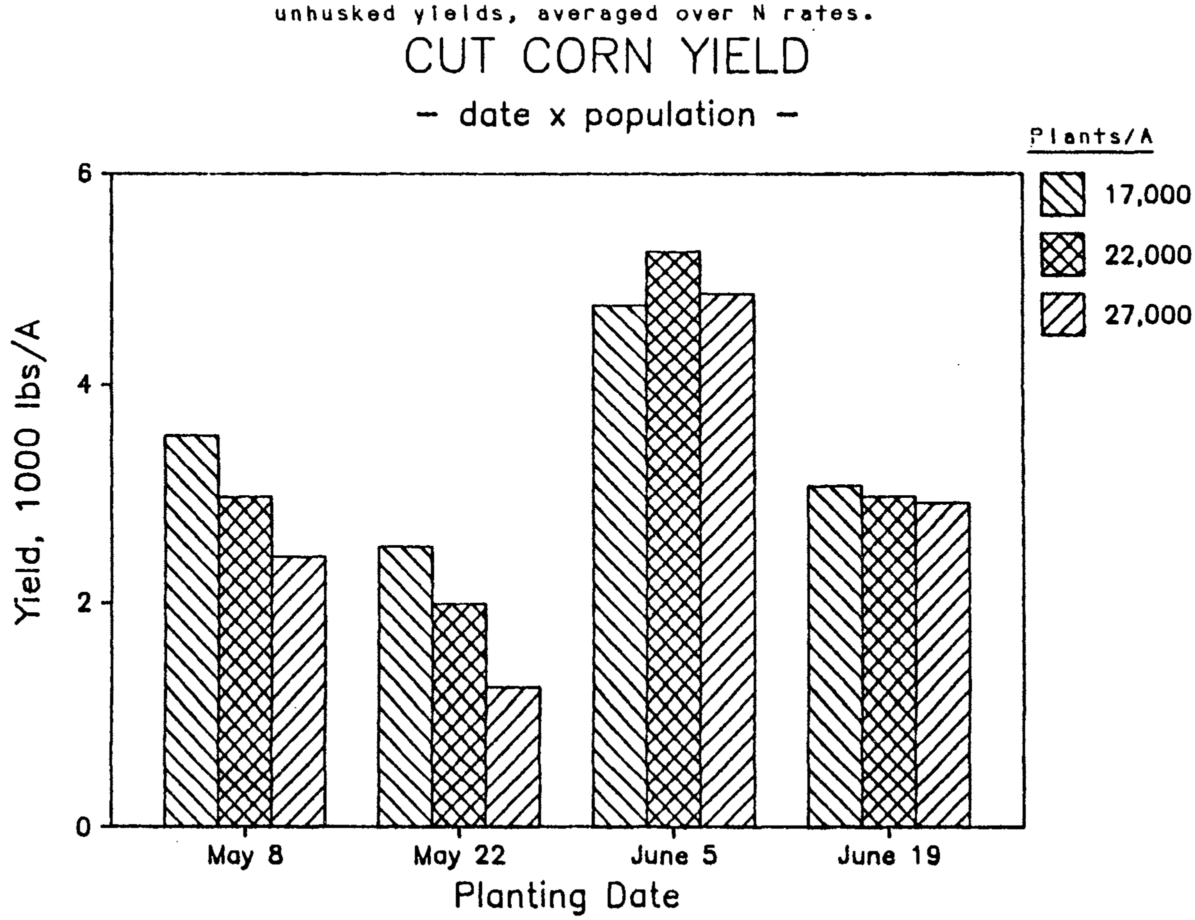


Figure 10. Influence of planting date and plant populations on cut corn yields, averaged over N rates.

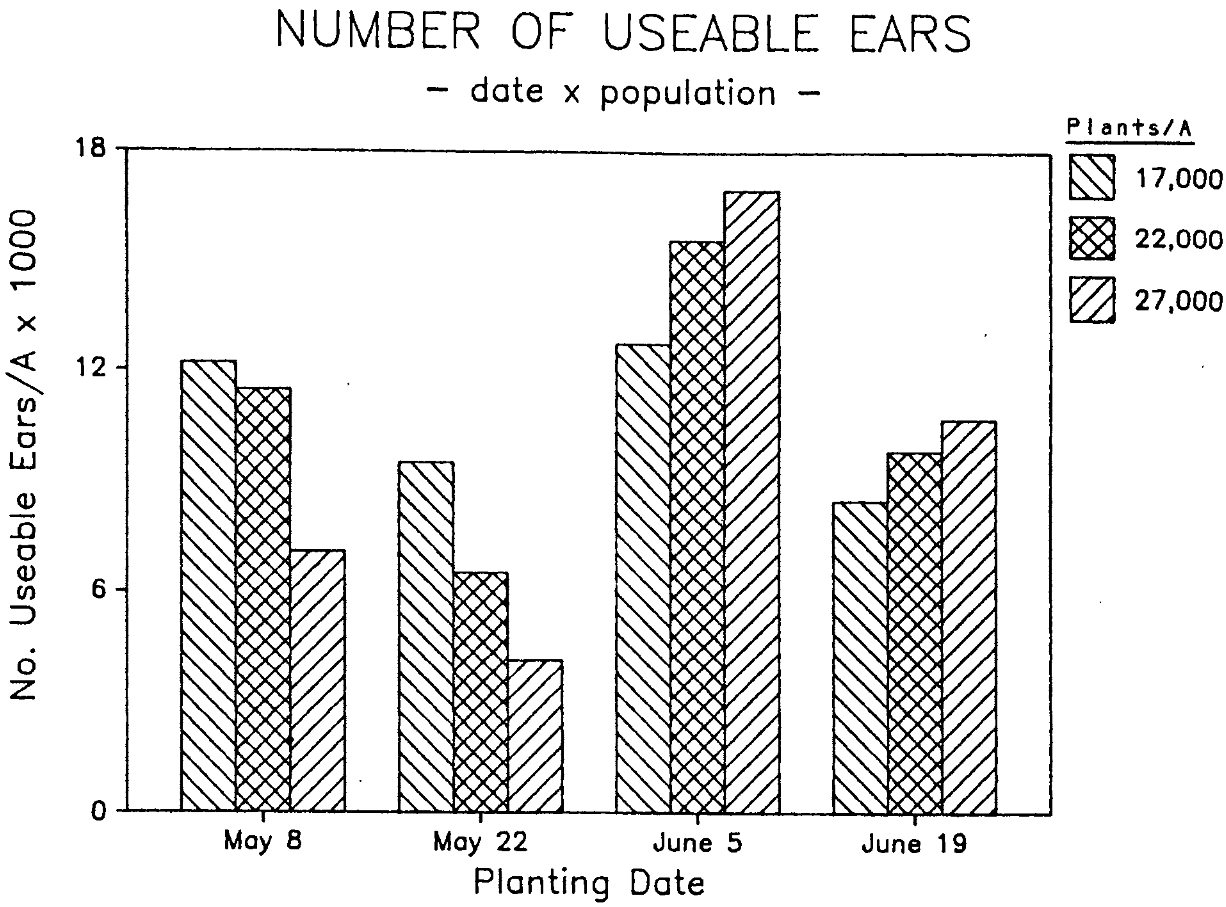


Figure 11. Influence of planting date and plant populations on number of usable ears/A, averaged over N rates.

CONTROL OF ANNUAL GRASS AND BROADLEAF WEEDS IN SWEET CORN

Leonard B. Hertz and Vincent Fritz
University of Minnesota
Southern Experiment Station
Waseca, Minnesota 56093

A number of herbicides were evaluated for weed control in sweet corn. 'Jubilee' sweet corn was planted on May 20, in a clay loam soil, pH 6.4 and organic matter 6.5% at the Southern Experiment Station, Waseca, Minnesota. The plots were 10 feet wide by 30 feet long, 4 rows with 30 inch spacings. The plots were randomized in a complete block design with four replications. The preplant incorporated (PPI) and preemergence (PRE) treatments were applied on May 20 with the PPI treatments incorporated to a depth of 2 inches. Early postemergence (EPO) treatments were applied on June 5 when the corn was in the 3-4 leaf stage and the weeds were 1/2-1 inch tall. Postemergence (PO) treatments were applied on June 19 when the corn was in the 6-8 leaf stage and weeds were 4-6 inches tall. All treatments were made with a CO_2 powered, bicycle sprayer delivering 20 gpa of water at 30 psi. Weed control was based on visual ratings taken on July 18. The weed population consisted of foxtail sp. (60%), velvetleaf (6%) and redroot pigweed (34%).

Control of annual grasses was good in all treatments except, the tank mixes of Prowl plus Bladex or Atrazine, which gave only fair control, 58% and 53% respectively. Atrazine alone gave 43% control of grasses. The lack of grass control was reflected in lower corn yields. Broadleaf weed control was good to excellent in all treatments except Ro-Neet alone which gave only 63% control of redroot pigweed. Some corn stunting was apparent with the tank mixes of Prowl plus Bladex and Prowl plus Atrazine. Complete results are presented on the accompanying Table.

Table. Weed control in sweet corn, Waseca, MN - 1986

Treatment	Rate (lb./A)[y]	Time of appl[x]	Weed Control (%) Grft[w]	Rrpw	Vele	Oval	Crop Inj.	Corn Husk	Yield[u] Cut
ME4 Brominal+Lasso	0.25+3	PO+PRE	73	90	98	63	0	3.4	1.7
ME4 Brominal+Lasso	0.38+3	PO+PRE	73	90	98	68	1	3.1	1.6
ME4 Brominal+Atrazine +Lasso	0.3+0.4 +3	PO +PRE	83	100	100	83	0	4.0	2.1
ME4 Brominal+Atrazine +Lasso	0.25+0.33 +3	PO +PRE	70	93	98	63	0	3.8	1.9
Atrazine+COCz +Lasso	0.5 +3	PO +PRE	80	100	88	70	0	4.1	2.1
Buctril+Lasso	0.25+3	PO+PRE	85	75	95	58	0	3.7	1.9
Buctril+Atrazine +Lasso	0.25+0.5 +3	PO +PRE	80	100	98	78	0	4.0	2.0
Buctril+Atrazine +Lasso	0.188+0.38 +3	PO +PRE	70	95	100	65	0	3.5	1.9
Lasso	4	PRE	83	88	83	60	0	3.3	1.6
Prowl+Bladex	1.5+2	EPO	58	98	100	48	3	2.7	1.3
Prowl+Atrazine	1.5+1.6	EPO	53	100	100	53	2	3.0	1.6
Prowl+Bladex +Atrazine	1.5+2 +1.6	EPO +EPO	68	100	100	68	0	3.9	1.7
Prowl+Bladex +Lasso	1+2 +4	EPO +PRE	95	100	100	95	1	4.5	2.2
Lasso+Bladex	4+2	PRE	93	85	78	60	0	3.1	1.6
Eradicane+Bladex	4+2	PPI	95	78	100	73	0	3.9	2.0
Atrazine	4	PRE	43	95	88	33	0	1.5	0.7
Ro-Neet+Bladex	4+2	PPI	93	83	95	75	0	3.7	1.7
Ro-Neet	4	PPI	93	67	93	57	1	3.2	1.7
Weeded	--	--	100	100	100	100	0	4.0	2.1
Untreated	--	--	0	0	0	0	0	0.1	0.0
LSD.05			18	11	11	19	21	1	1

z. COC: Crop oil concentrate, 1 qt./A
y. Rate: Measured in pounds active ingredient/A.
x. Application: PO=postemergence, EPO=early postemergence, Pre=preemergence, PPI=preplant incorporated.
w. Grft=green foxtail, Rrpw=redroot pigweed, Vele=velvetleaf, Oval=overall.
v. Injury: 0=none and 10=plants dead.
u. Yield: Measured in Tons/A.

Pea Root Rot Evaluation

D. Davis, F. Pfleger, V. Fritz, R. Allmaras, J. Percich

In 1986, the pea disease area at Waseca was paired with an adjacent, relatively disease free soil in order to provide a comparison for each test entry. A total of 139 entries were tested, of which 92 were University of Minnesota breeding lines. The planting was made on May 5, purposely late so as to provide more stress from root rot.

Results

Results are summarized on the table on the following pages. The disease rating is on a 1 to 5 basis, where 1 = no disease and 5 = plants dead. On some of the entries of greater interest as well as on some which appeared to have less disease we took a dry seed harvest from plots in the infested field and corresponding plots in the adjacent clean field. There are 2 things to look at on the yield data. First, the maximum yield on clean soil varies a lot. A good variety like Target gave a high yield of 750 grams. Secondly, the decrease in yield from clean to diseased soil also varies a lot. With Target, a root rot susceptible variety there was a 73% decrease in yield, while the decrease in yield for Minnesota 108 was only 3%. However, Minnesota 108 may have lower yield potential. Of greater interest, however, are some of the new selections such as Minnesota #s 56, 62, 63, and 68. All of these had yield decreases of less than 30% and high yield potential as well. The USDA group also is of interest as yield potential is very high and % decrease due to root rot was fairly low. Also, these USDA selections have good pod and plant type.

In the table, those numbers preceded by an asterisk are entries from which seed was kept for breeding and for evaluation in 1987. Many of the University of Minnesota entries look quite resistant, although on average they are late in maturity. Based on root rot rating and on plant and pod characteristics, and on yield, 45 Minnesota lines were selected. Of these, 8 were particularly attractive.

Soil Sampling to Determine Inoculum Localization

To determine if the fungus, *Aphanomyces euteiches*, which cause pea root rot, tends to concentrate at certain depths in the soil, such as above or below the plow pan, or at the layer of greatest concentration of organic material plowed down, many soil samples were taken by Dr. Ray Allmaras, USDA Soil Scientist. These were taken at various depths. Dr. Jim Percich, Plant Pathologist, currently is analyzing these samples for the fungus.

Evaluation for Root Rot Complex
University of Minnesota
Southern Experiment Station, Waseca[y]
1986

	% Stand	Date 50% Flowering	Estimate of Harvest Maturity	1-5 Disease Rating			Dry Seed Yield (gm)		
				6/20	6/24	7/1	Diseased	Clean*	% Decrease
CS 508-4-2-4C	78	6/17	7/3	4.3	2.7	4.5			
CS 2100EP (old 508-7)	83	6/18	7/3	4.3	3.3	4.5			
CS 8440F (old 520-11F)	64	6/17	7/1	4.7	3.7	4.7			
CS 517-4Fr	66	6/17	7/4	4.0	3.3	4.5			
CS 77EP	86	6/17	7/5	2.7	2.7	3.5			
CS 7705-4F	54	6/18	7/3	3.7	3.3	5.0			
CS 9000F (old 7705-11)	52	6/20	7/7	3.7	2.7	5.0			
CS 9713-8ES	83	6/12	7/1	5.0	3.3	4.2			
CS 9713-19C	41	6/17	7/3	4.0	4.0	4.7			
CS 9724-10C	78	6/12		3.0	2.0	4.2	160	418	-62
CS 9726-2F	66	6/16	7/3	3.0	2.7	4.0			
CS 9727-10Fr	71	6/12	7/3	2.7	2.0	3.5	398	604	-34
CS 9731-3C	83	6/18	7/4	3.7	2.7	4.5			
CS 9731-4	58	6/18	7/4	5.0	3.3	4.2			
Target	68	6/12	6/29	4.1	3.7	4.3	203	750	-73
MN 108	98	6/20?	7/15	3.0	1.7	2.5	339	348	-3

[y] Values are means of three 20-foot plots in the diseased area. Planted in single-row, 20', untrellised plots May 5.
* Mean yields for 4 entries are included from 2 plots in an adjacent clean site also are included.

Results from the Pea Disease Nursery, Waseca

Test Entry	50% Bloom[1]	Disease Rating Near Prime Harv.	Average Plot Yield (grams) Diseased	Clean	% Decrease
GG 250	6/20	3.5	218	316	-31%
GG 512	6/18	3.7	191	518	-63
GG 531	6/17	3.0	379	636	-40
GG 933	6/13	4.0			
Canners Seed 508-4	6/17	4.5			
Canners Seed 2100 EP	6/17	4.5			
Canners Seed 8440 F	6/18	4.7			
Canners Seed 517-4 Fr	6/17	4.5			
Canners Seed 77 EP	6/16	3.5			
Canners Seed 7705-4F	6/18	5.0			
Canners Seed 9000 F	6/20	5.0			
Canners Seed 9713-8 ES	6/10	4.2			
Canners Seed 9713-19C	6/17	4.7			
Canners Seed 9724-10C	6/8	4.2	160	418	-62
Canners Seed 9726-2 F	6/16	4.0			
Canners Seed 9727-10 Fr	6/12	3.5	398	604	-34
Canners Seed 9731-3 C	6/18	4.5			
Canners Seed 9731-4	6/18	4.2			
Rogers RB1	6/10	3.5	151	576	-74
Rogers RB2	6/9	4.4			
Rogers RB3	6/19	4.5			
Rogers RB4	6/20	4.2			
Rogers RB5	6/21	4.5			

Rogers RB6	6/22	4.2	117	166	-30
Rogers RB7	6/17	4.1			
Rogers RB8	6/7	3.7			
Rogers RB9	6/21	4.2			
Rogers RB10	6/15	3.2			
Rogers RB11	6/10	4.5			
Rogers RB12	6/16	3.7	277	631	-56
Rogers RB13	6/14	4.2			
Rogers RB14	6/16	5.0			
Rogers RB15	6/19	4.6			
Rogers RB16	6/21	4.4			
USDA 1	6/21	3.0			
USDA 3	6/17	3.5			
USDA 7	6/19	1.5	439	773	-43
USDA 8	6/20	3.5			
USDA 10	6/17	1.5	428	664	-36
USDA 13	6/18	4.5			
USDA 14	6/21	1.5	602	690	-13
USDA 15	6/21	3.7			
USDA 18	6/21	3.2			
USDA 20	6/19	2.0	432	628	-31
USDA 22	6/20	3.0			
USDA 23	6/21	3.5			
Minn. *47	6/20	2.5			
Minn. 48	6/20	3.5			
Minn. 49	6/20	3.0			
Minn. 50	6/19	3.0			

Minn. 51	6/20	3.5			
Minn. 52	6/20	3.0			
Minn. 53	6/19	3.1			
Minn. *54	6/18	3.0			
Minn. 55	6/20	3.3			
Minn. **56	6/19	1.5	502	674	-26
Minn. 57	6/14	2.0			
Minn. *58	6/20	2.0			
Minn. *59	6/16	2.5			
Minn. *60	6/18	3.2			
Minn. 61	6/20	3.5			
Minn. **62	6/14	1.7	554	596	-7
Minn. **63	6/17	1.7	455	526	-13
Minn. *64	6/20	2.5			
Minn. *65	6/21	2.0			
Minn. *66	6/20	1.5			
Minn. **67	6/13	1.0	364	530	-31
Minn. **68	6/14	1.7	541	618	-12
Minn. **69	6/18	1.8	481	810	-41
Minn. *70	6/20	2.0			
Minn. 71	6/19	2.5			
Minn. *72	6/11	3.5			
Minn. *73	6/20	2.0			
Minn. *74	6/19	2.5			
Minn. 75	6/18	3.0			
Minn. **76	6/20	1.7	405	384	+5
Minn. 77	6/20	2.5			

Minn. *78	6/19	3.5			
Minn. *79	6/20	3.0			
Minn. 80	6/20	3.5			
Minn. *81	6/18	2.5			
Minn. 82	6/17	3.0			
Minn. 83	6/20	2.7			
Minn. 84	6/19	2.8			
Minn. *85	6/20	3.5			
Minn. *86	6/20	3.2			
Minn. 87	6/19	3.5			
Minn. 88	6/19	4.5			
Minn. 89	6/18	2.7			
Minn. 90	6/19	4.0			
Minn. *91	6/20	2.5			
Minn. 92	6/18	2.5			
Minn. *93	6/20	2.5			
Minn. 108	6/20	2.0	339	348	-3
Target	6/11	4.3	203	750	-73
Minn. 96	6/19	4.0			
Minn. *97	6/17	3.5			
Minn. 98	6/16	3.0			
Minn. 99	6/19	3.5			
Minn. 100	6/19	2.5			
Minn. *101	6/20	1.5			
Minn. 102	6/15	4.5			
Minn. 103	6/20	3.5			
Minn. *104	6/18	2.5			

Minn. 105	6/20	3.5
Minn. 106	6/20	4.5
Minn. 107	6/20	4.5
Minn. *108	6/20	2.5
Minn. *109	6/18	2.5
Minn. *110	6/20	2.5
Minn. *111	6/20	2.0
Minn. *112	6/19	2.5
Minn. *113	6/17	3.0
Minn. *114	6/19	3.0
Minn. 115	6/19	4.0
Minn. 116	6/20	4.0
Minn. 117	6/21	4.0
Minn. 118	6/20	5.0
Minn. 119	6/20	2.0
Minn. *120	6/20	2.0
Minn. *121	6/19	2.0
Minn. *122	6/20	3.0
Minn. *123	6/21	2.0
Minn. *124	6/14	3.0
Minn. *125	6/19	2.5
Minn. **126	6/18	1.0
Minn. 127	6/20	3.5
Minn. *128	6/19	3.0
Minn. 129	6/20	5.0
Minn. 130	6/19	4.5
Minn. 131	6/20	4.0

Minn. 132	6/19	4.5
Minn. 133	6/20	4.0
Minn. 134	6/20	3.0
Minn. 135	6/19	3.5
Minn. 136	6/21	4.0
Minn. *137	6/20	3.0
Minn. 138	6/20	4.0
Minn. 139	6/20	4.5

FUNGICIDE SEED TREATMENT AND NITROGEN EFFECTS ON INOCULATION/NODULATION POTENTIAL AND YIELD IN PEAS

Vincent Fritz, Carl Rosen
James Hebel, Harvey Buchite
University of Minnesota
Southern Experiment Station
Waseca, Minnesota 56093

IMPORTANCE

Minnesota's pea production for processing is consistently rated among the top two states. 1986 production yielded 94,510 tons from 72,700 acres. With an average yield of 1.30 tons/A total cash receipts reached nearly $22 million dollars.

The roots of peas, a leguminous plant, is often engaged in a symbiotic relationship with a bacterium, Rhizobium. The establishment of this plant/bacterium relationship results in nodule formation (nodulation), which facilitates plant nitrogen utilization by extracting N_2 gas from the atmosphere and reducing it to an NH_4 form. It is uncertain whether artificial inoculation is beneficial for improved nodulation and nitrogen utilization in heavy soils. The benefits of nitrogen sidedressing may also effect nodulation.

Certain fungicide seed treatments may have some toxic effects on Rhizobium and nodulation. If other potential fungicides can be identified without adversely affecting the Rhizobium bacterium, nodulation may improve and, thereby, decrease the crops dependence on nitrogen for maximum economic return.

OBJECTIVES:

1) to determine if Captan fungicide has a deleterious effect on pea root infection of Rhizobium, nodulation, and yield.

2) to determine if the effect of nitrogen on nodulation, nitrogen utilization, and yield.

3) to determine the soil's potential for natural Rhizobium inoculation of pea roots.

MATERIALS AND METHODS:

The experimental design was a split plot with nitrogen treatments comprising the main plots and combinations of fungicide and inoculation treatments comprising the subplots. Four replicates were planted. The seed of 'Target' were planted on April 22. Seeds were treated with fungicides and either inoculated with Rhizobium or left uninoculated. The treated seeds were also grown under different nitrogen levels. The treatments were as follows:

Nitrogen Rates	Inoculation	Fungicide
lbs./A		
0	+	Captan
20	-	Thiram
40		

A total of 12 treatment combinations were represented in each replicate.

The parameters measured were as follows:

1) Yield (based on tenderometer reading)
2) Time to maturity
3) Soil N levels prior to planting
4) Nodule count at the 7-8 leaf node and at harvest (one linear meter comprised of three subsamples at each count)
5) Whole plant tissue nitrogen analysis at the 7-8 node (plants from No. 4 will be used for this)
6) Vine and seed nitrogen analysis at harvest

Peas were harvested when tenderometer readings approached 95.

RESULTS AND DISCUSSION:

Upon analysis, the use of progressively larger levels of N resulted in a significant increase in vine weight (Fig. 1) when averaged over all fungicide and inoculation treatments. However, this did not affect subsequent pea yield. The use of N also reduced early nodule counts (Fig. 2). As N levels were increased, nodulation generally decreased, however, this trend was not significant.

The use of either Thiram or Captan, Rhizobium inoculum, and different N levels did not significantly affect graded pea yield (Fig. 3), however, some trends were noticeable. When Captan was used, it appeared that Rhizobium increased graded yield at the various N levels. However, Rhizobium inoculation reduced graded yield in Thiram treated seed. The use of Captan without additional N resulted in greater early nodulation when compared to the use of Thiram.

Average nitrogen concentrations of the various plant samples did not indicate any significant trends or differences among the treatment combinations (Table 1).

SUMMARY:

It appears that Thiram may be slightly more harmful to early nodulation and subsequent yield than Captan, however, these observations were not significant. Soil potential for natural Rhizobium inoculation appears to be high. Treatment of seed with Rhizobium did not significantly increase nodulation or yield in a Nicollet clay loam soil. Increased nitrogen fertilization did not result in any increase in nitrogen content of any tissue samples collected.

Table 1. Nitrogen concentrations of plant samples collected at the 7-8 node stage and harvest.

			% N		
Fungicide	Rhizobium Inoculum	Nitrogen Rate (urea)	Whole Plant (7-8 node)	Vine Harvest	Seed Harvest
Captan	+	0	3.80	2.55	4.39
		20	3.49	2.43	4.40
		40	3.98	2.36	4.35
	-	0	3.89	2.57	4.42
		20	3.47	2.55	4.39
		40	4.07	2.32	3.17
Thiram	+	0	4.00	2.68	4.38
		20	3.74	2.40	4.37
		40	4.00	2.36	4.37
	-	0	3.94	2.52	4.47
		20	3.59	2.74	4.49
		40	3.90	2.27	4.40

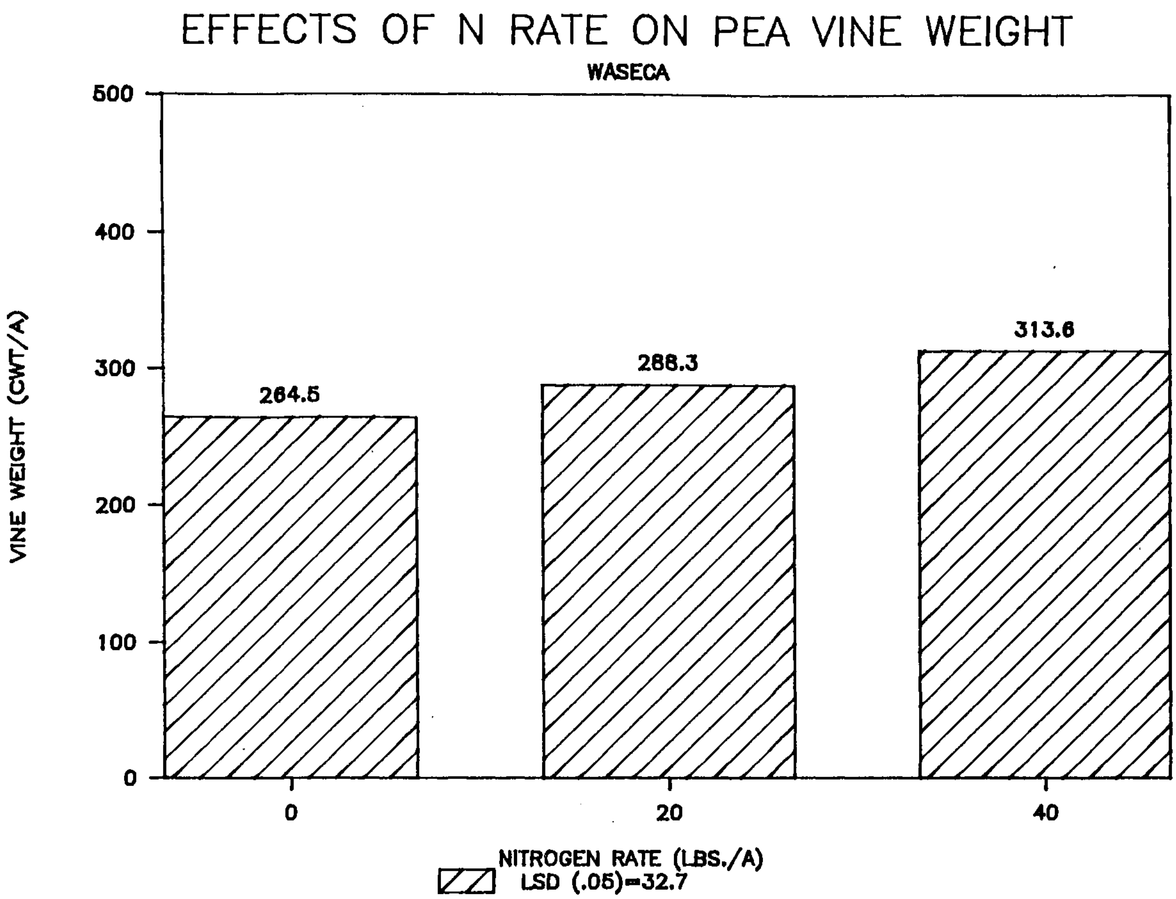


Fig. 1. Effect of nitrogen on Pea Vine Weight.

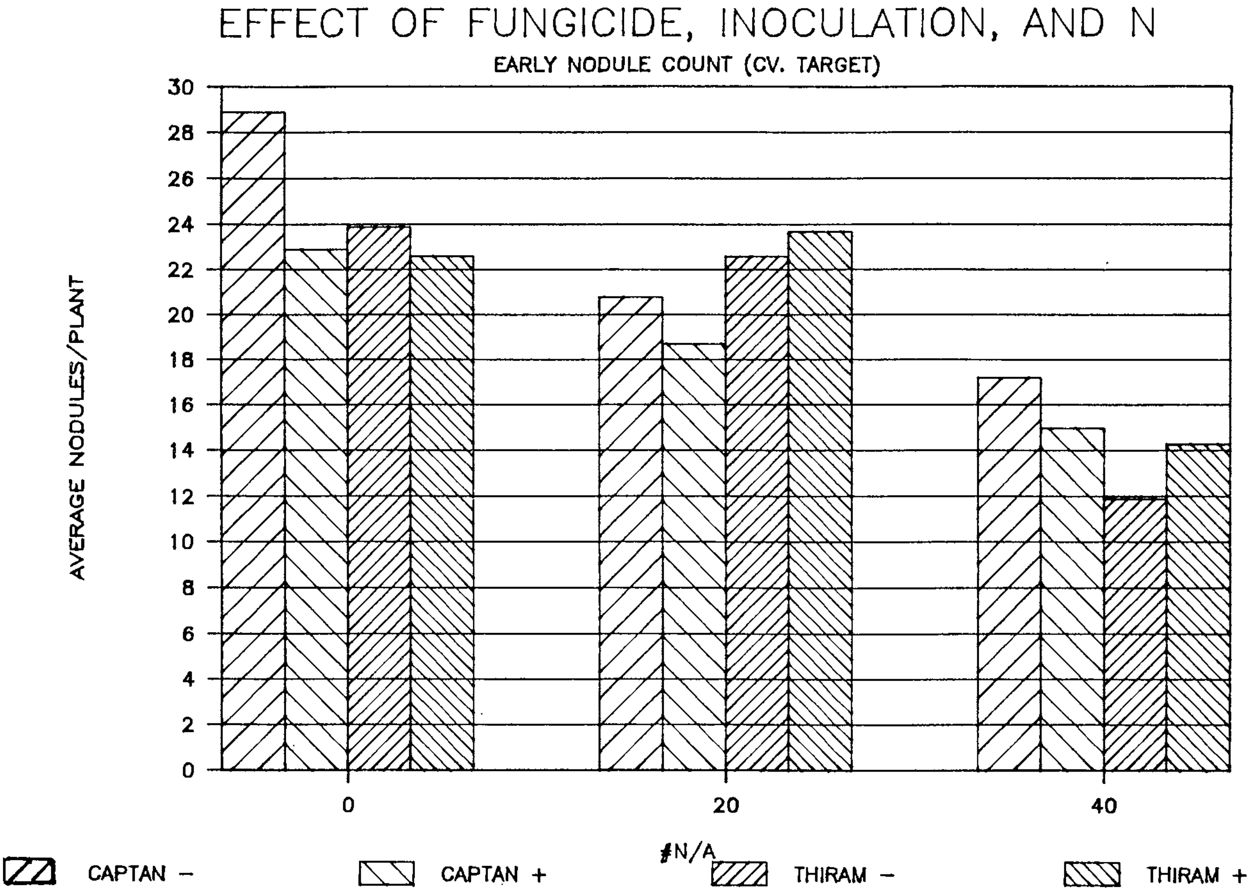


Fig. 2. Effect of fungicide, Rhizobium inoculation, and nitrogen rate on early nodule count.

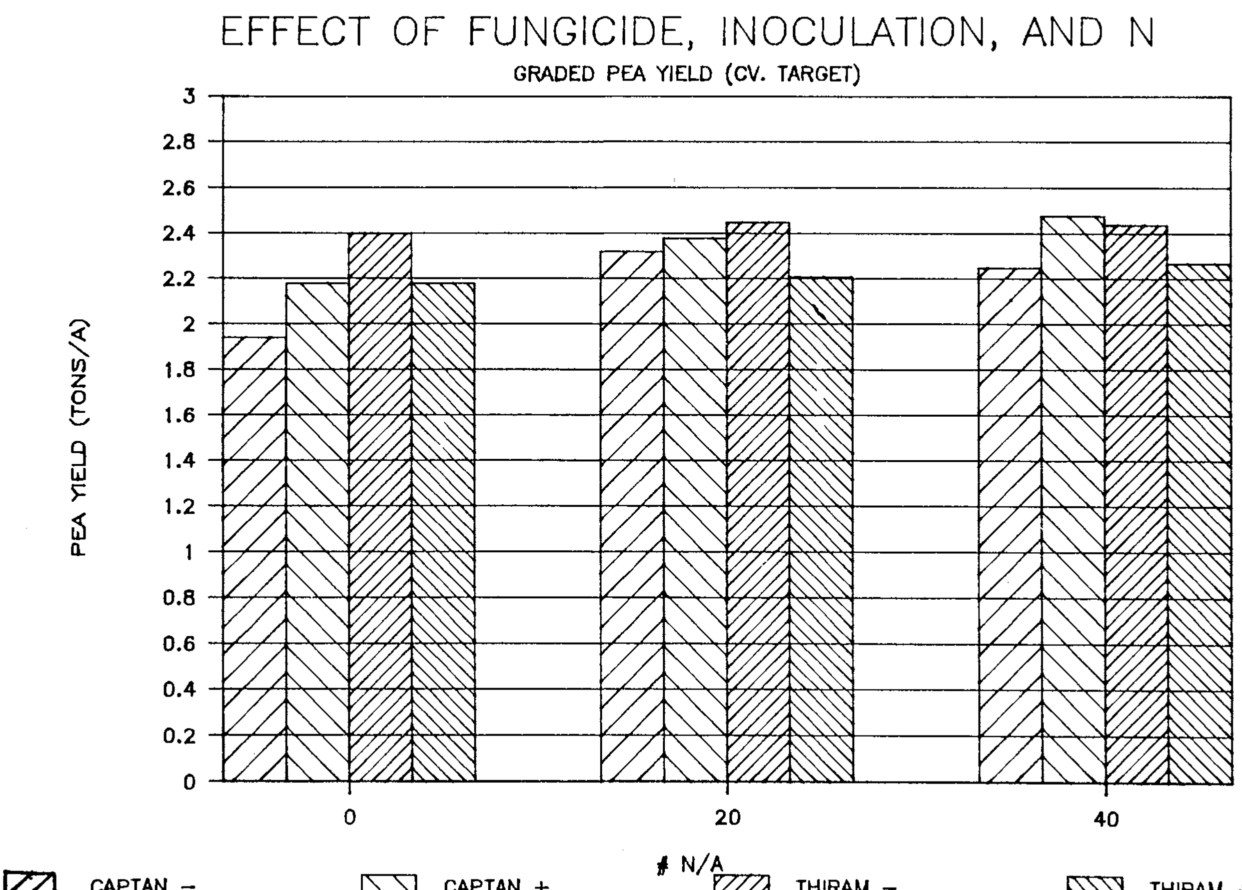


Fig. 3. Effect of fungicide, Rhizobium inoculation, and nitrogen rate on pea yield.

ANNUAL WEED CONTROL IN PEAS

Leonard B. Hertz and Vincent Fritz
University of Minnesota
Southern Experiment Station
Waseca, Minnesota 56093

A number of herbicides were evaluated for annual weed control in peas. Pea seed, 'Canners 9901', was planted on May 29 into a clay loam soil with a pH of 6.4 and 6.5% organic matter at the Southern Experiment Station, Waseca, Minnesota. The plots were 30 feet long by 7 feet wide, each with 10 rows. The plots were randomized in a complete block design with 4 replications. The preplant incorporated (PPI) and preemergence (PRE) treatments were applied on May 20, with the PPI incorporated 2 inches deep. Early postemergence (EPO) treatments were applied on June 5 and postemergence (PO) on June 19. All herbicides were applied using a CO_2 powered, bicycle sprayer, delivering 20 gpa water at 30 psi. Visual ratings of injury and weed control were made on June 19 for the PPI, PRE, and EPO treatments, and on July 18 for the PO treatments. The weed population consisted of foxtail sp. (20%), redroot pigweed (75%), and velvetleaf (5%).

Foxtail sp. control was excellent (80% or better) in all treatments. The tank mixes of Cinch plus Prowl, Fusilade plus Basagran and Cinch alone gave only fair control of redroot pigweed, but excellent (90% or better) control of velvetleaf. Substantial pea injury (plant stunting) resulted with Sonalan at 2 lb./A, which is reflected in lower shelled pea yield. At 1 lb./A Sonalan also caused some stunting but did not affect yield. Complete results are presented on the accompanying Table.

