University of Minnesota
Southern Experiment Station
Waseca, Minnesota

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89

STAFF LISTING
1989

Faculty

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Hugh Chester-Jones - Animal Scientist
Vincent A. Fritz - Horticulturist
Rene E. Greenwald - Station Coordinator
William E. Lueschen - Agronomist
Gyles W. Randall - Soil Scientist
Mark E. Wilson - Animal Scientist

Agronomy

Thomas R. Hoverstad - Assistant Scientist
Paul A. Adams - Senior Research Plot Technician
    Misc. Summer Help:
        Daniel D. Greenwald - Non-Exempt Temp. & Casual Employee
        Paul M. Haley - Non-Exempt Temp. & Casual Employee
        Brian K. Kanne-Research Plot Technician
        Kellie J. Roessler - Non-Exempt Temp. & Casual Employee

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Gary L. Dobberstein - Farm Animal Attendant
Richard D. Goetz - Farm Animal Attendant
Brian L. Lewer - Farm Animal Attendant
Dale W. Gehloff - Assistant Farm Animal Attendant
Thomas M. Lamont - Assistant Farm Animal Attendant
Perry P. Rieck - Assistant Farm Animal Attendant
John R. Scholljegerdes - Assistant Farm Animal Attendant
    Misc. Summer Help:
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        Douglas J. Faber - Student Laborer
        Theresa R. Hoen - Student Laborer
        Oyvind Lorentzen - Student Laborer
        Todd S. Voss - Student Laborer

General Experiment Station

Steven L. Buker - Farm Equipment Operator
Kraig M. Deling - Farm Equipment Operator
Russell F. Domonoske - Farm Equipment Operator
Frederic W. Bauman - Farm Equipment Operator

Horticulture

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        Gary G. Gack - Student Laborer
        Jason J. O'Brien - Non-Exempt Temp. & Casual Employee
        Sue J. Schoenfeld - Laborer
        Randy J. Vancura - Student Laborer

Office

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Steven A. Jaycox - Associate Administrator
Dolores A. Stelter - Principal Secretary
Deanne J. Nelson - Secretary
Jeanette D. Williams - Executive Secretary
    Misc. Summer Help:
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Wayne W. Gottschalk - Research Plot Technician
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        Craig H. Hajek - Student Laborer
        Brian N. Weller - Student Laborer

Maintenance

Robert F. Deef - General Maint. Supervisor
Phillip J. Keeley - Maint. and Operations Mechanic
Dennis L. Weckwerth - General Mechanic
Vernon L. Ferch - Bldg. & Grounds Worker III

SOUTHERN EXPERIMENT STATION

RESEARCH REPORT, 1989

This research report includes a complete listing of the research projects in progress at the Southern Experiment Station during 1989. 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
- Horticultural Science
- 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, the Minnesota Wheat Council, Midwest Food Processors Association (Minnesota Region), Minnesota Pork Producers Association, National Pork Producers Association, Minnesota Department of Agriculture and the Fats and Protein Research Foundation 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.

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Agronomy (Continued)

INTRODUCTION

The staff of the Southern Experiment Station is pleased to share with the readers of this publication the results of research conducted during 1989. 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. C. Eugene Allen, 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 agribusinesses 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:

William Arendt, Plainview
Leonard Binstock, Dodge Center
Julie Boyum, Hayfield
Norman Fredin, Albert Lea
Virgil Johnson, Caledonia
Garry Martin, Blue Earth
Paul Nesseth, Nerstrand
Charles Priebe, Waseca
David Rupprecht, Winona
Bill Sanborn, Pine Island
Jan Schwantz, Plainview
Kent Thiesse, Mankato
Denny Trio, Mapleton
Charles Vollum, Albert Lea
Ben Zweber, Elko

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. Operations began in 1913, following the authorization and funding of the Station by the Minnesota State Legislature in 1911. 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 2,000 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.

CHARTING A COURSE FOR THE FUTURE

Research will continue to be the principal function of the Southern Experiment Station. The Minnesota system of providing residential professional staff at each of its branch stations to provide high-quality, collaborative research with scientists from other locations throughout the University has proven to be effective and is viewed with high regard throughout the nation. With a number of branch stations located throughout the diverse regions of the state of Minnesota, each is ideally situated to focus on the adaptive research needs peculiar to its respective area. Thus, the Southern Experiment Station at Waseca concerns itself with a wide range of concerns associated with the production of corn, soybeans, vegetable crops for processing, as well as a number of lesser and new alternative crops. Among the livestock enterprises, the Station conducts research with swine, dairy cattle and dairy cattle raised for beef which are all important livestock enterprises in south central and southeastern Minnesota.

A broad spectrum of concerns has been listed and discussed in detail in previous issues of the annual report. Suffice it to say the direction of research is clearly determined by needs of the industry and the growing identification of the public at large with the role of agriculture in the socio-economic structure of society as well as the relationship of agricultural practices to the environment.

Thus, we anticipate that research at the Southern Experiment Station will continue to study how emerging technologies will impact on the following:

1. Improved productivity in agriculture,
2. Assure adequate food and fiber production,
3. Protect the environment,
4. Support the preservation of a rural culture,
5. Assure equitability in the value of research to all farmers as well as consumers.

USE OF THIS RESEARCH REPORT

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 1989. 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

1989 AGRONOMY PROJECT LIST

SOUTHERN EXPERIMENT STATION

William E. Lueschen, Agronomist

I. CORN

A. Corn Breeding - Steve Openshaw

The corn breeding project is a long-term project of the Southern Experiment Station with the objective of development and testing of germplasm for improving corn through plant breeding techniques. Included in this project in 1989 was an elite corn hybrid trial where several commercial corn hybrids were compared. This project also is responsible for evaluating the relative maturity of corn hybrids registered for sale in the state of Minnesota. This phase of the project was in cooperation with the Minnesota Department of Agriculture. The data for the corn hybrid elite trial are included in Part III of this report.

B. Corn Rootworm Study - Ken Ostlie

The objective of this study was to evaluate the performance of reduced rates of corn rootworm insecticides in a ridge-till system. Label rates and reduced rates of several insecticides were included in this trial. A detailed report of this project is not included in Part III of this report.

C. Corn-Soybean Rotation Studies - Kent Crookston

Two studies were conducted in 1989 to evaluate the influence of corn and soybean rotations on the performance of both crops. The objective of one study was to evaluate the influence of continuous corn and a corn/soybean rotation sequence on the performance of each of these crops where the primary tillage was fall chisel plowing. The objective of the second study which was initiated in 1982 was to evaluate the long-term effects of several corn and soybean rotations under a moldboard plow system. Sixteen rotation treatments were included in this study with all but four of these consisting of five years of corn on a plot followed by five consecutive years of soybeans. Rotations were established in 1982 so that in each year there were plots with a one-, two-, three-, four-, or five-year history of either corn or soybeans. Also included in this study were continuous corn and continuous soybean plots and plots that were rotated annually to corn and soybeans. The results of these studies are included in Part III of this report.