Table. Weed control in peas, Waseca, MN - 1986

Treatment	Rate[y] (lb./A)	Time of Appl[x]	Weed Control (%) Grft[w]	Rrp	Vele	Oval	Crop Inj[v]	Shelled pea yield[u]	Plant stand[t]
Cinch	1.5	PRE	95	63	98	58	0	1.1	14
Cinch+Prowl	1.5+0.75	PRE	100	65	100	65	0	1.2	14
Cinch+Treflan	1+0.5	PRE+PPI	100	98	100	98	0	1.2	13
Treflan	0.75	PPI	100	98	98	95	0	1.1	13
Treflan+Surflan	0.5+0.5	PPI	98	98	98	93	0	1.2	14
Treflan	0.5	PPI	100	90	98	90	0	1.1	14
Prowl	0.75	PRE	88	75	100	68	0	1.0	14
Surflan	0.75	PPI	88	98	98	85	0	1.2	14
Sonalan	1	PPI	98	100	98	95	2	1.3	12
Sonalan	2	PPI	100	100	100	100	7	0.6	9
Command	0.75	PRE	93	83	100	78	0	1.2	14
Fusilade+COC[z] +Basagran	0.25 +0.75	PO PO	98	65	90	73	0	1.0	12
Fusilade+COC[z] +Basagran	0.125 +0.75	PO PO	98	65	90	68	0	1.1	14
Fusilade+Basagran	0.25+0.75	PO	98	75	93	78	0	1.1	12
Control+ Fusilade+COC[z]	0.75 +0.25	PO PO	100	80	85	88	0	0.9	14
Fusilade+COC[z] +Blazer	0.25 +0.125	PO EPO	100	85	80	83	0	0.9	11
Lasso	3	PRE	93	78	100	78	0	1.0	14
Dual	3	PRE	88	73	100	68	0	1.0	12
Weeded	--	--	100	100	100	100	0	1.1	13
Untreated	--	--	0	0	0	0	0	1.1	14
LSD.05			7	18	8	19			

z. COC: Crop oil concentrate, 1 qt./A.
y. Rate: Measured in pounds active ingredient/A.
x. Application: PPI=preplant incorporated, PRE=preemergence, EPO=early postemergence, PO=postemergence.
w. Grft=green foxtail, Rrpw=redroot pigweed, Vele=velvetleaf, Oval=overall.
v. Injury: 0=none and 10=plants stunted.
u. Yield: Measured in Tons/A.
t. Stand: Number of plant/ft. of row.

EFFECTS OF SYSTEMIC FUNGICIDE SEED TREATMENTS ON BLACK SCURF (*RHIZOCTONIA SOLANI*) INCIDENCE, TUBER QUALITY, AND YIELD

Vincent Fritz and James Hebel
University of Minnesota
Southern Experiment Station
Waseca, Minnesota 56093

IMPORTANCE

Continuous crop production on the same land can lead to decreased yields and quality due to gradual increases in disease pressure. Black scurf (*Rhizoctonia solani*) has plagued a red potato production region of Minnesota (Hollandale) for several years. Systemic fungicide treatments may offer some control. This practice in conjunction with other cultural practices may result in a sound management strategy for control of black scurf.

OBJECTIVES

1) to determine if the use of systemic fungicide seed piece treatments significantly reduces the incidence of *Rhizoctonia solani* (black scurf).

2) to determine if these seed piece treatments have any effect on tuber size, quality, or yield.

EXPERIMENTAL PROCEDURES

Variety:	Norland and Chieftan
Planting Date:	May 22 and 28--respectively
Harvest Date:	September 24
Fungicide Treatments:	TOPS 2.5D (2.5% active)
	ROVRAL + TOPS 2.5D (1.0+1.5%)
	RHIZOLEX + TOPS 2.5D (1.0+1.5%)
	VITAVAX + TOPS 2.5D (1.0+1.5%)
	CAPTAN 7.5D
	UNTREATED
Treatment Rate:	All fungicides were applied at a rate of 1 lb./cwt.

EXPERIMENTAL DESIGN

Randomized Complete Block Design
Four replications

Location:	Hollandale, Minnesota
Soil:	Muck
Spacing:	8" within row, 35" between row

Seed tubers were machine cut and weighed portions were placed in large plastic bags. The fungicide treatment was then added and the bag was shaken for several minutes to ensure complete coverage of all seed piece surfaces. All treatments were applied at a 1 lb./cwt. of seed potatoes. The plots were planted using a two row mechanical transplanter equipped with potato seed piece holders. Each plot consisted of three rows and replicated four times.

Fifty seed pieces were planted in each row. Two sites were chosen, one containing the variety "Norland", and the other containing "Chieftan". Both sites contained extremely high levels of Rhizoctonia.

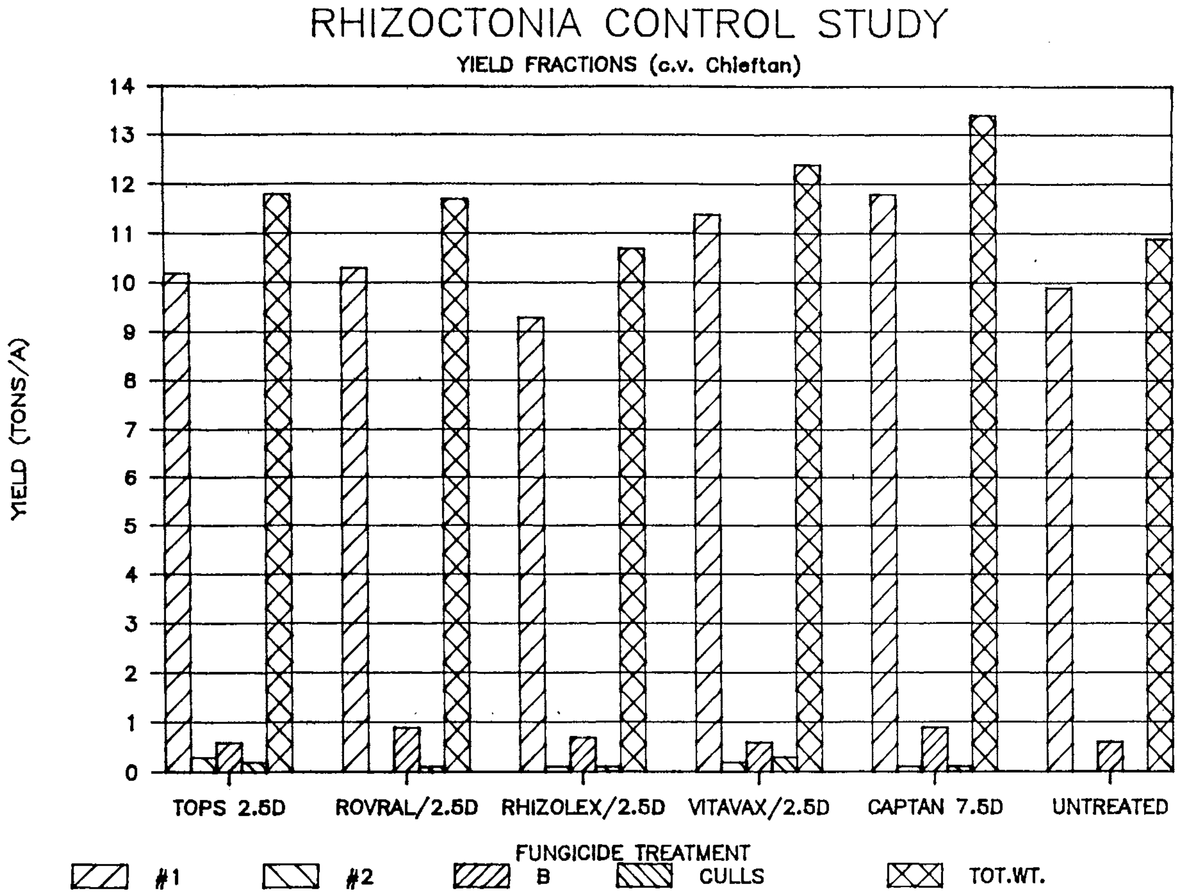
One month after planting, stand counts were taken. On September 24, both sites were hand harvested. Only the center row of each plot was harvested. Following harvest, yield fractions were determined. Also, ten randomly selected tubers were subjectively evaluated for Rhizoctonia severity (1=low, 5=high).

RESULTS AND DISCUSSION

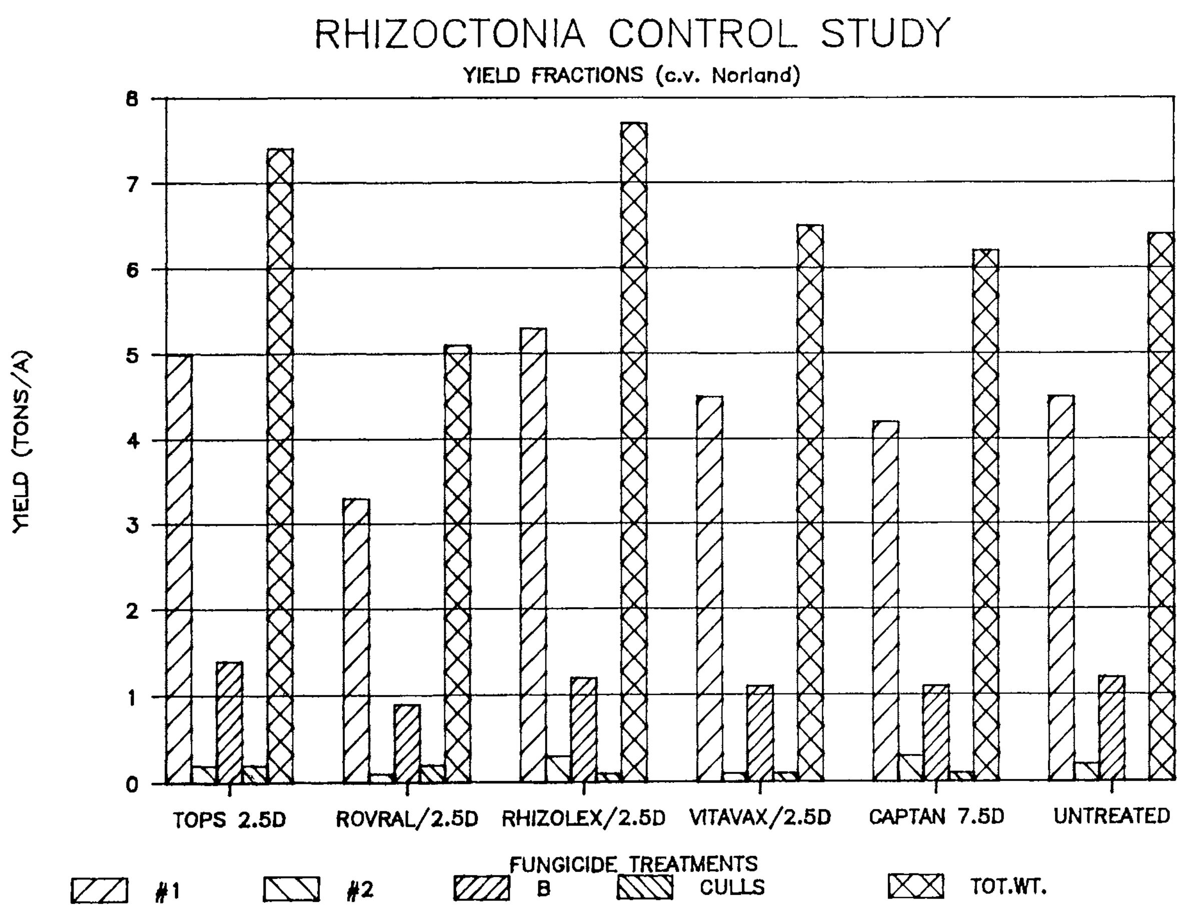
In general, the fungicide treatments did not offer any significant advantage over the untreated tubers for Rhizoctonia control. It should be mentioned that one reason for a poor stand at the "Norland" site may have been due to compaction problems. Seed piece quality could have also been a factor since the grower, in general, had difficulty with stand in other fields containing "Norland".

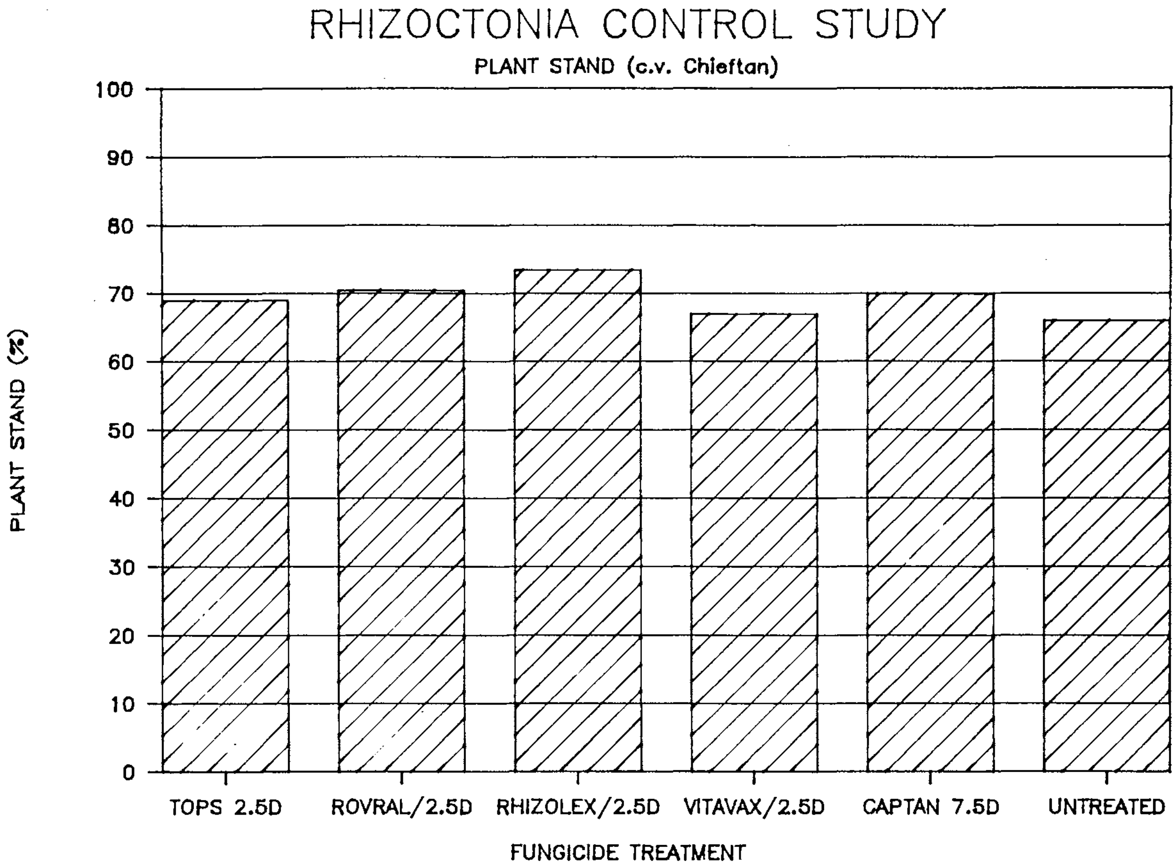
The effect of fungicide treatment on all yield fractions of "Chieftan" were non-significant (Fig. 1). Plant stand and disease severity ratings also indicated that any added benefit from the use of the fungicides was non-significant (Figs. 3 and 5); although the Rhizolex/2.5D treatment did decrease disease severity when compared to the other treatments.

The #2 grade yield fraction from the "Norland" site was significantly effected by fungicide treatments (Table 1). Rovral/2.5D and Vitavax/2.5D treatments resulted in lower #2 fractions than the Rhizolex/2.5D and Captan 7.5D fungicides. All other yield fractions were not significantly effected by fungicide treatment (Fig. 2). Plant stand and disease severity in the "Norland" site were also not significantly effected by fungicide treatments (Figs. 4 and 6). However, some reduction in disease severity was recorded from the Rovral/2.5D, Rhizolex/2.5D, and Vitavax/2.5D treatments when compared to the untreated seed pieces.

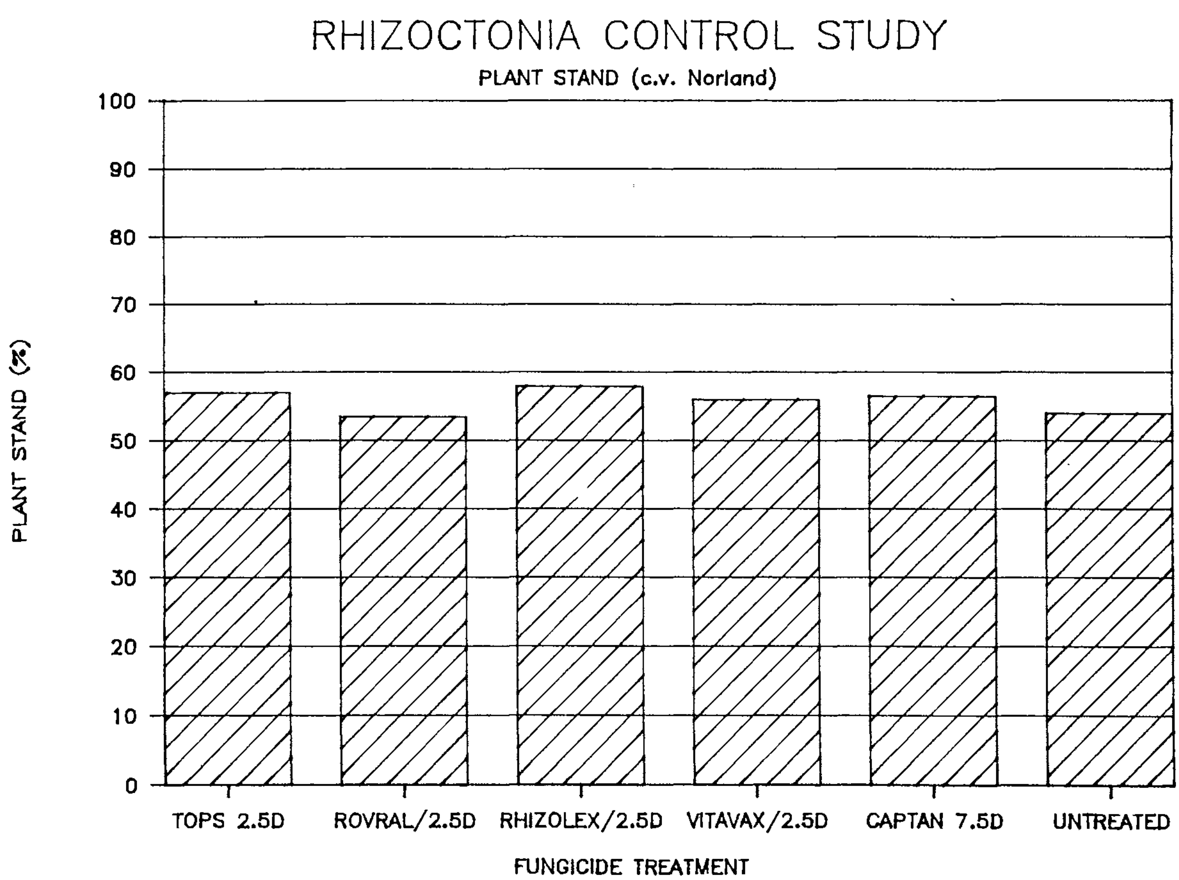


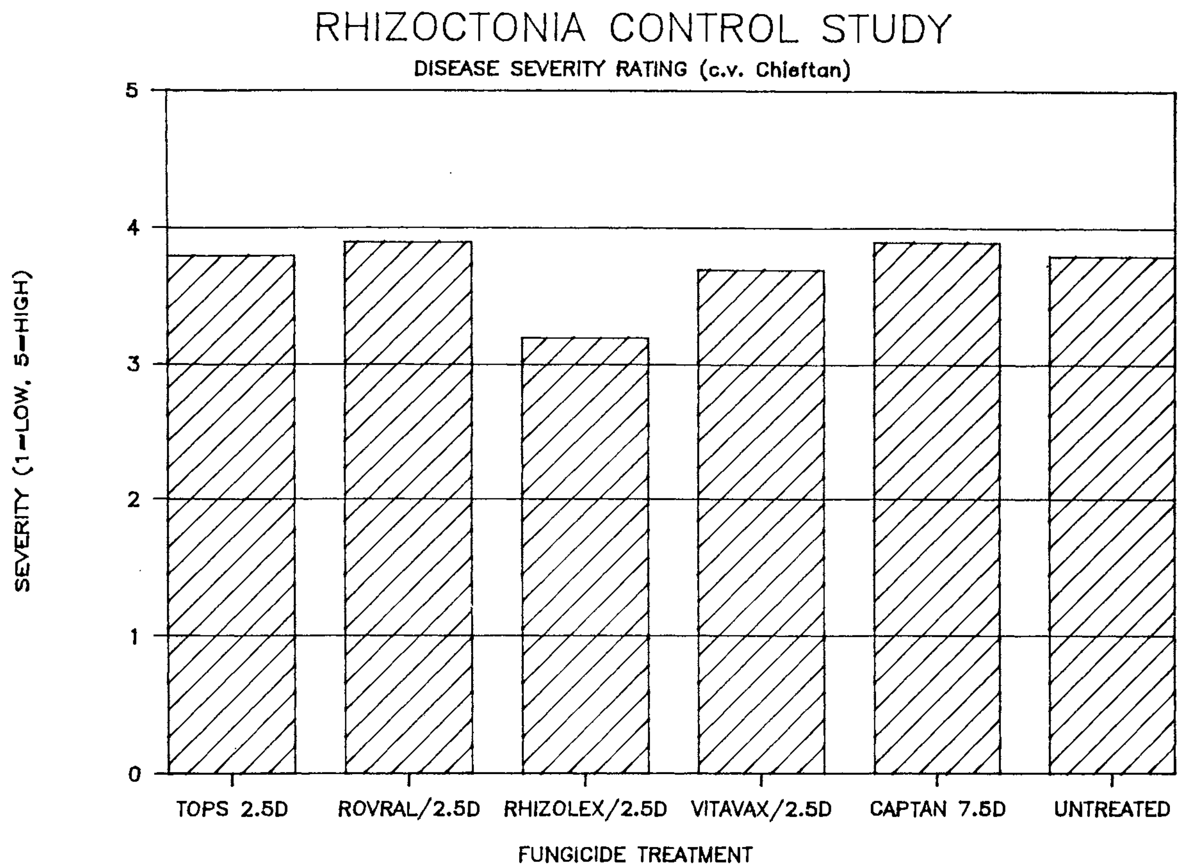
Figs. 1 - 2. Fungicide effects on yield fractions of two potato cultivars.





Figs. 3 - 4. Fungicide effects on plant stand of two potato cultivars.





Figs. 5 - 6. Fungicide effects on Rhizoctonia severity of two potato cultivars.

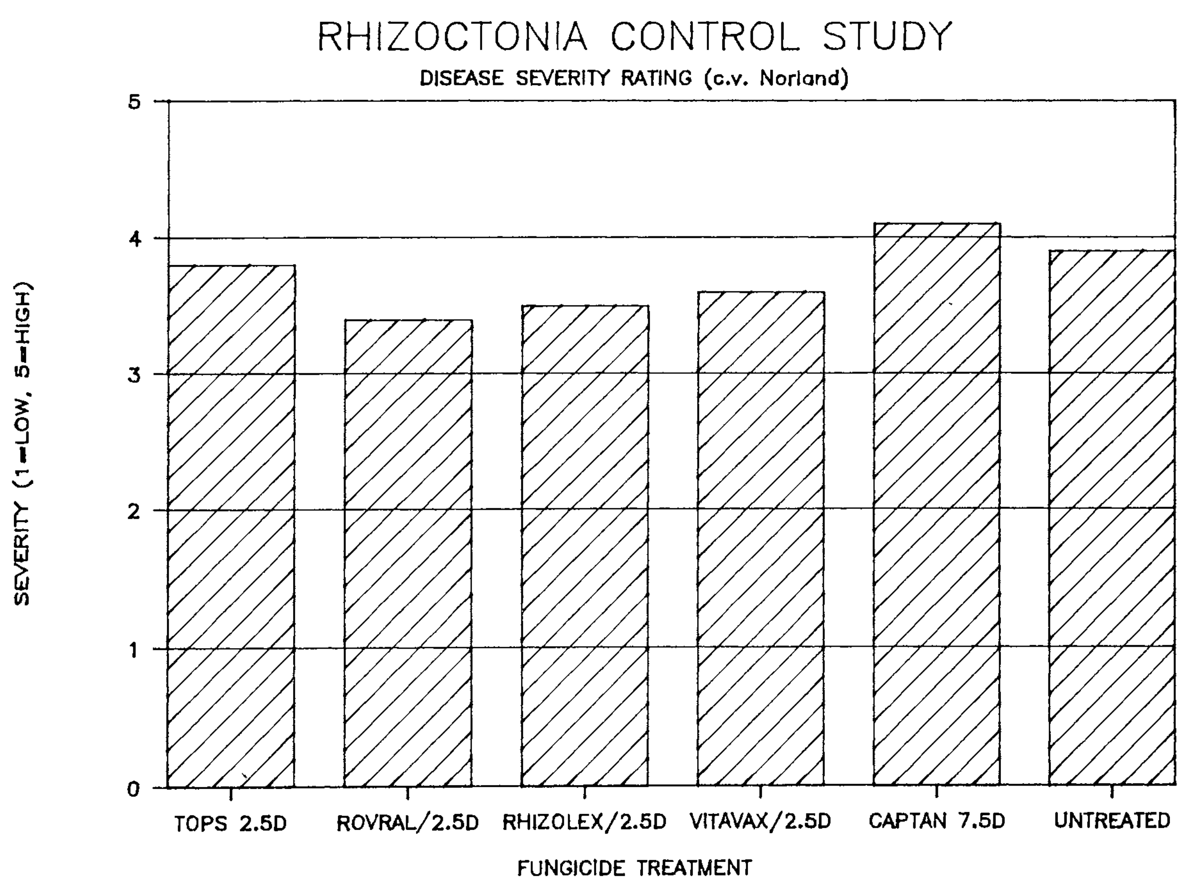


Table 1. Fungicide effect on #2 grade yield of potato (cv. Norland).

UNIVERSITY OF MINNESOTA
SOUTHERN EXPERIMENT STATION
WASECA, MINNESOTA

Rhizoctonia Control Study

Yield Fractions (c.v. Norland)

Fungicide	#2's Mean (Tons/A)
Tops 2.5D	.20
Rovral/2.5D	.10
Rhizolex/2.5D	.30
Vitavax/2.5D	.10
Captan 7.5D	.30
Untreated	.20

$LSD_{(.01)} = .13$

THE EFFECTS OF ETHEPHON (ETHYLENE) ON PERIDERM COLOR, QUALITY, AND YIELD OF RED POTATOES

Vincent Fritz and James Hebel
University of Minnesota
Southern Experiment Station
Waseca, Minnesota 56093

IMPORTANCE

Periderm color of red potatoes is a major marketing concern. A deep red potato with uniform color is not easily obtained. Inconsistent responses have occurred from using esters of 2,4-D for skin color enhancement. Production of anthocyanin, the pigment responsible for periderm color in potatoes, is an ethylene (growth regulator) mediated response. Growth regulators such as 2,4-D stimulate ethylene production. Ethephon has been used on an experimental basis for breaking dormancy in seed potatoes, however, prolonged exposure to ethylene can actually reduce the rate of shoot growth which results in short stubby shoots.

Foliar applications of ethephon were applied to study the effects of ethylene on periderm color enhancement in red potatoes.

OBJECTIVES

1) to determine if foliar applications of ethephon enhance the periderm color in potatoes.

2) to determine if ethephon effects the size of tubers, time to maturity, and yield.

MATERIALS AND METHODS

Treatments were comprised of foliar ethephon applications at four levels with surfactant (.05%), two levels of 2,4-D application, and a control. All treatments were applied at the onset of tuber set. In addition, one treatment of 2,4-D at 1 oz./A was applied ten days after the initial application of the split treatment. All treatments were applied with a CO_2 sprayer equipped with flat fan nozzles and calibrated to deliver 20 gal./A at 30 psi.

TREATMENTS

Ethephon--250ppm (E-1)
Ethephon--500ppm (E-2)
Ethephon--1500ppm (E-3)
Ethephon--2500ppm (E-4)
2,4-D (ester)--1 oz./A (2,4-D-1)
2,4-D (ester)--2 oz./A (split) (2,4-D-2)
    -apply half at tuber set and 10 days later
Surfactant Only (X-77)
Control

PARAMETERS MEASURED

- graded yield
- periderm color evaluation
- maturity differences
- storage data
- sprouting

RESULTS AND DISCUSSION

Potatoes treated with ethephon at 500ppm (8.8 ml. Ethrel® /gal.) significantly yielded more #1 grade tubers when compared to the surfactant and 2,4-D - (1 oz.) treatments (Fig. 1). When ethephon was increased to 1500 and 2500ppm (26.3 and 43.9 ml./gal.), #1 tuber yield dramatically declined. The loss of #1 grade tuber production from the higher ethephon treatments was reflected in the significant increase in #2 grade and culls (Fig. 2). This decrease in tuber quality was primarily due to the extensive increase in the number of growth cracks and tuber deformity from plants treated with high levels of ethephon (1500 and 2500ppm).

Periderm color was not significantly increased by ethephon. Maturity differences among treatments were not observed. Storage data is still being collected to determine ethephon effects on dormancy longevity.

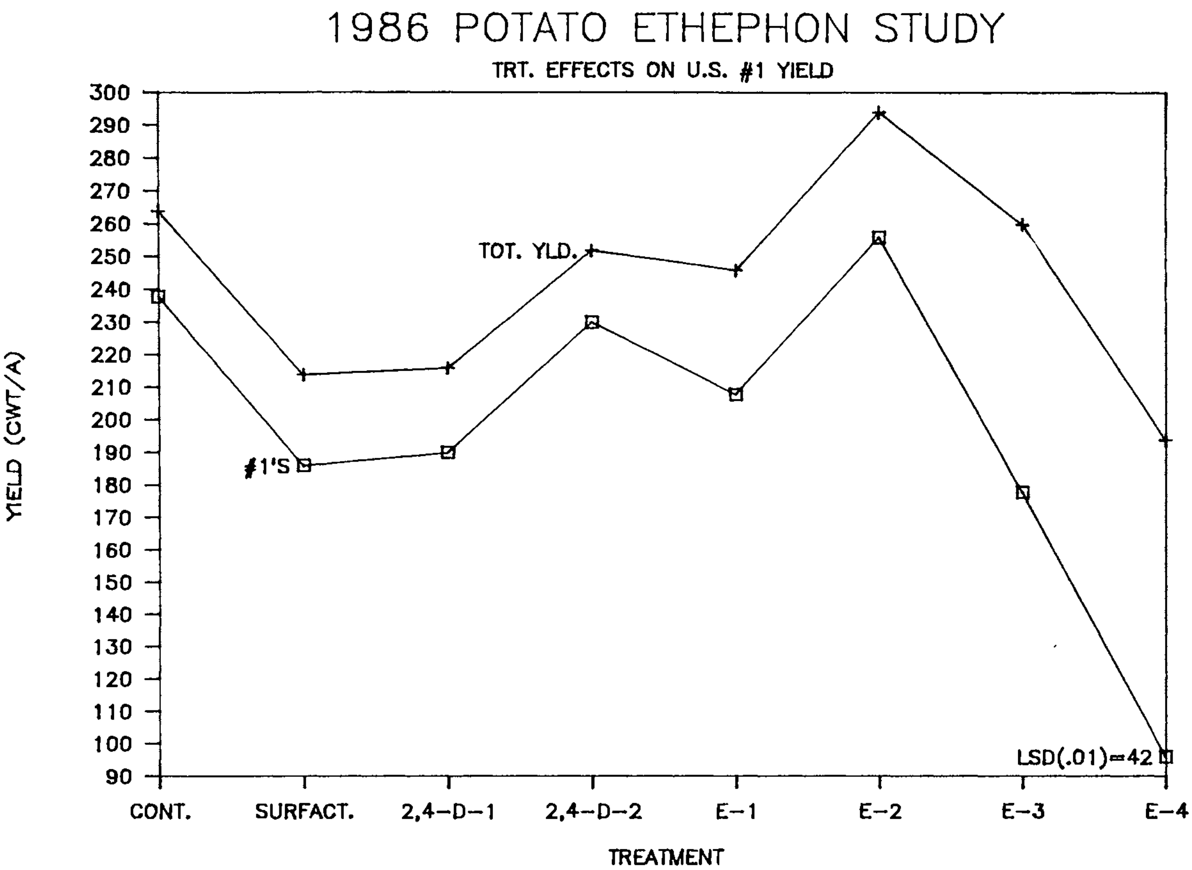


Fig. 1. Treatment effects on #1 grade and total yield of potato.

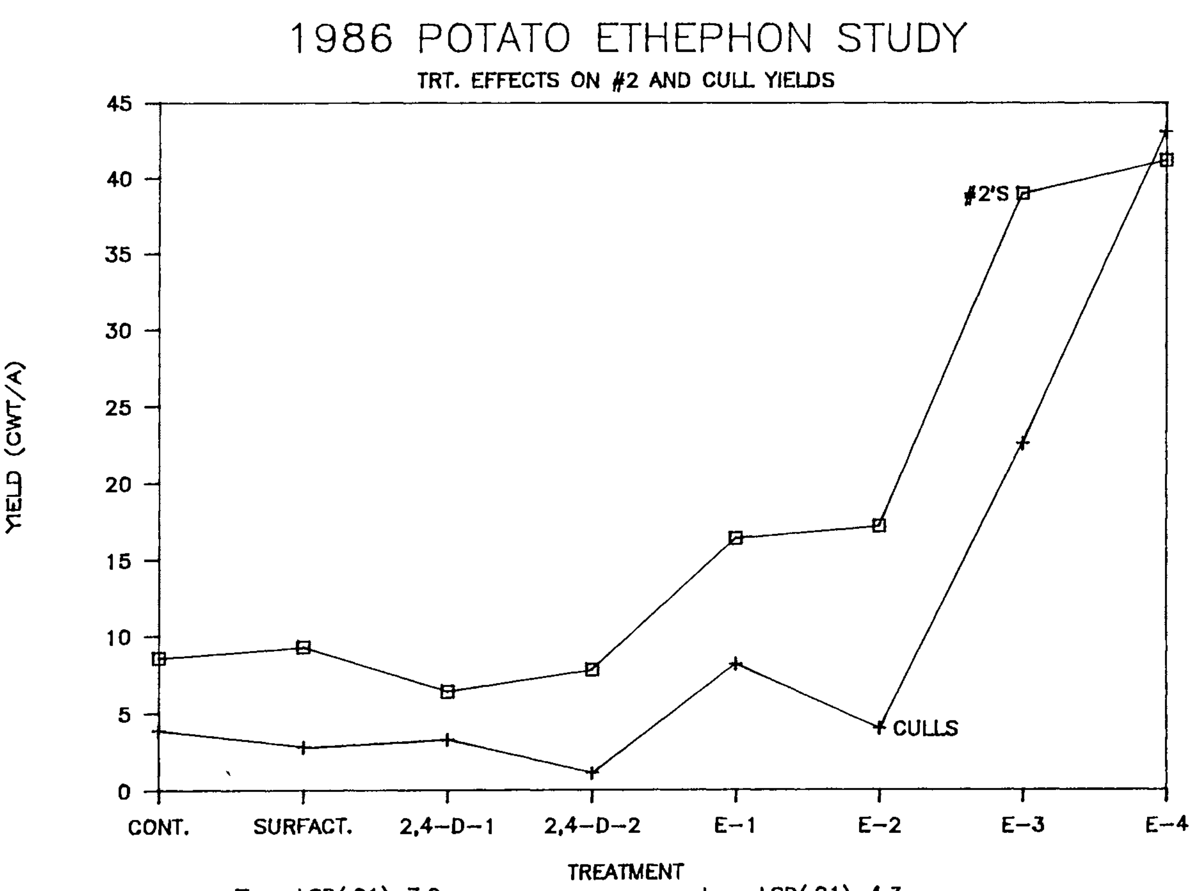


Fig. 2. Treatment effects on #2 grade and cull yield of potato.

RAISED BED ONION PRODUCTION STUDY

Vincent Fritz and James Hebel
University of Minnesota
Southern Experiment Station
Waseca, Minnesota 56093

IMPORTANCE

Recently, the use of raised beds in vegetable production has gained in popularity in the United States. The most obvious benefit from raised bed production has been the ability to furrow irrigate and better drainage for reduced disease occurrence. Other proposed effects of raise bed production (faster rate of emergence due to soil warming) have not been substantiated.

OBJECTIVES

1) to determine if the use of raised beds significantly effects seedling emergence.

2) to determine if time to maturity (top fall down) and yield is significantly effected by raised bed production.

EXPERIMENTAL DESIGN

Split plot

Four replicates

Variety: Trapps, Asgrow 3246

Location: Hollandale, Minnesota

MATERIALS AND METHODS

Before planting, 700 lbs. of 7-26-26/A was incorporated. Roundup (glyphosate) and Goal (oxyfluorfen) were applied preplant and post respectively for weed control. Seed of 'Trapps' and 'Asgrow 3246' were planted on April 22 and 23 respectively. A furrow insecticide treatment of Ethion-Thiram was applied at planting. Ten days after planting, stand counts were taken in each treatment on 10 feet of 2 rows. On September 2, 20 feet of the inner 4 rows of an 8 row plot were harvested and graded.

RESULTS AND DISCUSSION

The hybrid 'Asgrow 3246' had a significantly better stand when compared to the open pollinated variety, 'Trapps' (Fig. 1). The superior stand of 'Asgrow 3246' was also expressed in yield. Both #1 grade and total yield of 'Asgrow 3246' were significantly higher than 'Trapps' (Fig. 2). Yield was also effected by cultural method. When averaged over both varieties, #1 grade and total yield were significantly higher from onions grown without beds when compared to those on raised beds (p=.10) (Fig. 3). The study will be expanded in 1987.

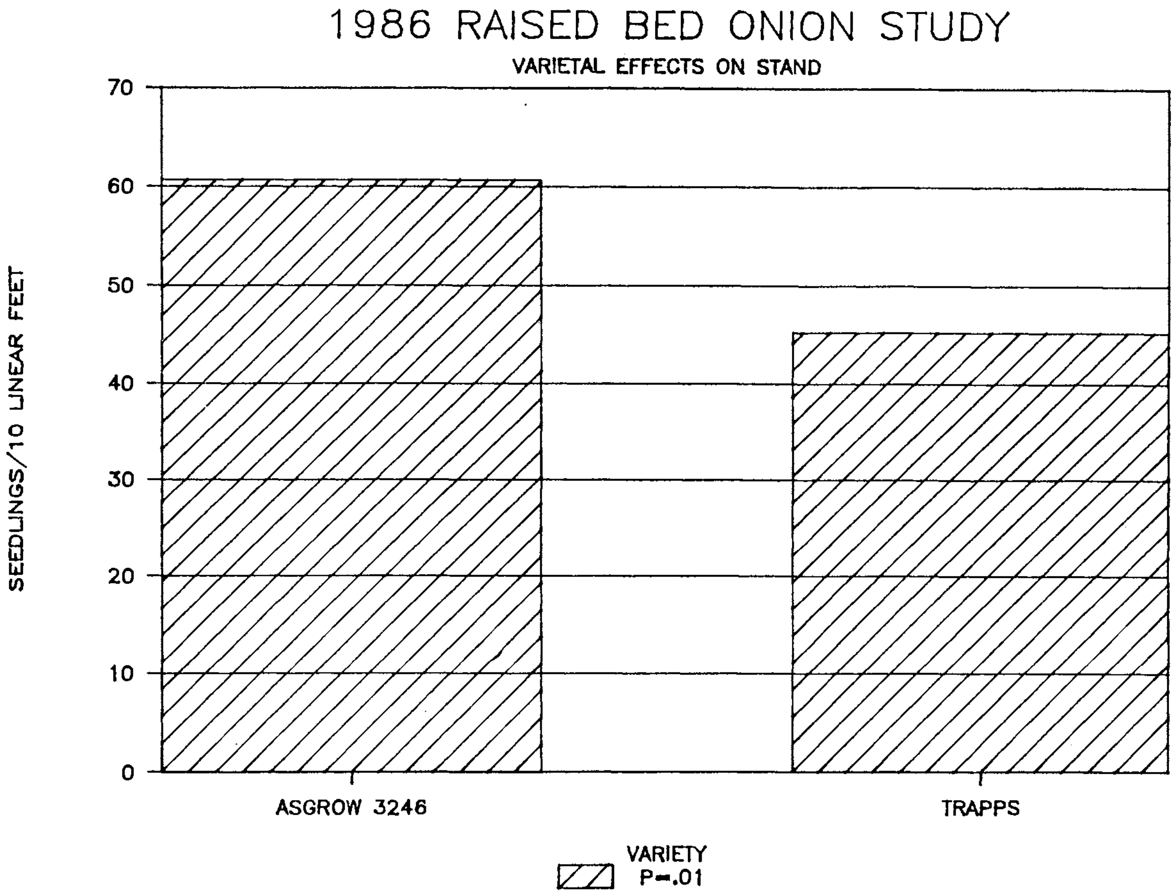


Fig. 1. The effect of variety on stand establishment.

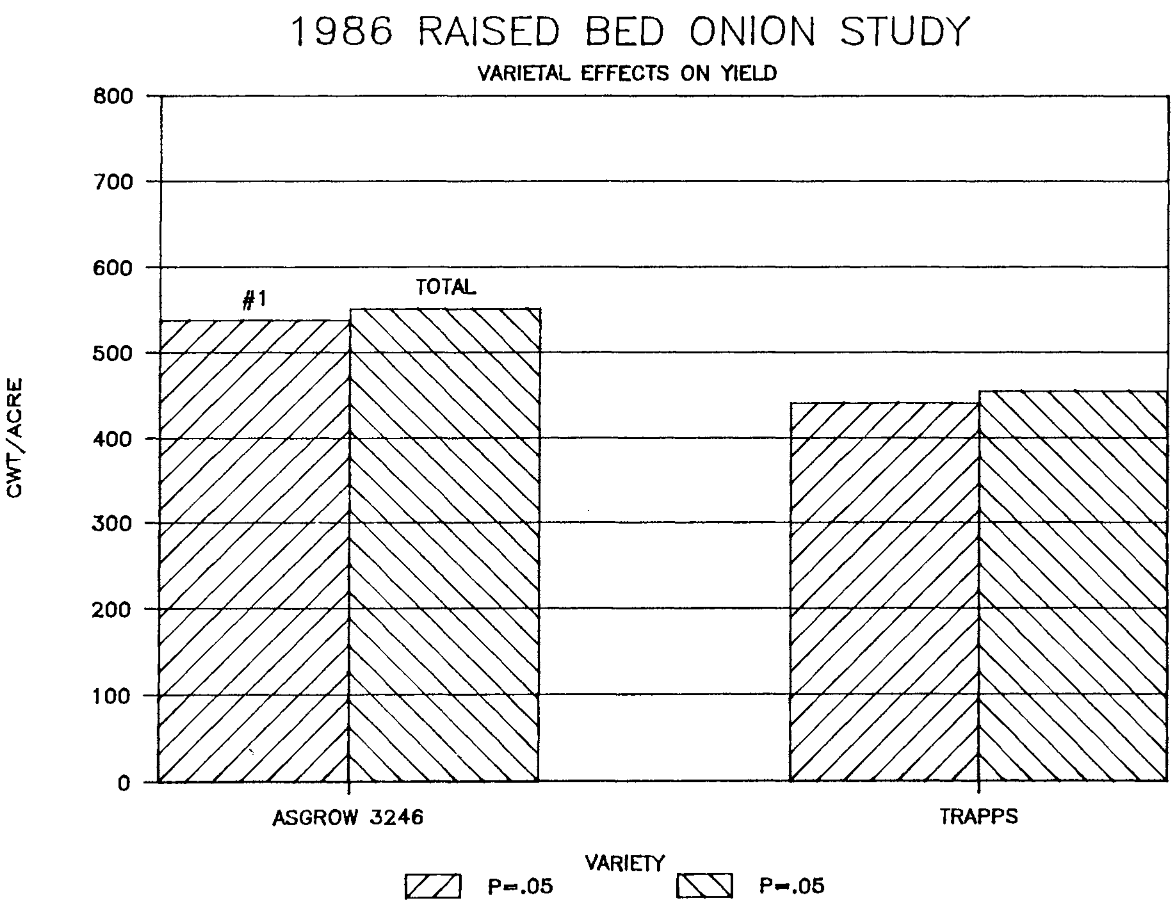


Fig. 2. The effect of variety on #1 grade and total yield.

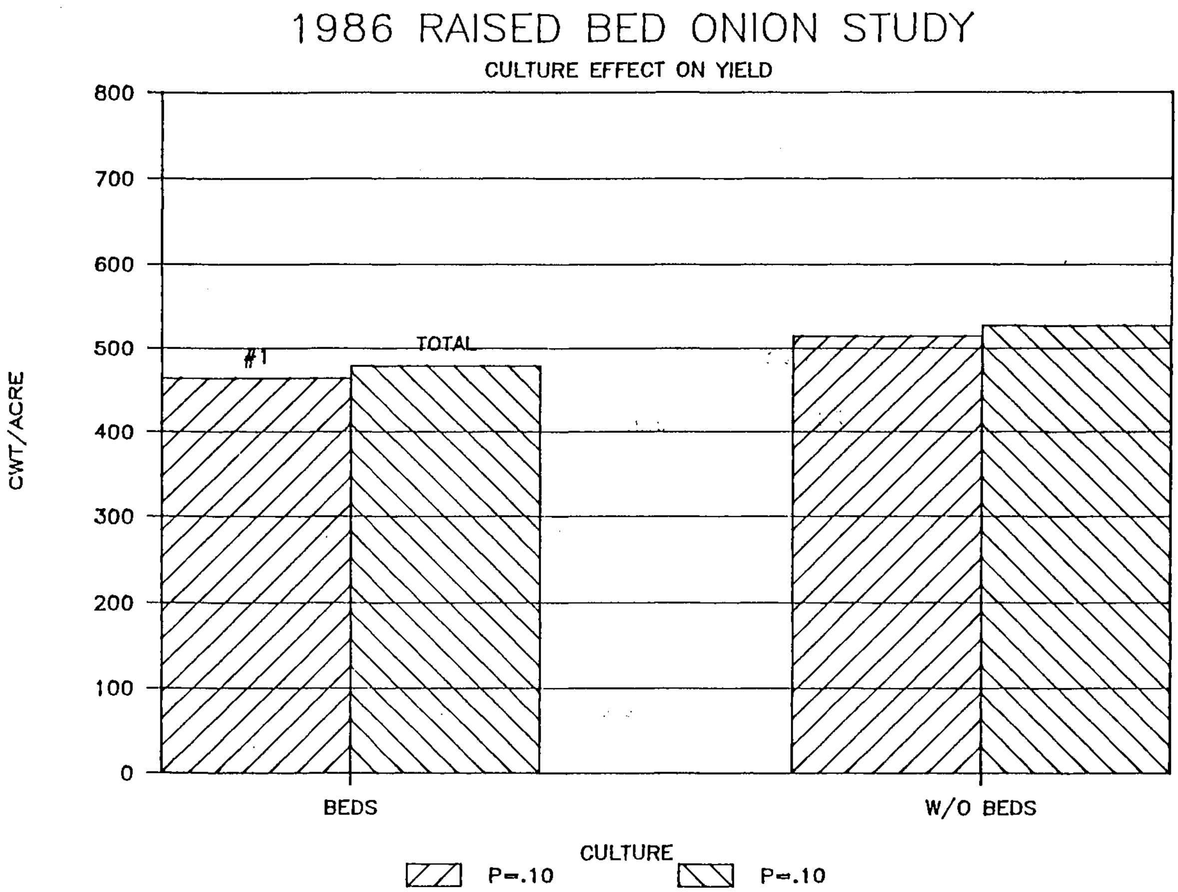


Fig. 3 The effect of cultural method on #1 grade and total yield.

SOUTHERN EXPERIMENT STATION
WASECA, MINNESOTA

WEATHER DATA - 1986

Month	Period	Precipitation 1986	Precipitation Normal[1/]	Avg. Air Temp. 1986	Avg. Air Temp. Normal[1/]	Growing Degree Days 1986	Growing Degree Days Normal[1/]
		---- inches ----		------ °F -----			
January	1-31	0.89	0.84	14.5	10.0		
February	1-28	0.52	0.99	13.4	16.4		
March	1-31	2.18	1.99	31.4	27.6		
April	1-30	4.13	2.64	48.4	44.7		
May	1-10	0.95		56.4		97.5	
	11-20	2.04		56.4		84.5	
	21-31	0.77		62.2		145.5	
	Total	3.76	3.76	58.4	57.7	327.5	334
June	1-10	0.91		66.5		165.0	
	11-20	1.77		68.8		186.5	
	20-30	5.21		70.9		204.0	
	Total	7.89	4.48	68.7	67.1	555.5	518
July	1-10	1.51		69.8		196.0	
	11-20	1.87		72.9		222.5	
	21-31	0.52		72.9		251.5	
	Total	3.90	4.02	71.9	71.2	670.0	641
August	1-10	0.11		67.2		173.5	
	11-20	0.40		66.6		170.0	
	21-31	1.90		61.2		136.5	
	Total	2.41	3.99	64.9	68.8	480.0	579
September	1-30	5.57	3.36	59.8	59.8	340.5	311
October	1-31	2.83	2.08	48.3	48.9	37.0	38
November	1-30	1.42	1.43	25.6	32.5		
December	1-31	0.35	1.02	21.6	18.0		
Year	Jan-Dec	35.85	30.60	44.1	43.6	2410.5[2/]	2421
Growing Season	May-Sep	23.53	19.61	64.7	64.9	2373.5	2383

1/ 30-year normal from 1951 - 1980.
2/ 50 to 86°F base, May 1 until first fall frost.

Notes:
1) Highest temperature on June 20 and July 19 -- 92°.
2) Highest 24-hour precipitation on June 21 -- 2.46".
3) Highest 48-hour precipitation on June 21-22 -- 4.64".
4) Last spring frost -- April 22.
5) First fall frost -- October 6.

ROTATION NITROGEN STUDY

Waseca, 1986

G. W. Randall, P. L. Kelly, and M. P. Russelle

Increasing the efficiency of fertilizer N along with fine-tuning fertilizer N recommendations by improved diagnostic techniques, symbiotic N fixation, crop rotation, etc. are goals which are gaining widespread research support throughout the United States. The adoption of crop rotations or sequences may play a vital role in the conservation of N. The purpose of this study is to determine the N needs of continuous corn (removed for grain), corn removed for silage, second year corn following soybeans, corn following soybeans, and corn following wheat.

EXPERIMENTAL PROCEDURES

Four crop sequences (continuous corn, corn-soybean, corn-wheat, and corn-wheat + alfalfa) were begun in 1974 on a Webster clay loam. Each N plot within each crop sequence is 15' wide (6 rows) by 50' long. Rates of N (0, 40, 80, 120, 160, and 200 lb N/A) have been applied annually to corn.

The corn-wheat + alfalfa sequence was dropped in 1981 in favor of a continuous corn system where all of the corn was removed as silage the preceding year. This gives us a comparison of the N needs between grain removal only compared to total above-ground biomass removal. In 1982, a C-C-Sb rotation was introduced to examine the N needs of second-year corn following soybeans. All plots are replicated five times in a split-split plot design with crop sequences as the main plot, which is split into six N rates with each N plot split into two corn hybrids.

In 1986, anhydrous ammonia was applied on April 23 to all corn plots. All plots were moldboard plowed in the fall of 1985 and field cultivated on April 25, 1986.

Each corn plot was split lengthwise and two corn hybrids (Pioneer 3732 and Pioneer 3906) were planted in 30" rows at 30800 ppA on May 3. Counter was applied to all corn plots at 1 lb/A to control rootworms. Weeds were chemically controlled along with one cultivation of the corn. A combination of 3½ qt Lasso plus 3½ lb Bladex/A was applied preemergence to corn. No starter fertilizer or broadcast P and K was used because of high soil test P and K levels.

Corn leaf samples were taken at silking from rows 2 and 3 (Hybrid A) and from rows 4 and 5 (Hybrid B) of each 6-row plot. Corn yields were taken by mechanically harvesting the same rows. Grain moisture and grain N data were obtained on the harvested samples.

After the 1985 harvest and again in the spring of 1986 prior to N application, soil samples were taken to a depth of 5' from the 0 and 160-lb N treatments which were applied to the continuous corn (grain) and continuous corn (silage) rotations. Soil samples were also taken from the 0-lb N treatments in the plots where soybeans and wheat were the 1985 crops. Two cores were taken/plot, divided into 1-foot increments, composited/rep, dried, crushed, and analyzed for NO_3-N by the University of Minnesota Soil Testing Laboratory.

RESULTS

Nitrate-N levels remaining in the soil profile after the 1985 crop, which was available to the 1986 corn, are presented in Table 1. When no fertilizer N was applied in 1985 (except the blanket 50-lb rate to wheat) very little difference in residual NO_3-N remaining in October appeared among the five crop sequences.

Samples taken from these 0-N plots the following spring showed marked decreases (33 to 58%) in NO_3-N compared to the fall sampling except following soybeans where NO_3 levels were reduced by only 22%. From 40 to 75% of the residual NO_3-N was found in the top foot of the 5-foot profile with all four crops. When the 160-lb rate of N was applied to continuous corn (grain and silage), a significant amount of residual N was found throughout the 5-foot profile in the fall. Samples taken the following April from these same plots showed approximately a 20% decline in NO_3-N throughout the profile. Reasons for these decreases are thought to be due to either denitrification or leaching.

Table 1. Effect of N rate applied to corn and crop sequence on residual NO_3-N remaining in the 0-5' profile in the fall of 1985 and at the beginning of the 1986 growing season.

	October, 1985				April 1, 1986			
	1985 Crop							
Profile depth	Corn (grain)	Corn (silage)	Soybeans	Wheat	Corn (grain)	Corn (silage)	Soybeans	Wheat
feet	lb NO_3-N/foot							
	0 lb N/A							
0-1	19	21	24	17	20	17	21	20
1-2	2	10	14	12	6	1	12	6
2-3	8	7	13	10	1	1	8	5
3-4	7	5	8	8	1	2	7	3
4-5	7	9	9	8	2	1	5	3
Total(lb NO_3-N/5')	53	52	68	55	30	22	53	37
	160 lb N/A							
0-1	27	23			24	23		
1-2	27	18			17	15		
2-3	24	19			19	19		
3-4	20	18			13	17		
4-5	21	19			15	12		
Total(lb NO_3-N/5')	119	97			88	86		

Corn grain yield, leaf N, grain N, grain N removed, and grain moisture at harvest are shown in Table 2 for each of the treatments. All data are an average of five replications. Averages and statistical interpretations for each of the main factors and the two-way interactions are shown in Table 3.

Grain yield

Corn yields were excellent in 1986 considering the moisture stress encountered from mid-July until mid-August. As in previous years crop sequence had a substantial effect on corn yield. Yields following soybeans or wheat were significantly higher (18 to 35 bu/A) than when following continuous corn (either for grain or silage) when averaged over N rates and hybrids. Second year corn yields following soybeans were not different from continuous corn. When averaged over N rates and hybrids, corn yields following soybeans were significantly higher than when following wheat. Yields were economically maximized with the 200-lb N rate when averaged over crop sequence and hybrids; however, the sequence x N rate interaction was highly significant. Yields from the two hybrids were identical when averaged over sequence and N rates.

Closer examination of the interactions reveals additional information. The sequence x N rate interaction was highly significant (P = 99% level) when averaged across hybrids. For the CC(g), CC(s), C-Sb, C-W, and Sb-C-C systems, highest yields were obtained statistically at the 160, 160, 120, 120, and 160-lb N rates, respectively, and were economically maximized at the 200, 200, 200, 160, and 200-lb rates, respectively. Yield responses of 84.7, 92.5, 72.0, 90.1, and 96.6 bu/A were obtained with the maximum economic rate of N for each of the respective crop sequences. Yields with the 0-lb N rate were lowest with the CC(g), CC(s) and Sb-C-C systems, intermediate with the C-W system, and highest with the C-Sb system. These data indicate that the higher amounts of plant residue incorporated from the 1985 CC(g) and Sb-C-C systems probably immobilized greater amounts of N than from the lower residue crop systems. Also, corn yield responses in all crop sequences to N rates of either 160 or 200 lb/A is not consistent with past years and indicates that the very wet June may have caused losses of fertilizer N.

Similar to 1985, the sequence x hybrid interaction was not significant indicating that the two hybrids behaved identically across all sequences. On the other hand, a significant N rate x hybrid interaction was found. At the 0- and 40-lb N rates, P3732 yields were 4.9 and 3.9 bu/A higher, r-espectively, than P3906. Yields were identical between the two hybrids at the 80-, 120- and 160-lb rates. At the 200-lb rate P3906 yielded 4.0 bu/A better than P3732 when averaged over sequences. No three-factor interaction was found.

Corn yield responses to N with each of the sequences did not appear to show any consistent relationship to the residual soil NO_3-N levels shown in Table 1. This is consistent with past years.

Table 2. Corn grain yield, leaf N, grain N, grain N removed, and grain moisture as influenced by previous crop, N rate and hybrid at Waseca, 1986.

		N rate (lb/A)					
Previous Crop	Hybrid	0	40	80	120	160	200
		Yield (bu/A)					
Cont. Corn (grain)	3906	68.3	94.4	112.1	131.7	148.8	160.0
	3732	75.8	97.8	111.8	135.6	153.0	153.6
Cont. Corn (silage)	3906	69.2	93.7	118.5	147.3	148.2	170.6
	3732	76.8	96.7	115.9	141.8	144.4	160.5
Soybeans	3906	108.0	134.2	147.8	166.0	174.1	177.7
	3732	106.0	141.8	145.8	169.0	175.0	180.3
Wheat	3906	80.7	111.1	143.4	169.4	170.3	172.3
	3732	85.3	111.9	141.5	165.0	174.1	174.0
Corn after soybeans	3906	56.4	84.1	104.9	139.8	153.1	160.6
	3732	63.2	89.1	110.9	138.3	148.1	152.3
		Leaf N (%)					
Cont. Corn (grain)	3906	1.30	1.39	1.77	2.07	2.27	2.42
	3732	1.33	1.48	1.77	2.20	2.54	2.62
Cont. Corn (silage)	3906	1.30	1.49	1.68	2.30	2.51	2.51
	3732	1.29	1.51	1.78	2.21	2.38	2.67
Soybeans	3906	1.45	1.84	2.28	2.63	2.57	2.84
	3732	1.55	2.01	2.27	2.62	2.73	2.80
Wheat	3906	1.34	1.76	2.07	2.35	2.74	2.65
	3732	1.43	1.67	2.07	2.65	2.75	2.89
Corn after soybeans	3906	1.16	1.38	1.60	2.12	2.43	2.60
	3732	1.18	1.41	1.81	2.29	2.34	2.66
		Grain N (%)					
Cont. Corn (grain)	3906	1.20	1.14	1.21	1.25	1.32	1.46
	3732	1.07	.96	1.01	1.09	1.18	1.25
Cont. Corn (silage)	3906	1.14	1.14	1.16	1.29	1.29	1.39
	3732	1.00	.96	.96	1.07	1.14	1.23
Soybeans	3906	1.13	1.19	1.22	1.33	1.36	1.49
	3732	.96	1.00	1.07	1.23	1.23	1.30
Wheat	3906	1.13	1.10	1.16	1.31	1.37	1.43
	3732	.96	.97	1.04	1.14	1.21	1.32
Corn after soybeans	3906	1.14	1.10	1.10	1.25	1.29	1.46
	3732	.97	.91	.97	1.08	1.13	1.24
		Grain N Removed (lb/A)					
Cont. Corn (grain)	3906	38.8	51.1	64.6	78.2	93.1	109.9
	3732	38.7	44.6	53.5	70.5	85.0	90.6
Cont. Corn (silage)	3906	37.2	50.4	65.0	90.1	90.7	112.2
	3732	36.7	44.0	52.6	71.8	78.0	93.2
Soybeans	3906	58.3	76.0	85.5	104.6	112.1	125.1
	3732	48.2	67.7	74.0	98.9	102.2	110.3
Wheat	3906	43.0	57.8	78.4	105.3	110.7	116.7
	3732	38.7	51.2	69.3	88.9	99.3	108.2
Corn after soybeans	3906	30.4	43.8	54.6	82.8	93.5	110.7
	3732	29.1	38.5	51.2	70.7	79.2	89.5
		Grain Moisture (%)					
Cont. Corn (grain)	3906	23.6	22.9	22.9	22.1	21.3	21.4
	3732	28.6	26.0	24.6	23.3	22.5	22.8
Cont. Corn (silage)	3906	24.0	23.2	22.8	22.1	21.9	21.4
	3732	28.9	26.1	25.1	24.1	23.3	22.8
Soybeans	3906	23.2	22.8	22.2	22.0	21.9	21.6
	3732	26.3	24.9	23.7	22.0	23.4	22.7
Wheat	3906	24.5	23.3	22.6	22.5	22.0	22.3
	3732	27.7	26.2	23.9	23.1	22.7	23.6
Corn after soybeans	3906	23.8	23.4	23.1	22.3	21.8	21.1
	3732	28.1	26.0	24.2	23.2	22.7	22.0

Table 3. Main factor and two-factor interaction averages for corn yield, grain moisture, grain N, grain N removal and leaf N in 1986.

Source		Yield	Grain Moisture	Grain N	Grain N removed	Leaf N
		bu/A	------- %	--------	lb/A	%
MAIN FACTORS						
Sequence						
Cont. corn (grain)		120.2	23.5	1.18	68.2	1.93
Cont. corn (silage)		123.6	23.8	1.15	68.5	1.97
Sb-C		152.1	23.1	1.21	88.6	2.30
Wht-C		141.6	23.7	1.18	80.6	2.20
Sb-C-C*		116.7	23.5	1.14	64.5	1.91
Signif. Level (%):		99	55	96	99	99
BLSD (.05) :		7.9	--	.05	6.6	.10
N Rate (lb/A)						
0		79.0	25.9	1.07	39.9	1.33
40		105.5	24.5	1.05	52.5	1.59
80		125.3	23.5	1.09	64.9	1.91
120		150.4	22.8	1.21	86.2	2.34
160		158.9	22.4	1.25	94.4	2.53
200		166.2	22.2	1.36	106.6	2.67
Signif. Level (%):		99	99	99	99	99
BLSD (.05) :		4.8	0.3	0.03	2.9	0.08
Hybrid						
P 3906		130.6	22.5	1.25	79.0	2.03
P 3732		131.2	24.5	1.09	69.1	2.10
Signif. Level (%):		51	99	99	99	99
INTERACTIONS						
Sequence x N Rate						
CC(g)	0	72.1	26.1	1.13	38.7	1.32
	40	96.1	24.5	1.05	47.9	1.43
	80	111.9	23.8	1.11	59.1	1.77
	120	133.6	22.7	1.17	74.3	2.13
	160	150.9	21.9	1.25	89.1	2.40
	200	156.8	22.1	1.35	100.3	2.52
CC(s)	0	73.0	26.4	1.07	36.9	1.30
	40	95.2	24.7	1.05	47.2	1.50
	80	117.2	24.0	1.06	58.8	1.73
	120	144.6	23.1	1.18	81.0	2.26
	160	146.3	22.6	1.21	84.4	2.45
	200	165.5	22.1	1.31	102.7	2.59
Sb-C	0	107.0	24.8	1.04	53.2	1.50
	40	138.0	23.8	1.10	71.8	1.92
	80	146.8	22.9	1.15	79.7	2.28
	120	167.5	22.5	1.28	101.8	2.62
	160	174.6	22.7	1.30	107.2	2.65
	200	179.0	22.2	1.39	117.7	2.82
Wht-C	0	83.0	26.1	1.04	40.8	1.38
	40	111.5	24.7	1.03	54.5	1.72
	80	142.5	23.2	1.10	73.9	2.07
	120	167.2	22.8	1.23	97.1	2.50
	160	172.2	22.4	1.29	105.0	2.74
	200	173.1	22.9	1.37	112.4	2.77

Source		Yield	Grain Moisture	Grain N	Grain N removed	Leaf N
		bu/A	------- % --------		lb/A	%
Sb-C-C*	0	59.8	25.9	1.05	29.7	1.17
	40	86.6	24.7	1.00	41.2	1.39
	80	107.9	23.6	1.04	52.9	1.71
	120	139.1	22.7	1.17	76.7	2.20
	160	150.6	22.2	1.21	86.4	2.38
	200	156.4	21.6	1.35	100.1	2.63
Signif. Level (%):		99	90	94	96	69
BLSD (.05) :		15.6	--	--	10.4	--
BLSD (.10) :		13.2	1.1	0.09	8.8	--
Sequence x Hybrid						
CC(g)	3906	119.2	22.4	1.26	72.6	1.87
	3732	121.2	24.6	1.09	63.8	1.99
CC(s)	3906	124.6	22.6	1.23	74.3	1.97
	3732	122.7	25.0	1.06	62.7	1.97
Sb-C	3906	151.3	22.3	1.29	93.6	2.27
	3732	153.0	24.0	1.13	83.6	2.33
Wht-C	3906	141.2	22.9	1.25	85.3	2.15
	3732	141.9	24.5	1.10	75.9	2.24
Sb-C-C*	3906	116.5	22.6	1.22	69.3	1.88
	3732	117.0	24.4	1.05	59.7	1.95
Signif. Level (%):		34	94	40	23	59
BLSD (.10) :		--	0.3	--	--	--
N rate x Hybrid						
0	3606	76.5	23.8	1.15	41.5	1.31
	3732	81.4	27.9	.99	38.3	1.36
40	3906	103.5	23.1	1.13	55.8	1.57
	3732	107.4	25.8	.96	49.2	1.61
80	3906	125.3	22.7	1.17	69.6	1.88
	3732	125.2	24.3	1.01	60.1	1.94
120	3906	150.8	22.2	1.29	92.2	2.29
	3732	150.0	23.3	1.12	80.1	2.39
160	3906	158.9	21.8	1.33	100.0	2.50
	3732	158.9	22.9	1.18	88.7	2.55
200	2906	168.2	21.6	1.44	114.9	2.61
	3732	164.2	22.8	1.27	98.4	2.73
Signif. Level (%):		96	99	23	99	28
BLSD (.05) :		4.2	0.5	--	3.2	--
Seq. x N rate x Hybrid						
Signif. Level (%):		29	4	39	74	90
BLSD (.10) :						.25
CV (%) :		5.8	3.8	4.8	8.0	7.7

* = Position in sequence for which measurements taken.

In summary, corn yields (averaged over hybrids) from the 200-lb rate were approximately 9% higher when following either soybeans or wheat compared to continuous corn (grain or silage). This advantage was slightly below the advantages shown in previous dry years. Also, contrary to reports from Purdue University, P3732 continued to respond to increasing N rates to 200 lb N/A. This same N rate also maximized the P3906 yield when averaged over sequences.

Grain Moisture

Grain moisture at harvest was unaffected by crop sequence but was reduced significantly by each N rate up through 160 lb/A. The shorter season hybrid (P3906) had significantly less moisture.

Interactions between crop sequence and N rate or hybrid were not significant at the 95% level. The highly significant interaction between N rate and hybrid was due to the greater difference in grain moisture betwwen the two hybrids at the low N rates (4.1 and 2.7 points at the 0 and 40-lb rates, respectively) compared to a 1.1 point difference at N rates ≥120 lb/A.

Grain N

Grain N concentrations were influenced by the crop sequence when averaged over N rates and hybrids. Highest N concentrations were found when corn followed soybeans while lowest levels occurred with second year corn after soybeans and CC(s). Grain N concentrations were increased by N rates up through 200 lb/A. The P3906 hybrid averaged 0.16% higher grain N or 1.0% higher protein than P3732 when averaged over sequence and N rate. The significant sequence by N rate interaction was due to the higher concentrations of N at N rates of ≥120 lb/A when corn followed soybeans or wheat compared to corn. At the low N rates, grain N concentrations were quite similar among the crop sequences except for CC(g) at the 0-lb rate. Interactions between sequence and hybrid and between N rate and hybrid were not found.

Grain N removed

Nitrogen removed in the grain crop was closely associated with both grain yield and grain N concentration. Highest grain N removal was when soybeans or wheat was the previous crop, when the 200-lb N rate was applied, and when P3906 was grown.

Nitrogen efficiency, as measured by grain N removed divided by fertilizer application rate, averaged 32, 30, 40, 47 and 35% for the N rates giving the highest yields (statistically) for the CC(g), CC(s), C-Sb, C-W, and Sb-C-C sequences, respectively. At the N rates where yields were maximized economically, the efficiency values were 31, 33, 32, 45, and 35%, respectively. Similar to 1985, N efficiency was highest in the corn-wheat sequence.

Leaf N

Concentrations in the earleaf at silking were significantly higher when corn followed either soybeans or wheat compared to following corn when averaged over N rates and hybrids. Leaf N was increased up through the 200-lb N rate when averaged over sequences and hybrids. Pioneer 3732 contained slightly more N in the earleaf than did P3906. Interactions among sequence, rate and hybrid were not significant (P = 95% level).

Silage production

Measurements were taken from the CC(s) crop sequence to determine fodder yield, fodder N concentration, fodder N uptake, silage yield, and total N uptake. Data shown in Table 4 indicate a significant effect of N up through the 120-lb rate on fodder yield. Similar to previous years, fodder yield of P3732 was significantly greater than P3906. The interaction between N rate and hybrid (P = 94% level) for fodder yield was due to P3906 responding to N rates up through 120 lb/A while P3732 only responded up through 80 lb/A. Fodder N concentration was maximized at the 200-lb rate and contrary to 1985 was significantly higher for P3732. Fodder N uptake was highest at the 200-lb N rate with an advantage for P3732 compared to P3906. The significant interaction between N rate and hybrid for fodder N concentration and uptake can be explained by P3906 maximizing both N concentration and uptake at the 120-lb rate while P3732 maximized both at the 200-lb rate.

Silage yields were increased significantly by N rates up through 160 lb/A and by the P3732 hybrid. Total N removed in the silage was increased with increasing N rates up through 200 lb/A. Equal amounts of N were removed by both hybrids. N efficiency with both hybrids fertilized at the 200-lb rate was 46%.

Summary - 1986

Corn grain yields averaged about 9% higher when corn followed either soybeans or wheat compared to continuous corn (grain or silage). Highest yields with minimum N input were found when corn followed either soybeans or wheat and were maximized at the 120-lb N rate. Yields with both P3732 and P3906 were maximized at the 160-lb N rate with the CC(g), CC(s), and Sb-C-C crop sequences. Grain N concentrations and grain N removal were significantly higher with the P3906 hybrid. Leaf N at silking was maximized at between 2.54% and 2.82% with the 200-lb rate for all crop sequences.

Table 4. Silage production as influenced by N rate and hybrid in a silage corn rotation at Waseca, 1986.

N rate	Hybrid	Fodder Yield	Fodder N	Fodder N Uptake	Silage Yield	Silage N Removal
lb/A		T DM/A	%	lb N/A	T DM/A	lb N/A
0	3906	1.55	.41	12.5	3.36	49.8
	3732	1.82	.42	15.2	3.86	53.6
40	3906	1.98	.34	13.3	4.48	63.9
	3732	2.44	.38	18.4	4.93	61.3
80	3906	2.35	.38	17.9	5.44	82.6
	3732	3.19	.38	24.3	6.41	82.2
120	3906	2.83	.42	23.6	6.53	106.7
	3732	3.18	.46	29.4	6.89	103.0
160	3906	2.90	.44	25.8	7.06	127.9
	3732	3.31	.44	29.5	7.64	127.6
200	3906	2.99	.45	26.9	7.29	142.0
	3732	3.39	.58	39.5	7.79	145.4
MAIN FACTORS						
N rate (lb/A)						
0		1.69	.41	13.9	3.66	51.7
40		2.21	.36	15.8	4.71	62.6
80		2.77	.38	21.1	5.93	82.4
120		3.01	.44	26.5	6.71	104.8
160		3.11	.44	27.6	7.35	127.8
200		3.19	.51	33.2	7.54	143.7
Signif. Level (%)[1/] :		99	99	99	99	99
BLSD (.05) :		.21	.04	3.0	.39	7.2
Hybrid						
3906		2.43	.40	20.0	5.69	95.5
3732		2.89	.44	26.0	6.27	95.5
Signif. Level (%)[1/] :		99	99	99	99	2
INTERACTION			Significance Level (%)[1/]			
N rate x Hybrid		94	99	97	55	11
CV (%) :		7.5	9.	14.	5.7	8.9

[1/] Probability level of significance

TWELVE-YEAR YIELD SUMMARY

Average corn yields over this 12-year period have been optimized with 175, 140, and 140 lb N/A for the continuous corn, corn-soybean, and corn-wheat sequences, respectively. At these N rates, yields for corn following soybeans and wheat where 15 and 13% higher than for continuous corn.

Table 5. Effect of previous crop on corn response to N from 1975-86 at Waseca.

N rate	Previous Crop: Corn(g)	Soybeans	Wheat
lb N/A	bu/A		
0	75	109	104
40	100	134	130
80	115	146	147
120	125	153	151
160	133	158	154
200	136	158	156

SPLIT APPLICATION OF N FOR CORN ON A WEBSTER SOIL

Waseca, 1986

G. W. Randall and P. L. Kelly

Improved nitrogen (N) efficiency is a goal of many corn producers because of the enhanced economic return to their fertilizer dollar. One potential method of improving the efficiency of N is to apply it closer to the period of greatest demand by the plant. For corn this is the period from three weeks prior to three weeks after tasseling. Applying N closer to this period limits the potential for N loss due to leaching or denitrification. Split applications of N have been shown to be quite beneficial on coarse-textured soils where leaching losses are common. The primary purpose of this study was to evaluate split applications of N to a naturally, poorly drained Webseter clay loam where leaching is thought not to be a problem.

EXPERIMENTAL PROCEDURES

A poorly drained Webster clay loam soil with lateral tile lines at 75-foot spacings was the experimental site. Corn, which had been fall moldboard plowed, was the previous crop. Soil tests of the site showed a pH = 6.9, OM = High, Bray P_1 = 58 lb/A (VH), and exchangeable K = 358 lb/A (VH).

Sixteen N treatments were applied in a randomized, complete-block design with five replications (Table 1). Each plot measured 10' wide (4 - 30" rows) by 60' long. Split treatments consisted of either a 1/3-rate applied preplant with the remaining 2/3 sidedressed or 2/3 applied preplant and 1/3 sidedressed. Preplant treatments of anhydrous ammonia (AA) and urea-ammonium nitrate solution (UAN) were applied on April 24 and May 5, respectively. Anhydrous ammonia was injected while the UAN was broadcast applied on the soil surface. Immediately after UAN application, the entire experimental area was field cultivated.

Corn (Pioneer 3906) was planted at 30400 ppA on May 7. No starter fertilizer was used. Counter was used at a rate of 1 lb(ai)/A to control rootworms. Weeds were chemically controlled with a pre-emergence application of Lasso (3½ qt/A) plus Atrazine (3 qt/A). Rootworm and weed control were excellent.

The sidedress portions of the split treatments were applied at the 8-leaf stage (June 19). The AA was injected while the UAN was applied either in bands to the soil surface 6" from the row using a bicycle sprayer with no. 55 orifices or injected 4 to 5" deep using Yetter coulters and thin-profile knives. All plots were cultivated on the following day to incorporate the surface-applied UAN. On June 21 and 22, 2.46 and 2.18 inches of rain, respectively, fell to completely saturate the plots for a 7 to 10-day period.

Five randomly selected whole plants were harvested from the center two rows at the silk initiation stage (July 18 for the 60, 120 and 180-lb N rates and July 21 for the 0-lb rate), were chopped, dried and weighed for dry matter accumulation, and were analyzed for total N concentration. Stover and silage yields were obtained at physiological maturity (PM) (Sept. 8) by hand harvesting 15' of row. Grain yields were determined on October 1 by harvesting the center two rows with a modified JD3300 plot combine. Chemical analyses of the whole plants, stover, and grain were performed by the Research Analytical Laboratory, University of Minnesota.