D. Corn Antitranspirant Study - William Lueschen

The objective of this study was to evaluate the effects of time of application of a new experimental compound that is being evaluated as an antitranspirant in corn. This product has the potential of reducing the amount of water required to produce corn; thereby making water use by the corn crop more efficient. Since this study involved an experimental compound that is not available to producers and the likelyhood of this product being commercialized is unlikely, a detailed report of this study is not included in Part III of this report.

E. Corn Root Health and Lorsban - Ward Stienstra and William Lueschen

The objective of this trial was to evaluate the effectiveness of Lorsban, applied at planting time in a 7-inch T-band, on the seedling health and development of young corn plants. Five corn hybrids were evaluated in this trial, and data were collected on stand establishment, seedling health and grain yield. A summary of the results of this trial are included in Part III of this report.

F. Effects of Cultivation on Corn Weed Control - William Lueschen and Jeffrey Gunsolus

This study was designed to evaluate the influence of time of cultivation on weed control in corn with and without herbicide applications. This study also involved an evaluation of the effectiveness of a rotary hoe for improving weed control in corn. Two cultivation treatments were superimposed on the rotary hoe treatments and four herbicide regimes were included in this study. A detailed summary of the results of this trail is included in Part III of this report.

G. Herbicide Performance in Corn - Jeffrey Gunsolus

The emphasis of this study in 1989 was to evaluate preemergence and postemergence herbicides for weed control in corn. Experimental herbicides and experimental herbicide combinations were compared to label treatments in this study. Major emphasis was placed upon the evaluation of DPX-V9360 (Accent) for postemergence grass control in corn. A number of postemergence broadleaf herbicides were also evaluated in 1989. Similar trials were conducted at Lamberton, Morris and Rosemount, Minnesota to provide a basis for herbicide recommendations for Minnesota corn growers. A summary of the results of this trial are included in Part III of this report.

H. Water Quality Research - Doug Buhler, Brent Sorenson, and William Lueschen

Two studies were conducted as part of the water quality project. In the first study we evaluated the effects of tillage systems on the dissapation and movement of alachlor (Lasso), atrazine (Aatrex) and dicamba (Banvel) within the soil profile. Tillage treatments included were fall moldboard plowing, fall chisel plowing, a ridge-till system, and a no-till system where corn has been grown continuously. Both soil and water samples were collected periodically throughout the season to monitor the movement of the previously mentioned herbicides in the soil profile. A second study, initiated in 1988, was designed to take a more detailed look at the soil movement of the herbicides previously mentioned. In this study small lysimeters were placed in the soil in the fall of 1987 and a small amount labeled herbicide was placed on the soil surface within each of these lysimeters in the spring of 1988. Since the spring of 1988 the lysimeters have been extracted from the soil periodically and have been taken to the laboratory for detailed analysis. A brief summary of the results from the tillage study are included in Part III of this report. At this time the laboratory analysis for the second phase of the study have not been completed and the results are not available for this report.

I. Wild Proso Millet Control in Corn - William Lueschen and Jeffrey Gunsolus

The objective of this study was to evaluate soil applied and postemergence herbicide treatments for controlling wild proso millet in corn. One of our major objectives in this study was to evaluate the effects of time and rate of application of DPX-V9360 (Accent) on control of wild proso millet. This study was conducted on the Jeff Brussel farm approximately 6 miles northeast of Owatonna, Minnesota. A summary of the results of this trial are included in Part III of this report.

J. Woolly Cupgrass Control in Corn - William Lueschen and Jeffrey Gunsolus

The objective of this study was to evaluate the effects of soil applied and postemergence herbicides on control of woolly cupgrass in corn. This trial was very similar to our wild proso millet study in that we evaluated the effects of time and rate of application of DPX-V9360 (Accent) on woolly cupgrass control in corn. A summary of the results of this research are included in Part III of this report.

K. Effects of a Seed Applied Safener on Corn Injury from Clomozone, Imazaquin and Imazethapyr - William Lueschen and Jeffrey Gunsolus

The objective of this study was to evaluate the performance of a seed applied safener (F-80) on corn injury obtained by applying Clomozone (Command), imazethapyr (Pursuit), and Imazaquin (Scepter), prior to planting corn. Two corn hybrids were evaluated in this study: 1) Cargill 3477 was evaluated with the F-80 applied to the seed by Cargill at the time the normal fungicide treatment was applied and 2) Pioneer 3737 that we treated using the dry formulation of F-80 and shaking the seed in a bag to coat the seed. A summary of the results of this trial are included in Part III of this research report.

L. Poast Tolerant Corn Studies - Don Wyse, Peter Dotray, and Kathy Reynolds

The objective of this trial was to evaluate corn that has tolerance to sethoxydim (Poast) herbicide. This corn line was developed at the University of Minnesota by researchers working with tissue culture techniques to select corn that was tolerant to sethoxydim. Three studies were conducted in 1989 to evaluate the field performance of this tolerant corn. A summary of these results are not included in Part III of this research report.

M. Effects of Rate of DPX-V9360 and Terbufos Insecticide on Injury to Field Corn and Sweet Corn - William Lueschen, Gordon Harvey, Jim Kells and Vincent Fritz

This study was conducted as a cooperative project between the University of Wisconsin, (Dr. Gordon Harvey); Michigan State University, (Dr. Jim Kells); and the University of Minnesota, (Dr. William E. Lueschen, and Dr. Vincent Fritz). The objective of this study was to evaluate the effects of postemergence applications of DPX-V9360 (Accent) on the injury to sweet corn and field corn. This study involved an assessment of the effects of rate of application of DPX-V9360 and the soil applied insecticide terbufos (Counter) on the tolerance of both types of corn to this new herbicide. A summary of the results of the trial from all three locations is included in Part III of this research report.

N. Primary Tillage and Weed Control in Corn - William Lueschen, Jeffrey Gunsolus and Douglas Buhler

The objective of this study was to evaluate the performance of the rotary hoe and cultivation as the only means of controlling weeds in corn. Three primary tillage systems were evaluated: fall moldboard plowing, fall chisel plowing and a ridge-till system. Rotary hoe treatments included rotary hoeing approximately 6 days after planting or rotary 6 days after planting with a repeat rotary hoeing 9 days after planting. Two cultivations were performed on all of these treatments. There is no summary of these results in Part III of this report.

O. Herbicide Carryover Studies - William Lueschen and Jeffrey Gunsolus

Because of the extremely dry conditions experienced during the summer of 1988, there was a lot of concern about the potential for soybean herbicides carrying over and causing injury on corn planted in the spring of 1989. To evaluate this carryover potential, we established two studies that were planted following herbicide trials that were conducted on soybeans 1988. Our primary objective was to evaluate the effects of time and rate of application of herbicides applied in 1988 on the carryover potential to corn in the spring of 1989. The primary herbicides of interest were clomazone (Command) and imazethapyr (Pursuit). We observed very little early season injury symptoms and there were no yield effects of either of these herbicides applied in 1988 on corn yields in 1989. Summaries of these studies are included in Part III of this report.

P. The Effect of Bentazon, Terbufos, and a Seed Safner on DPX-V9360 and DPX-V9360 + DPX-E9636 Induced Corn Injury - William Lueschen and Jeffrey Gunsolus

The objective of this study was to evaluate the effects of a seed safener (F-80) and tubufos insecticide on corn injury from postemergence application of DPX-V9360 (Accent) and DPX-V9360 + DPX-E9636 (DPX-79406). We also evaluated the corn injury effects of tank mixing these herbicides with bentazon. A summary of this study is included in Part III.

II. SOYBEANS

A. Soybean Breeding - Jim Orf and Thomas Hoverstad

The objective of this long-term project has been to improve soybean production through varietal development. Each year the Southern Experiment Station has served as one of the major testing locations for materials developed by the soybean breeding project. Small plot evaluations included in the 1989 trials were: new experimental lines, preliminary tests, Uniform Regional tests, and public and private variety tests. In addition to these trials, we also maintain a disease nursery for screening soybean genotypes for resistance to diseases. An evaluation of early generation crosses were also included in this project. The performance of a number of soybean varieties were evaluated to determine response to row spacing and planting date. Data collected from the soybean variety evaluations conducted at Waseca and other locations throughout Minnesota are published in a publication entitled "Varietal Trials of Farm Crops". A summary of many of the trials conducted under this project are included in Part III of this report.

B. Effect of Soybean Seed Treatment on Phytopthora Root Rot - Ward Stienstra and William Lueschen

The objective of this study was to evaluate the effects of several seed treatments on stand establishment, development and growth of soybeans. Included in this trial were a number of chemical seed treatments as well as a new material that represents a biological approach to controlling soybean diseases. We also included an evaluation of seeding rate to determine if seeding rate could be increased to compensate for plant loss because of early seedling diseases. A summary of this project is included in Part III of this report.

C. Herbicide Performance in Soybeans - Jeffrey Gunsolus and William Lueschen

The primary objective of this study was to evaluate preplant incorporated and postemergence herbicides for weed control in soybeans. Major emphasis was placed on postemergence broadleaf control in soybeans by evaluating a number of herbicides and additives. Similar studies were conducted at the experiment stations at Lamberton, Morris and Rosemount. These trials provide the basis for herbicide recommendations which are contained in the extension bulletin entitled "Cultural and Chemical Weed Control in Field Crops for 1990". A summary of this project is included in Part III of this report.

D. Weed Control in No-Till Soybeans - William Lueschen

The objective of this study was to evaluate fall applied herbicides, early preplant spring applications, preemergence or postemergence herbicides, as well as burndown treatments, for weed control in no-till soybean production. The major emphasis in this study was to evaluate the potential for imazethapyr (Pursuit) in a no-till system. This project was supported in part by a grant from the Minnesota Soybean Research and Promotion Council. A summary of the results of this trial are included in Part III.

E. Influence of Time and Rate of Application of Acifluorfen, Bentazon and Sethoxydim on Weed Control in Soybeans - William Lueschen, Jeffrey Gunsolus, and Robert Schmitt

The objective of this study was to evaluate the influence of reduced rates of postemergence herbicides on weed control in soybeans. Included in this study were the effects of time and rate of herbicide application, as well as the time of cultivation, on weed control in soybeans. The rates that were evaluated included recommended label rates, one-half label rates, and one-fourth label rates. Herbicides were applied at three different times of application, one set of herbicide treatments were applied 13 and 14 days after planting, the second set were applied 20 and 21 days after planting and a third set were applied 27 and 28 days after planting. Three cultivation regimes were superimposed on each herbicide treatment. One of the major emphasis in this study was to document the stage of weed development at the time of application of each of the postemergence herbicide treatments. A summary of this study conducted at Waseca and Lamberton is included in Part III of this report.

F. Effects of Reduced Herbicide Rates, Rotary Hoeing and Row Spacing on Weed Control in Soybeans - William Lueschen, Jeffrey Gunsolus, and Robert Schmitt

The objective of this study was to evaluate the effectiveness of the rotary hoe for improving weed control in soybeans where reduced rates of trifluralin (Treflan), alachlor (Lasso) or bentazon (Basagran) + acifluorfen (Blazer) + sethoxydim (Poast) were applied. A second objective of the study was to compare weed control in 30-inch and 10-inch rows. The 30-inch rows were cultivated to improve weed control. Another objective was to evaluate the effects of a one-time and two-time rotary hoeing on weed control in soybeans to determine if timely rotary hoeing can help reduce or eliminate the need for herbicides. A summary of the results of this study is included in Part III of this report.

G. Postemergence Weed Control in Soybeans with Acifluorfen, Bentazon and Sethoxydim - William Lueschen and Jeffrey Gunsolus

The objective of this study was to evaluate split applications of sethoxydim (Poast), bentazon (Basagran) and acifluorfen (Blazer) for weed control in soybeans. The second objective was to evaluate the effects of rate of application and additives on the performance of split application of herbicides for controlling giant foxtail, redwood pigweed, common lambsquarters, and velvetleaf in soybeans. A summary of the results of this trial are included in Part III.

H. Winter Rye as a Cover Crop to Provide Weed Control for Weed Control in Soybeans - William Lueschen and Dennis Warnes

Two studies were conducted to evaluate the potential for rye as a means of assisting with weed control in soybeans. One study was conducted on a site with a moderate weed infestation while a second study was conducted where the weed population was very heavy. The rye cover crop was seeded in the fall of 1988 and the rye was killed with glyphosate (Roundup) prior to seeding soybeans no-till in the spring of 1989. The rye cover crop system was compared to a more conventional herbicide program. A summary of these studies are included in Part III of this report.

I. Velvetleaf Eradication - William Lueschen

The purpose of this study, initiated in 1974, has been to evaluate the longevity of velvetleaf seed in the soil under different crop management practices. Variables range from continuous corn, continuous alfalfa and continuous oats to continuous chemical fallow and continuous cultivation fallow. In this study soil samples have been taken every three years to monitor the demise of velvetleaf seed in the soil. No plants have been permitted to produce seed at any time since this study was initiated. Since 1974 certain treatments that have involved tillage have resulted in about a 95% reduction in velvetleaf seed population in the soil. Since 1989 was not a year for sampling for velvetleaf seeds in the soil, no summary of the results are included in Part III of this report.

J. Wild Proso Millet and Volunteer Corn Control in Soybeans - William Lueschen and Jeffrey Gunsolus

The objective of this study was to evaluate wild proso millet control with preplant incorporated, preemergence and postemergence herbicides in soybeans. Our main emphasis in this study was to evaluate a number of postemergence grass compounds and the influence that additives have on the performance of these compounds. In addition to evaluating wild proso millet we also evaluated control of volunteer corn in this study. This study was located approximately 6 miles northeast of Owatonna, Minnesota on the Jeff Brussel farm. A summary of the results of this trial are included in Part III of this report.

K. Woolly Cupgrass and Volunteer Corn Control in Soybeans - William Lueschen and Jeffrey Gunsolus

The objective of this study was to evaluate the control of woolly cupgrass in soybeans with preplant, preemergence and postemergence soybean herbicides. This study was very similar to our wild proso millet study and contained the same treatments with one exception, the rate of application of postemergence herbicides were increased by 30 to 100 percent as compared to the wild proso millet rates. Again, our major emphasis in this study was to evaluate the effects of postemergence herbicides and additives on control of woolly cupgrass. We also evaluated control of volunteer corn in this study. This study was located about 5 miles north of Faribault, Minnesota on the Tom Trnka farm. A summary of the results of this study are included in Part III of this report.