RESULTS

Whole plant N at silking

Severe N deficiency symptoms were very apparent for the lower N rates at the silking stage. Whole plant N concentrations given in Table 1 show all N treatments with significantly more N than the control. Factorial comparisions of the treatments show a linear response to N rate when averaged over source-time of application. When averaged over N rates significantly less whole plant N was found with the preplant AA and the split applications of 1/3 + 2/3 UAN and 2/3 AA + 1/3 UAN treatments compared to the 1/3 UAN + 2/3 AA treatment.

Whole plant dry matter at silking

Total dry matter accumulation at silking was increased significantly over the control by all N treatments (Table 1). Factorial comparison of the treatments shows a linear response to N rate when averaged over method of application. Highest DM accumulation occurred with the preplant AA and the 2/3 AA + 1/3 UAN split treatments. These two treatments also showed the lowest N concentrations, probably a result of plant dilution.

Table 1. Whole plant N, stover N, stover yield, and final population as influenced by split applications of N.

Nitrogen			Whole plant at silk		Stover		Final
Rate	Time[1/]	Source[2/]	N	DM	N	Yield	population
lbN/A			%	g/pl	%	TDM/A	ppA x 10^3
0	--	CHECK --	.68	73	.39	1.65	26.5
60	PP	AA	.95	95	.36	2.28	27.2
120	"	"	1.27	98	.42	2.56	28.9
180	"	"	1.37	99	.47	2.95	30.7
60	1/3PP+2/3SD	UAN(PP)+AA(SD)	1.26	89	.39	2.11	27.6
120	"	"	1.36	88	.42	2.30	28.3
180	"	"	1.48	89	.49	2.47	27.3
60	"	UAN(PP)+UAN(Drib.SD)	1.04	88	.36	2.09	27.8
120	"	"	1.26	92	.36	2.26	27.1
180	"	"	1.42	95	.42	2.75	28.4
60	"	UAN(PP)+UAN(Inj.SD)	1.11	85	.33	2.08	26.6
120	"	"	1.36	89	.40	2.46	27.7
180	"	"	1.38	98	.42	2.46	27.7
60	2/3PP+1/3SD	AA(PP)+UAN(Drib.SD)	1.06	91	.38	2.60	27.6
120	"	"	1.27	95	.40	2.54	28.6
180	"	"	1.37	102	.41	2.65	28.9
	Signif. Level (%):[3/]		99	99	99	99	99
	BLSD (.05) :		.10	7	.06	.28	1.1
	CV (%) :		6.5	5.9	11.	8.6	2.9
FACTORIAL COMPARISONS							
Main Factors							
N Rate (lb/A)							
60			1.08	90	.37	2.23	27.4
120			1.30	92	.40	2.42	28.1
180			1.40	97	.44	2.65	28.6
	Signif. Level (%):[3/]		99	99	99	99	99
	BLSD (.05) :		.05	3	.02	.12	.47
Method (N Time-Source)							
PP - AA			1.20	97	.42	2.60	28.9
PP/SD - UAN/AA			1.37	88	.44	2.29	27.7
PP/SD - UAN/UAN (Dribble)			1.24	92	.38	2.37	27.8
PP/SD - UAN/UAN (Inject)			1.28	91	.38	2.33	27.3
PP/SD - AA/UAN (Dribble)			1.23	96	.40	2.60	28.4
	Signif. Level (%):[3/]		99	99	99	99	99
	BLSD (.05) :		.06	5	.04	.17	.63
Interaction			Significance Level (%)[3/]				
N Rate x Method			90	49	58	94	99

1/ PP = preplant, SD = sidedress applied at the 8-leaf stage.
2/ AA = anhydrous ammonia, UAN = 28-0-0, Inj = injected 4 to 5" deep, Drib = dribbled in a band next to row.
3/ Probability level of significance.

Stover N

Nitrogen concentrations in the stover at PM were increased linearly by the N rates from 60 to 180 lb/A (Table 1). Only the 180-lb rate of preplant AA and 1/3 UAN (PP) + 2/3 UAN (SD) resulted in stover N concentrations significantly higher than the check. This was probably due to higher yields with all of the N treatments, thus, leading to greater dilution in the stover and translocation of N to the grain. Slight N differences existed among the five methods but none were significantly different from the check.

Stover Yield

Stover yield was increased signficantly over the check by all of the N treatments (Table 1). Highest yields were obtained with the 180-lb rate regardless of source or time of application. Significantly higher yields were found when the preplant (PP) applications consisted of AA compared to UAN. Yield differences were not found between the sidedressed AA and UAN sources or between the method of UAN application (dribble vs injected).

Table 2. Corn grain and silage production as influenced by split applications of N.

Nitrogen			Grain				Silage	Total N
Rate	Time	Source	Yield	H_2O	N	N Removal	Yield	Uptake
lb/A			bu/A	--- %	----	lb/A	TDM/A	lb/A
0	--	CHECK --	50.7	24.1	1.20	28.8	3.21	42.0
60	PP	AA	89.4	23.5	1.17	49.5	4.85	65.7
120	"	"	123.4	22.1	1.34	77.8	6.07	99.6
180	"	"	138.2	21.2	1.54	100.3	6.79	127.8
60	1/3PP+2/3SD	UAN(PP)+AA(SD)	91.4	22.7	1.27	55.0	4.80	71.6
120	"	"	125.6	22.2	1.44	85.4	5.79	105.2
180	"	"	140.7	21.9	1.56	104.0	6.07	128.4
60	"	UAN(PP)+UAN(Drib.SD)	68.8	23.6	1.24	40.4	4.22	55.5
120	"	"	100.8	22.3	1.25	59.5	5.04	75.9
180	"	"	127.2	21.3	1.42	85.6	6.37	108.9
60	"	UAN(PP)+ UAN(Inj.SD)	80.3	22.9	1.24	47.0	4.39	60.7
120	"	"	107.4	22.7	1.31	66.9	5.59	86.6
180	"	"	128.7	21.1	1.49	91.1	5.93	112.0
60	2/3PP+1/3SD	AA(PP)+UAN(Drib.SD)	89.1	22.8	1.20	50.5	5.53	70.5
120	"	"	114.0	21.3	1.35	72.6	5.95	93.0
180	"	"	134.7	21.2	1.49	94.9	6.23	116.6
	Signif. Level (%):		99	99	99	99	99	99
	BLSD (.05) :		11.2	1.1	.07	7.8	.53	7.1
	CV (%) :		8.2	3.5	3.9	8.8	7.6	6.3
FACTORIAL COMPARISONS								
Main Factors								
N Rate (lb/A)								
60			83.8	23.1	1.22	48.5	4.76	64.8
120			114.2	22.1	1.34	72.4	5.69	92.1
180			133.9	21.4	1.50	95.2	6.28	118.7
	Signif. Level (%):		99	99	99	99	99	99
	BLSD (.05) :		5.1	.5	.03	3.6	.24	3.2
Method (N Time - Source)								
PP - AA			117.0	22.3	1.35	75.9	5.90	97.7
PP/SD - UAN/AA			119.2	22.3	1.42	81.4	5.55	101.7
PP/SD - UAN/UAN (Dribble)			98.9	22.4	1.30	61.8	5.21	80.1
PP/SD - UAN/UAN (Inject)			105.5	22.2	1.35	68.3	5.30	86.4
PP/SD - AA/UAN (Dribble)			112.6	21.8	1.35	72.7	5.90	93.4
	Signif. Level (%):		99	67	99	99	99	99
	BLSD (.05) :		7.0		.04	4.7	.34	4.3
Interaction			Significance Level (%)					
N Rate x Method			17	67	96	32	96	91

Final Population

Final populations were higher with increasing rate of N (Table 1). Similar to stover yield, populations were highest with those treatments that received their preplant N as AA compared to UAN. Exact reasons for these relationships and the highly significant N rate x method interaction are not obvious.

Grain Yield

Grain yields were increased significantly over the control by all N treatments (Table 2). Highest yields were obtained at the 180-lb rate for all application methods. When averaged over N rates, there was no difference between the single preplant AA application and the split applications when AA was either applied PP or SD in combination with UAN. However, split applications of N where UAN was the only source produced significantly lower yields. Yields were approximately 5 to 20% lower when UAN was the sidedressed material. Injecting the UAN did not significantly improve grain yields over the dribbled application method. These results indicate that significant losses of N occurred with the sidedressed UAN treatments. It is quite likely that the 4.54" of rain 2 to 3 days after the SD treatments were applied and the subsequent saturated soils may have contributed to denitrification and/or leaching of the N applied as UAN. Under these conditions the AA would have been fixed to the exchange sites and would not have undergone significant nitrification during this period. Thus, it was not susceptible to either denitrification or leaching.

Grain Moisture

Grain moisture at harvest was reduced by all of the 120 and 180-lb N treatments but was not affected significantly by the method of application (Table 2).

Grain N

Grain N was increased significantly over the control by all of the 120- and 180-lb N treatments and increased linearly at N rates from 60 to 180 lb/A when averaged over methods of application (Table 2). Highest N concentration was found with the split application of preplant UAN and sidedressed AA. The split treatment using UAN for both PP and SD applications resulted in significantly lower N concentrations. The highly significant N rate x method interaction was probably due to the small differences between the 60 and 120-lb rates when UAN was the only N source.

Grain N Removal

Grain N removal (product of grain yield times grain N concentration) was increased significantly over the check and linearly by all N rates (Table 2). Highest N removals were associated with the 180-lb rate with the single PP application of AA and the split application where AA was sidedressed. When averaged over N rates, N removal was highest with the split application where AA was SD, intermediate with the single PP application of AA and the split treatment where AA was applied PP, and lowest with the split applications where UAN was the sole source.

Nitrogen efficiency based on grain N removal minus that removed by the check averaged 33, 36, and 37% for the 60, 120, and 180-lb rates, respectively. When averaged over N rates, methods of application ranked according to highest efficiency were: split with UAN + AA (44%), single with preplant AA (39%), split with AA + UAN (37%), split with UAN both PP and SD injected (33%), and split with UAN both PP and SD dribbled (28%).

Silage Yield

Similar to grain yields, silage yields were increased significantly by all N treatments and continued to increase up through the 180-lb N rate (Table 2). Application of AA either all PP or 2/3 PP resulted in yields significantly higher than the other treatments. Lowest silage yields occurred with the split treatments when UAN was the sole N source, regardless of application method.

Total N Uptake

Total N uptake by the corn was calculated by multiplying the stover N concentration times stover yield and adding it to grain N removal. Results of total N uptake were almost identical to those of grain N removal.

Table 3. Time of N uptake as influenced by rates and split applications of N.

Nitrogen Rate	Nitrogen Time	Nitrogen Source	Stover N Yield[1/] Silk	Stover N Yield[1/] PM	Grain N Yield at PM Total	Grain N Yield at PM OLD[2/]	Grain N Yield at PM NEW[3/]	NEW[3/]
lb/A			lb N/A					% of total
0	-- CHECK	--	29.3	13.2	28.8	16.2	12.7	45
60	PP	AA	54.0	16.2	49.5	37.8	11.7	24
120	"	"	79.0	21.8	77.8	57.1	20.7	26
180	"	"	92.4	27.5	100.3	64.8	35.4	35
60	1/3PP+2/3SD	UAN(PP)+AA(SD)	67.6	16.6	55.0	50.9	4.0	6
120	"	"	74.4	19.8	85.4	54.5	30.8	36
180	"	"	79.4	24.4	104.0	55.0	49.0	46
60	"	UAN(PP)+UAN(Drib.SD)	56.3	15.2	40.4	41.1	-0.8	-
120	"	"	69.5	16.4	59.5	53.1	6.4	10
180	"	"	84.1	23.3	85.6	60.8	24.8	29
60	"	UAN(PP)+UAN(Inj.SD)	55.2	13.7	47.0	41.5	5.5	11
120	"	"	74.2	19.7	66.9	54.5	12.4	19
180	"	"	83.0	20.9	91.1	62.0	29.0	32
60	2/3PP+1/3SD	AA(PP)+UAN(Drib.SD)	58.9	20.0	50.5	39.0	11.6	23
120	"	"	76.5	20.4	72.6	56.1	16.5	24
180	"	"	88.4	21.7	94.9	66.8	28.2	29
	Signif. Level (%):		99	99	99	99	99	99
	BLSD (.05) :		8.5	3.6	7.8	10.0	11.7	15.
	CV (%) :		9.4	13.7	8.8	14.9	46.8	45.0
FACTORIAL COMPARISONS								
Main Factors								
N Rate (lb/A)								
60			58.4	16.3	48.5	42.1	6.4	12
120			74.7	19.6	72.4	55.1	17.4	23
180			85.5	23.6	95.2	61.9	33.3	34
	Signif. Level (%):		99	99	99	99	99	99
	BLSD (.05) :		3.8	1.5	3.6	4.4	5.2	6
Method (N Time - Source)								
PP - AA			75.1	21.8	75.9	53.3	22.6	28
PP/SD - UAN/AA			73.8	20.3	81.4	53.5	28.0	30
PP/SD - UAN/UAN (Dribble)			70.0	18.3	61.8	51.6	10.1	12
PP/SD - UAN/UAN (Inject)			70.8	18.1	68.3	52.7	15.6	21
PP/SD - AA/UAN (Dribble)			74.6	20.7	72.7	53.9	18.8	25
	Signif. Level (%):		75	99	99	4	99	99
	BLSD (.05) :		-	2.3	4.7	-	7.2	9
Interaction			Significance Level (%)					
N Rate x Method			95	97	32	84	86	92

1/ Silk = silk stage, PM = physiological maturity.

2/ OLD N = N in stover at silk - N in stover at PM; the difference is assumed to be translocated to the grain.

3/ NEW N = Total N in grain - OLD N; the difference is assumed to be absorbed from the soil after silking and/or translocated from the roots.

Nitrogen efficiency based on total N uptake minus that removed in the check averaged 38, 42, and 43% for the 60, 120, and 180-lb rates, respectively. When averaged over N rates, efficiency was 46, 50, 32, 37 and 43% for the single PP application of AA, split UAN + AA, split UAN + UAN dribble, split UAN + UAN injected, and split AA + UAN, respectively.

Time of N Uptake

To determine the effect of delayed/split applications of N on the time of N uptake relative to silking, whole plants (above-ground portions) were analyzed for total N at the silking stage and at PM (both grain and stover). Nitrogen uptake at the time of silking was increased linearly over the check by all N treatments (Table 3). Method of application did not affect pre-silk N uptake. The significant (P = 95% level) N rate x method interaction was due the minimal affect of N rate with the UAN(PP) + AA(SD) treatment compared to all other treatments.

Stover N yield was increased over the check by all of the 120 and 180-lb rates except the 120-lb UAN(PP) + UAN(Drib.SD) treatment (Table 3). Treatments that contained AA, either PP or SD, generally showed slightly more stover N than those that contained only UAN. The significant interaction between N rate and method was due to the lack of rate effect with the AA(PP) + UAN(SD) treatment in contrast to the significant rate effect with the other treatments. The difference between N yield at silking minus that at PM was assumed to be translocated to the grain and is termed OLD N. The amount of OLD N was increased linearly by N rate but was not affected by method of application (time-source).

NEW N is assumed to be that N taken up into the above-ground portion of the plant after silking and is calculated by substracting the OLD N from the total N in the grain at PM (Table 3). New N as a percent of the total N in the grain averaged 45% from the check treatment. This high amount was primarily due to the low N uptake by the N deficient plants prior to silking. NEW N was increased significantly with increasing rate of application and averaged 12, 23 and 34% with the 60, 120 and 180-lb rates, respectively. The method of application (time-source) had a highly significant effect on the time of N uptake. Averaged over N rates, NEW N ranged from a high of 30% with the UAN(PP) + AA(SD) treatment to a low of 12% with the UAN(PP) + UAN(Drib.SD) treatment. Highest NEW N levels were found with the treatments that contained AA. Injecting the sidedressed UAN resulted in significantly higher levels of NEW N compared to the dribbled application. Split applications of N did not result in greater amounts of late-season N uptake (NEW N) than the preplant AA treatment. These data further substantiate the poor efficiency of the split applications of UAN under these climatic conditions, especially when dribbled on the soil surface.

Residual Soil NO_3-N

Soil samples were taken in 1-foot increments to a depth of 5' from the check plots and all 180-lb N treatments to determine the effect of method (time-source) of N application on the amount of NO_3-N remaining in the soil after harvest. The data shown in Table 4 indicate only 22 to 35 lb/A more NO_3-N in the soil with the 180-lb rates compared to the check. Differences among methods of application were not significant for the total NO_3-N in the 0-5' profile.

Table 4. Residual soil NO_3-N in mid-Oct, 1986 as influenced by N application method.

Profile depth	Check	Application method [1/] Preplant AA	Split UAN+AA	Split UAN+UAN(D)	Split UAN+UAN(I)	Split AA+UAN(D)
feet	lb NO_3-N/A					
0 - 1	20.6	20.6	25.8	22.3	16.7	26.6
1 - 2	14.1	21.4	24.9	17.6	18.6	20.2
2 - 3	12.8	20.8	26.8	26.5	19.0	17.4
3 - 4	12.9	21.4	19.8	24.3	26.3	19.5
4 - 5	17.4	22.4	16.1	19.8	19.2	20.9
Total in 0 - 5' profile	78.	106.	113.	110.	100.	105.

[1/] 180 lb N/A

N Recovery

A partial N budget can be obtained by adding the total N uptake shown in Table 2 to the residual NO_3-N shown in Table 4 for each 180-lb treatment, and then subtracting out the uptake plus residual from the check treatment. From this one can calculate the percent recovery at the end of the season by dividing by the rate of N application. At the optimum 180-lb N rate, the percent recovery averaged: preplant AA (63%), UAN + AA (67%), UAN + dribbled UAN (55%), UAN + injected UAN (51%), and AA + dribbled UAN (56%).

CONCLUSIONS

Corn production was not improved in 1986 by split application of N to this Webster soil. Highest yields and greatest efficiency were obtained with the single preplant application of AA and the split application of 1/3 UAN(PP) + 2/3 AA(SD). Poorest yields and N efficiency occurred with the split applications when UAN was the sole N source. Differences between dribbled and injected SD application of UAN generally did not exist. These tesults may have been heavily influenced by the 4+ inches of rain that fell 2 to 3 days after the SD treatments were applied. However, one would have thought that under these wet conditions split applications of N would have performed better than a single preplant application.

ACKNOWLEDGEMENT

Sincere appreciation is extended to Pioneer Hi-Bred International for their financial assistance in this project.

NITROGEN SOURCES AND RATES FOR CONTINUOUS CORN IN GOODHUE COUNTY

1986

G. W. Randall and P. L. Kelly

The purpose of this investigation was to continue a study which had been started in 1985 to determine the influence of various N sources and N rates on corn production and residual soil NO_3-N in a silt loam soil.

EXPERIMENTAL PROCEDURES

This study was located at the Roger and Doug Kleese farm on a Mount Carroll silt loam (Mollic Hapludalf) that had been planted to continuous corn. The field had been chisel plowed annually until the spring of 1986 when it was moldboard plowed. Soil tests in 1985 indicated: pH = 6.2, Bray P_1 = 48 lb/A (VH), exchangeable K = 374 lb/A (VH), and extractable SO_4-S = 7 ppm (Medium).

Sixteen N treatments (Table 1) were applied in May, 1985 and were applied again to the same plots in 1986. A randomized, complete-block design with four replications was used. Each plot measured 10' wide (4 - 30" rows) x 35' long.

Corn (Pioneer 3737) was planted on May 6 with 100 lb of 9-23-30/A applied in a 2 x 2" band with the planter. Excellent weed and rootworm control were obtained with Bicep and Counter, respectively.

Nitrogen treatments were broadcast on the soil surface on May 14 and were not incorporated. (Surface residues were absent.) An additional 30 lb N/A as AN was split applied as a sidedress treatment to one of the existing 120-lb treatments at the 8-leaf stage (June 19).

Soil samples were taken from the AN treatments in 1-foot increments to 8 feet on April 22 (prior to application of the N) and again on November 11. All samples were dried, ground and analyzed for NO_3-N. Grain yields were taken on October 10 by hand harvesting.

RESULTS AND DISCUSSION

Growing conditions during 1986 were excellent. Rainfall for the growing season totaled over 27 inches. Under these conditions one would predict high yields and downward movement of NO_3-N.

Corn grain yields shown in Table 1 were increased over the check by all of the N treatments even though the ckeck yielded 159.6 bu/A. This high yield without N was probably due to a number of factors: an excellent growing season, favorable conditions for soil mineralization to supply N, and stimulated mineralization due to the moldboard plowing of the site which had been chisel plowed for a number of years. Yields continued to increase significantly with each increment of N up to 180 lb N/A. The 240-lb rate did not increase yield additionally. Split application of 150 lb N/A did not significantly increase yields over the single preemergence application of 120 lb/A and did not match the yield of the 180-lb rate. When averaged over N rates, significant yield differences (P = 90% level) among the N sources were not found. There was no N source x N rate interaction.

Ear moisture was lowered by most of the N treatments compared to the check (Table 1). Although slight population differences existed, they were not influenced by N rate or source.

Residual NO_3-N in the 0-8' soil profile in April, 1986 from the 1985 N treatments indicate a linear relationship to N rate up through 180 lb N/A (Table 2). These amounts are 18, 7, 28, 18, and 40% lower than from samples taken from the same 0, 60, 120, 180 and 240-lb N rate plots in mid-November, 1985. This indicates that significant amounts of NO_3 were lost from this soil profile over the winter and early spring, most likely by leaching.

Amounts of residual NO_3-N remaining in the 0-6' profile at the end of the 1986 growing season were very low (Table 3). Slight increases were found at the 180- and 240-lb N rates, but these were still low when considering the high rate of application and the small yield response over the 120-lb N rate. These data suggest that under these high-rainfall conditions substantial amounts of NO_3 were leached from the rooting profile of these well drained, silt loam soils.

Table 1. Corn yields and final population as influenced by N rource and rate of application.

N Treatment[1/]		Grain	Ear	Final
Source	Rate	Yield	Moisture	population
	lb N/A	bu/A	%	ppA x 10^3
CHECK	0	159.6	34.6	27.2
AN	60	193.1	32.9	27.2
"	120	207.4	31.7	27.1
AS	60	192.6	32.2	26.4
"	120	202.2	33.2	26.4
UAN	60	188.0	31.9	26.4
"	120	207.0	31.4	27.0
UAN+S	60	199.8	31.8	26.8
"	120	213.3	32.1	28.1
Urea	60	186.1	31.7	26.0
"	120	201.8	31.8	27.1
½UR+½AS	60	190.4	32.4	27.5
"	120	202.6	31.8	26.7
AN	180	214.2	32.2	27.8
"	240	214.7	31.8	27.9
"	150 split[2/]	203.3	32.5	26.4
Signif. Level (%):		99	96	99
BLSD (.05) :		9.3	2.0	1.2
CV (%) :		3.6	3.4	2.8
INDIVIDUAL FACTORS				
N Source (50 + 100 lb)				
AN		200.2	32.3	27.2
AS		197.4	32.7	26.4
UAN		197.5	31.6	26.7
UAN+S		206.6	32.0	27.4
Urea		196.5	32.1	27.1
½UR+½AS		194.0	31.8	26.6
Signif. Level (%):		87	46	86
N Rate (lb/A)				
60		191.7	32.1	26.7
120		205.7	32.0	27.1
Signif. Level (%):		99	34	85
INTERACTION			Significance Level (%)	
Source x Rate		14	53	87

1/ AN = ammonium nitrate, AS = ammonium sulfate, UAN = urea-ammonium nitrate, UAN + 2% S as AS(25-0-0-2), and UR = urea.

2/ 120 lb N/A applied 5/14 + 30 lb N/A applied 6/19 at 8-leaf stage.

Table 2. Residual soil NO_3-N in the soil profile in April, 1986 as influenced by N rate applied in May, 1985.

Profile depth	N Application Rate (lb/A)				
	0	60	120	180	240
feet	lb NO_3-N/foot				
0-1	18	18	17	32	23
1-2	7	13	13	27	26
2-3	11	18	25	28	33
3-4	9	22	25	37	27
4-5	8	15	19	15	19
5-6	9	15	12	18	20
6-7	9	12	16	15	13
7-8	11	13	15	13	11
Totals					
0-5'	53	86	99	139	128
5-8'	29	40	43	46	44
0-8'	82	126	142	185	172

Table 3. Residual soil NO_3-N in the soil profile in November, 1986 as influenced by N rate applied in May, 1986.

Profile depth	N Application Rate (lb/A)				
	0	60	120	180	240
feet	lb NO_3-N/foot				
0-1	16	15	18	17	20
1-2	4	5	6	22	19
2-3	2	2	4	15	23
3-4	5	6	5	11	14
4-5	8	11	7	12	11
5-6	8	11	9	12	10
Totals	43	50	49	89	97

CONCLUSIONS

Excellent growing conditions during 1986 resulted in very high corn yields (160 bu/A) when no N was added but were significantly increased up to 214 bu/A with 180 lb N/A. No differences among sources of N were found. Significant amounts of NO_3-N were lost from the 0-8' soil profile during the winter of 85-86 with substantial losses from the 0-6' profile during the 1986 growing season.

NITROGEN APPLICATION METHODS FOR IMPROVED EFFICIENCY IN RIDGE-PLANT TILLAGE SYSTEMS

Gyles W. Randall and Bert Bock

Conservation tillage systems (>30% residue cover) have been shown to effectively reduce erosion and runoff while incresing water storage and maintaining crop yields. Ridge-plant tillage, a strip tillage system for row crop reduction, is becoming quite popular throughout much of the northern Corn Belt. Nitrogen placement methods for corn grown in this system are somewhat limited because of the absence of primary and secondary tillage -- only the shaving of the ridge at planting or the building of the ridge at cultivation. Consequently, many farmers apply some of their N as UAN solution with a herbicide in a strip over the row at planting. The remainder of the N is either injected preplant as AA or applied sidedress as AA or UAN.

Because of the need for improved N efficiency in a ridge-plant system, the objective for this study will be to:

1. determine the effect of placement and time of N application on yield and N utilization by corn in continuous corn and corn-soybean sequences,

2. evaluate band vs broadcast and split vs single applications of N for improved N efficiency.

3. evaluate the point injector applicator as a feasible technique for precise placement of UAN solutions, and

4. monitor soil NO_3 levels before, during, and after the cropping season as affected by the N treatments.

EXPERIMENTAL PROCEDURES

Twelve N treatments were chosen to provide a N response curve and to compare various times and methods of N application (Table 1). The optimum rate chosen was 150 and 100 lb N/A for continuous corn and corn after soybeans, respectively. Band and broadcast applications of UAN were surface-applied with a motorized bicycle sprayer equipped with CO_2 cylinders. Nozzles (8006) were spaced 15" apart for the broadcast treatment. The band treatments (B-R) were applied in 8 to 10" wide strips with nozzles (8006E) spaced at 30". Anhydrous ammonia was injected about 7" deep. The point-injected treatments were injected 4 to 5" deep and were either placed 2 to 3" to the side of the planted row on the ridge (PINJ-R) or midway between the rows in the valley (PINJ-V). Sidedress applications were made at the 15-leaf stage with the point-injector wheels attached to a Hagie Hy-Boy. None of the sidedress operations damaged the corn plants.

A list of experimental procedures used, dates of application, and dates of specific plant phenology is given in Table 2. Both sites are high in organic matter and in P and K fertility. Consequently, neither broadcast nor starter fertilizers were applied. The Webster soil has a high pH and grades towards a Canisteo (high pH variant of the Webster). The site where corn followed soybeans is a Nicollet-Webster complex and has slightly better internal drainage than the Webster. However, tile lines spaced at 75' intervals run perpendicular to the plots at both sites.

Table 1. Nitrogen treatments applied to continuous corn and corn following soybeans in 1986.

Trt. No.	N Rate, Previous crop: Corn[1/]	N Rate, Previous crop: Soybeans[2/]	N Source	Application: Time[3/]	Application: Method[4/]
	---- lb N/A --				
1	0	0	CHECK	---	
2	150	100	AA	PP	INJ-V
3	100	60	UAN	PE	B-R
4	150	100	UAN	PE	B-R
5	200	140	UAN	PE	B-R
6	150	100	UAN	PE	Bdct
7	150	100	UAN	PE	PINJ-R
8	150	100	UAN	PE	PINJ-V
9	30/120	30/70	UAN/AA	PE/SD 8-1f	B-R/INJ-V
10	30/120	30/70	UAN/UAN	PE/SD 8-1f	B-R/PINJ-V
11	30/120	30/70	UAN/UAN	PE/SD 15-1f	B-R/PINJ-V
12	30/90	30/50	UAN/UAN	PE/SD 15-1f	B-R/PINJ-V

1/ 30/120 = 20% preemergence/80% sidedress
30/90 = 25% preemergence/75% sidedress

2/ 30/70 = 30% preemergence/70% sidedress
30/50 = 40% preemergence/60% sidedress

3/ PE/SD 8-1f = preemergence/sidedress 8-leaf stage
PE/SD 15-1f = preemergence/sidedress 15-leaf stage

4/ INJ-V = anhydrous ammonia injected in valley; B-R = UAN band sprayed on ridge; Bdct = UAN broadcast sprayed; PINJ-R = UAN point injected in ridge; PINJ-V = UAN point injected in valley.

Similar planting date, planting rate, hybrid and N application times were used at both sites. The sidedress treatment at the 15-leaf stage was applied 1 week prior to 50% silking and 2 weeks before the blister (BL) stage.

Climatic conditions for the 1986 growing season showed above normal precipitation with normal temperatures (Table 3). However, precipitation during the season was highly variable. April was wetter than normal while May was normal. June started out dry but ended up with 6.54" in the last 12 days. On June 21 and 22, 2.46 and 2.18" of rain fell, respectively. This heavy rainfall plus some rain on the 18th and later in June caused saturated soil conditions for a 7 to 10 day period. The 8-leaf N treatments (no. 9 and 10) were applied on June 25 and may have been highly influenced by these wet conditions. However, problems (penetration, sealing, etc.) were not encountered during N application.

Precipitation was limited during the 40-day period from July 17 through August 25 when a total of 1.83" occurred in 14 separate rainfall events. This resulted in some stress to the plants, especially the continuous corn, and may have affected the performance of the 15-leaf stage treatments. Rainfall was above normal in September and October and may have leached some of the residual NO_3-N.

Table 2. Experimental procedures used in the point injector study at Waseca in 1986.

Variable	Previous Crop: Corn	Previous Crop: Soybeans
Soil Type	Webster cl	Nicollet cl - Webster cl complex
Soil pH	7.4 (7.0 - 7.9)	6.9
Soil B&K P_1 (lb/A)	41 VH	62 VH
Soil Exch. K (lb/A)	283 H	512 VH
Soil OM	H	H
No. of replications	5	4
Planting date	May 19	May 19
Planting rate (plants/A)	30400	30400
Hybrid	Pioneer 3737	Pioneer 3737
Row width	30"	30"
P&K fertilizer used	None	None
Herbicide	Lasso (3½ lb/A) + atrazine (3 lb/A)	Lasso (3½ lb/A) + Bladex (3 lb/A)
Herbicide applc'n date	May 23	May 19
Insecticide	Counter (1 lb ai/A)	None
N Application dates:		
Preemergence - AA	May 19	May 19
Preemergence - UAN	May 21	May 21
8-leaf	June 25	June 25
15-leaf	July 17	July 17
50% silk date	July 24	July 24
Blister stage date	Aug 1	July 31
Physiological maturity date	Sept 29	Sept 30
Harvest date	Oct 16	Oct 22

Soil moisture measurements taken from an adjoining site of Webster soil indicate satisfactory amounts of available soil water in the 0-5' profile from early May until mid-July (Table 4). During August available water averaged about 50% of field capacity with virtually no available water in the top 2 feet. Soil moisture was recharged during September and October and reached saturation again by early November. No explanation is available for the slightly lower available soil water levels on July 3.

Surface residue accumulation prior to planting was more than 2X as high following the 1985 corn crop compared to soybeans (Table 5). After planting residue accumulation averaged over 30% with continuous corn when measurements were made perpendicular to the row. Measurements made in the 8 to 10" wide band centered on the ridge/row showed 10 and 6% residue cover for the continuous corn and corn following soybeans, respectively. This light amount of residue on the ridge would not be expected to interfere significantly with the band sprayed UAN. On the other hand the 20 to 32% residue cover levels could affect the broadcast treatment. Ridge height prior to planting was satisfactory at both sites. Soil NO_3-N levels in the 0 to 5' profile in April were considered to be low at both sites.

Table 3. Precipitation and air temperature averages during the 1986 growing season at Waseca.

Month	Period	Precipitation 1986	Precipitation Normal[1/]	Avg. Air Temp. 1986	Avg. Air Temp. Normal[1/]
		---- inches ----		------ °F ------	
April	1-30	4.13	2.64	48.4	44.7
May	1-10	0.95		56.4	
	11-20	2.04		56.4	
	21-31	0.77		62.2	
	Total	3.76	3.76	58.4	57.7
June	1-10	0.91		66.5	
	11-20	1.77		68.8	
	21-30	5.21		70.9	
	Total	7.89	4.48	68.7	67.1
July	1-10	1.51		69.8	
	11-20	1.87		72.9	
	21-31	0.52		72.9	
	Total	3.90	4.02	71.9	71.2
Aug	1-10	0.11		67.3	
	11-20	0.40		66.6	
	21-31	1.90		61.3	
	Total	2.41	3.99	64.9	68.8
Sept	1-30	5.57	3.36	59.8	59.8
Oct	1-31	2.83	2.08	48.3	48.9
Growing season May - Sept		23.53	19.61	64.7	64.9

1/ 30-year Normal from 1951-1980.

Table 4. Soil moisture in a 0-5' profile of a Webster soil planted to corn during 1986.

Date	Soil Depth (inches) 0-12	12-24	24-36	36-48	48-60	0-60	Percent of field capacity
	------------- inches available water -------------						%
May 2	1.83	1.64	1.71	2.87	2.40	10.45	95
May 23	1.96	1.57	1.48	2.61	2.28	9.90	90
June 3	1.84	1.32	1.58	2.61	2.23	9.58	87
June 16	2.05	1.47	1.52	2.57	2.25	9.86	89
July 3	1.37	1.30	1.36	2.36	2.03	8.42	76
July 17	1.75	1.32	1.58	2.77	2.29	9.71	88
Aug 1	.64	.75	1.09	2.01	1.67	6.16	56
Aug 18	.11	.37	.88	2.07	1.91	5.34	48
Sept 2	1.13	.29	.78	2.48	2.36	7.04	64
Sept 18	1.78	1.51	1.42	2.24	1.74	8.69	79
Oct 1	1.94	1.67	1.75	2.47	1.95	9.78	89
Oct 16	1.73	1.54	1.79	2.53	2.13	9.72	88
Nov 3	1.91	1.55	1.77	3.11	2.54	10.88	98

Table 5. Surface residue accumulation, ridge height and NO_3-N content of the 0-5' soil profile prior to planting in 1986.

Previous crop	Surface residues[1/] Before planting	Across plot	Within row	Ridge height	Soil NO_3-N[2/]
	------------ % ------------			cm	lb/A 0-5'
Corn	56	32	10	12	40
Soybeans	25	20	6	14	61

1/ Before planting = May 1; After planting = May 28.
2/ April 23.

RESULTS AND DISCUSSION

Continuous Corn

Plant height, earleaf N concentration, final population and grain moisture

Plant height and earleaf (opposite and below the ear) N concentration at silking were both increased over the check by all of the N treatments (Table 6). Sidedressing the split application of N at the 15-leaf stage (trts 11 and 12) resulted in significantly shorter plants and lower leaf N concentrations than either the preemergence (PE) or 8-leaf stage split applications. Little difference in either height or N concentration was found between the preemergence and 8-leaf split applications. Slightly less leaf N was found with the 100-lb rate and the 150-lb broadcast treatment compared to the 150-lb N rates of banded UAN. No difference was found between the AA treatment (no. 2) and the band-applied UAN treatment (no. 4). Slight differences in final population were noted but did not appear to be closely related to the N treatments. Grain moisture at harvest, an indication of maturity, was reduced by all of the N treatments compared to the check.

Table 6. Plant height, earleaf N concentration, final plant population and grain moisture as influenced by the N treatments for continuous corn in 1986.

Trt. No.	Plant height[1/]	Leaf N concentration	Final population	Grain moisture
	cm	%	ppAx10^{-3}	%
1	133	1.29	29.6	24.6
2	202	2.58	29.2	22.8
3	202	2.34	27.9	22.9
4	204	2.59	27.7	22.1
5	206	2.67	28.1	22.7
6	205	2.44	27.0	22.2
7	201	2.53	27.9	22.2
8	204	2.65	28.3	23.2
9	196	2.66	28.7	22.3
10	197	2.54	30.0	22.2
11	170	1.73	29.4	23.4
12	169	1.73	28.6	22.8
Signif. Level (%):	99	99	99	99
BLSD (.05) :	8	0.14	1.7	1.0
CV (%) :	3.7	5.2	4.1	3.4

1/ To top of tassel

Corn yields and grain:stover ratio

All corn yields and the grain:stover ratio were significantly affected (P = 99% level) by the N treatments (Table 7). Stover yields at the blister (BL) stage were highest with the PE application, but were reduced by approximately 11 and 28% by the split applications at the 8- and 15-leaf stages, respectively. Slightly lower yields were found with the 100-lb rate compared to the 150-lb PE treatments. Stover yield differences among the 150-lb band, broadcast and injected methods of application were not found.

Fodder and silage yields at physiological maturity (PM) showed the same effects as stover yields at BL (Table 7). Yields were highest with the single PE applications but were not different among the application methods (band, broadcast and injected). Split N applications at the PE + 8-leaf and PE + 15-leaf stages resulted in approximately 15 and 24% lower fodder yields, respectively, with no difference between N sources (trt 9 vs 10) or N rates at the 15-leaf stage (trt 11 vs 12). Silage yields were reduced about 12 and 15% with the PE + 8-leaf and PE + 15-leaf stage applications, respectively, compared to the single PE applications.