L. Effects of Time of Application and Additives with Bentazon, and Lactofen for Velvetleaf Control in Soybeans in 1989 - William Lueschen and Thomas Hoverstad

The objective of this study was to evaluate the influence of time of application and herbicide additives on the performance of bentazon (Basagran) and lactofen (Cobra) for velvetleaf control in soybeans. These postemergence herbicides were applied when velvetleaf was in the 3- to 4-leaf stage and also when velvetleaf was in the 5- to 6-leaf stage. In addition to evaluating velvetleaf control, we evaluated the response of these treatments on early season soybean injury. A summary of this study is included in Part III of this report.

III. SMALL GRAINS

A. Cereal Rust - Alan Roelfs and Thomas Hoverstad

Prevalence of rust on cereal crops including wheat, oats, barley and rye are monitored each year to establish over a period of years the average date of the first appearance of rust and the amount of inoculum that arrives in southern Minnesota. This study is conducted as part of a regional rust survey on small grains. A summary of the results are included in Part III of this report.

B. Oat Breeding - Deon Stuthman and Thomas Hoverstad

Three studies were conducted under this project with the objective of improving oat varieties through plant breeding techniques. In two of the studies we evaluated maturity, lodging, disease resistance and yield of commercially available, as well as, experimental lines of oats. The third study was designed to evaluate the agronomic traits of oats following five consecutive cycles of recurrent selection. Yield, lodging, disease resistance and seed quality were the parameters evaluated. Similar studies were conducted at other branch experiment stations to provide a basis for oat growers in Minnesota to select varieties for their farm. The results of these studies are summarized in an extension bulletin entitled "Varietal Trials of Farm Crops 1990". A summary of the results of these trials are included in Part III of this report.

C. Spring Wheat Varietal Trials - Robert Busch and Thomas Hoverstad

The objective of this study was to evaluate the performance of spring wheat varieties in southern Minnesota. Included in the trial were standard height and semi-dwarf varieties. The parameters evaluated included: plant height, lodging, maturity, yield, protein, and baking quality. A summary of the results of this trial are included in Part III.

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

Each year a Uniform Regional Winter Wheat Nursery is established to evaluate varieties and experimental lines developed by wheat breeders from several states. These plots are evaluated for winter hardiness, lodging resistance, height and yield. A summary of this study is not included in Part III of this report.

E. Weed Control in Spring Wheat - Beverly Durgan and William Lueschen

The objective of this study was to evaluate the performance of postemergence herbicides for weed control in spring wheat. Herbicides treatments were included that control both broadleaf weeds and annual grasses. In addition to evaluating weed control, we evaluated crop injury and the influence of these herbicide treatments on wheat yield. A summary of the results of this study are included in Part III.

IV. FORAGES

A. Alfalfa Variety Yield Trials - Don Barnes and William Lueschen

Two alfalfa variety trials were harvested on a 4-cut system, during the 1989 growing season. One trial was seeded in the spring of 1986; the other was established in the spring of 1988. These studies included varieties that are registered for sale as an alfalfa variety in the state of Minnesota. The data collected on these studies is used to help growers select the best alfalfa varieties for their farms in southern Minnesota. Similar trials are conducted at other branch stations throughout Minnesota and the results of these trials are published in the extension bulletin entitled "Varietal Trials of Farm Crops". A summary of the results of these variety trials are included in Part III of this report.

B. Alfalfa for Establishment on CRP Acres - Craig Sheaffer and William Lueschen

The objective of this study which was established in the spring of 1987 was to evaluate the use of alfalfa on Conservation Reserve acres. These plots were not harvested for yield although half of the plots were clipped during the 1988 growing season. Our objective was to evaluate the longevity of alfalfa under these conditions as a means of evaluating alfalfa as a potential crop for CRP acres. Since the stands were severely damaged during the winter of 1989, the alfalfa did not persist well and the trial was terminated in the spring of 1989. Therefore, no summary of the results of this trial are included in Part III.

C. Prediction of Alfalfa Variety Persistance by Seeding Year Cutting Frequency Tests - Craig Sheaffer and Don Barnes

The objective of this study was to evaluate the effects of several cutting management regimes superimposed on this trial in 1987 on the winter survival and subsequent performance of alfalfa varieties. There were 24 varieties that were established in 1988 which represented a range in winter hardiness and disease tolerance. A summary of this trial is included in Part III of this report.

D. Alfalfa Herbicide Efficacy Trail - Roger Becker, Craig Sheaffer and William Lueschen

This study was designed to evaluate the efficacy of herbicides for weed control in seedling alfalfa. In addition to alfalfa seeded alone, alfalfa was seeded with oats in certain treatments and herbicides were evaluated for oat control as well as weed control in these treatments. A summary of this study is included in Part III of this report.

E. No-Till Alfalfa Establishment into Oat Stuble - Roger Becker, Criag Sheaffer, and William Lueschen

The objective of this study was to compare alfalfa establishment into oat stuble after oat harvest by no-till and conventional seeding methods. This technique was compared with early spring seeding of alfalfa using oats harvested for grain, oats clipped at the boot stage or alfalfa that was clear-seeded. Data was collected on alfalfa yields, alfalfa stands and weed control. No summary of the results of this study are included in Part III of this report because 1990 will be the first year where treatments can be compared.

V. NEW AND LITTLE GROWN CROPS

A. Amaranth Varieties - Dan Putnam

The objective of this study was to evaluate a number of varieties of amaranth for adaptation to southern Minnesota conditions. However, due to the extremely dry conditions poor germination of all varieties resulted and the study was terminated. Therefore, no summary of this trial is included in Part III of this report.

B. Winter Canola Study - Dan Putnam

A winter canola trial was established in the fall of 1988 to evaluate winter canola varieties for southern Minnesota. However, due to cold temperatures and lack of snow cover during the winter, this entire planting suffered severe winter kill. Therefore, the trial was abandoned in the spring of 1989 and no summary of the trial is included in Part III of this report.

VI. ENTOMOLOGY

A. Corn Borer Survey - David Andow

The objective of this study has been to monitor the appearance and the degree of severity of European Corn Borer in early planted corn. This has been an ongoing project at the Experiment Station for many years. On a weekly basis a field is monitored to assess the damage caused by European Corn Borer and to evaluate the stage of development of the corn borers. A summary of the results of this project are not included in this report.

B. Insect Light Trap - Dharma Sreenivasam and William Lueschen

Nightly insect collections were made from late May to early August to monitor the presence of economically important agronomic insects. This data provided information on the potential for insect pests to develop in corn, soybeans, alfalfa and small grains. This project was conducted in cooperation with Dr. Sreenivasam, a member of the staff of the Minnesota Department of Agriculture. No summary of this project is included in Part III of this report.

VII. DEMONSTRATION PLOTS

A. Small Grain Variety Demonstrations - Thomas Hoverstad and William Lueschen

The purpose of this small grain variety demonstration was to demonstrate varieties currently recommended for use in Minnesota. This demonstration included both spring wheat and oat varieties. No summary of this demonstration is included in Part III of this report.

B. Planting Date Demonstration - William Lueschen and Thomas Hoverstad

Planting date demonstrations were established on both corn and soybeans with planting dates ranging from approximately April 17 through July 5. This planting date demonstration was used to illustrate the differences in growth and development of corn and soybeans as influenced by planting date. We also used these plots to demonstrate the effects of simulated hail damage on both corn and soybeans and the ability of each crop to recover from simulated hail damage. We also had a planting date by plant population demonstration where we planted corn at 20,000; 27,700; and 32,000 seeds per acre on April 17, May 1, and May 15. A plant population demonstration was also established in soybeans using both 30-inch and 10-inch rows with seeding rates of approximately 50,000; 100,000; 150,000; 200,000; 300,000 seeds per acre. These plots were used for field days and workshops conducted at the Experiment Station.

C. Herbicide Injury Demonstration - William Lueschen and Thomas Hoverstad

The purpose of this demonstration was to illustrate the injury symptoms that occur on corn and soybeans when herbicides are not applied according to label directions or when herbicide carryover occurs. Therefore, we purposely misapplied herbicides to induce injury symptoms. This demonstration was used at a number of workshops and field days at the Experiment Station to train individuals to recognize injury symptoms caused by various causes classes of herbicides. There is no summary of data collected from this demonstration included in Part III of the report.

D. Alternate Crops Demonstration - Dan Putnam and Tom Hoverstad

A number of crops that have been grown in Minnesota were planted to demonstrate the growth and development of these crops in southern Minnesota. The purpose of this study was to provide visitors with the opportunity to see various new and unusual crops which are produced to a limited extent in Minnesota or in various parts of the country. No data was collected from this demonstration and therefore, there is no summary of this demonstration in Part III of this report.

1989 Animal Science Project List

Southern Experiment Station

Hugh Chester-Jones
Mark E. Wilson

I. Non-Ruminants - Swine

A. Determining nutrient levels for tomorrow's economy: A new approach - Hugh Chester-Jones, Jim Pettigrew, Vernon Eidman, Larry Jacobson, Ron Moser and Steve Cornelius.

This study is designed to quantify the response in performance and carcass quality of growing and finishing pigs to diets containing varying energy (fat) and lysine (soybean) levels at various environmental temperatures. The response in performance will then be used to estimate economically optimal marketing and environmental conditions. A preliminary overview is outlined in Section III.

B. Influence of an oral dose of L-Tyrosine or L-Phenylalanine on sow productivity - M. D. Tokach, S. G. Cornelius, J. W. Rust, H. Chester-Jones, L. J. Johnston and D. M. Ziegler.

It has been shown that L-Tyrosine increases catecholamine synthesis which has been shown to increase litter size. West German researchers have shown that an oral dose of 100 mg/kg body weight of L-Tyrosine administered 24 hours after weaning will increase litter size by 2.7 pigs/litter. As tyrosine can provide 50% of the phenylalanine + tyrosine requirement, an oral dose of L-phenylalanine may respond similarly. This study objective is to evaluate the influence of L-tyrosine, L-phenylalanine or glutamic acid (usage N-source) on sow productivity. Data is not available for a summary report.

C. Evaluation of cheese food as a substitute for dry skim milk in weanling pig diets - Troy Lohrman, Jim Pettigrew, Mike Tokach, Mark Wilson and Arnold Hoeppner.

Improvements in gain (15-20%) and feed efficiency (13-18%) are commonly seen from the addition of milk products to piglet corn-soy diets up to 2 weeks post-weaning. However, a limiting factor is the cost of dried skim milk (DSM). Some companies are using a product called cheese food (CF) as a substitute for DSM. Cheese food is made from rejected cheese from the human retail sector. The objectives of this study are to examine the effectiveness of CF as a substitute for DSM in the diets of weanling pigs and determine what fraction of DSM can be replaced by CF to maintain or improve performance. Data is too preliminary for a meaningful summary to be reported.

D. Injection of B vitamins at weaning to reduce stress - Mark Wilson, Hugh Chester-Jones, Jim Pettigrew and Jerry Hawton.

It is well established in pigs that early weaning results in a post-weaning depression of growth rate exemplified by weight loss, diarrhea, decreased adipose stores and decreased feed intakes. If post-weaning depression is partially caused by decreased feed intake, and the pig has a greater need for fat metabolism to maintain energy needs, there may be a greater need for B vitamins at this point for the newly weaned piglet. B vitamins are well established for their role in metabolism of CHO and lipids. The objective of this study is to determine if there is a benefit for vitamin B supplementation during the immediate post weaning period. Data is too preliminary for a meaningful summary to be reported.

E. The use of lecithin as an emulsifier in diets for grower/finisher pigs - Margaret Overland, Mike Tokach, and Mark Wilson.

Lecithin is a soybean by-product known chemically as phophatidyl choline, consisting of a glycerol backbone esterfied to two fatty acids and one phosphoric acid, choline. In animal feed lecithin is used as an emulsified but also has been suggested as enhancing absorption of fat in diets for chicks and humans. The objective of this study is to examine the effect of 2% lecithin on fat (soy-oil) digestibility when fed to grower/finisher pigs. The study data is too preliminary for a meaningful summary to be reported.

II. Ruminants - Holstein Beef

A. Performance of Holstein steers fed starter diets containing rolled corn and pelleted supplements with protein level adjusted bi-weekly - H. Chester-Jones, J. C. Meiske, D. M. Ziegler, and B. T. Larson.

Typically a constant percentage of dietary protein fed daily is an accepted practical method. Results from previous studies at the Southern Experiment Station suggest that NRC requirements for your large frame calves may be over-estimated at certain stages of growth. This study will evaluate protein requirements by making weekly adjustments of actual protein intake based on body weight to meet 85, 100 or 115% of NRC requirement estimates. A summary report is outlined in Section III.

B. Effect of feed flavors and probiotics on dry matter intake, performance and health of young male Holstein calves during the pre-weaning and immediate post-weaning periods - H. Chester-Jones, D. M. Ziegler, Steve Moreland, J. C. Meiske and D. E. Otterby.

One of the concerns in raising young calves for Holstein-beef, especially if purchased through sale barn auctions, is the high risk in terms of possible chronic health problems. This often translates into inconsistencies in ability of these young calves to adapt quickly to dry rations. There is an indication that oral dosing of probiotics at times of stress have enhanced appetite. In addition, the use of feed flavors in dry starter diets has been suggested as enhancing intake. The objectives of this study were to compare the use of probiotics and feed flavors as regimens to enhance feed intake during pre-weaning and 4 wks post weaning periods. An initial summary is given in Section III.

C. Performance of finishing Holstein steers in the feedlot with or without a final implant during the last 100 days on feed - H. Chester-Jones, D. M. Ziegler, J. C. Meiske, B. T. Larson and T. M. Peters.