Table 7. Corn yields at the blister stage (BL) and at physiological maturity (PM) and grain:stover ratio as influenced by the N treatments for continuous corn in 1986.

Trt. No.	Yield: Stover (BL)	Yield: Fodder (PM)	Yield: Silage (PM)	Yield: Grain (PM)	Grain:stover[1/] ratio
	gDM/plant	---- TDM/A	-----	bu/A	
1	62	0.92	2.20	54.9	1.48
2	121	2.14	5.64	131.3	1.46
3	114	2.10	5.21	106.2	1.20
4	123	2.08	5.38	128.4	1.46
5	125	2.35	6.34	134.5	1.37
6	126	2.11	5.61	119.9	1.37
7	125	2.13	5.91	133.0	1.48
8	118	2.24	5.79	128.7	1.38
9	108	1.83	5.05	122.9	1.60
10	111	1.82	4.96	113.6	1.50
11	89	1.57	4.68	124.0	1.89
12	86	1.67	4.95	118.0	1.74
Signif. Level (%):	99	99	99	99	99
BLSD (.05) :	10	0.27	0.70	9.9	0.25
CV (%) :	8.0	12.	12.	7.3	13.

1/ Grain Yield (TDM/A) ÷ Fodder DM Yield

Grain yields were increased by N rates up through 150 lb/A when band-applied PE (Table 7). Adding an additional 50 lb N/A (trt 5) did not increase yield significantly (P = 95% level). However, the broadcast application (trt 6) did reduce yield significantly (P = 90%). Surface-band and point-injected PE applications of UAN resulted in yields equal to those from AA (trt 2). No difference was found between the point injections of UAN into the ridge (trt 7) vs into the valley (trt 8). Split applications at the PE + 8-leaf stage reduced yields about 13% when the source of N at 8-leaf stage was UAN The wet, saturated conditions may have denitrified some of the NO_3^- in the UAN which was applied into this zone of residue accumulation (valley). In addition, the urea component may have been susceptible to leaching, although rainfall after application was not excessive, or to NH_3 volatilization in the high pH medium of the concentrated injection. Alternatively, NO_2^- could have accumulated at the periphery of the UAN injection and then diffused outward where it could have been lost to the atmosphere as NO, NO_2 or N_2. Split application of 150-lb N as UAN at the PE + 15-leaf stage was superior to the split application at the PE + 8-leaf stage, but yields were still about 5% lower than with the single PE applications. Using a lower rate of N (120 lb/A) when split applying at the PE + 15-leaf stage (trt 12) resulted in a 6 bu/A yield loss compared to the 150-lb rate, and thus does not support the concept of lower N application rates with split- and sidedress-applied treatments.

Grain stover ratios were lowest for the 100-lb N rate, intermediate for the 150-lb rates applied PE and PE + 8-leaf, and substantially higher for the PE + 15-leaf applications (Table 7). Even though stover yields at BL and fodder yields at PM were low with these late split applications, the late-applied N apparently stimulated grain development, resulting in comparable grain yields to the single PE applications.

Nitrogen concentrations

Nitrogen concentrations in the stover at BL and in the fodder and grain at PM were increased over the check by all of the 150 lb N/A treatments (Table 8). In addition, plant N concentrations from the broadcast treatment were consistently below those from the PE surface band or injected treatments. Stover N concentrations were increased linearly with the surface-band treatments up through 200 lb N/A. When applied at the 150-lb N rate, stover N concentrations were highest when injecting UAN into the ridge at PE or by the split application of UAN at PE and AA at the 8-leaf stage. Delaying the second portion of the split application until the 15-leaf stage resulted in significantly less N in the stover at BL. This was not surprising, however, because of the short time (15 days) between N application and BL.

Fodder N concentrations at PM were highest with the split applications where most of the N was applied at the 8-leaf stage (Table 8). Waiting until the 15-leaf stage resulted in significantly less fodder N than when applied at the 8-leaf stage and slightly less than the PE applications.

Table 8. Nitrogen concentrations in the stover at the blister stage and in the stover and grain at physiological maturity as influenced by the N treatments for continuous corn in 1986.

Trt. No.	N Concentration in Stover (BL)	Fodder (PM)	Grain (PM)
	------------ %	------------	------------
1	0.64	0.33	1.11
2	1.07	0.47	1.35
3	0.86	0.36	1.15
4	1.09	0.45	1.30
5	1.22	0.51	1.34
6	1.01	0.42	1.26
7	1.20	0.46	1.37
8	1.16	0.47	1.32
9	1.24	0.58	1.36
10	1.15	0.52	1.40
11	0.97	0.39	1.25
12	0.88	0.38	1.21
Signif. Level (%):	99	99	99
BLSD (.05) :	0.09	0.07	0.07
CV (%) :	7.3	13.	4.8

Grain N concentrations were not different between the surface-band and the point-injected UAN treatments except with the split application at the 15-leaf stage (Table 8). Reducing the N rates to either 100 or 120 lb/A gave grain N concentrations significantly lower than the 150-lb rates that were injected.

Nitrogen yield (uptake)

Nitrogen uptake (the product of DM yield times N concentration) in the stover (BL), fodder, grain and silage was increased substantially over the check by all N treatments (Table 9). In general, these results closely resemble the yield data. Nitrogen uptake was not different between the surface-applied band treatment and the injected treatments at the PE or 8-leaf stage. Split application at PE + 15-leaf stage reduced stover, fodder and silage N uptake but had little effect on grain N uptake.

Time of N uptake

Calculations were made to determine both the amount of N taken up by the corn before and after BL and the relative amounts of this assimilated N that was translocated to the grain (Table 10).

Table 9. Nitrogen yield (uptake) at the blister stage and at physiological maturity as influenced by the N treatments for continuous corn in 1986.

	Stage			
Trt.	Blister	Physiological mature		
No.	Stover	Fodder	Grain	Silage[1/]
	Total N (lb/A)			
1	26.1	5.9	28.8	34.8
2	83.7	20.1	83.9	104.0
3	59.9	15.2	57.8	73.0
4	82.1	18.6	79.3	97.9
5	93.4	23.7	85.0	108.7
6	75.5	17.9	71.2	89.1
7	92.1	19.5	86.4	105.9
8	84.7	21.1	80.2	101.4
9	85.1	21.4	79.0	100.4
10	84.4	19.1	75.4	94.5
11	55.8	12.4	73.5	85.8
12	48.0	13.2	67.4	80.6
Signif. Level %):	99	99	99	99
BLSD (.05) :	8.3	3.8	8.1	9.2
CV (%) :	10.	19.	9.7	8.9

1/ Grain + fodder

Table 10. Time of N uptake as influenced by the N treatments for continuous corn in 1986.

Trt. No.	Time of N Uptake				NEW as a percent of total N
	OLD[1/]	NEW[2/]	OLD[1/]	NEW[2/]	
	-- mg/plant --		---- lb N/A ----		%
1	308	135	20.2	8.7	30
2	990	316	63.6	20.3	24
3	723	218	44.6	13.1	23
4	1041	259	63.5	15.8	19
5	1130	246	69.7	15.3	18
6	966	231	57.5	13.6	19
7	1186	226	72.6	13.8	16
8	1021	267	63.5	16.7	21
9	1008	242	63.7	15.3	19
10	989	152	65.4	10.0	13
11	671	462	43.4	30.0	40
12	552	518	34.8	32.6	48
Signif. Level (%):	99	99	99	99	99
BLSD (.05) :	136	175	8.4	10.6	14
CV (%) :	13.	48.	13.	47.	45.

1/ OLD = N in stover at the BL stage - N in fodder at the PM stage; the difference is the N taken up prior to the BL stage and translocated to the grain.

2/ NEW = Total N in grain - OLD; the difference is assumed to be that N absorbed from the soil after BL and/or translocated from the roots.

Plants growing in the check treatment (0 lb N/A) accumulated 30% of the total N in the grain after the BL stage. This rather high amount (consistently higher than most of the N treatments) was due to the very low amounts of assimilated N found in the stover at BL and fodder at PM. Single applications of N at PE or split applications at PE + 8-leaf stage resulted in post-BL N uptake ranging from 13 to 24% with no difference among treatments. This was in stark contrast to the split applications at PE + 15-leaf stage where 40 to 48% of the total grain was absorbed after BL. These results indicate that much of the late-season applied N was channeled directly into the grain, but yields (both plant and N) were still not optimized with these late-season N applications.

Soil Nitrate-N

Soil cores (2 per plot) were taken from mid-way between the rows to a depth of 4 feet at the BL stage and to 5 feet in early November. All cores were divided into 1-foot increments, composited for each depth within each plot, dried, ground, and analyzed for NO_3-N.

Results from the mid-season BL stage shown in Table 11 indicate greater amounts of NO_3 with the AA treatments applied either PE (trt 2) or sidedressed at the 8-leaf stage (trt 9) compared to all of the UAN treatments. Nitrate levels with the UAN treatments applied either PE or split between PE and 8-leaf stage (trt 10) were not different from the check even though the split treatment had been applied only 5 weeks prior to sampling. In contrast, the 8-leaf stage application of AA still showed a high concentration of NO_3 in the 0-1' layer.

Table 11. Nitrate-N in the 0-4' soil profile at the blister stage as influenced by the N treatments for continuous corn in 1986.

Profile	Treatment Number						
depth	1	2	4	6	8	9	10
feet	lb NO_3-N/A						
0-1	9	15	18	10	14	99	16
1-2	4	25	7	9	10	14	4
2-3	9	24	9	11	11	8	7
3-4	8	14	9	9	11	6	8
Total in 0-4' profile:	30	78	43	39	46	127	35

Nitrate-N levels remaining in the 0-5' profile after harvest showed little difference among any of the PE or early sidedress (8-leaf) treatments and the check (Table 12). Split application at the PE + 15-leaf stage, however, resulted in almost twice as much NO_3 carryover, indicating reduced plant uptake of the late-season N application with little loss from the soil. Previous experiences on these soils indicates that much of this residual NO_3 may be lost from the profile before the next crop season.

Table 12. Nitrate-N in the 0-5' soil profile after harvest as influenced by the N treatments for continuous corn in 1986.

Profile	Treatment Number											
depth	1	2	3	4	5	6	7	8	9	10	11	12
feet	lb NO_3-N/A											
0-1	16	15	13	18	20	15	20	15	20	17	27	23
1-2	9	11	8	11	13	10	12	12	17	13	35	28
2-3	7	14	10	13	11	10	11	11	16	13	36	22
3-4	11	19	13	15	17	14	13	15	17	14	20	13
4-5	11	18	11	13	16	14	13	15	12	12	13	15
Total in 0-5' profile:	54	77	55	70	77	63	69	68	82	69	131	101

Recovery of N

Recovery of N was obtained by adding the total N uptake shown in Table 9 to the residual NO_3-N shown in Table 12, and then subtracting out the uptake plus residual from the check treatment. Highest recoveries were obtained with the AA treatments applied either PE or split-applied at the 8-leaf stage or with the split applications of UAN at the PE + 15-leaf stage (Table 13). The high post-harvest recovery with the late season split application, due primarily to residual NO_3 in the soil, can be very misleading. If the NO_3 is lost from the soil before the crop in the succeeding year can utilize it, then it cannot be interpreted as true recovery. Soil samples will be taken in May, 1987 to determine the fate of the NO_3 over this 6-month period. Recoveries from the surface band and point injected PE applications of UAN were markedly greater than from the broadcast application.

Table 13. Nitrogen recovery as a percent of the applied N.

Trt. No.	Cropping System	
	Cont. Corn	Corn after Soybeans
	--- % recovery[1/] ----	
2	61	52
3	39	23
4	53	53
5	48	45
6	42	40
7	57	73
8	54	64
9	62	58
10	50	36
11	85	90
12	77	59

1/ (Total N uptake in the plant + residual soil NO_3-N after harvest) - (plant N uptake + soil NO_3-N of the check treatment).

Corn following Soybeans

Plant height, earleaf N concentration, final population and grain moisture

Plant height and leaf N concentration were increased over the check by all of the PE treatments and the split applications at PE + 8-leaf stage (Table 14). Split application at the PE + 15-leaf stage had little positive effect on either plant height or leaf N. Consistent differences between the surface-band, broadcast and injected application methods were not found, probably because of reduced levels of surface residue when following soybeans. Slight differences in final population were noted but did not appear to be related closely to N treatment. In contrast to continuous corn, grain moisture at harvest was not affected by the N treatments.

Table 14. Plant height, earleaf N concentration, final plant population and grain moisture as influenced by the N treatments applied to corn following soybeans in 1986.

Trt. No.	Plant height[1/]	Leaf N concentration	Final population	Grain moisture
	cm	%	$ppAx10^{-3}$	%
1	210	2.18	23.8	21.5
2	223	2.73	24.1	20.7
3	224	2.44	22.6	21.0
4	228	2.83	24.0	21.0
5	229	2.73	24.0	21.1
6	227	2.69	23.0	20.5
7	226	2.77	23.0	21.2
8	225	2.77	24.4	21.0
9	222	2.75	22.6	20.8
10	225	2.69	24.6	21.2
11	216	2.38	24.6	21.5
12	214	2.39	22.8	21.2
Signif. Level (%):	99	99	97	57
BLSD (.05) :	5	0.26	1.8	
CV (%) :	1.8	7.0	4.3	2.8

1/ To top of tassel

Corn Yields and Grain:Stover ratio

Stover yields at BL were maximized with the single PE applications of UAN and AA and were reduced by the split applications at the PE + 15-leaf stage (Table 15). Yields with the earlier split applications (8-leaf stage) were statistically similar to the PE applications.

Fodder yields were increased over the check by the AA treatments and by the 140-lb N rate (Table 15). Lowest fodder yields were obtained with the 0, 60 and 80-lb N rates.

Silage yields were increased over the check by the single PE treatments of 1) AA at 100 lb N/A, 2) UAN at 140 lb N/A and 3) the single point injected applications of UAN in either the ridge or valley (Table 15). Yield differences, however, were small compared to those from continuous corn.

Grain yield differences were also small compared to continuous corn, but were increased significantly over the check by all 80 and 100-lb N treatments (Table 15). Highest grain yields were obtained with the PE point injections of UAN either into the ridge or the valley. Yields from the injection of UAN into the ridge were significantly higher (P = 95% level) than from the PE applications of AA or surface applied UAN treatments applied at the 100-lb rate. The reason for this cannot be explained at this time. Split applications at the PE + 8-leaf or PE + 15-leaf stages resulted in yields comparable to the single PE applications. Increasing the N rate to 140 lb/A did not result in significant yield increases over any of the treatments except the 0 and 60-lb rates. These results demonstrate that the proper range of N rates was used to evaluate the sources, time and methods of N application. In contrast to continuous corn, grain:stover ratios were not affected by any of the N treatments.

Table 15. Corn yields at the blister stage (BL) and at physiological maturity (PM) and grain:stover ratio as influenced by the N treatments applied to corn following soybeans in 1986.

Trt. No.	Yield: Stover (BL)	Yield: Fodder (PM)	Yield: Silage (PM)	Grain (PM)	Grain:stover[1/] ratio
	gDM/plant	---- TDM/A	----	bu/A	
1	111	2.36	6.13	128.4	1.30
2	142	2.74	7.19	145.0	1.26
3	133	2.32	6.32	135.0	1.38
4	140	2.56	6.84	148.4	1.37
5	143	2.76	7.12	151.4	1.32
6	140	2.53	6.66	142.9	1.35
7	139	2.82	7.45	163.9	1.39
8	138	2.67	7.32	159.0	1.41
9	137	2.56	6.74	152.0	1.41
10	131	2.60	6.98	143.1	1.31
11	121	2.52	6.80	153.2	1.45
12	125	2.35	6.64	144.1	1.45
Signif. Level (%):	99	99	99	99	19
BLSD (.05) :	13	0.35	0.91	13.1	--
CV (%) :	6.7	8.0	7.5	6.1	12.

1/ Grain DM Yield (TDM/A) ÷ Fodder DM Yield

Nitrogen Concentrations

Nitrogen concentrations in the stover at BL were increased over the check by all of the N treatments except split application at the PE + 15-leaf stage (Table 16). Highest stover N concentrations were generally obtained with the single PE treatments and split applications at the PE + 8-leaf stage. Compared to these treatments, yields were decreased by the single PE applications of UAN at the 60-lb rate and the broadcast 100-lb rate and by the split applications at the PE + 15-leaf stage. Inconsistent differences were found for fodder N concentrations.

Grain N concentrations were increased over the check by all of the N treatments (Table 16). However, no differences were found among the placement methods or time of application when applied at the 100 or 80-lb N rates.

Table 16. Nitrogen concentrations in the stover at the blister stage and in the stover and grain at physiological maturity as influenced by the N treatments applied to corn following soybeans in 1986.

Trt. No.	N Concentration in Stover (BL)	Fodder (PM)	Grain (PM)
	------------ % ------------		
1	0.92	0.39	1.11
2	1.38	0.48	1.32
3	1.09	0.42	1.21
4	1.27	0.44	1.32
5	1.31	0.56	1.34
6	1.09	0.46	1.30
7	1.28	0.52	1.32
8	1.28	0.58	1.32
9	1.30	0.48	1.31
10	1.30	0.50	1.30
11	1.13	0.54	1.29
12	1.02	0.48	1.30
Signif. Level (%):	99	95	99
BLSD (.05) :	0.16	0.15	0.07
CV (%) :	9.5	17.	4.0

Nitrogen Yield

Nitrogen yield (uptake) closely paralleled the dry matter yields of the stover (BL), fodder, grain and silage and the N concentration in the stover at BL. Stover N yield at BL was increased over the check treatment by all of the N treatments except the split appplication at the PE + 15-leaf stage (Table 17). Highest N yields were obtained with the single PE treatments (100 lb N/A) and the split application at the PE + 8-leaf stage. N yields from these treatments were significantly higher than from the late-applied split application. This was not unexpected considering the short 2-week period between N application and BL.

Fodder N uptake was increased over the check by the 140-lb N rate, the PE point injections of UAN both into the ridge or the valley, and the 100-lb rate split applied at PE + 15-leaf stage.

Grain N uptake was increased over the check by all N treatments (Table 17). Highest N uptake was obtained with the PE point injection applications, primarily due to the high grain yields.

Total N uptake into the corn (silage) was increased over the check by all N treatments except the 60-lb rate (Table 17). At the 100-lb rate, N uptake was significantly higher with the point injected PE treatments than with the other PE and split treatments.

Table 17. Nitrogen yield (uptake) at the blister stage and at physiological maturity as influenced by the N treatments applied to corn following soybeans in 1986.

Trt. No.	Stage: Blister Stover	Physiological mature: Fodder	Physiological mature: Grain	Physiological mature: Silage[1/]
	Total N (lb/A)			
1	53.6	18.4	67.6	86.0
2	103.9	25.5	90.6	116.2
3	72.4	19.5	77.2	96.7
4	94.5	22.7	92.7	115.4
5	99.3	31.6	95.7	127.3
6	76.7	23.6	87.5	111.1
7	90.1	29.0	102.7	131.7
8	94.9	31.0	99.2	130.2
9	88.9	24.2	94.4	118.6
10	92.6	26.0	88.2	114.2
11	73.7	27.1	93.7	120.8
12	64.2	22.8	88.0	110.9
Signif. Level (%):	99	99	99	99
BLSD (.05) :	13.4	7.6	8.5	11.4
CV (%) :	12.	19.	7.0	7.3

[1/] Grain + fodder

Time of N uptake

The percent of the total N in the grain that was absorbed post-BL (NEW N) compared to that N assimilated prior to BL is shown in Table 18. Almost 50% of the grain N from the check treatment is NEW, due to the low amount of N assimilated prior to BL and subsequently translocated to the grain. Percent NEW N with the N treatments ranged from 14 to 53%, but was rather inconsistent among the PE treatments. The late-season (15-leaf) split treatment gave a significantly higher percent of NEW N than did the earlier split application (8-leaf). Moreover, the split PE + 8-leaf application did not result in a greater proportion of post-BL N uptake than most of the single PE applications. In general, corn following soybeans absorbed approximately 35% more of its total grain N after BL than did corn following corn.

Nitrate-N

Soil NO_3-N amounts for the N treatments were approximately 2X to 3X higher than the check at the BL stage (Table 19). However, all amounts were lower than expected and differences among treatments were not consistent, which is in contrast to continuous corn.

Table 18. Time of N uptake as influenced by the N treatments applied to corn following soybeans in 1986.

Trt. No.	Time of N Uptake OLD[1/]	NEW[2/]	OLD[1/]	NEW[2/]	NEW as a percent of total N
	--- g/plant --		---- lb NA ----		%
1	0.67	0.63	35.2	32.4	47
2	1.48	0.23	78.4	12.2	14
3	1.07	0.49	52.9	24.3	31
4	1.36	0.40	71.8	20.9	22
5	1.28	0.53	67.7	28.0	29
6	1.05	0.68	53.1	34.4	39
7	1.21	0.83	61.1	41.6	40
8	1.19	0.66	63.9	35.3	35
9	1.29	0.61	64.8	29.7	31
10	1.23	0.40	66.6	21.6	24
11	0.86	0.87	46.6	47.1	50
12	0.83	0.93	41.4	46.7	53
Signif. Level (%):	99	99	99	99	99
BLSD (.05) :	0.25	0.39	13.0	19.0	18
CV (%) :	16.	40.	16.	38.	35.

1/ OLD = N in stover at the BL stage - N in fodder at the PM stage; the difference is the N taken up prior to the BL stage and translocated to the grain.

2/ NEW = Total N in grain - OLD; the difference is assumed to be that N absorbed from the soil after BL and/or translocated from the roots.

Table 19. Nitrate-N in the 0-4' soil profile at the blister stage as influenced by the N treatments applied to corn following soybeans in 1986.

Profile depth	Treatment Number 1	2	4	6	8	9	10
feet	-----	-----	-----	lb NO_3-N/A	-----	-----	-----
0-1	5	15	5	6	10	10	5
1-2	1	9	5	4	14	5	4
2-3	2	16	12	15	17	13	11
3-4	9	14	13	14	15	13	12
Total in 0-4' profile:	17	54	35	39	56	41	32

Post-harvest levels of residual NO_3 in the 0-5' profile were slightly higher with all N treatments compared to the check (Table 20). The split application of 30 lb N PE + 70 lb N at the 15-leaf stage resulted in a marked increase in carryover NO_3. Most of this was located in the 1-3' zone. Soil samples taken in the spring of 1987 will show whether this NO_3 has remained for the 1987 crop.

Table 20. Nitrate-N in the 0-5' soil profile after harvest as influenced by the N treatments applied to corn following soybeans in 1986.

Profile depth	Treatment Number											
	1	2	3	4	5	6	7	8	9	10	11	12
feet	lb NO_3-N/A											
0-1	17	15	19	17	16	19	17	18	17	14	18	18
1-2	12	13	12	17	15	12	17	15	15	11	27	19
2-3	10	13	10	16	18	15	16	15	14	13	38	18
3-4	11	24	12	18	18	14	22	18	22	17	20	16
4-5	15	22	15	21	20	20	20	19	22	18	17	16
Total in 0-5' profile:	65	87	68	89	87	80	92	85	90	73	120	87

Nitrogen recovery

Nitrogen recovery (plant uptake + soil NO_3) ranged from 23 to 90% of the N applied (Table 13). Highest recoveries were associated with the highest yielding treatments (PE point injection of UAN) and the late season application that resulted in higher residual NO_3 levels in the soil. However, elevated recoveries of N based on residual NO_3 may not be high if much of this N has been lost prior to uptake by the succeeding crop.

CONCLUSIONS

Based on this one year's results we can make the following preliminary statements:

1) The extremely wet late June period followed by a dry 6-week period from mid July to August undoubtedly affected some of the results.

2) Corn production was optimized with N rates of 150 and 100 lb/A for continuous corn and corn following soybeans. Thus, a proper range of N rates (0 to 200 lb/A and 0 to 140 lb/A for continuous corn and corn after soybeans) was used to evaluate the time and methods of N placement.

3) Time of application was more critical for continuous corn compared to corn after soybeans.

4) Split applications of N were not superior to single preemergence applications. Yields and N uptake tended to be lower, however, more late-season applied N was absorbed after the BL stage and translocated to the grain. This was especially true for the split preemeergence + 15-leaf application.

5) Surface band applications of UAN directly on the row were equal to AA and were generally superior to broadcast UAN, especially with continuous corn.

6) Point injection of UAN at preemergence was superior to other methods and times of application when corn followed soybeans. Reasons for this are still unclear.

7) Point injection of UAN into the valley-area at the 8-leaf stage in continuous corn was inferior to the injection of AA.

8) Late-season (15-leaf) application of N resulted in markedly more residual NO_3 remaining in the soil at the end of the growing season. This NO_3 is susceptible to "between season" loss.

9) The point injector method of incorporating N into a conservation tillage system shows promise and should continue to be researched and developed. Mechanical problems were not encountered.

ACKNOWLEDGEMENT

Sincere appreciation is given to the National Fertilizer Development Center at TVA for their financial assistance in this project.

NITROGEN SOURCES FOR CORN WITH CONSERVATION TILLAGE IN SOUTHERN MINNESOTA

1986

G. W. Randall, P. L. Kelly and C. Zadak

Conservation tillage, which leaves plant residues on the soil surface, is frequently being practiced in southern Minnesota. These residues have been shown to affect N losses. Hence, best management practices, including proper N sources, are necessary to minimize loss of N and maximize economic return. The purpose of this study was to evaluate various N sources for corn production with conservation tillage on two contrasting soils in southern Minnesota.

EXPERIMENTAL PROCEDURES

Two sites which had been ridge-planted in 1985 were seletected for this study. One location was on a Mount Carroll silt loam (Mollic Hapludalf) on the Doug Emerson farm in Goodhue County. This soil represents a large acreage of well-drained, low organic matter, loessial soils cropped to corn in southeastern Minnesota. The other location was at the Southern Experiment Station, University of Minnesota in Waseca County. This Webster clay loam (Typic Haplaquoll) has inherently poor drainage, high organic matter content, and is extensively cropped to corn and soybeans. It represents a large acreage of soils in Southern Minnesota and Northern Iowa.

Soybeans was the previous crop in Goodhue Co. while the Waseca site had been in continuous corn. Soil tests for the Goodhue and Waseca sites follow: pH = 5.7 and 7.1; Bray extractable P_1 = 28 and 42 lb/A (High and Very High); exchangeable K = 222 and 427 lb/A (Med-High and Very High); and extractable SO_4 - S = 8 and 8 ppm (both Medium), respectively, for the two locations. Nitrate-N totaled 48 and 42 lb/A in the 0-5' profile (40 and 35 lb NO_3-N/A in 0-3') profile at the two sites. These were very low residual NO_3 levels. Surface coverage by plant residues averaged 32 and 44% at the two sites, respectively. Ridge height averaged 5.4 inches at the Waseca site.

Sixteen N treatments were replicated four times at the Goodhue site while 13 treatments were replicated four times at the Waseca site. A randomized, complete-block design was used at each site. Each plot measured 10' wide (4 - 30' rows) x 40' long in Goodhue County and 10' wide x 60' long in Waseca County.

Corn (Pioneer 3737) was planted with a John Deere Max-Emerge planter at a population of 27700 plants/acre on May 8 in Goodhue Co. and on May 7 in Waseca Co. Excellent weed and corn rootworm control was obtained with proper chemicals at both sites.

Nitrogen treatments were broadcast applied on the soil surface on May 14 in Goodhue Co. and on May 7 in Waseca Co. Rainfall in the 10-day period following N application in Goodhue Co. totaled 0.30" with .10" on the 1st day and 0.20" on the 10th day following application. At Waseca, 2.99" rain occurred in the 10-day period with .02", .57", .36" 1.38", .11", .53" and .02" on the 1st, 2nd, 3rd, 4th, 6th, 7th and 10th days, respectively, following application. Three quarters of the N (75 lb/A) for the split application was sidedress applied on the soil surface at the 7-leaf stage (June 19) at Goodhue Co. On the next day 1.80" of rain fell to move the AN into the surface soil.

Ten randomly selected leaves opposite and below the ear were taken at silking for N and S analyses. Fodder and grain yields were obtained at physiological maturity by hand harvest techniques at the Goodhue location while plots were combine harvested at Waseca. All stover and grain analyses were conducted on samples gathered at harvest. Chemical analyses were performed by the Research Analytical Laboratory, University of Minnesota.

Soil samples were taken in 1-foot increments to a depth of 3' from the 0, 60, 120, 180, and 240-lb AN treatments on November 11 at the Goodhue Co. site. These samples were dried, ground, and analyzed for NO_3-N to determine the carryover and accumulation of NO_3 in the soil profile.

RESULTS AND DISCUSSION

Rainfall during the 1986 growing season was considerably above normal in Goodhue Co. and slightly above normal in Waseca Co. (Table 1). Conditions were exceptionally dry during the 5-week period from mid-July to mid-August at Waseca and resulted in lower yields than expected. Slight amounts of rain occurred on the first day following application at both locations. However, these amounts would not have been sufficient to incorporate the surface-applied N adequately and some volatilization may have occurred. In Goodhue Co. 0.20" and 0.75" of rain fell 10 and 12 days, respectively, after application and should have incorporated the N sufficiently. During the 10-day period following application at Waseca, 2.99" of rain occurred to incorporate the N. Saturated soils did result, however, and may have caused some denitrification.

Table 1. Rainfall during the May thru October growing season in Goodhue and Waseca Counties.

Month	Location: Goodhue	Location: Waseca
	inches	
May	3.42	3.76 (0.00)[1/]
June	4.89	7.89 (+3.41)
July	6.61	3.90 (- .12)
August	2.30	2.41 (-1.58)
September	10.54	5.57 (+2.21)
October	2.85	2.83 (+ .75)
TOTAL	30.61	26.36 (+4.67)

[1/] Departure from 30-year normal.

Goodhue County

Even though low levels of NO_3 occurred in the soil profile at the beginning of the growing season, the combination of soybeans as the previous crop along with extremely favorable growing conditions during the season resulted in a minimal corn response to the N treatments (Tables 2 and 3). These small differences made it difficult to clearly establish the effects of the N sources and their interaction with rate of N application.

Nitrogen Concentrations

Leaf and grain N concentrations were increased over the control by the 100-lb N/A application rate but generally not by the 50-lb rate (Table 2). When averaged over N rate, differences among the N sources were not significant at the P = 95% level. At the 50-lb rate leaf N was lowest with the urea + AS treatment while grain N was lowest with the UAN treatment. The 100-lb N rate averaged over the six sources increased leaf, stover, and grain N significantly (P = 95% level). Increasing the application rate of AN from 100 to 200-lb N/A increased leaf N significantly but did not influence stover or grain N. The split application of AN did not improve the N concentrations in the plant tissue over the single, preemergence application. Significant (P = 90% level) interactions between N source and N rate were not found for leaf N, stover N, and grain N. Final population was not influenced by N source or rate.

Yields

Stover, silage and grain yields were increased significantly over the check by most of the N treatments, especially the 100-lb N rate (Table 3). Only the 50-lb N rate as urea failed to increase silage and grain yields over the check. When averaged over N rates, highly significant differences were found among the N sources. Stover and silage yields were lowest with urea and highest with the UAN, UAN + S and AS treatments. Grain yields were lowest with the urea + AS treatment and highest with the AS and UAN + S treatments; although differences among the AN, AS, UAN, UAN + S and urea treatments were not significant. Based on these results with AS and UAN + AS, one can speculate as to a S response, although the lower yields with the urea + AS treatment clouds the picture. The 100-lb N rate significantly increased stover, silage and grain yields over the 50-lb rate. Yields were also increased over the 100-lb rate by the 150-lb rate but not by the 200-lb rate or by the split treatment. No interaction between N rate and source was observed.

N Uptake

Uptake of N (product of N concentration times either the grain or grain + stover dry matter yield) was increased significantly over the check by all of the treatments except the 50-lb N rate as urea or UAN (Table 3). Both grain and total N uptake were consistently lowest with urea when averaged over N rates. Little difference in N uptake was found among the other N sources. Both grain and total plant uptake were increased by the 100-lb rate over the 50-lb rate. Grain and total N uptake were increased over the 100-lb rate by the 150-lb rate as AN but not by the 200-lb rate or the split application. There was no N source x rate interaction. The significant N source by N rate interaction was due to higher grain and total plant uptake at the 120-lb rate with the AS, UAN + S, urea, and urea + AS sources, while with AN and UAN, uptake was not affected by rate. Reasons for this interaction are not known at this time, but may merely reflect the variability in the data.

Table 2. Nitrogen concentration in corn tissue and final population as affected by N source and rate of application in Goodhue Co.

N Treatment		N concentration in			Final
Source[1/]	Rate	Leaf	Stover	Grain	population
	lb N/A	%			ppA x 10^3
CHECK	0	2.63	.51	1.18	21.7
AN	50	2.76	.59	1.27	21.5
"	100	3.02	.63	1.39	20.6
AS	50	2.73	.52	1.22	23.1
"	100	3.01	.57	1.38	23.2
UAN	50	2.76	.54	1.20	22.6
"	100	2.97	.55	1.39	21.1
UAN+S	50	2.84	.55	1.24	22.2
"	100	3.03	.60	1.38	22.3
Urea	50	2.88	.50	1.24	21.6
"	100	2.92	.55	1.30	21.2
½UR+½AS	50	2.72	.54	1.23	22.7
"	100	2.91	.65	1.35	22.4
AN	150	3.00	.64	1.42	23.5
"	200	3.15	.67	1.35	23.7
"	100 split[2/]	3.07	.64	1.39	22.1
Signif. Level (%):		99	96	99	42
BLSD (.05) :		.18	.14	.07	
CV (%) :		4.4	13.	4.3	8.6
INDIVIDUAL FACTORS					
N Source (50+100 lb)					
AN		2.89	.61	1.33	21.1
AS		2.87	.55	1.30	23.1
UAN		2.87	.55	1.30	21.9
UAN+S		2.93	.58	1.31	22.2
Urea		2.90	.52	1.27	21.4
½UR+½AS		2.82	.60	1.29	22.6
Signif. Level (%):		54	66	61	72
N Rate (lb/A)					
50		2.78	.54	1.23	22.3
100		2.98	.59	1.37	21.8
Signif. Level (%):		99	97	99	62
INTERACTION			Significance Level (%)		
Source x Rate		68	9	77	5

1/ AN = ammonium nitrate, AS = ammonium sulfate, UAN = urea-ammonium nitrate, UAN + S = UAN + 2% S as AS (25-0-0-2), and UR = urea.
2/ 25 lb at preemergence (May 14) and 75 lb at 7-leaf stage (June 19).

Table 3. Corn yields and N uptake as influenced by N source and rate of application in Goodhue Co.

N Treatment		Yields			Ear	N Uptake	
Source	Rate	Stover	Silage	Grain	Moisture	Grain	Total[1/]
	lb N/A	----- TDM/A -----		bu/A	%	----- lb N/A -----	
CHECK	0	2.36	6.42	152.3	36.8	85.4	109.7
AN	50	2.60	7.26	173.3	36.4	104.2	134.5
"	100	2.65	7.46	179.4	36.8	118.2	151.6
AS	50	2.67	7.46	179.0	36.2	103.4	131.4
"	100	2.93	8.01	188.9	36.4	123.4	156.9
UAN	50	2.53	7.16	173.1	35.9	98.4	126.0
"	100	3.19	8.20	186.5	36.4	122.9	158.2
UAN+S	50	2.82	7.51	175.6	36.3	103.0	134.0
"	100	3.00	8.13	191.6	35.7	125.4	161.8
Urea	50	2.49	6.82	161.6	36.3	94.8	119.9
"	100	2.52	7.15	172.8	35.1	106.6	134.2
½UR+½AS	50	2.72	7.38	174.4	36.7	102.0	131.4
"	100	2.77	7.55	177.7	36.6	113.4	149.5
AN	150	3.13	8.32	193.6	35.9	129.9	170.0
"	200	2.83	7.86	187.4	35.8	119.8	157.1
"	100 split	2.80	7.51	175.1	36.8	115.1	151.1
Signif. Level (%):		99	99	99	29	99	99
BLSD (.05) :		.39	.67	16.5		12.5	17.1
CV (%) :		9.2	6.2	6.2	2.9	8.3	8.8
INDIVIDUAL FACTORS							
N Source (50+100 lb)							
AN		2.63	7.36	176.4	36.6	111.2	143.0
AS		2.80	7.73	184.0	36.3	113.4	144.2
UAN		2.86	7.68	179.8	36.2	110.7	142.1
UAN+S		2.91	7.82	183.6	36.0	114.2	147.9
Urea		2.51	6.98	176.1	35.7	100.7	127.1
½UR+½AS		2.74	7.46	167.2	36.6	107.7	140.4
Signif. Level (%):		98	99	98	59	95	95
BLSD (.05) :		.28	.46	11.7		10.6	15.3
N Rate (lb/A)							
50		2.64	7.27	172.8	36.3	101.0	129.5
100		2.84	7.75	182.8	36.2	118.3	152.1
Signif. Level (%):		99	99	99	34	99	99
INTERACTION				Significance Level (%)			
Source x Rate		88	65	17	47	45	30

1/ Grain + stover

Sulfur Concentrations

Sulfur applications totaled 114, 8, and 57 lb S/A with the AS, UAN + S, and urea + AS treatments, respectively. These amounts of S significantly increased leaf and stover S concentrations and S uptake at the P = 99% level and grain S at the P = 93% level (Table 4). Highest S concentrations and uptake were generally found with the 114-lb rate of S. The 8 lb/A S rate applied with UAN increased leaf S over the UAN alone treatment but did not affect stover or grain S concentrations or S uptake. Nitrogen:S ratios ranged from 10.8 to 14.3 for leaves, 7.6 to 9.7 for stover, and from 13.6 to 14.5 for grain. Lowest N:S ratios were associated with either the 114 or 57-lb S rates.

Table 4. Sulfur concentrations and uptake by corn as influenced by N sources in Goodhue Co.