Previous studies have indicated an inconsistency in performance of finishing Holstein steers during the last 100 days in the feedlot. A common denominator appears to be related to the timing of the last implant given before market weight is attained. The objectives of this study were to a) evaluate if there is an implant effect that may contribute to the decrease in performance after 800 lb for feedlot Holstein steers and b) to evaluate the effect of using Synovex-S alone vs combination of Synovex (progesterone and estradiol) and Finaplex (trenbelone acetate) as final implants, on performance of Holstein steers during the final 100 days in the feedlot. A preliminary summary is given in Section III.

D. Evaluation of implanting strategies for Holstein steers from weaning to market weight - H. Chester-Jones, D. M. Ziegler, P. Anderson and J. C. Meiske.

Previous studies from Wisconsin have indicated that the effectiveness of a single implant given to 275 lb Holstein steers is similar to steers given 2 or 3 implants in terms of performance and carcass quality. There was a reduction in carcass quality with increasing number of implants which concurs with results from the current Southern Experiment Station finishing study. The objectives of the present study are to evaluate the effect of 1, 2 or 3 implants given to steers from weaning (reimplanting every 84 days) on performance and carcass quality at market weight. Secondly, to compare Synovex and Ralgro as the implants used throughout the study. Data is too preliminary for a meaningful summary to be reported.

E. High corn feeding strategies for Holstein steers - An overview of Southern Experiment Station research - H. Chester-Jones.

This report reviews previous work conducted by the Southern Experiment Station in a perspective that addresses each phase of production from calves purchased at one week old or less and fed to a market weight of 1100+ lbs. A complete report is given in Section III.

F. Effect of supplementary fat and forage/concentrate ratio in finishing diets fed to Holstein steers on carcass composition - H. Chester-Jones, J. C. Meiske and D. M. Ziegler.

This study attempts to test the hypothesis that by increasing energy density of finishing diets, by supplementary fat, a higher forage to concentrate ratio can be maintained and still enable performance to be maximized. This may also have a positive effect on carcass composition in terms of consistency. Data is too preliminary to report.

III. Ruminants - 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 selecting for milk yield appeared in the 1985 Southern Experiment Station Annual Report pp 270-275. Data is still being conducted 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 when emphasises selection for milk protein. A detailed outline of this new project appeared in the 1986 Southern Experiment Station Annual Report pp 218-219. Data has not been compiled in summary form to give an update on this project.

B. Post-partum reproductive performance under identical management for dairy cows genetically selected for two levels of milk production - Brad Sequin, H. 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 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 is not in a summary form to give a meaningful report.

C. Relationship of feed utilization to growth patterns and body compositional changes in dairy heifers from divergent genetic lines - K. D. Murphy, H. Chester-Jones, D. E. Otterby, R. D. Appleman, J. D. Linn, L. B. Hansen, B. A. Crooker and D. M. Ziegler.

There is a dearth of information on individual feed intake by dairy heifers from 3-4 months old to first calving. This study has the objectives to: a) establish a database of known feed intakes in heifers to enable feeding programs to be refined; b) establish base lines of circulating growth related hormones, and c) to validate two indirect body composition measurements, deuterium oxide and urea space dilution, to enable reliable in vivo body compostion estimates to be obtained. Data is not in a summary form to give a meaningful report.

D. Growth hormone and testicular development in bull calves as genetic markers for milk production - Bo Crabo, Parchun Kishore, Les Hansen, Hugh Chester-Jones, John Wheaton and David Ziegler.

Primary objectives of this study are to find a genetic marker for milk production in bull calves and to characterize the relationship between GH and testicular development in bulls. Data is not in summary form to give a meaningful report.

E. Effects of treatment of lactating dairy cows with prostaglandin between 35 and 65 days post partum - Jim Wenzel, Brad Seguin, Hugh Chester-Jones and David Ziegler.

The objectives of this study are to determine the effect of prostaglandin treatment, prior to or early into the breeding period, on calving-to-first-estrus, calving-to-first-service, and calving-to-conception intervals. The hypothesis is that prostaglandin treatment of cows 35-63 days post partum does not alter the above intervals compared with placebo-treated controls. Summary data is not available for a complete report.

1989 HORTICULTURE PROJECTS

Vincent A. Fritz

HORTICULTURIST

SOUTHERN EXPERIMENT STATION

I. SWEET CORN

A. Common Rust Epidemiology - Vincent Fritz, James Groth and Richard Zeyen

The primary objective of this study is to evaluate the effects of different plant populations at different planting dates on the incidence and progression of common maize rust (Puccinia sorghi) and yield recovery in sweet corn. The long term goal of this study is to develop a computer predictive model which would help maximize control strategy effectiveness. Rust severity will be measured objectively by using a video leaf area meter which should enhance the quality of the eventual computer model. Data from this research are not reported herein.

B. Systemic Fungicides for Common Rust Control - Vincent Fritz and James Hebel

In conjunction with the rust epidemiology study listed above, several systemic fungicides are being evaluated for rust control potential. The possible adoption of the use of systemic fungicides over contact fungicides for rust control by the processing industry will change control strategies significantly. The eventual computer model will incorporate strategies for both types of fungicides. A detailed report can be found in Part III.

C. Physiological Factors Affecting High Sugar (SH2) Variety Performance - Vincent Fritz, Alicia Borowski and Luther Waters

The major problem associated with high sugar sweet corn varieties is germination/stand establishment. This study was initiated in 1987 to determine if specific physical and physiological characteristics (seed moisture, seed coat integrity, carbohydrate analysis, embryo-endosperm ratio, etc.) contribute to reduced seed viability in high sugar sweet corns. Seed handling and drying procedures will also be evaluated for optimum germination/stand establishment. Data from this research are not reported herein.

D. Vacuum Moisturization Seed Treatment - Vincent Fritz and James Hebel

This is a new study which focuses on investigating methods which may improve germination/stand establishment in high sugar (sh_2) sweet corn varieties particularly in cold, wet soils during early spring (50 - 53°F). Seeds receiving vacuum moisturization treatments using water and polyethylene glycol (PEG 8000) at various temperatures will be compared to an untreated control. Germination, stand establishment, and seeding vigor measurements will be collected. Data from this research are not reported herein.

I. SWEET CORN (Continued)

E. Seed Fungicide Evaluation Trial - Krishna Mohan and Vincent Fritz

A cooperative study with the University of Idaho is being conducted to compare the effects of 39 fungicide seed treatments on stand establishment. The Southern Experiment Station is one of many sites cooperating in the country. A preliminary report can be found in Part III.

F. Organic Solvent Infusion of Fungicides - Patricia Hung and Vincent Fritz

Another study was initiated this year with the objective of improving germination and stand establishment in high sugar sweet corn varieties. The use of organic solvents (i.e. acetone, xylene, methanol) may improve fungicide seed treatment by actually infusing the liquids into the seed coat rather than an external coating which is the common practice in the seed industry. Germination, seedling vigor ratings, final stand, and yields are the primary data which will be collected. Data from this research are not reported herein.

G. High Sugar (sh_2) Variety Trial - Rochester - Dennis Schrock and Vincent Fritz

This year a variety trial was installed on a grower's field in the Rochester area to evaluate yield performance and eating quality for fresh market growers in southern Minnesota. A detailed report can be found in Part III.

H. Causes of Poor Huskability in Sweet Corn - David Davis and Vincent Fritz

The importance of understanding the hereditary nature of desirable plant characteristics is the basis for improved varieties over the years. A preliminary report can be found in Part III.

I. Annual Grass and Broadleaf Weed Control in Sweet Corn - Leonard Hertz and Vincent Fritz

The objective of this study was to evaluate sweet corn performance under 28 preemergence and postemergence weed control treatments. Experimental and labeled herbicides were included. A detailed report can be found in Part III.

J. Nitrogen, Population and Planting Date Effects on Yield and Quality - Carl Rosen and Vincent Fritz

This study is to evaluate the effects of different plant populations at various dates throughout the extended sweet corn planting season. In addition, various rates of nitrogen fertilization are being evaluated for optimal fertilization efficiency in each plant population and planting date. Data from this research are not reported herein.

II. PEAS

A. Evaluation of Pea Cultivars and Breeding Material - David Davis, Frank Pfleger and Vincent Fritz

This is a continuing study which was initiated in 1976 to screen breeding lines and commercial varieties for root rot resistance. A detailed report can be found in Part III.

B. Root Rot (Aphanomyces) Ecology Study - Ray Allmaras, Vincent Fritz, David Davis, Frank Pfleger, and Jim Percich

The study was initiated in 1988 to observe the effects of previous crop history and compaction on soil moisture, bulk density, pea root development and *Aphanomyces* populations at various soil depths. Data from this research are not reported herein.

C. Selective Weed Control in Canning Peas - Leonard Hertz and Vincent Fritz

The objective of this study is to evaluate preplant, preemergence, early postemergence, and postemergence weed control strategies using several herbicides at various concentrations and in combination with other herbicides. A total of 20 treatments will be evaluated. A detailed report can be found in Part III.

D. Nitrogen, Fungicide Seet Treatment, and Rhizobium Inoculation Effects on Processing Pea Performance - Carl Rosen and Vincent Fritz

This study was initiated in 1986 to evaluate performance of *Rhizobium* inoculated pea seeds in heavy clay soils of southern Minnesota. In addition, Captan and Thiram were used as fungicide treatments. Captan may have a toxic effect on *Rhizobium* and subsequent nodulation. Nitrogen was also applied at four rates to determine nitrogen effects on nodulation, nitrogen utilization, and yield. Data from this research are not reported herein.

III. ONIONS

A. Plant Population Study - Vincent Fritz and James Hebel

This study will investigate the effects of various plant populations on marketable bulb size and maturity in yellow storage onions in Hollandale (Southeast Minnesota). An open pollinated variety, "Trapps", was used for the study. Seeds were planted at 5-7, 9-11, and 13-15 per foot. The study is in its second year. A detailed report can be found in Part III.

B. Variety Trial - Vincent Fritz and James Hebel

The variety "Trapps" will not be available to growers in Hollandale (Southeast MN) for the 1990 growing season. An extensive variety trial was planted to help growers determine which varieties may be viable substitutes for "Trapps". A total of 42 are being evaluated. A detailed report can be found in Part III.

III. ONIONS (Continued)

C. Onion Weed Control - Vincent Fritz and Larry Binning, Univ. of Wisconsin

One of the principal barriers to consistent quality onion production is weed competition. Weed control is particularly difficult in small acreage crops like onions because of the very small amount of federally labeled herbicides available. In addition, onions are very poor weed competitors. This study was designed to evaluate various rates and timing of currently labeled materials for improved efficiency of weed control. A total of 30 treatments are being evaluated in Hollandale (Southeast Minnesota). A detailed report can be found in Part III.

IV. POTATOES

A. Variety Trial - Florian Lauer and Vincent Fritz

This is an ongoing study that was initiated in 1982 in Hollandale (Southeast Minnesota). The objective of the study is to evaluate breeding lines and other commercial varieties for production potential in peat soils. This year fifteen varieties will be evaluated. Data for this research are not reported herein.

V. STRAWBERRIES

A. Variety/Row Cover Evaluation - James Luby, Vincent Fritz and James Hebel

The evaluation of 7 varieties under different row covers for winter protection and early season growth was initiated in 1988. The objective is to determine the best varieties and row cover system for southern Minnesota. Data from this research are not reported herein.

VI. TREES AND FLOWERS

A. NC-7 Regional Ornamental Plant Trials - Mark Widrlechner, James Hebel, Harold Pellet and Vincent Fritz

This continuous study is to observe plant material from different parts of the world for adaptability to southern Minnesota. The study was initiated in 1959. Data from this research are not reported herein.

B. Chrysanthemum Evaluation Trial - Peter Ascher, Vincent Fritz and James Hebel

The purpose of this study is to evaluate the performance of several chrysanthemum breeding lines for possible release in Minnesota. This is a continuing study. Three varieties are to be available to gardeners in 1989. Data from this research are not reported herein.

1989 SOIL SCIENCE PROJECTS

G. W. Randall

SOIL SCIENTIST

SOUTHERN EXPERIMENT STATION

A. FERTILIZATION PROJECTS

1. Nitrogen

a. 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 soybeans. Application time ranged from preplant (PP) to split applications at the PP and 8-leaf or PP and 14-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. Results from the 1989 investigation are not yet available.

b. Influence of Nitrogen and Potassium Fertilization on the Yield and Nutrient Accumulation of Different Corn Hybrids - Gary Malzer and Gyles Randall

A study was established in 1987 to determine the interactive effects of nitrogen with and without N-Serve and potassium fertilization on 1) the yield and nutrient accumulation of four genetically different corn hybrids and 2) the soil NH_4/NO_3 status during the growing season. Nitrogen was applied at the V-6 stage as anhydrous ammonia at rates of 0, 80 and 160 lb/A with and without N-Serve. Potassium was applied and incorporated in the fall of 1986 at rates of 0 and 100 lb K/A. The hybrids used were Pioneer 3615, Pioneer 3475, LH74 x LH51, and LH74 x LH82. Soil samples from the 0-1' zone and whole corn plant samples were taken at four stages of growth (V12, R1, R4 and R6) to monitor soil inorganic N and N accumulation patterns of the hybrids. Data are not reported herein.

c. Soybean Response to Residual Effects of N Treatments Applied to Corn in 1987 - Gary Malzer and Gyles Randall

Soybeans were grown following the 1988 Hybrid x N x K Study (see b. above) to determine whether residual effects from these treatments influence soybean yields. Soybean yields averaged 48 bu/A but were not influenced by the previous year's N treatments. Data are not reported herein.