N Source[1/]	Leaf S	Stover S	Grain S	Sulfur Uptake Grain	Total
	%			lb S/A	
AN	.213	.065	.096	8.16	11.6
AS	.279	.075	.100	8.89	13.3
UAN	.207	.059	.097	8.56	12.3
UAN+S	.223	.067	.095	8.59	12.6
Urea	.210	.057	.093	7.64	10.5
½UR+½AS	.256	.077	.099	8.36	12.6
Signif. Level (%):	99	99	93	99	99
BLSD (.05) :	.011	.011		.53	1.0
CV (%) :	3.3	11.	3.2	4.1	5.7

1/ 100 lb N/A

Residual Nitrate - N

Samples taken to a 3-foot depth after harvest showed very little relationship between N application rate and the NO_3 remaining in the soil profile (Table 5). Nitrate-N levels were very low. Apparently most of the N not taken up by the plants was leached beyond the 3-foot depth. (Because of extremely wet conditions, it was impossible to get samples below this depth.)

Table 5. Residual soil NO_3-N in the soil profile in November as influenced by N rate in Goodhue Co.

Profile depth	N Application Rate (lb/A) 0	60	120	180	240
feet	lb NO_3-N				
0-1	10	12	15	20	18
1-2	4	4	5	13	11
2-3	4	4	6	9	7
Totals 0-3	18	20	26	42	36

Nitrogen Budget

A partial N budget can be obtained by adding the total N uptake shown in Table 3 to the residual NO_3-N shown in Table 5 for each treatment, and then subtracting out the uptake plus residual from the check treatment. From this one can calculate the percent recovery by dividing by the respective N application rate. Using this method, % recovery totaled 54, 50, 56 and 33% for the 50, 100, 150, and 200-lb N rates, respectively. These low recovery rates indicate that substantial amounts of fertilizer N were lost from the soil or immobilized into the soil organic matter during the 1986 season.

Waseca County

Nitrogen Concentrations

Leaf N was increased significantly over the check by all N treatments (Table 6). Grain N was increased significantly by all of the 150-lb treatments except with the UAN and urea + AS sources. Stover N concentrations were generally not increased over the check by any of the N treatments due to the high variability (CV = 14.0). Leaf, stover, and grain N concentrations with the 150-lb rate averaged 16, 27 and 12% lower at this site than with the 100-lb rate at the Goodhue site.

When averaged over N rates, leaf N was significantly higher with the AA and AS treatments compared to the UAN and UAN + S treatments with the urea treatments being intermediate. Stover N was highest with the AA and AS treatments. Grain N was not affected by source of N. When averaged over the six N sources, leaf and grain N were both increased significantly by the 150-lb N rate. Interactions between N source and N rate were not significant for leaf, stover, or grain N.

Table 6. Nitrogen concentration in corn tissue, final population, and plant height as affected by N source and rate of application in Waseca Co.

N Treatment Source[1/]	Rate	N concentration in Leaf	Stover	Grain	Final population	Plant height
	lb N/A	----	%	----	ppA x 10^3	cm
CHECK	0	1.46	.39	1.01	23.7	90
AA	75	2.30	.44	1.05	24.2	103
"	150	2.65	.51	1.21	24.5	103
AS	75	2.15	.45	1.10	24.7	120
"	150	2.59	.44	1.25	24.8	120
UAN	75	1.91	.38	1.02	24.2	109
"	150	2.35	.38	1.14	25.8	114
UAN+S	75	1.75	.39	1.01	24.2	110
"	150	2.45	.43	1.20	24.4	120
Urea	75	2.01	.39	1.06	24.2	115
"	150	2.65	.43	1.21	24.3	112
½UR+½AS	75	2.06	.39	1.11	24.7	118
"	150	2.39	.37	1.15	24.9	119
Signif. Level (%):		99	95	99	26	99
BLSD (.05) :		.29	.11	.15		6
CV (%) :		9.7	14.	8.7	4.9	4.2
INDIVIDUAL FACTORS						
N Source						
AA		2.47	.48	1.13	24.4	103
AS		2.37	.45	1.18	24.7	120
UAN		2.13	.38	1.08	25.0	112
UAN+S		2.10	.41	1.11	24.3	115
Urea		2.33	.41	1.13	24.3	114
½UR+½AS		2.23	.38	1.13	24.8	119
Signif. Level (%):		99	99	50	24	99
BLSD (.05) :		.23	.06			4
N Rate (lb/A)						
75		2.03	.41	1.06	24.3	112
150		2.51	.43	1.20	24.8	115
Signif. Level (%):		99	75	99	80	90
INTERACTION		Significance Level (%)				
Source x Rate		58	35	22	20	90

1/ AA = anhydrous ammonia, AS = ammonium sulfate, UAN = urea-ammonium nitrate, UAN + S = UAN + 2% S as AS(25-0-0-2), and UR = urea.

Final Population and Plant Height

Plant population was not influenced by any of the N treatments (Table 6). Plant height (extended leaves) data taken on June 26 show plants to be 13 to 30 cm (5 to 12") taller with all of the N treatments compared to the check (Table 6). Plants were tallest with the AS and Urea + AS treatments, intermediate with the UAN, UAN + S and urea treatments, and significantly shorter with AA when averaged over N rates. Difference between the two N rates was not significant at the P = 95% level.

Yields

Grain and silage yields were increased over the check by all of the N treatments while stover yields were increased by only the 150-lb treatments (Table 7). Grain moisture was reduced significantly from the check by all of the N treatments.

When averaged over N rate, significant differences (P = 90% level) in stover and silage yields were not found among the N source treatments. Grain yields were highest with the AA and AS treatments and were significantly reduced (about 13%) with the UAN and UAN + S treatments. Stover, silage, and grain yields were all increased significantly by the 150-lb N rate over the 75-lb rate. Interactions between N source and N rate were not significant at the P = 95% level.

Table 7. Corn yields and N uptake as influenced by N source and rate of application in Waseca Co.

N Treatment		Yields			Grain	N Uptake	
Source	Rate	Stover	Silage	Grain	Moisture	Grain	Total[1/]
	lb N/A	----- TDM/A -----		bu/A	%	---- lb N/A ----	
CHECK	0	1.37	3.53	67.4	24.3	32.4	43.2
AA	75	1.94	5.47	121.7	22.0	60.9	78.3
"	150	2.08	6.09	141.0	21.1	80.8	101.5
AS	75	2.36	5.76	120.6	21.5	63.1	84.3
"	150	2.23	6.07	143.2	20.4	84.8	104.2
UAN	75	1.90	5.16	102.9	22.2	49.9	64.4
"	150	2.32	6.05	122.4	20.8	66.2	84.4
UAN+S	75	1.74	4.57	104.4	21.4	50.4	63.9
"	150	2.38	6.34	129.9	21.0	74.7	94.8
Urea	75	1.83	4.88	108.9	22.7	55.0	69.4
"	150	2.61	6.68	143.0	22.2	82.3	104.6
½UR+½AS	75	1.98	5.31	124.4	21.9	66.0	81.4
"	150	2.19	5.85	131.3	20.3	72.0	88.5
Signif. Level (%):		99	99	99	99	99	99
BLSD (.05) :		.59	.89	19.1	1.3	16.4	20.5
CV (%) :		18.	12.	12.	4.1	18.	18.
INDIVIDUAL FACTORS							
N Source							
AA		2.01	5.78	131.3	21.5	70.9	89.9
AS		2.29	5.92	131.9	20.9	74.0	94.3
UAN		2.11	5.60	112.7	21.5	58.1	74.4
UAN+S		2.06	5.46	117.1	21.2	62.6	79.3
Urea		2.22	5.78	126.0	22.5	68.6	87.0
½UR+½AS		2.08	5.58	127.9	21.1	69.0	85.0
Signif. Level (%):		46	29	95	98	88	88
BLSD (.05) :				16.8	.97		
N Rate (lb/A)							
75		1.96	5.19	113.8	21.9	57.5	73.6
150		2.30	6.18	135.1	20.9	76.8	96.4
Signif. Level (%):		99	99	99	99	99	99
INTERACTION				Significance Level (%)			
Source x Rate		91	91	45	26	43	51

1/ Grain + stover

N Uptake

Nitrogen uptake in both the grain and total plant (grain + stover) was increased (P = 95% level) over the check by all treatments (Table 7). When averaged over N rates, differences among N sources were not significant although N uptake was consistently lowest with the UAN and UAN + S treatments. Uptake of N was significantly (P = 99% level) increased by the 150-lb N rate over the 75-lb rate when averaged over N sources. There was no N source by N rate interaction.

Sulfur Concentrations

Sulfur application rates with the AS, UAN + S, and urea + AS treatments totaled 170, 12, and 85 lb S/A, respectively. The 170-lb S rate consistently resulted in highest leaf, stover, and grain S (Table 8). Leaf, stover, and grain S were also increased with the 85-lb rate. The 12-lb rate applied with UAN did not affect leaf S concentrations but did increase stover and grain S slightly. Sulfur uptake in the grain was only increased with the AS treatment (170 lb S/A) while total plant S uptake was increased with both the 85- and 170-lb S rates. Nitrogen:S ratios ranged from 8.7 to 17.7 for leaves, 4.5 to 10.2 for stover, and 11.7 to 15.1 for grain. In all cases lowest N:S ratios were found with the 85 and 170-lb S rates as AS while highest N:S ratios occurred with the AA treatments. Slight reductions inthe N:S ratio were noted with the UAN + S treatment.

Table 8. Sulfur concentrations and uptake by corn as influenced by N sources in Waseca Co.

N Source[1/]	Leaf S	Stover S	Grain S	Sulfur Uptake Grain	Sulfur Uptake Total
	--- % ---			--- lb S/A ---	
AA	.150	.050	.080	5.38	7.42
AS	.297	.097	.104	7.07	11.38
UAN	.150	.042	.080	4.68	6.70
UAN+S	.162	.055	.089	5.50	8.04
Urea	.160	.043	.080	5.45	7.72
½UR+½AS	.235	.071	.098	6.13	9.36
Signif. Level (%):	99	99	99	99	99
BLSD (.05) :	.034	.010	.008	1.12	1.59
CV (%) :	13.	12.	6.1	12.	13.

1/ 150 lb N/A

SUMMARY

Although differences did exist among the N sources when averaged over N rates, these differences did not show a consistent advantage for any one particular source. In Goodhue Co. slight advantages appeared with AS and UAN + S while urea and urea + AS resulted in the poorest yields. In Waseca Co., highest yields and N uptake were obtained with AA and AS while UAN and UAN + S resulted in the lowest yields. Corn production was maximized by the 150-lb rate at both locations.

Corn production was not enhanced significantly by the sulfur in the N treatments although S concentrations in the plant and S uptake were increased at both locations. A nitrogen budget calculated from the plant N uptake and residual soil NO_3 data in Goodhue Co. indicated N recovery to range from 33 to 56%, indicating substantial loss of N in 1986. Since SO_4-S is mobile and is easily leached, the extremely wet conditions during the growing season may have accounted for the rather consistent increases in plant S concentrations and S uptake with the 57 and 114-lb rates of S applied as AS.

ACKNOWLEDGEMENT

Sincere appreciation is extended to Allied Corporation, Division of Fibers and Plastics, for their financial assistance in this project.

NITROGEN LOSS TO TILE LINES AS AFFECTED BY TILLAGE

Waseca, 1986

G. W. Randall and P. L. Kelly

Nitrogen losses to tile lines have been documented in a number of research studies including some conducted at Lamberton and Waseca, Minnesota. These studies primarily showed that N losses were a function of the N application rate and amount of precipitation. To some degree the time of application and crop grown have been shown to influence NO_3-N loss to tile lines. The purpose of this long-term study is to determine if tillage has an effect on N utilization, accumulation of NO_3-N in the soil profile, and the subsequent loss of NO_3-N to tile lines.

EXPERIMENTAL PROCEDURES

A study was initiated in 1975 on a Webster clay loam at Waseca to monitor the movement of N into a tile line installed in each of 12 plots measuring 45' by 50'. Each plot is enclosed with plastic sheeting to a 6' depth. Annual N rates of 0, 100, 200, and 300 lb N/A were applied from 1975-1979. No N was applied for the 1980 and 1981 crops. Residual N from N applied over the 5-year period (75-79) was utilized by the 1980 and 1981 corn crops. Soil samples to 10' and tile water samples taken in late 1981 showed little remaining evidence of the previous treatments.

In the fall of 1981, eight plots with the most uniform tile flow rates over the 1975-81 period were selected. Two tillage treatments (fall moldboard plow and no tillage) were replicated four times and randomized over the previous plot histories. Corn was grown on these plots in 1982 through 1985. The stalks were chopped in October, 1985 and moldboard plots plowed.

On April 22, 180 lb N/A as ammonium nitrate was broadcast applied to the surface of all plots. The moldboard treatment was then field cultivated. Corn (Pioneer 3732) was planted on May 3 at a population of 27700 plants/A with a John Deere Max-Emerge planter equipped with ripple coulters. Starter fertilizer was not used because of the high soil tests. Counter was applied at 1 lb (ai)/A to control rootworms. Weeds were controlled with a preemergence application of Lasso (3½ lb/A) and atrazine (3 lb/A) applied May 15. Weed and insect control was excellent.

The leaf opposite and below the ear was taken from 10 randomly selected plants per plot at silking (Moldboard plow = July 18, No tillage = July 21) and was analyzed for N. Silage and grain yields were taken at physiological maturity by hand harvesting 30 and 60' of row, respectively, from each plot.

Tile lines began flowing in mid March, 1986 and continued to flow intermittently until mid-July. Conditions were extremely dry in late-July and August and no tile flow was recorded during this period. Tile lines commenced flowing again in late September and flowed throughout October. When tile lines were flowing, flow rates were measured daily and samples taken on a Monday, Friday, Wednesday two-week rotation for NO_3^- analysis. All analyses were done by the Research Analytical Lab.

Soil NO_3-N in the 0-8' profile was determined from two cores/plot taken in 1-foot increments on October 23, 1986.

RESULTS

Although yields and N removal tended to be consistently higher with the moldboard plow (MP) system compared to the no tillage (NT) system, differences between the two tillage systems were not significant at the P = 90% level (Table 1). Leaf and grain N and final population were not influenced by tillage system. Experimental variability was low as indicated by CV's below 5 for yield. These end-of-season results are markedly different from what was expected in mid-July. At that time, the MP plots exhibited larger corn growth with a dark green color, and advanced maturity compared to the shorter corn that showed N deficiency symptoms on the NT plots.

Table 1. Influence of tillage system on corn production and N utilization at Waseca in 1986.

Tillage system	Final population	Leaf N	Silage		Grain		
			Yield	N uptake	Yield	N	N removal
	$x10^{-3}$	%	T DM/A	lb N/A	bu/A	%	lb N/A
Moldboard Plow	27.2	2.38	7.19	129.3	143.4	1.32	90.0
No Tillage	28.2	2.45	7.10	123.5	136.1	1.25	80.6
Signif. Level (%):[1/]	81	35	30	43	78	81	81
CV (%) :	2.8	7.8	4.0	10.	4.8	4.7	9.3

[1/] Probability level of significance.

Precipitation for April, June and the September-October period was 1.5, 3.3 and 3.0 inches above normal, respectively. Thus, most of the tile flow shown in Table 2 occurred in April, May, June and October. Total tile flow was slightly higher from the NT plots, however, the flow-weighted NO_3-N concentration was slightly lower. Total NO_3-N lost via the tile lines was not different between the two tillage systems. Average NO_3-N concentrations in the tile water continued their upward movement from about 11 mg/L in 1984 to 12 mg/L in 1985 to between 12.8 and 14.0 mg/L in 1986.

Table 2. Influence of tillage system on tile flow, NO_3-N concentration and NO_3-N loss in 1986.

Tillage system	Tile flow	Nitrate-N	
		Concentration[1/]	Loss
	acre inches	mg/L	lb N/A
Moldboard Plow	15.8	14.0	48.2
No Tillage	17.4	12.8	52.0

[1/] Flow-weighted

Parameter		Month: Mar	Apr	May	June	July	Sept	Oct	Nov	Total
		acre-inches								
Tile Flow	MP	2.32	2.57	3.64	3.82	.34	.76	2.38	.01	15.83
	NT	1.46	3.50	4.29	4.26	.49	.53	2.82	.03	17.38
		mg/L								
NO_3-N Concentration	MP	12.7	13.2	13.3	15.6	14.7	12.6	15.0	15.0	14.0
	NT	9.9	11.1	12.3	17.8	14.0	13.6	13.3	10.8	12.8
		lb N/A								
NO_3-N Loss	MP	6.1	7.7	11.6	13.2	1.2	1.9	7.6	0.02	48.2
	NT	3.4	9.0	11.7	17.9	1.6	1.5	8.2	0.07	52.0

Residual NO_3-N in the soil profile at the end of the 1986 growing season showed about 80 lb/A more N remaining with the NT system (Table 3). Greater amounts of NO_3 were found at each 1-foot increment with the NT system. The largest differences between the two tillage systems occurred below 5' where substantially more NO_3 had accumulated with NT. These results are somewhat different from 1985 when only about 30 lb more N remained under the NT system.

Table 3. Influence of tillage systems on residual NO_3-N in the soil profile in Oct., 1986.

Profile depth feet	Tillage System Mb. Plow	No Tillage
	-------- NO_3-N (lb/A)	---------
0-1	14.2	18.5
1-2	13.2	28.7
2-3	24.2	26.4
3-4	29.0	36.2
4-5	27.2	28.9
5-6	19.3	37.3
6-7	17.4	32.0
7-8	15.8	29.9
Total (lb NO_3-N/A 0-8')	160.3	237.9

FIVE-YEAR SUMMARY

The cumulative totals for the 5-year period (1982-1986) are shown in Table 4. Corn yields over this period have averaged 8 bu/A better with moldboard plow tillage. Approximately 10% more N has been removed in the grain with moldboard plow tillage. This has been due to both higher yields and slightly higher grain N concentrations with the moldboard tillage system some years. Even so, very little difference in applied N removed in the grain exists between the two treatments (48% vs 44% for MP vs NT, respectively). Even though total water flow and NO_3-N lost through the tile lines was about 10% higher with no tillage, this small difference is considered to be insignificant when considering tile flow variability among the eight plots over this 5-year period.

Table 4. Cumulative effects of the two tillage systems over the 5-year period.

Parameter	Tillage System Mb. plow	No tillage
Fert. N applied (lb/A)	900	900
Corn grain removed (bu/A)	673	633
N removed in grain (lb/A)	436	396
N removed in grain as a percent of applied N (%)	48	44
Tile flow (acre inches)	56.9	61.1
Nitrate-N lost in tile (lb/A)	136.6	149.3
N lost via tile lines as a percent of applied N (%)	15	17

SOIL TEST COMPARISON STUDY

Waseca, 1986

G. W. Randall and P. L. Kelly

Soil testing is one of the best and most economical methods of ascertaining the nutrient status of the soil. The test then serves as the basis for fertilizer recommendations for crops. Many private and public laboratories provide that service to Corn Belt farmers. The purpose of this study is to compare the soil analyses and fertilizer recommendations given by five regional laboratories for corn production in Southern Minnesota. Working with the laboratories in this comparison study we should be able to improve and standardize fertilizer recommendations for corn and soybean production.

PROCEDURES

Two experimental sites measuring 150' by approximately 300' were selected for sampling in October, 1979. One of the sites had a history of high P and K fertilization while the other had not received P or K since 1974. The soil type in the former is a Nicollet clay loam while that in the latter is primarily Webster clay loam with some Nicollet clay loam. Tile lines spaced at 75' intervals provide excellent drainage at both sites. Neither site can be irrigated.

Four samples consisting of approximately 35 cores each from a 0-7" depth were taken from each site. All samples were oven dried at 95°F, crushed and mixed thoroughly. The samples were then subdivided and sent to five laboratories which test the majority of the soil samples from Southern Minnesota. The laboratories were: A & L Agricultural Laboratories, Inc., Omaha, NE; Harris Laboratories, Inc., Lincoln, NE; Minnesota Valley Testing Laboratories, Inc., New Ulm, MN; AMOCO/Cropmate Co., Reinbeck, IA; and University of Minnesota Soil Testing Laboratory, St., Paul, MN. Soil anslyses requested consisted of pH, OM, extractable P, exchangeable K, extractable S and the micronutrients generally tested by each laboratory. Based on the results from the U of M laboratory these two sites were then classified as being initially "very high" and "medium-high". The fertilizer recommendations given by the five laboratories were then applied as five treatments in the spring of 1980 for corn. An additional check (no fertilizer) treatment was included in the randomized, complete-block design with six replications. Each plot measures 15' wide and 55' long.

After the 1980 crop, soil samples (5 cores/plot times 6 replications yielding 30 cores per treatment) were taken yearly from each treatment and sent to the respective laboratory. This allowed us to follow the buildup or decline of nutrients in the soil as affected by the recommendations of a particular laboratory over time. After 6 years (1980-85) the "very high" fertility site was terminated.

Fertilizer amounts based on the analyses and recommendations from the summer 1985 samples were applied October 31 to the appropriate plots before moldboard plowing. These fertilizer recommendations were based on a soybean yield goal of 55 bu/A following corn. Soybeans (Hardin) were planted in 15" rows on May 22. Chemical weed control consisted of 3½ qt. Lasso and 6 qt. Amiben/A applied preemergence to all plots.

Seed yield and moisture were determined by harvesting each plot with a modified JD 3300 plot combine. Yields were converted to 13.5% moisture.

In August, 1986, 0-7" soil samples were taken from each treatment except Cropmate's and were sent to the laboratory of the respective treatment. (The Cropmate laboratory is no longer in operation.) The recommendations obtained from these samples will be used for the 1987 growing season.

Medium-high testing site

The soil test results and the accompanying recommended fertilizer program of each laboratory are shown in Table 1. While the numeric values of the five laboratories were generally similar the corresponding interpretation (whether the soil tested high, low, medium, deficient etc.) varied substantially. Phosphorus and K recommendations among the labs were quite different. Nitrogen was recommended by two of the labs. Also, sulfur and zinc were each recommended by a private lab. Only one of the four private labs recommended liming the soil.

Table 1. Soil test results and the recommended fertilizer program from each laboratory on the medium-high testing site at Waseca in 1986.

Test	Soil Test Laboratory A&L	Harris	MVTL	Cropmate	U of M
	Soil Test Results[1/]				
pH	6.3	6.7	6.3	6.5	6.8
pH (buffer)	6.7	---	7.0	7.0	---
Phosphorus	22 H	24 L	27 VH	36 H	17 H
Potassium	187 M	132 D	135 H	100 L	145 H
Organic matter (%)	4.7 H	4.2 A	4.3 M	5.6	H
Calcium	3200 H	3471 E	4350	2410 H	---
Magnesium	540 VH	440 A	590	363 H	---
Sulfur	8 M	8 A	16 VH	21 H	4 LM
Iron	74 VH	44 E	39 S	---	---
Manganese	31 VH	20 E	16 S	2.1 VH	---
Zinc	3.3 H	1.3 E	1.2 H	1.6 M	1.3 M
Copper	1.5 H	1.0 A	1.1 S	---	---
Boron	1.7 H	---	1.4 S	---	---
ENR (lb/A)	96	---	---	112	---
C.E.C. (meq/100 g)	23.4	21.4	27	15.3	---

1/ All soil test results are stated in ppm unless noted otherwise.

Nutrient	A&L	Harris	MVTL	Cropmate	U of M
	Recommended Fertilizer Program[2/]				
Nitrogen	10	20	0	0	0
Phosphorus (P_2O_5)	25	72[3/]	0	28	20
Potassium (K_2O)	40	215[3/]	43	124[3/]	40
Sulfur	10	--	--	--	--
Iron	--	--	--	--	--
Manganese	--	--	--	--	--
Zinc	--	1.5	--	--	--
Lime (T/A)	1.5	--	--	--	--

2/ All values indicate pounds of nutrients recommended per acre for a yield goal of 55 bushels of soybeans per acre.

3/ Value includes maintenance recommendation, plus 50% of the buildup recommendation which was to be applied over a two-year period.

The treatments that received fertilizer yielded significantly more than the unfertilized check (Table 2). However, there were no significant yield differences among the fertilizer treatments (recommendations).

Table 2. Effect of fertilizer recommendations on soybean seed yield on the medium-high testing site at Waseca in 1986.

Lab	Fertilizer Recommendations	Seed Yield	Seed Moisture
	lb/A[1]	bu/A	%
A&L	10 N + 25 P + 40 K + 10 S	55.8	14.9
Harris	20 N + 72 P + 215 K + 1.5 ZN	57.3	15.0
MVTL	43 K	55.3	14.9
Cropmate	28 P + 124 K	55.1	15.0
U of M	20 P + 40 K	54.7	14.8
Check		48.9	14.7
	Signif. Level (%):[2]	99	99
	BLSD (.05) :	3.0	.2
	CV (%) :	4.7	1.0

1/ P and K expressed on oxide basis.
2/ Probability level of significance.

SUMMARY - 1986

Substantial differences again existed among the laboratories fertilizer recommendations. High amounts of P were recommended by the Harris lab while high amounts of K were recommended by the Harris and Cropmate Labs. Nitrogen, micronutrients and sulfur were recommended by two of the four private labs.

Differences in grain yield were not observed among the five laboratories' recommendations. Yields were excellent.

Fertilization resulted in highest profit from the MVTL recommendations and no profit from the Harris recommendations (Table 3). Fertilizer costs ranged from $4/A with the MVTL recommendation to $39/A with the Harris recommendation.

Table 3. Effect of fertilizer recommendations on yield, value, fertilizer, cost and economic return on the medium-high testing site at Waseca in 1986.

Lab	Yield	Value @ 4.57/bu	Fert[1] cost	Return[2]
	bu/A	$/A	$/A	$/A
A&L	55.8	255	13	19
Harris	57.3	262	39	0
MVTL	55.3	253	4	26
Cropmate	55.1	252	17	12
U of M	54.7	250	8	10
Check	48.9	223	--	--

1/ Using May, 1986 prices for each nutrient expressed as dollars/lb as follows: N, .18; P_2O_5, .20; K_2O, .09; S, .28; Zn, 1.09.
2/ Return yield value @4.57/bu - (fertilizer cost & value of check trt).

SEVEN-YEAR SUMMARY

Yield responses paid for the fertilizer recommendations made by all five laboratories (Table 4). However, net return was highest with the lowest cost fertilizer recommendations. The higher cost recommendations given by A&L, Harris, and Cropmate resulted in lowest economic return. It is interesting to note the very narrow range in crop value among the five laboratories over this 7-year period (a low of $2409/A to a high of $2421/A).

Table 4. Effect of fertilizer recommendations on total crop value, total fertilizer cost and result- resulting economics on the medium-high testing site at Waseca from 1980-86.

	7-Yr Total		
Lab	Crop Value[1/]	Fertilizer cost	Return[2/]
	$/A		
A&L	2409	384	+199
Harris	2421	474	+121
MVTL	2412	287	+299
Cropmate	2411	449	+136
U of M	2415	263	+326
Check	1826	0	---

1/ 3.00, 2.40, 3.00 and $2.07/bu used for corn in 1980, 1981, 1983 and 1985, respectively, and 5.50, 6.00 and $4.57/bu used for soybeans in 1982, 1984 and 1986, respectively, for a seven-year total crop value.

2/ Return over 7-year period = crop value - (fertilizer cost & value of check treatment.

STARTER FERTILIZER PLACEMENT EFFECTS ON CORN PRODUCTION

Waseca, 1986

G. W. Randall and P. L. Kelly

Starter fertilizers will increase in popularity as farmers attempt to maximize return from their fertilizer dollar and as reduced tillage becomes more popular. However, with less spring secondary tillage, farmers sometimes encounter problems with the conventional disk opener systems when moist soil is dislodged by them and then sticks to the depth bands on the planter. The result can be uneven seeding depth. To correct this problem, farmers would like to remove the disk opener fertilizer attachment and instead place the starter fertilizer directly with the seed rather than in the conventional 2 x 2" placement. The purpose of this study was to evaluate seed placement versus 2 x 2" placement of three liquid fertilizers on the early growth, final stand, and yield of corn.

Experimental Procedures

A Nicollet clay loam soil planted to corn in 1985, moldboard plowed in the fall, and field cultivated in the spring was the experimental site. The soil tests were: pH = 6.4, OM = High, Bray P_1 = 72 lb/A (VH), and exchangeable K = 390 lb/A (VH).

A randomized, complete block design with four replications was used. Factorial treatments consisting of three liquid starter fertilizers (10-34-0, 9-18-9 and 7-21-7), three rates and two placement methods (directly with the seed and 2" to the side and below) plus a no starter fertilizer check were applied. The 10-34-0 and 7-21-7 were applied at rates of 5, 10 and 15 gal/A while the 9-18-9 was applied at 4, 8, and 12 gal/A to give similar salt rates among all three sources.

Corn (Pioneer 3732) was planted in 30" rows with a JD Max-Emerge planter at 27,700 plants per acre on May 3. The liquid materials were applied either directly on the seed by running the delivery tube between the double disk openers on the planter or in the 2 x 2" position with the starter fertilizer disk opener. Counter (1 lb ai/A) was used as the rootworm insecticide. Chemical weed control consisted of 3½ qt. Lasso and 3½ qt. Bladex/A applied preemergence.

Plant counts to obtain emergence rate and final stand were then taken daily from two rows each 55' long for 12 days beginning on the 9th day after planting. Grain yield was determined by harvesting each plot with a modified JD 3300 plot combine.

Results and Discussion

Growing conditions following planting were excellent for corn germination and emergence. Soil temperature at the 2" depth averaged well above 50°F (Table 1). Soil moisture in the seed zone was slightly below field moist capacity at planting. Six days after planting 0.57" of rain thoroughly wet the seed zone. This was followed by 1.74" on the next two days which more than likely leached much of the salt from the seed zone.

The salt rate ($N+K_2O$) of fertilizers has been shown to be important when applying fertilizer with the seed. Ammonia toxicity and/or salt burn can affect the germination of seedlings. A rule of thumb in Minnesota based on older research is not to apply more than 15 lb of $N+K_2O$/A. The $N+K_2O$ application rates with the various treatments are shown in Table 2. Salt levels are higher for 7-21-7 and 9-18-9 than for 10-34-0 because of the K component. Fifteen gallons of either 10-34-0 or 7-21-7 and 12 gal of 9-18-9 clearly exceeded the 15 lb/A threshold.

Table 1. Daily precipitation and average soil temperatures (2" depth) in the 2-week period following planting.

Days after planting	Avg. Soil temperature (2")	Precipitation
	°F	inches
1	60	0
2	69	0
3	70	0
4	65	0
5	61	.02
6	59	.57
7	59	.36
8	56	1.38
9	62	0
10	66	.11
11	53	.53
12	60	0
13	57	T
14	56	.02

Table 2. Salt rate as influenced by starter fertilizer material and rate of application.

Application rate	Liquid fertilizer		
	7-21-7	10-34-0	9-18-9
gal/A	----------	lb $N+K_2O/A$	----------
4			7.7
5	7.5	6	
8			15.4
10	15.0	12	
12			23.1
15	22.5	18	

Emergence rate was generally delayed by about 1 day by the seed-placed fertilizers, especially with the high rate of application (Table 3). Application of the high rate of all fertilizer materials with the seed resulted in less than 50% of the plants emerged on the 10th day following planting compared to about 75% with the 2 x 2" placement. Emergence rates did not appear to be affected differently by the three liquid fertilizers. By 14 days after planting emergence had approached 100% regardless of treatment.

Final populations of the starter fertilizer treatments were not significantly lower than the check treatment (Table 4). Factorial analyses (Table 5) showed no population differences among the three liquid fertilizer materials and the three application rates but did show a highly significant difference (P = 99% level) between the two placement positions. However, when averaged over materials and rates, seed placement reduced the final population by only 2% compared to 2 x 2" placement. Interactions between material and rate of application, material and placement, and rate and placement were not significant at the P = 90% level.

Grain yield and moisture were not affected significantly (P = 95% level) by any of the treatments (Tables 4 and 5). A yield response was not obtained over the check yield.

Conclusion

Application of 10-34-0, 7-21-7 and 9-18-9 at the higher rates with the seed resulted in about a 1-day delay in emergence and a 2% reduction in population but did not affect yield. Moist conditions at planting and the 2.33" of rain that occurred from 5 to 8 days after planting more than likely diluted and moved the salts out of the seed zone. To be on the safe side, however, we cannot recommend rates greater than 10 gal/A with these materials when applied with the seed. Rates should be reduced further if soil conditions are very dry at planting and/or soils are lower in organic matter and coarse to medium textured. Application of urea-containing starter fertilizers (9-18-9) is discouraged even at low rates because of potentially severe phytotoxicity of the urea.

Table 3. Influence of liquid starter fertilizer material, application rate, and placement on emergence rate of corn.

Treatment			Days after planting								
Material	Rate	Placement	9	10	11	12	13	14	16	18	20
	gal/A		% of final stand								
None	0	Check	16	72	89	99	99	99	99	100	100
7-21-7	5	Seed	8	59	79	89	95	97	97	98	100
"	"	2 x 2	12	78	91	99	100	100	100	100	100
"	10	Seed	1	35	57	87	95	97	98	99	100
"	"	2 x 2	8	77	92	97	100	100	100	100	100
"	15	Seed	5	48	66	90	97	100	100	100	100
"	"	2 x 2	20	77	91	98	99	100	100	100	100
10-34-0	5	Seed	17	77	91	99	99	99	99	100	100
"	"	2 x 2	20	80	89	97	99	99	100	100	100
"	10	Seed	8	49	69	93	98	98	99	100	100
"	"	2 x 2	15	67	89	98	100	100	100	100	100
"	15	Seed	4	44	61	90	95	99	100	100	100
"	"	2 x 2	10	75	89	98	100	100	100	100	100
9-18-9	4	Seed	11	69	87	95	97	98	99	100	100
"	"	2 x 2	5	69	87	94	95	97	99	100	100
"	8	Seed	5	62	82	93	99	100	100	100	100
"	"	2 x 2	11	68	87	94	99	99	100	100	100
"	12	Seed	6	46	66	85	93	98	97	99	100
"	"	2 x 2	17	79	93	99	99	99	100	100	100

Table 4. Influence of liquid starter fertilizer material, application rate and placement on plant population, grain moisture and corn grain yield.

Material	Rate	Placement	Final population	Corn grain Moisture	Corn grain Yield
	gal/A		ppA x 10^3	%	bu/A
None	0	Check	27.1	22.3	144.6
7-21-7	5	Seed	27.1	21.1	139.3
"	"	2 x 2	26.9	21.7	145.4
"	10	Seed	26.2	21.7	137.3
"	"	2 x 2	27.3	22.3	144.7
"	15	Seed	26.1	21.8	138.9
"	"	2 x 2	27.1	21.4	146.4
10-34-0	5	Seed	26.1	21.4	137.8
"	"	2 x 2	27.7	21.7	141.8
"	10	Seed	27.1	21.9	151.3
"	"	2 x 2	27.0	21.6	147.4
"	15	Seed	26.2	21.6	143.9
"	"	2 x 2	26.6	21.7	143.9
9-18-9	4	Seed	27.1	21.7	143.4
"	"	2 x 2	27.0	22.0	152.3
"	8	Seed	26.2	21.7	142.3
"	"	2 x 2	27.3	22.1	141.5
"	12	Seed	26.4	20.7	144.5
"	"	2 x 2	27.5	21.4	141.6
Signif. Level (%):[1/]			99	81	60
BLSD (.05) :			1.2	-	-
CV (%) :			2.5	3.0	5.4

[1/] Probability level of significance.

Table 5. Factorial analyses of the effect of liquid starter fertilizer material, rate, and placement on corn production parameters.

Factors		Population	Corn grain Moisture	Corn grain Yield
MAIN FACTORS		ppA x 10^3	%	bu/A
Material				
7-21-7		26.8	21.7	142.0
10-34-0		26.8	21.6	144.3
9-18-9		26.9	21.6	144.3
Signif. level (%):		27	8	51
Rate (gal/A)				
5/4		27.0	21.6	143.3
10/8		26.9	21.9	144.1
15/12		26.6	21.4	143.2
Signif. level (%):		75	94	9
Placement				
Seed		26.5	21.5	142.1
2 x 2		27.1	21.8	145.0
Signif. level (%):		99	91	89
INTERACTIONS				
Material x Rate				
7-21-7	5	27.0	21.4	142.3
"	10	26.8	22.0	141.0
"	15	26.6	21.6	142.6
10-34-0	5	26.9	21.5	139.8
"	10	27.1	21.7	149.4
"	15	26.4	21.7	143.9
9-18-9	4	27.0	21.9	147.9
"	8	26.7	21.9	141.9
"	12	27.0	21.1	143.1
Signif. level (%):		53	89	92
Material x Placement				
7-21-7	Seed	26.5	21.6	138.5
"	2 x 2	27.1	21.8	145.5
10-34-0	Seed	26.5	21.6	144.3
"	2 x 2	27.1	21.7	144.4
9-18-9	Seed	26.6	21.4	143.4
"	2 x 2	27.3	21.8	145.1
Signif. level (%):		4	56	73
Rate x Placement				
5/4	Seed	26.8	21.4	140.2
"	2 x 2	27.2	21.8	146.5
10/8	Seed	26.5	21.8	143.6
"	2 x 2	27.2	22.0	144.5
15/12	Seed	26.2	21.4	142.4
"	2 x 2	27.1	21.5	144.0
Signif. level (%):		40	19	58
			Significance level (%)	
Material x Rate x Placement		99	60	26

DECLINE RATES OF SOIL TEST P AND K IN A CORN-SOYBEAN ROTATION

1986

G. W. Randall and S. D. Evans

With good fertilization practices over the last 20 to 30 years, many farmers throughout the Cornbelt have built their P and K soil tests to high and very high levels. Studies conducted over the last 12 years have not shown corn and soybean yield increases from additional broadcast P and K at these high to very high test levels. Consequently, a number of farmers have curtailed P and K fertilization on these high testing soils. Two commonly asked questions in this scenario are: (1) How fast will my soil test drop if I don't continue to add fertilizer P and K? and (2) At what test level should I begin to add P and K to maintain fertility at an optimum level for efficient and economical production? The purposes of this study are to determine (1) the decline rates of soil test P and K and (2) the optimum soil test level which should be maintained for economical corn and soybean production.

EXPERIMENTAL PROCEDURES

High rates of P and K were applied over a 12-year period (1973-84) in studies at the Southern Experiment Station at Waseca (Table 2) and the West Central Experiment Station at Morris (Table 3). These rates created a wide range of soil test values upon which we can evaluate the decline rates of soil test P and K when no additional fertilizer is added. Treatments 2, 3, and 4 did not receive additional P in 1985 while treatments 6 and 7 at Waseca did not receive K. The K treatments were not included at Morris because of very high native soil test K levels. Treatment 5, which had a moderately high level of fertilization prior to 1985, continues to receive P and K, and thus, serves as the high fertility control.

The P and K materials (0-46-0 and 0-0-60) were broadcast on the soil surface and incorporated by moldboard plowing the corn residue in the fall of 1985. Specific experimental procedures used for soybeans at the two locations are presented in Table 1. Management practices providing for optimum yields were employed at each location. Starter fertilizer was not used. Planting was delayed somewhat at both locations by wet weather in mid-May.

Table 1. Experimental procedures for soybeans on the high P and K rate study at the two branch stations in 1986.

Variable	Location: Morris	Location: Waseca
Planting date	5/20	5/22
Row spacing	6"	15"
Planting rate	3 beans/foot	4½ beans/foot
Variety	Evans	Hardin
Herbicide	3# Lasso + 2½# Amiben/A (Bdct)	3½# Lasso + 3# Amiben/A (Bdct)
Harvest date	10/1	10/8
Soil type	Aastad clay loam	Webster clay loam

RESULTS AND DISCUSSION

Total phosphate (P_2O_5) and potash (K_2O) applied over the 12-yr period ranged from 0 to 1200 lb/A (Tables 2 and 3). These application rates plus the 1985 rates resulted in highly significant differences in soil test P at both locations but no significant difference in soil test K at Waseca. At Waseca soil test P ranged from 14 to 100 lb P/A (Table 2). Soybean yields were increased significantly by P but plateaued at soil P levels higher than 46 lb/A. Slightly lower yields were seen at the 255 lb K/A test compared to the control (trt 5), but this yield depression (3.2 bu/A) was not significant at the P = 95% level.

At Morris, Bray P_1 ranged from 10 to 75 lb/A while Olsen's $NaHCO_3$ test ranged from 12 to 79 lb P/A (Table 3). Increasing Bray P_1 from 10 to 35 lb/A resulted in a highly significant 22.1 bu/A yield response. No additional yield response was noted with the 75 lb/A soil test level compared to the 35-lb level. Leaf P was significantly lower at the 14 lb/A soil P level compared to levels of

35 lb/A and above (Table 4.) Increasing soil test P over 35 lb/A did not further increase leaf P concentration. Phosphorus deficient soybean plants showed slightly elevated concentrations of Fe and Zn in the leaves. None of the other nutrient concentrations were affected by the P treatments.

Table 2. Soil test values, soybean seed moisture, and soybean yield as influenced by 13 years' application of P and K at Waseca.

	P and K Treatments						
	Total		Soil Test 2/			Soybean seed	
No.	1973-84	1985 1/	pH	P	K	Moisture	Yield
	----- lb P_2O_5 + K_2O/A -----			--- lb/A ---		%	bu/A
2	0 + 1200	0 + 100	6.8	14	305	14.8	45.7
3	600 + 1200	0 + 100	6.6	46	290	15.0	49.1
4	1200 + 1200	0 + 100	6.6	85	295	14.9	50.4
5	600 + 1200	100 + 100	6.7	50	290	15.0	50.8
6	1200 + 0	100 + 0	6.7	100	255	14.7	47.6
7	1200 + 600	100 + 0	6.7	99	270	14.8	49.7
	Signif. Level (%):		17	99	35	94	95
	BLSD (.05) :			21			3.7
	CV (%) :		2.9	19.	13.	0.9	3.7

1/ Treatments applied Fall of 1985 for 1986 crop.
2/ Samples were taken in October before 1986 treatments were applied.

Table 3. Soil test values, soybean seed moisture, and soybean yield as influenced by 13 years' application of P and K at Morris.

	P and K Treatments							
	Total		Soil Test 2/				Soybean seed	
No.	1973-84	1985 1/	pH	P_1	P_{Ol}	K	Moisture	Yield
	---- lb P_2O_5 + K_2O/A -----			------ lb/A -------			%	bu/A
2	0 + 1200	0 + 100	7.9	10	12	590	13.9	28.1
3	600 + 1200	0 + 100	7.7	35	36	530	14.4	50.2
4	1200 + 1200	0 + 100	7.8	75	79	545	14.4	50.7
5	600 + 1200	100 + 100	7.8	32	34	530	14.6	47.0
	Signif. Level (%):		78	99	99	79	99	99
	BLSD (.05) :			19.	21.		0.3	11.2
	CV (%) :		1.1	32.	33.	7.5	1.3	16.

1/ Treatments applied Fall of 1985 for 1986 crop.
2/ Samples were taken in October before 1986 treatments were applied.

Table 4. Effect of high P and K rates on the nutrient concentrations in the soybean leaves at Morris in 1986.

1985 Treatment		Nutrient Concentration 1/								
No.	P & K Rate	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
	lb P_2O_5 + K_2O/A	---------- %			----------	----------	----------	ppm	----------	----------
2	0 + 100	.37	2.40	.87	.45	165	82	47	10.9	47
3	0 + 100	.55	2.49	.80	.44	132	79	43	9.9	45
4	0 + 100	.56	2.61	.80	.43	134	85	40	9.9	44
5	100 + 100	.53	2.47	.79	.45	136	81	42	9.2	46
Signif. Level (%):		99	87	67	44	99	58	96	73	61
BLSD (.05) :		.09	-	-	-	21	-	4	-	-
CV (%) :		12.	4.5	8.3	4.7	8.8	5.7	5.9	11.	5.5

1/ Uppermost, mature trifoliate at the R2 stage.

CONCLUSIONS

Long-term (12-yr) P additions to these two soils created a wide range in soil test P levels. Soybean yields were optimized over the no P treatments at soil test P levels of 35 lb/A at Morris and 46 lb/A at Waseca. In this first year of the study following the 12-year P and K applications, we were not able to detect consistent decline rates in soil test P and K when these materials were not added. Additional years will be needed to determine these decline rates.

PLACEMENT OF P AND K FOR SOYBEANS IN TWO REDUCED TILLAGE SYSTEMS

G. W. Rehm and G. W. Randall

With greater emphasis on improved fertilizer efficiency and with reduced tillage being commonplace, fertilizer P and K placement is becoming a hotly debated issue. In an effort to improve our knowledge and provide the best economical recommendations, an experiment was designed with the following objectives:

1. To determine the interaction between tillage system and placement of P and K on crop yield in a corn-soybean rotation.

2. To measure the effect of placement of P and K on nutrient uptake by crops in two contrasting tillage system.

3. To quantify the distribution of P and K in the root zone after the positioning of these nutrients by selected placement methods.

4. To evalaute practical sampling procedures which can be used to accurately predict requirements for fertilizer P and K as affected by both fertilizer placement and tillage system used.

Experimental Procedures:

This study was initiated at three branch experiment stations of the University of Minnesota (Waseca, Lamberton, Morris) in the fall of 1983. Relevant soil properties measured at the initiation of the study are listed in Table 1. Corn was the test crop in 1984 and 1985. Soybeans were grown on all plots in 1986.

Table 1. Selected soil test properties for the experimental sites at Waseca.

	Fertility Level	
Soil Property	High	Low
pH	6.6	6.1
P, lb/acre (Bray & Kurtz #1)	48	14
K, lb/acre (1 N $NH_4C_2H_3O_2$)	433	190
Organic matter, %	3.5+	3.5+
Texture	clay loam	clay loam

Four factors (tillage system, rate of applied P_2O_5 and K_2O, placement of P_2O_5 and K_2O, and starter fertilizer use) are being evaluated at Waseca. The treatments in the complete factorial as well as other treatments of interest are listed in Table 2.

The study was conducted on both low fertility and high fertility sites at Waseca. Only one site (high fertility) was used at Morris.

Some explanation should be provided for treatments 28 through 36 at the Waseca and Morris locations. The term, "deep band", describes the placement of the N-P-K suspension used (4-12-24) at a depth of 10-12 inches. In treatments 29 and 30, the 10X rate was applied so that it would be in the middle (M) of future rows of corn and soybeans. In treatments 31 and 32, the "deep band" was placed so that it would be directly below the rows (BR) of future crops. Since ridges were formed prior to treatment application in the fall of 1983, treatments 31 and 32 were not used for the ridge-till planting system at Morris. Space limitations prevented the use of treatments 29 and 30 at the high fertility site at Waseca.

The annual X rate of P_2O_5 and K_2O is applied in the middle of the existing rows in a band at a depth of 6-8 inches in treatments 29 through 32. Starter fertilizer will also be used each year for treatments 29 through 32.

In treatments 33 through 36, the deep band at the 10X rate was applied so that it would be in the middle of future rows. No annual band application is used for these treatments. The appropriate starter fertilizer, however, will be used for these treatments.

Treatments were applied at all locations in late October of 1985. The fall chisel tillage operation takes place after fertilizer application each year. Depth of chiseling is 6 to 8 inches. A secondary tillage operation is used prior to spring planting with this tillage system. Management practices that will contribute to the highest yield are used at each location.

Soybeans were sampled at early to mid bloom. The most recently matured trifoliate was taken from 50 plants. These samples were dried, ground, and analyzed for P and K by standardized ICP procedures.

Soybean yields were measured with plot combines at all locations. Yields are corrected to a 13.5% moisture basis before reporting. Standard analysis of variance procedures were used for separation of treatment means. The standardized "t" test is also used for some mean comparisons. This test will be identified in the results and discussion section when used.

Results and Discussion:

At the time of this writing, tissue samples collected from the Waseca location had not been analyzed for P and K. Therefore, only yield data from Waseca are summarized in this report. Average yields from each of the treatments are shown in Table 3. The complete statistical analysis of variance (ANOVA) is given for both fertility levels in Table 4. In Table 4, the sources of variation (treatment factors) are abbreviated as follows: T = tillage, P = placement method, R = rate of P and K application, and S = starter fertilizer treatment.

Table 2. Treatments used at the Waseca and Morris locations.[1/]

Treatment Number	Tillage	Rate[2/]	Factor Placement	Starter Use[3/]
1	Ridge	--	--	No
2	Chisel	--	--	No
3	Ridge	--	--	Yes
4	Chisel	--	--	Yes
5	Ridge	X	Broadcast	No
6	Chisel	X	Broadcast	No
7	Ridge	X	Broadcast	Yes
8	Chisel	X	Broadcast	Yes
9	Ridge	1.5X	Broadcast	No
10	Chisel	1.5X	Broadcast	No
11	Ridge	1.5X	Broadcast	Yes
12	Chisel	1.5X	Broadcast	Yes
13	Ridge	X	Surface Band	No
14	Chisel	X	Surface Band	No
15	Ridge	X	Surface Band	Yes
16	Chisel	X	Surface Band	Yes
17	Ridge	1.5X	Surface Band	No
18	Chisel	1.5X	Surface Band	No
19	Ridge	1.5X	Surface Band	Yes
20	Chisel	1.5X	Surface Band	Yes
21	Ridge	X	Subsurface Band	No
22	Chisel	X	Subsurface Band	No
23	Ridge	X	Subsurface Band	Yes
24	Chisel	X	Subsurface Band	Yes
25	Ridge	1.5X	Subsurface Band	No
26	Chisel	1.5X	Subsurface Band	No
27	Ridge	1.5X	Subsurface Band	Yes
28	Chisel	1.5X	Subsurface Band	Yes
29	Ridge	X + 10X[4/]	Subsurface Band + Deep Band (M)[5/]	Yes
30	Chisel	X + 10X	Subsurface Band + Deep Band (M)[5/]	Yes
31	Ridge[6/]	X + 10X	Subsurface Band + Deep Band (BR)	Yes
32	Chisel[6/]	X + 10X	Subsurface Band + Deep Band (BR)	Yes
33	Ridge	10X	Deep Band	No
34	Chisel	10X	Deep Band	No
35	Ridge	10X	Deep Band	Yes
36	Chisel	10X	Deep Band	Yes

1/ Treatments applied to both high and low fertility sites at Waseca; treatments applied to high fertility site at Morris.

2/ X = 44 lb P_2O_5 + 87 lb K_2O/acre; 1.5 X = 66 lb P_2O_5 + 131 lb K_2O/acre.

3/ Starter rate was 100 lb 7-21-7/acre at Waseca; 110 lb 10-34-0/acre at Morris.

4/ 5 X rate was substituted for the 10 X rate at Morris.

5/ M = deep band applied in the middle of the row; BR = deep band applied below the row.

6/ Treatment not used at Morris location because ridges were built prior to the application of fertilizer.

Table 3. Soybean yield averages from the high and low fertility sites at Waseca.

Treatment No.	Fertility Level High	Fertility Level Low
	------ Yield (bu/A) ------	
1	54.9	45.2
2	55.8	45.0
3	54.5	45.5
4	56.5	45.2
5	57.3	50.5
6	55.7	49.6
7	55.4	50.0
8	57.1	48.7
9	56.7	49.6
10	55.3	48.1
11	55.6	50.8
12	56.0	48.5
13	56.5	52.1
14	56.9	48.6
15	54.2	51.1
16	60.2	49.4
17	57.7	51.6
18	55.2	50.2
19	57.3	53.2
20	55.4	47.9
21	57.0	50.0
22	59.9	49.7
23	57.8	49.6
24	59.0	49.0
25	56.5	50.5
26	56.7	49.6
27	56.9	49.4
28	57.3	48.9
29	56.4	53.1
30	56.0	50.6
31	-	51.0
32	-	50.7
33	56.7	51.8
34	60.3	51.7
35	57.2	49.2
36	56.2	50.5

Table 4. The ANOVA for soybean yield from low and high fertility sites at Waseca.

	Low Fertility				High Fertility			
Source	DF	SS	F	PR>F	DF	SS	F	PR>F
T	1	67.335	14.88	.0002	1	7.992	1.01	.3191
P	2	22.435	2.48	.0910	2	35.281	2.22	.1159
TxP	2	20.610	2.28	.1100	2	8.456	.53	.5895
R	1	.001	.01	.9924	1	15.925	2.01	.1611
TxR	1	2.407	.53	.4682	1	35.648	4.49	.0376
PxR	2	1.896	.21	.8115	2	8.431	.53	.5904
TxPxR	2	1.731	.19	.8263	2	20.830	1.31	.2758
S	1	6.917	.76	.4695	1	1.830	.12	.8913
TxS	1	0.000	.00	1.0000	1	15.298	1.93	.1694
PxS	2	3.650	.40	.6696	2	4.546	.29	.7519
TxPxS	2	5.141	.57	.5692	2	15.639	.98	.3785
RxS	1	.932	.21	.6513	1	0.000	.00	1.0000
TxRxS	1	4.008	.89	.3498	1	2.666	.34	.5641
PxRxS	2	1.481	.16	.8494	2	1.480	.09	.9111
TxPxRxS	2	12.174	1.35	.2671	2	16.648	1.05	.3559
Error	71	321.271	-	-	71	563.711	-	-
CV:		4.3%					5.0%	

None of the treatments applied had a significant influence on yield at the high fertility site. The analysis of variance shows a significant tillage x rate interaction. Since main effects were not significant, little importance is attached to this observation. Yields from the high fertility site averaged over rate are summarized in Table 5.

Table 5. Effect of tillage system, P and K placement, and starter fertilizer use on the yield of soybeans at the high fertility site at Waseca.

	Tillage System					
	Ridge Till			Fall Chisel		
Placement	Starter	No Starter	Avg.	Starter	No Starter	Avg.
	bu/acre					
Broadcast	55.5	57.0	56.3	56.6	55.5	56.1
Surface Band	55.7	57.1	56.4	57.8	56.6	57.2
Subsurface Band	57.3	56.7	57.0	58.5	58.3	58.4
AVG.	56.2	56.9		57.6	56.8	

Tillage system had a highly significant effect on soybean yield at the low fertility site. Yields were higher when the ridge-till management system was used. Placement also had a significant effect at the 90% confidence level. When averaged over the other variables studied, highest yield was produced by the surface band application. This effect was not observed at the low fertility site at Lamberton and the importance of this observation is questioned at this time. Yield data from the low fertility site are summarized in Table 6.

Table 6. Effect of tillage system, P and K placement, and starter fertilizer use on yield of soybeans at the low fertility site at Waseca.

	Tillage System					
	Ridge Till			Fall Chisel		
Placement	Starter	No Starter	Avg.	Starter	No Starter	Avg.
	bu/acre					
Broadcast	50.4	49.7	50.1	48.6	48.8	48.7
Surface Band	52.1	51.8	52.0	48.7	49.4	49.1
Subsurface Band	49.5	50.6	50.1	49.1	49.6	49.4
AVG.	50.7	50.7		48.8	49.3	

The "t" test was used to make comparisons between selected treatments that were not included as part of the complete factorial. The results are summarized in Table 7.

Table 7. Comparison of selected treatments from the high and low sites at the Waseca location.

Comparison	Fertility Level Low	Fertility Level High
	bu/acre	
control	45.1	55.3
starter only	45.4	55.5
t value	.29	.26
control	45.1	55.3
subsurface band + starter	49.3	58.4
t value	5.17*	3.74*
deep band, no starter	51.7	56.5
deep band + starter	50.2	56.7
t value	.17	.19
deep band below row + subsurface band + starter	52.2	-
deep band between row + subsurface band + starter	50.8	-
t value	1.59	-
deep band below row + subsurface band + starter	52.2	56.3
deep band + starter	50.2	56.7
t value	1.65	.23
deep band below row + subsurface band + starter	52.5	56.3
deep band; no starter	51.7	56.5
t value	.46	.18

* difference between treatments is significant at the .05 confidence level.

Use of starter only (100 lb 7-21-7 per acre) had no significant effect on yield at both the high and the low fertility sites. The application of P_2O_5 and K_2O in a subsurface band plus the use of a starter produced a significant increase in yield when compared to the control at both sites.

The deep band used to apply 440 lb P_2O_5 and 870 lb K_2O per acre at a depth of 10 to 12 inches in the fall of 1983 was apparently still being utilized to increase soybean yields. There was no difference in yield when comparisons were made for application of the initial deep band either below the row or in the middle of the 30 inch rows. Use of a subsurface band plus a starter in addition to the original deep band did not improve yields when this treatment was compared to the use of the deep band either with or without starter fertilizer.

<u>Summary</u>

The results of the trials conducted at all three locations in 1986 can be summarized as follows:

1. The effect of tillage system on soybean yield was inconsistent. Yields were higher when the ridge-till system was used at the low fertility site at Waseca. Yield was not affected by tillage at all other sites.

2. Concentration of P and K in the most recently matured trifoliate at early to mid-bloom was influenced by tillage system used. Concentrations were generally higher when soybeans were grown in the ridge-till rather than the fall chisel management system.

3. In contrast to corn, use of starter fertilizer had no effect on soybean yield in both tillage systems.

4. Except for the low fertility site at Waseca, placement of P and K had no significant effect on soybean yield. Soybeans responded to fertilization at the low fertility sites, but response was not affected by placement.

5. Fertilizer applied in deep bands in the fall of 1983 increased soybean yield at the low fertility site at Waseca in 1986. Use of subsurface bands annually in addition to the deep bands did not produce additional increases in yield.

PHOSPHORUS APPLICATION METHODS FOR IMPROVED EFFICIENCY IN A CORN-SOYBEAN ROTATION

Waseca, 1986

J. A. Lamb, G. W. Rehm, G. W. Randall, W. W. Nelson

Objectives

The primary objective of this study is to evaluate the efficiency of deep band placement methods for P fertilizers over the diverse environmental conditions of Minnesota. Results obtained from these studies would relate closely to the Northern Great Plains and for much of the Corn Belt. Under this broad objective are the following specific objectives.

1. Determine the efficiency of deep band application of P as compared to broadcast application on a wheat-soybean rotation in Northwestern Minnesota and a corn-soybean rotation in Southern and Western Minnesota.

2. Determine the effect of distance from the row of a deep band in row crops and the distance between bands in solid seeded crops on both P uptake by crops and subsequent yield.

3. Determine the effect of soil test P level on the efficiency of deep bands.

4. Determine residual effects of deep band and broadcast placement of fertilizer P on P uptake and crop yield.

Experimental Procedures:

This study was conducted at three locations: Waseca, Lamberton, and Crookston, MN in 1986. Corn and soybeans were grown at Waseca and Lamberton and spring wheat and soybeans grown at Crookston. The following variables were measured on corn at Waseca and Lamberton; grain yield, forage yield, forage P concentration and uptake, ear leaf P concentration at silking, and grain moisture content. Soybean variables measured at all locations were: grain yield, forage yield, forage P concentration and uptake, leaf P concentration at mid-flower, and grain moisture. At Crookston the parameters measured on the wheat were grain yield, grain protein content, bushel weight, grain moisture content, forage yield, and whole plant P concentration and uptake at anthesis. The grain moisture has been incorporated into the grain yield data. The corn, soybean, and wheat grain yields have been corrected to 15.5, 13.5, and 13.5% moistures, respectively, and reported as bushels per acre. Forage yields, bushel weight, protein, leaf P, and ear leaf P are reported as pounds per acre, pounds per bushel, percent, percent, and percent, respectively.

Table 1 lists the treatments that were established on all six sites. Four replications of a complete factorial arrangement of three methods of phosphorus placement and give phosphorus rates were established. The broadcast method was incorporated at all locations. The knife method at Waseca (corn and soybeans), Lamberton (corn and soybeans), and Crookston (soybeans) placed a preplant band of fertilizer at a 6-inch depth between the 30 inch width rows. At the Crookston (spring wheat) site the knife method placed preplant fertilizer 6 inches deep with a shank spacing of 15 inches. The row method at Waseca (corn and soybeans), Lamberton (corn and soybeans), and Crookston (soybeans) involved a band of fertilizer applied at planting 5 to 7 inches from the row and 2.5 to 3 inches deep. The Crookston (spring wheat) site row treatment involved placement of fertilizer directly with the seed. The phosphorus rates were 0, 10, 20, 30 and 40 pounds P per acre. Ammonium polyphosphate, 10-34-0, was the P source at all locations.

Table 1. Treatment description for 1986.

Treatment	P Treatment	
Number	Placement	Rate
		lb P/A
1	Broadcast	0
2	Broadcast	10
3	Broadcast	20
4	Broadcast	30
5	Broadcast	40
6	Knife*	0
7	Knife*	10
8	Knife*	20
9	Knife*	30
10	Knife*	40
11	Row +	0
12	Row +	10
13	Row +	20
14	Row +	30
15	Row +	40

* 15-inch width at wheat-soybean location
\+ 5-7 inches from row in soybean and corn - applied with seed in spring wheat

Broadcast and knife applied:	Crookston	October 25, 1985
	Lamberton	October 20, 1985
	Waseca	October 22, 1985
Row applied:	Crookston	May 16, 1986 - Soybean
	Crookston	May 19, 1986 - Spring Wheat
	Lamberton	May 7, 1986 - Corn and Soybeans
	Waseca	May 21, 1986 - Corn and Soybeans

Some stress occurred on the crops in 1986. The corn at Waseca had a lower grain yield because of late planting date caused by spring rains. The Crookston spring wheat site had a moderate infestation of barley thrips and later than optimum planting date because of a wetter than normal spring.

Results and Discussion

Because of the type of treatments in this study, all data was analyzed for P rate statistics which included analyses for linear and quadratic effects. Statistics for the method and method by rate interaction were obtained from analyses on data for which the 0 pound per acre P rate was dropped. The orthogonal contrasts of broadcast versus knife and row methods and knife versus row were also tested.

Table 2 contains the regression coefficients and R^2 values for effect which were significantly affected by P rate. The analyses were divided by method if there was a significant method affect. This occurred at the Lamberton location.

Table 2. Regression coefficients and R^2 values for significant P rate effects at Waseca.

Crop	Effect	Method	Intercept b_0	Linear b_1	Quadratic b_2	R^2
Corn	Yield	-	98.1	1.19	-1.66	0.98
Corn	Forage	-	9951	38.11	-	0.91
Soybean	Yield	-	33.6	0.107	-	0.90
Soybean	Forage	-	4889	19.4	-	0.79

Table 3 lists the means for each treatment and each level of each factorial effect. Also included is a summary of significance probabilities for each measured observation.

Corn - Grain and forage yield at Waseca were increased by P fertilization. This would be expected because for the low soil test value for phosphorus. Grain yields were maximized at 30 lb P/A according to the regression. Method of application did not effect grain yields. The forage yield was maximized at a P rate greater than 40 lb P/A. No method effect occurred for forage yield.

Soybeans - Soybean grain and forage yields were increased at Waseca and Lamberton from P fertilizer. Also, soybean leaf P concentrations were increased at Lamberton. No method response occurred at Waseca for grain and forage yields or at Crookston for forage yield.

Table 3. Corn and soybean yields as affected by P rates and placement methods at Waseca in 1986.

		Yield			
		Corn		Soybean	
Method	P Rate	Grain	Forage	Seed	Forage
	lb P/A	bu/A	lb/A	bu/A	lb/A
Broadcast	0	94.3	9425	33.1	4850
	10	102.3	9895	35.8	5175
	20	110.4	10995	36.4	4915
	30	125.1	10910	37.3	5630
	40	117.3	11270	37.9	5715
Knife	0	103.5	9890	33.5	5120
	10	107.4	11015	35.9	5430
	20	120.4	10670	36.1	5115
	30	125.5	11635	36.0	5090
	40	122.4	11380	36.9	5640
Row	0	97.6	9850	32.3	4640
	10	114.2	10760	34.4	5150
	20	110.8	10660	35.6	5040
	30	112.4	11090	37.5	5925
	40	115.0	11250	37.9	5720
Treatment Averages					
Broadcast		113.8	10768	36.8	5359
Knife		118.9	11175	36.2	5319
Row		113.1	10940	36.3	5459
	0	98.5	9722	32.9	4870
	10	107.9	10557	35.4	5252
	20	113.9	10775	36.0	5023
	30	121.0	11212	36.9	5548
	40	118.2	11300	37.5	5692
Statistical Analysis					
Method		0.37	0.56	0.70	0.73
Broadcast vs Knife and Row		0.56	0.38	0.41	0.85
Knife vs Row		0.20	0.54	0.89	0.45
P Rate		0.0006	0.003	0.0004	0.001
Linear		0.0001	0.0002	0.0001	0.0002
Quadratic		0.095	0.25	0.21	0.62
Method x P Rate		0.57	0.86	0.88	0.46
C.V.(%):		11.3	9.5	6.7	9.7

Conclusion

Based on this first years results, corn and soybean yields were increased significantly with P rates of 30 and 20 lb/A, respectively. Although method of application was not statistically significant, it did appear that the knifed-in treatments produced consistently higher hields, especially at the higher P rates. Row applications of greater than 10 lb P/A did not increase yields over the 10 lb P/A rate. Additional years will be required to thoroughly evaluate these treatments for highest P efficiency.

Acknowledgement

Sincere appreciation is extended to the Fluid Fertilizer Foundation for their financial assistance in this project.

CONSERVATION TILLAGE FOR CORN AND SOYBEAN PRODUCTION

Waseca, 1986

G. W. Randall and J. B. Swan

With increasing emphasis on controlling erosion and minimizing energy requirements (time, labor, and fuel), tillage practices have changed markedly over the last decade. Many of tillage practices have come to be known as "conservation tillage". To fit this definition, a tillage practice must leave 30% of the soil surface covered with residue after planting. The primary purpose of this study is to evaluate five conservation tillage (CT) systems in a long-term corn-soybean sequence. A secondary objective is to determine the value of starter fertilizers in CT systems.

EXPERIMENTAL PROCEDURES

To evaluate some of these CT practices an experiment was started in 1975 with continuous corn grown on a Webster clay loam at the Southern Experiment Station. Five tillage treatments (no tillage, fall moldboard plow, fall chisel plow, ridge-plant and till-plant [flat]) were replicated four times. Each plot was 20' wide by 125' long. Tile lines spaced 75' apart run perpendicular to the rows in all plots. Beginning in 1979 all plots were split into two, 4-row plots -- one with starter fertilizer and the other without.

After 8 years of continuous corn, soybeans were planted in 1983 to begin a long-term corn-soybean rotation. Tillage and starter fertilizer treatments remained the same except the till-plant (flat) treatment was changed to a spring-disk (20" disk blade) treatment (Table 1). Because of increased pressure of the grass weeds in the no tillage treatment, all plots were split so that either the front or rear half received a postemergence application of Poast at a rate of ¼ lb/A with 1 qt of oil concentrate in the years that soybeans were grown.

Ridges for the ridge plant treatment in 1986 were built in June, 1985. After the 1985 soybean harvest, the moldboard and chisel plow treatments were performed. On April 25 the moldboard and chisel plow treatments were field cultivated once and the spring disk treatment was disked twice. Ammonium nitrate was broadcast-applied at a rate of 160 lb N/A immediately before the secondary tillage. Ridges for 1987 soybeans were prepared on June 25.

Corn (Pioneer 3732) was planted in 30" rows at a rate of 30,400 plants/A on May 6. All treatments except no-till were planted with a John Deere 7100 planter equipped with 2" fluted coulters. B&H ridge cleaners were attached to the planter for the ridge-plant (RP) treatment. Because of high surface soil density with no tillage, seeding depth was not adequate with this planter. Thus, a JD 7000 planter was used to get better seeding depth on this tillage treatment. Ten gallons/A of 7-21-7 was used as the starter treatment.

Broadcast P and K were not applied for the 1986 corn crop because of very high soil tests. Soil tests on this site in 1984 averaged: pH = 6.7, $Bray_1$ extractable P = 60 lb/A and exchangeable K = 424 lb/A. Chemical weed control consisted of 3½ lb Lasso and 3½ lb Bladex/A applied preemergence. In order to evaluate the effectiveness of the preemergence herbicide application on weed control, a plastic sheet 18" wide and 6' long was placed between the 4th and 5th rows of each plot during herbicide spraying to prevent the application of herbicide onto the soil surface. Weed counts (grass and broadleaf) were taken on June 3 from sprayed and unsprayed areas. Treatments 2, 3, 4, and 5 were cultivated on June 13. Weed control was excellent on all cultivated plots.

Surface residue coverage was measured by the line-transect method on April 9 prior to spring tillage and on May 27 after planting. Planting depth was determined by cutting off the coleoptile at the soil surface from all the plants in a 10-foot length of row in each tillage plot 33 days after planting. The seeds were then excavated and the length of the coleoptile to the seed was measured. Early plant growth (EPG) was determined by harvesting the above ground portion of 10 random plants per plot 41 days after planting. On June 17 soil samples were taken to a 12" depth from both the starter and no starter portions of the no tillage (NT), moldboard plow (MP), and chisel plow (CP) systems. Eight cores were taken from each plot and after dividing into 0-2, 2-4, 4-6, 6-9, and 9-12" depths were composited. After drying at 100°F they were submitted to the University of Minensota Soil Testing Lab for pH, $Bray_1$ extractable P and exchangeable K analyses.

Corn leaf samples were taken on July 16 from all treatments except NT, which was sampled on July 18, by randomly sampling the leaf opposite and below the ear from the starter treatment within each tillage treatment. Yields were taken by combine harvesting the center two rows from each plot with a modified JD 3300 combine. Grain moisture and N concentrations were determined on each of these samples.

RESULTS

Since the 2-way and 3-way interactions at the bottom of Table 1 are non-significant (P = 90% level), the comparison of main effects (tillage, starter fertilizer, and previous Poast treatment) is appropriate.

Significant differences in final population, grain moisture and grain yield were found among the tillage treatments when averaged over starter fertilizer and previous Poast treatments (Table 1). Final population of the NT and RP plots averaged about 2500 plants/A fewer than with the other treatments. Differences in final stand did not exist among the MP, CP and spring disk (SD) treatments. Final population was slightly higher with the starter fertilizer treatments but was not affected by the previous application of Poast.

Grain moisture, an indication of maturity, was significantly higher with the NT treatment compared to the CP, RP and SD treatments (Table 1). This was consistent with previous years when both continuous corn and corn after soybeans were grown. Grain moisture for the MP, CP, RP and SD systems was not significantly different at the P = 95% level. Neither starter fertilizer nor the previous Poast treatments affected grain moisture.

Grain yields were not significantly different (P = 95% level) among the MP, CP, RP and SD systems when averaged over starter fertilizer and Poast treatments (Table 1). The NT yields were closer to those from the other tillage systems this year than in previous years but were still significantly lower than the MP, RP and SD systems. Starter fertilizer gave a highly significant 9.7 bu/A yield increase when averaged across tillage systems. Even though a statistically significant interaction between tillage system and starter fertilizer did not exist (18% level), largest responses to starter were obtained with NT (12.7 bu/A), CP (12.1 bu/A), and RP (10.8 bu/A). Yield response to starter fertilizer averaged only 8.7 and 4.2 bu/A for the SD and MP systems, respectively. The previous Poast treatments did show a 4.5 bu/A yield advantage which was significant at the P = 92% level. This should perhaps be discounted because there was no Poast x tillage interaction and weed control was excellent with all tillage treatments except NT.

Early plant growth was affected significantly by the tillage systems (Table 2). Plants were largest with the RP and CP systems, were intermediate in size with the MP and SD systems and were significantly smaller with NT. Starter fertilizer increased early plant weight by 9% when averaged across tillage systems. The interaction between tillage and starter fertilizer was not significant (57% level). The correlation between EPG and grain yield was not significant when starter fertilizer was used ($r = +.397$) but was significant at the 99% level when no starter was used ($r = +.566$). A linear rather than curvilinear relationship was best for each. These relationships agree well with those obtained in 1984.

Grain N was not influenced by tillage or starter fertilizer (Table 2.) However, N removal in the grain (product of grain N concentration and grain yield) was affected significantly by both tillage and starter fertilizer. This effect was due largely to the yield differences among the treatments, which resulted in lowest N removal with the NT system and the plots without starter fertilizer.

Residue measurements taken prior to planting showed significant differences among the treatments for percent of the soil surface covered with residue from the previous crops (Table 3). The treatments ranked NT > SD > RP = CP > MP. After planting, surface residue measurements were taken both within the row and randomly across the plot area. All tillage treatments showed significantly more residue than the MP treatment. However, only the RP and NT systems exceeded 30% and therefore met the definition of "conservation tillage". Within the row measurements showed slightly less residue than random across the plot measurements for all tillage sytems except MP.

Planting depth was not affected significantly by the tillage systems (Table 3). This was not consistent with previous years. The variability in the seeding depth as measured by standard deviation and range in depths indicates least variability with the NT, CP, MP and SD systems and greatest variability with the RP system. Seed placement averaged between 1.6" and 1.8" for the five tillage systems. Even though these differences are less than in previous years with continuous corn, they do point out the need for careful adjustment of the planter even when following soybeans.

Table 1. Influence of tillage methods, starter fertilizer and previous Poast herbicide treatment on corn production at Waseca in 1986.

Treatment: Tillage	Starter fert.[1/]	Poast herb.[2/]	Final population x 10^3	Grain: Moisture %	Grain: Yield bu/A
No tillage	S	P	30.1	22.2	151.3
"	S	NP	29.6	22.7	156.8
"	NS	P	26.8	22.8	141.6
"	NS	NP	30.0	23.9	141.1
Fall plow, f. cult.	S	P	32.3	22.3	171.7
" "	S	NP	32.0	22.6	155.4
" "	NS	P	30.8	21.7	158.4
" "	NS	NP	31.3	22.9	160.3
Fall chisel, f. cult.	S	P	32.0	21.7	167.3
" "	S	NP	31.6	21.9	160.6
" "	NS	P	30.4	21.6	154.5
" "	NS	NP	31.4	22.0	149.3
Ridge plant	S	P	30.2	21.8	172.1
" "	S	NP	29.7	21.8	166.1
" "	NS	P	28.8	21.8	164.0
" "	NS	NP	27.6	22.2	152.5
Spring disk	S	P	32.3	21.9	166.7
" "	S	NP	32.4	21.4	173.6
" "	NS	P	30.5	22.1	168.3
" "	NS	NP	30.9	22.2	155.1
INDIVIDUAL FACTORS					
Tillage					
No tillage			29.1	22.9	147.7
Fall plow			31.6	22.4	161.5
Fall chisel			31.4	21.7	157.9
Ridge plant			29.1	21.9	163.7
Spring disk			31.6	21.9	165.9
Significance Level (%):			99	97	95
BLSD (.05) :			1.6	0.8	13.3
Starter Fertilizer (SF)					
Starter			31.2	22.0	164.2
No starter			29.9	22.3	154.5
Significance Level (%):			99	86	99
Poast Herbicide					
Poast			30.4	22.0	161.6
No Poast			30.7	22.4	157.1
Significance Level (%):			41	93	92
Interactions			Significance Levels (%)		
Tillage x SF			3	45	18
Tillage x Poast			36	46	35
SF x Poast			78	76	37
Tillage x SF x Poast			27	3	79
CV (%)			6.4	4.2	7.0

1/ S = starter fertilizer used and NS = no starter fertilizer used.
2/ P = Poast herbicide used and NP = no Poast herbicide used in 1985.

Table 2. Influence of tillage methods and starter fertilizer on corn production at Waseca in 1986.

Treatment: Tillage	Starter fert.[1/]	Early plant growth	Grain: N	Grain: N Removal
		g/plant	%	lb/A
No tillage	S	7.9	1.41	100.7
No tillage	NS	6.7	1.38	92.7
Fall plow, f. cult.	S	9.9	1.32	107.4
Fall plow, f. cult.	NS	8.6	1.37	102.9
Fall chisel, f. cult.	S	9.9	1.39	109.6
Fall chisel, f. cult.	NS	9.5	1.38	100.7
Ridge plant	S	10.7	1.37	111.8
Ridge plant	NS	10.0	1.37	106.1
Spr. disk	S	9.1	1.40	110.4
Spr. disk	NS	8.8	1.41	112.2
INDIVIDUAL FACTORS				
Tillage				
No tillage		7.3	1.40	96.7
Fall plow		9.2	1.35	105.1
Fall chisel		9.7	1.38	105.1
Ridge plant		10.4	1.37	109.0
Spr. disk		8.9	1.40	111.3
Signif. Level (%):		99	61	92
BLSD (.05) (.10)*:		1.3		9.9*
Starter fertilizer				
Starter		9.5	1.38	108.0
No starter		8.7	1.38	102.9
Signif. Level (%):		99	23	96
Till x SF IA				
Signif. Level (%):		57	31	38
CV (%) :		7.0	3.9	6.9

1/ S = starter fertilizer used and NS = no starter fertilizer

Table 3. Influence of tillage methods for corn following soybeans on surface residue, seeding depth and leaf N at Waseca in 1986.

Treatment	Surface Residence: Before planting	After Planting: Across plot	After Planting: Within row	Planting Depth: Average	Planting Depth: S	Planting Depth: Range	Leaf nitrogen
	%	%	%	mm	mm	mm	%
No tillage	80	80	71	47	2.0	40-60	2.77
Fall plow	2	4	4	40	3.1	21-58	2.55
Fall chisel	20	28	16	47	4.7	38-64	2.65
Ridge plant	24	34	17	41	8.4	25-57	2.61
Spr. disk	56	24	21	42	4.3	30-51	2.63
Signif. Level (%):	99	99	99	75			83
BLSD (.05) :	9	6	7	-			-
CV (%) :	18.	13.	19.	13.			4.5

Nitrogen concentration of the earleaf at silking was not influenced significantly by tillage (Table 3). Visual N deficiency symptoms were more apparent on the MP plots than with the other tillage systems, however. The 4.54-inch rainfall that occurred on June 22 and 23 and the subsequent wet soil conditions over the next 7 to 10-day period were primarily responsible for the slight N deficiency.

The rate of seedling emergence was determined by counting the number of plants that had spiked thru in 100-feet of row/plot from the 9th to the 24th day after planting. Emergence, as a percent of final stand, shown in Table 4 indicates most rapid emergence with the RP system. Emergence was delayed about 2 days with the MP, CP and SD systems and about 3 days with the NT systems. These differences continued through about the 6 to 8-leaf stage, but by silking phenological differences among the RP, MP,CP and SD were not evident. The NT system, however, continued to be about 2 days behind at silking and reached physiological maturity a few days after the other tillage systems.

Table 4. Influence of tillage methods on the emergence progress of corn following soybeans at Waseca in 1986.

	Days Post Planting										
Treatment	9	10	11	12	13	14	15	16	17	21	24
	% emerged										
No tillage	0	0	1	12	37	60	89	94	98	100	100
Fall plow	0	0	6	30	67	81	97	98	99	100	100
Fall chisel	0	2	6	31	78	89	96	98	100	98	100
Ridge plant	7	35	50	81	95	97	99	99	99	100	100
Spring disk	0	1	4	25	69	83	96	97	99	100	100

Weed counts (broadleaf and grass) were taken between the 4th and 5th rows from randomly placed 1 ft sections/plot 18 days after preemergence herbicide application. Weed pressure from broadleaf weeds was not great, as counts were low from both herbicide treated and untreated areas (Table 5). Considering the grass weed pressure, grasses were controlled extremely well by the herbicides in all tillage systems. It should be noted that the RP and MP systems had the fewest grass weeds when no herbicide was applied and least weeds after herbicide application. Grass control was not as good in the NT system because of at least two reasons. Weed pressure without herbicides was extremely high and probably the greater surface residue accumulation prevented the preemergence herbicides from fully contacting the soil.

Table 5. Weed populations on June 3 as affected by tillage and herbicide for corn following soybeans at Waseca in 1986.

	Herbicide[1/]		No Herbicide	
Treatment	Grasses	Broadleaves	Grasses	Broadleaves
	plants/10 sq. ft.[2/]			
No tillage	27	1	2411	4
Fall plow	2	1	24	3
Fall chisel	16	2	361	5
Ridge plant	0	1	39	7
Spring disk	21	0	526	1

1/ 3½ lb Lasso and 3½ lb Bladex/A, preemergence
2/ Average over 4 replications

Soil samples taken in increments from the NT, MP and CP tillage systems indicate a tremendous drop in soil pH in the 0-2" surface layer of this well-buffered soil with NT and a slight drop with CP (Table 6). There was little difference in soil pH between the starter and no starter treatments except in NT where starter lowered the pH from 5.7 to 5.3 in the 0-2" layer. Phosphorus tended to accumulate in the 0-2" layer with both the CP and NT systems. As a result of the 8 years of starter vs no starter comparison, soil test P levels were slightly higher for the starter treatments in all tillage systems. Potassium accumulated in the 0-2" layer only with NT and did not show a relationship to the starter fertilizer treatments.

Table 6. Soil test pH, P and K after corn planting from the no-tillage, moldboard plow and chisel plow tillage treatments.

Profile depth	No Tillage		Moldboard Plow		Chisel plow	
	Starter	No Starter	Starter	No Starter	Starter	No Starter
inches	Soil pH					
0-2	5.3	5.7	6.6	6.8	6.4	6.3
2-4	6.2	6.3	6.7	6.8	6.6	6.5
4-6	6.6	6.7	6.8	6.8	6.9	6.7
6-9	6.7	6.8	6.9	6.8	6.9	6.9
9-12	6.8	6.8	7.0	7.0	7.0	6.9
	Soil P (ppm)					
0-2	50	41	33	23	44	32
2-4	27	30	35	22	25	25
4-6	20	20	28	20	15	16
6-9	18	18	23	13	10	12
9-12	11	13	9	10	7	7
	Soil K (ppm)					
0-2	315	317	240	216	250	331
2-4	247	259	238	220	201	212
4-6	200	194	212	204	161	168
6-9	162	167	190	168	153	145
9-12	140	147	148	136	144	138

SUMMARY - 1986

This was the second crop of corn grown after soybeans in this long-term study with continuous corn from 1975 through 1982, soybeans in 1983 and 1985, and corn in 1984. Surface residues prior to planting were greater than 50% with the NT and SD systems and remained above 30% after planting with the NT and RP systems. Plant emergence was fastest with RP, delayed by about 2 days with the MP, CP and SD systems, and by about 3 days with NT. Weed pressure was reduced considerably with the Lasso + Bladex preemergence application. Lowest weed pressure was noted with the RP and MP systems. Highest weed counts, primarily grasses, were found with the NT and SD systems. Early plant growth was greatest for the RP system and least for NT. Phenological plant development throughout the season continued to be a couple of days behind with the NT plants compared to plants grown on the other tillage systems. Leaf N was not affected by tillage or starter fertilizer. Yields among the MP, CP, RP and SD systems were not different but averaged about 8% higher than with NT. Starter fertilizer increased yields by 6% when averaged over tillage systems. However, yield increases due to starter were greatest with the NT, CP and RP systems. Soil samples taken from both the starter and no starter plots in the NT, MP and CP systems show a large drop in soil pH in the top 2" layer with NT, accumulation of high amounts of P in the top 2" with NT and CP, accumulation of K in the top 2" with NT and slightly higher soil P levels associated with the 8-year history of starter vs no starter comparison.

TWELVE-YEAR YIELD SUMMARY

Grain yields from the five tillage systems where starter fertilizer was used from 1975-1982 are shown in Table 7. The 8-year average yield shows a 5.3 bu/A yield advantage for the moldboard plow over the ridge-plant system. Some of this difference can be attributed to the 17 bushel advantage in 1980 for moldboard plowing. The chisel plow and till-plant (flat) systems showed intermediate yields while lowest yields were obtained with no tillage. Weed control was excellent in all treatments except no tillage. Postemergence herbicides were applied to no tillage in 1979 and 1980 and did provide better weed control.

Four-year data (1979-82) indicate some advantage for the use of starter fertilizer with the chisel plow (6 bu/A), ridge-plant (5 bu/A) and no tillage systems (5 bu/A). No reason can be given for the obvious difference in response to starter fertilizer between the no tillage and till-plant (flat) systems when both treatments represent the most severely reduced tillage systems.

Yields with no tillage continue to be significantly below the other tillage systems since converting to a corn/soybean sequence (Table 7). Corn yields in this sequence have not been significantly different among the MP, CP, RP and SD systems when starter fertilizer has been used. Without starter fertilizer, yields from the CP and RP systems have averaged about 7% less than from the MP and SD systems. Soybean yields in this sequence averaged about 6% higher with the moldboard plow system compared to the CP, RP, or SD systems with virtually no difference among the latter three systems.

Table 7. Influence of tillage methods and starter fertilizer on long-term corn and soybean yields at Waseca.

Treatment		Cont. Corn Yield		Soybeans	Corn
Tillage	Starter	1975-82	1979-82	1983 & 85	1984 & 86
		bu/A			
No tillage	Yes	129.2	140.6	36.6	145.6
"	No		136.0	35.4	133.4
Fall plow	Yes	154.5	170.9	48.4	159.3
"	No		170.8	47.8	160.5
Fall chisel	Yes	144.4	161.8	46.1	156.3
"	No		155.5	43.8	148.3
Ridge plant	Yes	149.2	161.5	45.8	158.6
"	No		156.4	45.0	147.8
Till plant (flat) 1/	Yes	144.9	154.8	45.3	163.2
"	No		157.4	45.6	158.0

1/ This treatment was converted to a spring disk (2x) beginning with the 1983 crop.

TILLAGE SYSTEMS FOR CORN AND SOYBEAN CROP SEQUENCES

Waseca, 1986

G. W. Randall, P. L. Kelly and R. R. Allmaras

Corn-soybean rotations have often been compared to continuous corn and soybean monocultures using a particular tillage system. Seldomly, however, have these comparisons been made over a range of primary tillage systems. The purpose of this study is to determine the effect of tillage on corn and soybean production when grown in a monoculture compared to a rotation.

Experimental Procedures

A study had been established on this Webster clay loam site in the fall of 1980 to determine the relationship between primary tillage and the incidence of corn and soybean diseases in continuous corn, continuous soybeans and a corn-soybean rotation. The tillage systems were fall moldboard plow (MP), fall chisel plow (CP), and no tillage (NT). After this 5-yr study was completed in 1985, the initial tillage plots and some of the monoculture plots were kept intact to take advantage of the past tillage and cropping history. Some of the monoculture plots were changed to a corn-soybean sequence so that there are now four cropping systems over each tillage system. The cropping systems are continuous corn (C-C), corn-soybean (C-Sb), soybean-corn (Sb-C), and continuous soybeans (Sb-Sb). Each treatment is replicated four times in a split-plot design with tillage as the main plot and crop system as the subplot.

Fall tillage was performed in October, 1985 after stalk chopping all corn plots. Spring secondary tillage consisted of disking the CP plots on April 25 and field cultivating the MP and CP plots on May 3.

Nitrogen was broadcast applied as ammonium nitrate prior to secondary tillage to all 1986 corn plots at a rate of 200 lb N/A regardless of previous crop. Broadcast P and K were not applied because of high soil test P and K levels. Starter fertilizer was not used.

Corn (Pioneer 3737) was planted on May 6 at a rate of 27700 ppA with a John Deere Max-Emerge 4-row planter equipped with 2" fluted coulters. Counter (1 lb ai/A) was applied to all corn plots at the time of planting. Weeds were chemically controlled with a combination of 3½ qts. Lasso and 3½ qts Bladex/A applied preemergence with no further row cultivation.

Soybeans (Hardin) were planted in 30" rows with the aforementioned planter at a rate of 9 beans/foot on May 22. Weeds were controlled with a preemergence application of Lasso (3½ qts/A) + Amiben (6 qts/A) with no additional cultivation.

A modified JD 3300 plot combine was used to harvest both the corn and soybeans. Corn and soybean yields are expressed at 15.5 and 13.5% moisture, respectively.

All wheel traffic during the season was confined to the same inter-row areas that were trafficked at the time of planting. This resulted in wheel traffic on one side of each row with the other side non-compacted by machinery operations.

Results and discussion

Corn yields were extremely good but were not affected significantly (P = 90% level) by tillage (Table 1). The 10.1 bu/A difference between the MP and NT systems was only significant at the P = 67% level even though a very low CV was present. A 17.8 bu/A advantage for corn following soybeans compared to continuous corn was highly significant (P = 99%). Grain moisture was significantly higher with NT but was not affected by crop sequence. Final plant population was not affected by either tillage or crop sequence. An interaction between tillage and crop sequence was not found (P = 90% level) for grain yield or plant population.

Soybean yields also were extremely good and were not affected by tillage (Table 2). The 13% yield reduction found with continuous soybeans compared to soybeans following corn was highly significant. Seed moisture content at harvest was not influenced by either tillage or crop sequence. Neither soybean yield nor seed moisture showed an interaction between tillage or crop sequence.

Table 1. Corn grain yield and moisture content and final population as affected by tillage and crop sequence.

Tillage	Crop Sequence	Grain Yield	Grain Moisture	Final population
		bu/A	%	x 10^{-3}
MP	C-C	175.3	18.1	27.2
"	C-Sb	192.4	18.5	27.2
CP	C-C	176.0	18.5	26.6
"	C-Sb	194.6	18.9	28.5
NT	C-C	185.0	19.7	27.8
"	C-Sb	202.9	19.0	27.3
FACTORIAL COMPARISONS				
Tillage				
MP		183.9	18.3	27.2
CP		185.3	18.7	27.6
NT		194.0	19.4	27.6
Signif. Level (%):1/		67	97	27
BLSD (.05) :			0.7	
Crop Sequence				
C-C		178.8	18.8	27.2
C-Sb		196.6	18.8	27.7
Signif. Level (%):1/		99	16	69
Tillage x Sequence Interaction				
Signif. Level (%):1/		2	90	89
CV (%) :		4.1	2.6	3.9

1/ Probability level of significance.

Table 2. Soybean seed yield and moisture content as affected by tillage and crop sequence.

Tillage	Crop Sequence	Soybean Yield	Soybean Moisture
		bu/A	%
MP	Sb-Sb	50.6	14.7
"	Sb-C	55.5	14.6
CP	Sb-Sb	48.2	14.7
"	Sb-C	56.2	14.6
NT	Sb-Sb	47.3	15.0
"	Sb-C	56.0	14.8
FACTORIAL COMPARISONS			
Tillage			
MP		53.1	14.6
CP		52.2	14.7
NT		51.6	14.8
Signif. Level (%):		23	75
Crop Sequence			
Sb-Sb		48.7	14.8
Sb-C		55.9	14.6
Signif. Level (%):		99	89
Tillage x Sequence Interaction			
Signif. Level (%):		57	30
CV (%) :		5.7	1.2

Conclusions

These first-year results indicate no significant effect of tillage on either corn or soybean yields regardless of crop sequence. This is surprising since over the past 15 years continuous corn yields with NT have rarely matched those yields from MP in research conducted at Waseca. However, the effect of cropping sequence remained consistent with previous years results. Continuous corn and continuous soybean yields were depressed by 9 and 12%, respectively, compared to a corn-soybean rotation.

CORN PRODUCTION AS AFFECTED BY TILLAGE IN A SOYBEAN-CORN MANAGEMENT SYSTEM

Waseca, 1986

G. W. Randall, P. L. Kelly, W. E. Lueschen,
J. F. Moncrief, and D. R. Hicks

The objectives of this study initiated in the fall of 1985 were to evaluate the effect of tillage following soybeans on (1) corn production, (2) the optimum N rate for corn production, (3) corn hybrid performance and the interaction of hybrid with tillage, and (4) N uptake patterns of five corn hybrids.

Experimental procedures

Five tillage systems (continuous no tillage (NT), continuous paraplow (PP), continuous ridge-plant (RP), NT after soybeans and chisel plow (CP) after corn, and CP after soybeans and moldboard plow (MP) after corn) were established in the fall of 1985 on a Webster soil that had soybean stubble. A split plot design with tillage as main plots and N rate as subplots was used with 4 replications. Only the CP/MP treatment received spring secondary tillage -- one field cultivation. Five corn hybrids (Pioneer 3737, Pioneer 3732, DeKalb 524, Supercrost 2410, and Funks G-4327) were planted on May 6 at a population of 29900 plants/acre. Pioneer 3737 was used in the "N rate" portion of the study while all hybrids were used in the "hybrid" part of the study. No starter fertilizer or rootworm insecticides were used. Weed control was excellent with a preemergence application of Lasso + Bladex.

Nitrogen rates of 0, 40, 80, 120, 160 and 200 lb N/A were applied midway between the rows as anhydrous ammonia at the 3-leaf stage (June 2). Surface residue measurements were taken from the 40- and 120-lb plots via the line-transect method on the same day just prior to N application. Ridges were built for 1987 on June 25. Extended leaf plant heights were taken on July 7. Silking stage whole plant dry matter accumulation and N concentration were measured on 5 random plants per plot on July 21-25; the onset of silk initiation varied with N rate. Final plant populations were taken on August 28. Total DM at physiological maturity (PM) was obtained by harvesting 8 consecutive plants from 5 feet of row, weighing, chopping, subsampling, drying and weighing. Grain yields were obtained by harvesting with a modified JD 3300 plot combine on October 10. Nitrogen concentrations of the stover at silking and fodder and grain at PM were determined by the Research Analytical Lab.

Results

Surface residue coverage after planting but before ammonia injection was greatly affected by the tillage system and by the planter (Table 1). Residue accumulation was lowest with the CP and RP systems, intermediate for the PP system and highest with NT. Scalping of the ridge-top resulted in the least amount of residue along the row.

Table 1. Effect of tillage on residue cover after planting.

Tillage System	Residue accumulation[1/] In row	Between row
	---------- % ----------	
No Till	20	29
Paraplow	13	21
Ridge-plant	4	14
No Till/CP	19	32
Chisel/MP	7	9

[1/] Each number is an average of 8 observations.

Grain yields were not significantly affected by the tillage systems but were affected by the N rates (P = 99% level) (Table 2). Grain yields were optimized at the 120-lb rate of N application. There was no interaction between tillage system and N rate.

Table 2. Corn yield following soybeans as influenced by tillage system and N rate.

N Rate	Tillage System[1/] CP/MP	NT	NT/CP	PP	RP	Avg.
lb N/A	----------	----------	bu/A	----------	----------	----------
0	88.2	82.2	83.5	78.9	78.8	82.3
40	115.3	121.0	129.3	118.5	133.1	123.4
80	148.0	153.7	145.8	140.4	150.6	147.7
120	155.5	156.7	145.3	158.7	156.8	154.6
160	157.3	159.4	166.6	148.8	154.3	157.3
200	145.7	148.6	157.5	154.1	161.3	153.4
Average:	135.0	136.9	138.0	133.2	139.2	136.5

[1/] Pioneer 3737 only.

In the hybrid portion of the study, grain yields were not affected by tillage (Tables 3 and 6). However, a highly significant difference existed among hybrids. Highest yields were obtained with Pioneer 3737 followed by DeKalb 524. Yields were intermediate with the Pioneer 3732 and Supercrost 2410 hybrids. Premature death of the Funks G-4327 hybrid began to occur in mid-August and resulted in substantially lower yields. There was no interaction between tillage system and hybrid.

Table 3. Corn yield following soybeans as influenced by tillage system and hybrid.

Hybrid	Tillage System[1/] CP/MP	NT	NT/CP	PP	RP	Avg.
	bu/A					
P3737	157.3	159.4	166.6	148.8	154.3	157.3
P3732	127.2	137.2	150.1	139.0	134.0	137.5
DK524	158.5	134.7	149.5	146.3	139.5	145.7
SC2410	130.3	127.3	126.9	127.5	139.6	130.3
G-4327	98.7	117.4	111.3	116.0	118.1	112.3
Average:	134.4	135.2	140.9	135.5	137.1	136.6

1/ 160 lb N/A

Final population was reduced significantly (7%) with the RP tillage system but was not different among hybrids (Table 4). Because the plant population was less with the RP tillage system compared to the CP, NT and PP systems, some of the plant properties expressed on an area basis will also show this effect (Tables 4-7).

At the silking stage stover DM yield was less with the RP system compared to the other systems when expressed on an area basis, but differences among tillage systems was not evident when expressed on a per plant basis (Table 4). Stover DM yield was significantly higher for DK524 than for the other hybrids when averaged over tillage systems. The SC2410 plants were smallest. No tillage x hybrid interaction was found for stover yield. Nitrogen concentrations in the stover at silking were not affected by either tillage or hybrid (Table 4).

Nitrogen uptake at silking was influenced by tillage when expressed on an area basis due to the lower population with the RP system (Table 4). Uptake of N was also affected by hybrid. Greatest uptake was noted with DK524 primarily because of the higher DM accumulation.

At physiological maturity (PM) fodder yields were not different among tillage systems when expressed on a per plant basis but were less with RP when expressed on an area basis (Table 5). Similar to the silk stage, largest fodder DM occurred with the DK524 hybrid. Fodder N concentration was not affected by tillage when averaged over hybrids but was significantly higher with Funks G-4327 when averaged over tillage operations (Table 5). The significant tillage x hybrid interaction for fodder N concentration was largely due to lower N concentrations with SC2410 with the RP system compared to other tillage systems. At the same time fodder N was highest with DK524 in the RP system while it was lowest in the NT system. Due to the rather high variability this interaction may not be practically significant.

Fodder N uptake (accumulation) at PM was highest with the CP system and lowest with the RP system when averaged over hybrids (Table 5). Due to both higher DM yield with DK524 and higher N concentration with G-4327, fodder N uptake was highest with these two hybrids. Pioneer 3737 showed the lowest N uptake in the fodder.

Table 4. Final population and plant properties at silking as influenced by tillage and hybrid.

Tillage	Hybrid	Final popl'n	Stover DM Yield		Stover N Conc.	N Uptake	
		x10^{-3}	g/plt	TDM/A	%	g/plt	lb/A
CP/MP	P3737	29.3	124	4.00	1.48	1.85	119
"	P3732	28.6	130	4.12	1.37	1.80	114
"	DK524	29.1	138	4.43	1.47	2.04	130
"	SC2410	29.1	116	3.72	1.52	1.78	114
"	G-4327	29.6	122	3.97	1.36	1.65	107
NT	P3737	29.8	119	3.91	1.41	1.68	110
"	P3732	28.9	122	3.90	1.42	1.74	111
"	DK524	29.6	131	4.26	1.47	1.92	125
"	SC2410	28.2	116	3.61	1.50	1.74	109
"	G-4327	28.8	130	4.13	1.55	2.02	128
PP	P3737	29.4	118	3.84	1.50	1.79	116
"	P3732	28.8	121	3.84	1.36	1.64	104
"	DK524	28.5	133	4.17	1.32	1.77	110
"	SC2410	27.8	118	3.62	1.32	1.57	96
"	G-4327	29.6	126	4.12	1.34	1.70	111
RP	P3737	27.2	116	3.46	1.40	1.63	98
"	P3732	26.1	123	3.54	1.35	1.67	96
"	DK524	27.0	139	4.14	1.37	1.90	114
"	SC2410	27.7	111	3.38	1.45	1.60	98
"	G-4327	27.3	116	3.49	1.35	1.57	94
Main Factors							
Tillage							
	CP	29.1	126	4.05	1.44	1.82	117
	NT	29.1	124	3.96	1.47	1.82	117
	PP	28.8	123	3.92	1.37	1.69	108
	RP	27.1	121	3.60	1.38	1.67	100
Signif. Level (%) :		99	78	99	63	74	96
BLSD (.05) :		0.5	-	0.13	-	-	13.6
Hybrid							
	P3737	28.9	119	3.80	1.45	1.74	111
	P3732	28.1	124	3.85	1.37	1.71	106
	DK524	28.5	135	4.25	1.41	1.91	120
	SC2410	28.2	115	3.59	1.45	1.67	104
	G-4327	28.8	124	3.92	1.40	1.73	110
Signif. Level (%) :		89	99	99	80	97	98
BLSD (.05) :		0.9	6.8	0.25	-	0.16	10.1
Interaction							
Tillage x Hybrid				Signif. Level (%)			
		68	25	4	81	59	56
CV (%) :		3.5	8.2	9.5	7.4	12.	12.

Table 5. Dry matter yield and N concentration in the fodder at physiological maturity and pre-silk N uptake that was translocated to the grain as influenced by tillage and hybrid.

Tillage	Hybrid	Fodder DM Yield		Fodder N Conc.	Fodder N Uptake		Grain N from PRE-SILK uptake	
		g/plt	TDM/A	%	g/plt	lb/A	g/plt	lb/A
CP/MP	P3737	104	3.36	.56	.59	37.9	1.26	81.0
"	P3732	103	3.24	.52	.53	33.4	1.27	80.7
"	DK524	121	3.90	.58	.71	45.8	1.32	84.2
"	SC2410	101	3.22	.59	.59	38.0	1.18	75.8
"	G-4327	101	3.27	.68	.69	44.9	0.96	62.2
NT	P3737	95	3.13	.50	.48	31.3	1.20	78.9
"	P3732	101	3.21	.50	.50	32.0	1.24	78.9
"	DK524	103	3.37	.46	.48	31.4	1.44	93.8
"	SC2410	101	3.13	.64	.64	39.7	1.11	69.0
"	G-4327	101	3.21	.65	.66	42.0	1.36	86.3
PP	P3737	90	2.92	.53	.48	31.0	1.31	85.3
"	P3732	106	3.37	.55	.58	36.7	1.06	67.5
"	DK524	119	3.72	.53	.63	39.3	1.14	71.2
"	SC2410	109	3.32	.60	.65	39.6	0.93	56.6
"	G-4327	104	3.38	.60	.62	40.7	1.07	70.0
RP	P3737	95	2.84	.47	.45	27.0	1.18	70.6
"	P3732	105	3.02	.50	.53	30.4	1.14	65.6
"	DK524	118	3.53	.57	.68	40.3	1.22	73.2
"	SC2410	99	3.03	.46	.46	27.9	1.15	70.0
"	G-4327	92	2.76	.55	.51	30.5	1.06	63.9
Main Factors								
Tillage								
	CP	106	3.40	.59	.62	40.0	1.20	76.8
	NT	100	3.21	.55	.55	35.3	1.27	81.4
	PP	106	3.34	.56	.59	37.5	1.10	70.1
	RP	102	3.04	.51	.52	31.2	1.15	68.7
Signif. Level (%):		72	99	85	93	99	59	79
BLSD (.05) :		-	0.20	-	.07	4.6	-	-
Hybrid								
	P3737	96	3.06	.51	.50	31.8	1.24	79.0
	P3732	104	3.21	.52	.53	33.1	1.18	73.2
	DK524	116	3.63	.54	.62	39.2	1.28	80.6
	SC2410	102	3.18	.57	.58	36.3	1.09	67.9
	G-4327	99	3.16	.62	.62	39.5	1.11	70.6
Signif. Level (%):		99	99	99	99	99	88	91
BLSD (.05) (.10)*:		5.6	0.20	.04	.06	3.9	-	10.5*
Interaction								
Tillage x Hybrid		Signif. Level (%)						
		86	51	97	99	96	41	53
CV (%) :		8.3	9.2	12.	15.	15.	20.	20.

Table 6. Grain yield, N concentration and N uptake as influenced by tillage and hybrid.

Tillage	Hybrid	Grain Yield		Grain N Conc.	Grain N Uptake	
		g/plt	bu/A	%	g/plt	lb/A
CP/MP	P3737	141	157.3	1.37	1.94	102.1
"	P3732	106	127.2	1.43	1.52	86.0
"	DK524	137	158.5	1.34	1.83	100.2
"	SC2410	116	130.4	1.38	1.60	85.0
"	G-4327	84	98.6	1.48	1.24	68.9
NT	P3737	126	159.4	1.32	1.66	99.6
"	P3732	116	137.2	1.29	1.50	83.9
"	DK524	109	134.7	1.27	1.39	81.6
"	SC2410	104	127.2	1.35	1.40	81.0
"	G-4327	100	117.4	1.37	1.37	76.2
PP	P3737	111	148.8	1.42	1.57	99.7
"	P3732	118	139.0	1.33	1.57	87.5
"	DK524	124	146.3	1.30	1.61	90.1
"	SC2410	112	127.5	1.37	1.52	82.1
"	G-4327	105	116.0	1.36	1.43	74.4
RP	P3737	128	154.3	1.39	1.78	101.3
"	P3732	120	134.0	1.36	1.64	86.1
"	DK524	131	140.0	1.33	1.73	88.0
"	SC2410	124	139.6	1.32	1.64	87.3
"	G-4327	93	118.1	1.40	1.30	78.0
Main Factors						
Tillage						
	CP	117	134.4	1.40	1.63	88.4
	NT	111	135.2	1.32	1.46	84.5
	PP	114	135.5	1.35	1.54	86.8
	RP	119	137.1	1.36	1.62	88.1
Signif. Level (%):		61	9	98	83	55
BLSD (.05) :		-	-	0.05	-	-
Hybrid						
	P3737	127	155.0	1.37	1.74	100.7
	P3732	115	134.4	1.35	1.56	85.9
	DK524	125	144.8	1.31	1.64	90.0
	SC2410	114	131.2	1.35	1.54	83.8
	G-4327	96	112.5	1.40	1.33	74.4
Signif. Level (%):		99	99	99	99	99
BLSD (.05) :		10.6	10.5	0.04	0.13	6.8
Interaction						
Tillage x Hybrid		Signif. Level (%)				
		89	57	75	77	21
CV (%) :		14.	12.	4.2	13.	12.

Table 7. Total plant N uptake and post-silk absorbed N (NEW) in the grain as influenced by tillage and hybrid.

Tillage	Hybrid	Total Plant N at PM		Grain N from POST-SILK Uptake		
		g/plt	lb/A	g/plt	lb/A	%[1/]
CP/MP	P3737	2.53	140.1	.68	21.1	32
"	P3732	2.05	119.4	.25	5.2	17
"	DK524	2.55	145.9	.51	16.0	26
"	SC2410	2.19	123.0	.41	9.1	25
"	G-4327	1.93	113.8	.28	6.7	21
NT	P3737	2.14	130.8	.46	20.6	27
"	P3732	2.00	116.0	.26	5.0	17
"	DK524	1.88	113.0	-.05	-12.1	0
"	SC2410	2.04	120.8	.29	12.0	20
"	G-4327	2.03	118.2	.01	-10.1	<1
PP	P3737	2.05	130.7	.26	14.4	17
"	P3732	2.15	124.2	.51	20.0	32
"	DK524	2.24	129.4	.47	18.9	30
"	SC2410	2.16	121.6	.59	25.5	40
"	G-4327	2.05	115.2	.36	4.4	24
RP	P3737	2.23	128.2	.60	30.7	32
"	P3732	2.16	116.5	.49	20.5	30
"	DK524	2.41	128.3	.51	14.7	29
"	SC2410	2.09	115.2	.49	17.3	28
"	G-4327	1.81	108.4	.24	14.1	23
Main Factors						
Tillage						
	CP	2.25	128.4	.43	11.6	24
	NT	2.02	119.7	.19	3.1	12
	PP	2.13	124.2	.44	16.6	28
	RP	2.14	119.3	.47	19.5	28
Signif. Level (%):		80	84	74	79	84
Hybrid						
	P3737	2.23	132.5	.50	21.7	27
	P3732	2.09	119.0	.38	12.7	24
	DK524	2.27	129.2	.36	9.4	20
	SC2410	2.12	120.1	.45	16.0	28
	G-4327	1.96	113.9	.22	3.8	17
Signif. Level (%):		99	99	86	91	71
BLSD (.05) :		0.17	9.0	-	13.1	
Interaction						
Tillage x Hybrid			Signif. Level (%)			
		94	51	47	22	51
CV (%) :		11.	10.	81.	146.	74.

1/ On a per plant basis

The N assimilated by the plants at the silk stage that was subsequently translocated to the grain wasnot influenced by tilage or hybrid (P = 95% level) (Table 5). Variability was high (CV = 20%) and, thus, may have masked any real differences.

Grain N concentration for the CP tillage system was significantly higher than for the NT system when averaged over hybrids (Table 6). Concentrations of N for PP and RP were intermediate and were not statistically different from either the CP or NT systems. Grain N concentrations were highest for G-4327 and lowest for DK524. No tillage x hybrid interaction was found.

Grain N uptake was not significantly affected by the tillage treatments (Table 6). Due to the low grain yields with G-4327, total grain N uptake was also significantly lower than the other hybrids. Highest grain N uptake occurred with Pioneer 3737. A significant tillage x hybrid interaction was not found.

Total plant N at PM was not influenced by tillage when averaged over hybrids (Table 7). However, when averaged over tillage systems, significantly greater N uptake was found with the P3737 and DK524 hybrids.

One of the objectives of this study was to determine if either tillage or hybrid affected the amount of N taken up by the plant after silking (late season uptake) and then accumulated in the grain. The POST-silk uptake data shown in Table 7 are extremely variable and, consequently, do not indicate an effect of either tillage or hybrid on late-season N uptake. Part of this variability is due to the population differences. In addition, it appears that we will need to improve our sampling methodology if we are to reduce this variability.

Conclusions

Based on these first-year results:

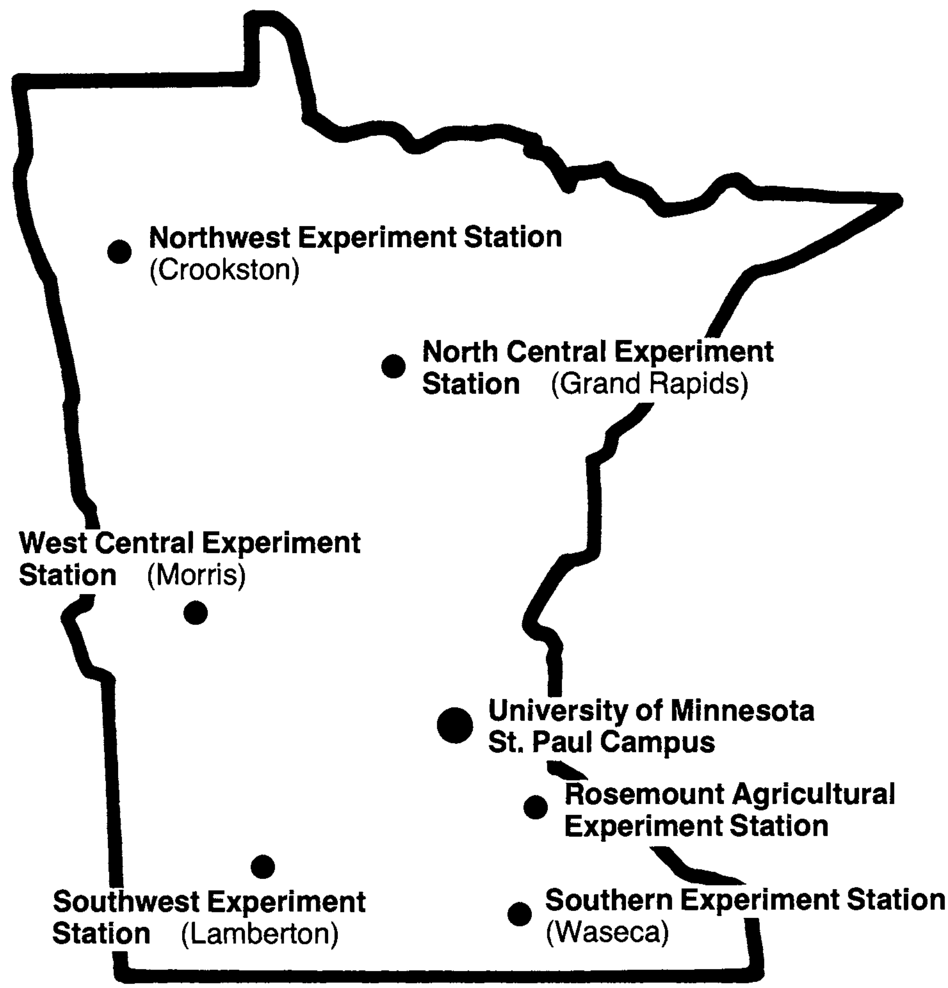
1) corn yields were not affected by tillage systems when in a corn-soybean sequence.

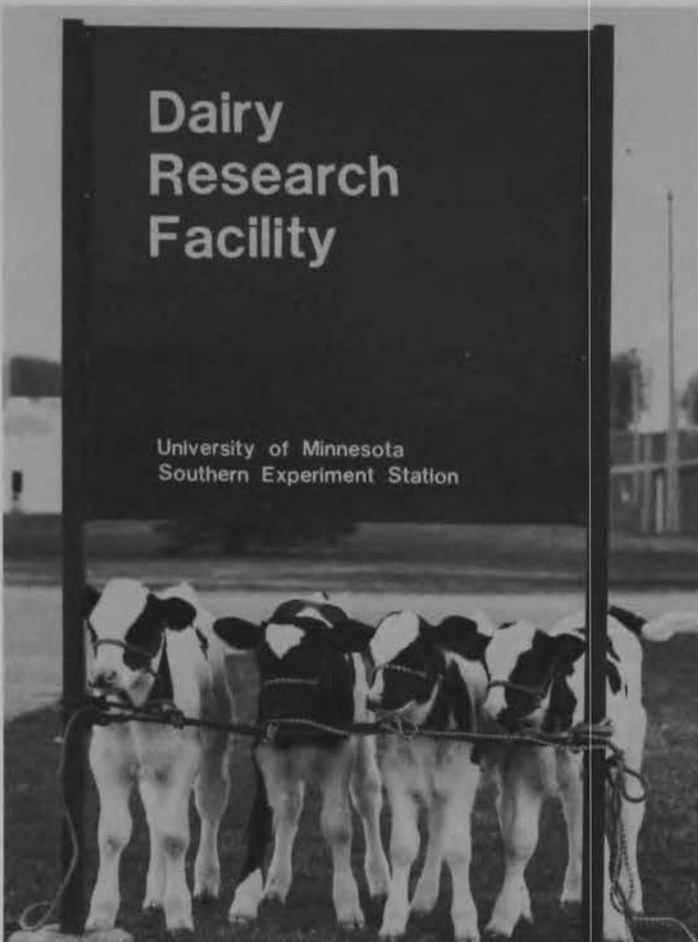
2) corn yields were optimized with 120 lb N/A.

3) the optimum N rate was not affected by tillage system.

4) substantial yield differences occurred among the five hybrids evaluated, but there was no interaction with tillage system.

Minnesota Agricultural Experiment Station Locations





GO-FOR RESEARCH