A. FERTILIZATION PROJECTS

1. Nitrogen (continued)

d. Residual Soil Nitrate in Second Year Corn Following Alfalfa as Influenced by Tillage and Corn Hybrid - Gyles Randall and Brian Anderson

Studies were initiated in 1988 at the Southern Experiment Station, Waseca; Agricultural Experiment Station, Rosemount; and in Winona County to determine if six genetically different 105-d RM hybrids differ in yield and in the pattern and extent of N accumulation following alfalfa. A second objective was to determine the effect of tillage (moldboard plow vs no tillage) on N uptake and yield of corn and on residual soil N. Yields and N uptake varied inconsistently among hybrids and were increased by moldboard tillage at two sites. A detailed report of the soil nitrate results is contained in Part III.

e. Nitrogen Placement in a Ridge Tillage System - George Rehm and Gyles Randall

A study was initiated in the fall of 1987 to determine the effect of N placement and time of N application on corn production in a ridge-plant system. Urea was placed in the ridge in the fall, while UAN was injected into the ridge at planting. These treatments were compared to fall-applied ammonia and urea midway between the ridges. Yields were generally increased with increasing rate of N except with the fall application of urea in the ridge. This treatment severely depressed grain yield. Data are not reported herein.

f. Development of a Nitrogen Soil Test to Predict Sidedress N Needs - Gyles Randall, Michael Schmitt, Gary Malzer, and George Rehm

Results from recent studies conducted in Vermont, Pennsylvania, Wisconsin, Iowa, and Kentucky indicate a high potential for the spring nitrate test as a predictor of sidedress N needs by corn under humid climate conditions. Studies to investigate the pre-sidedress NO_3 test were conducted at 14 locations in southeastern, south-central, and east-central Minnesota in 1989. Soil samples were taken in 1-foot increments to a depth of 5' prior to planting and after harvest while samples to 3' were taken at the V2 and V6 stages. Nitrogen treatments were sidedress-applied at the V6 stage. Results from this large-scale study are not yet complete; thus, the data are not reported herein.

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.

A. FERTILIZATION PROJECTS

3. 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 (1985-1987) to these low testing soils were 0, 10, 20, 30 and 40 lb P/A. Residual effects of these treatments were very apparent in 1989 as yields were increased over the control by about 40 bu/A with the 30 and 40-lb rates. Band application (6" deep) appeared to have greater carryover value than either the broadcast or 2 x 2" methods. A detailed report is not contained herein.

4. Potassium Placement in a Ridge Tillage System - George Rehm and Gyles Randall

A study was initiated in the fall of 1987 to determine if K banded directly into the ridge is either harmful or beneficial to corn production. Rates used were 0, 20, 40, 80 and 160 lb K_2O/A. Neither final stand nor yield were influenced by these K treatments this year. Data are not reported herein.

B. TILLAGE PROJECTS

1. Conservation Tillage for Corn and Soybean Production - 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. Subsoil Compaction and Depth of Subsoiling - Ward Voorhees and Gyles Randall

A new compaction study was initiated in the fall of 1986 to determine: 1) the effect of annual vs one-time high axle-weight loads on the degree of subsoil compaction and related soil properties in a corn and soybean rotation, 2) the effect of subsoiling depth on the amelioriation of the compacted soil, and 3) the influence of both compaction and subsoiling depth on plant growth and yield. The compaction was accomplished using a 800-bu grain cart with an axle weight of 23 T/A. Subsoiling depths were 0" 13" and 21". Neither corn nor soybean yields were affected by deep compaction or subsoiling depth in 1989. Data are not reported herein.

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

The purpose of this study has been 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 has been the application of 0 or 100 lb/A of 7-21-7 liquid starter fertilizer applied in a 2" x 2" band. The residual effects of these 4-year fertilizer treatments showed a 14 to 21 bu/A yield response for the X rate over the three application methods. A 28 bu/A response was found with the 10X rate. The project leader is Dr. George Rehm, Department of Soil Science. Data from this research are not being reported herein.

C. ENVIRONMENTAL PROJECTS

1. Nitrogen Loss to Tile Lines as Affected by Tillage - Gyles Randall and Brian Anderson

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 1989 tile flow, although minimal, and were analyzed immediately for the pesticides of concern. Data from this research are not reported herein.

C. ENVIRONMENTAL PROJECTS

3. Nitrate Losses to Tile Drainage as Affected by Nitrogen Fertilization of Corn in a Corn-Soybean Rotation - Gyles Randall, Gary Malzer and Brian Anderson

A study was established in the fall of 1986 to determine the influence of time of N application and the use of a nitrification inhibitor on NO_3 movement and accumulation in the soil, NO_3 losses via tile drainage, and yield and N uptake by corn grown in a rotation with soybeans. A detailed report is contained in Part III.

4. Impact of Nitrogen and Tillage Management Practices on Corn Yield and Potential Groundwater Contamination in Southeastern Minnesota - Gyles Randall, Brian Anderson, and Jim Anderson

Studies were conducted 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. Yield data from these studies are reported in Part III.

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. All data are sent to Dr. Baker as part of his soil water network. A detailed summary of the bi-weekly data is contained in Part III.

University of Minnesota
1989 Elite Field Corn Hybrid Test Results

Corn Breeding Project, Dept. of Agronomy & Plant Genetics, U of M, 1991 Buford Circle,
St. Paul, MN 55108 612/625-8700 (S.J.Openshaw, R.H.Peterson, B.B.Larson)

--In cooperation with:

Central Minn. Demo. Res. Irrigation Center, AVTI, Staples, (M.J.Wiems)
Northwest Experiment Station, Crookston (J.V.Wiersma)
Rosemount Experiment Station, Rosemount (D.O.Sandstrom)
Southern Experiment Station, Waseca (W.E.Lueschen)
Southwest Experiment Station, Lamberton (J.H.Ford)
West Central Experiment Station, Morris (D.D.Warnes)

The primary objective of these tests is to provide some information on the relative performance of the approximately 380 field corn hybrids that are newly registered for sale in the state each year. Because the data are limited to only two locations in one year for any 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 choosing one or a few hybrids for large-scale commercial use.

Seed of all newly registered hybrids was requested from the owners of these hybrids, and hybrids for which seed was obtained were included in these tests. Several other hybrids were included for comparison in these tests by the branch experiment stations and the corn breeding project. No fee was requested or paid by the owner of any hybrid entered. The presence or absence of any hybrid is 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, i.e., hybrids rated 105-115 RM were tested in southern Minnesota, 90-100 RM hybrids were tested in central Minnesota, and 70-85 RM hybrids were tested in northern Minnesota. Other hybrids included varied in their RM ratings. Hybrid comparisons should include consideration of RM rating.

Management information for each location is summarized below. Row spacing at all locations was 30 inches. Plots at Lamberton, Waseca, Rosemount and Morris were 2 rows 22 feet long and were planted and harvested by a modified planter and combine. Plots at Staples were 1 row 25 feet long and planted and harvested by hand and shelled by machine. The Crookston location was discarded.

At each location, three plots of each hybrid were grown and measured,and data in the tables are averaged over the three plots (replications).

Data given in the following tables is:

H2O = % grain moisture at harvest.
YLD = shelled grain yield in bushels per acre at 15.5% moisture.
STAND = number of plants per acre at harvest.
RM = Minnesota Relative Maturity rating assigned by the owner of the hybrid. RM of newly registered hybrids is subject to change.

Management information summary:

CMDRIF, Staples: Previous crop - beans; primary tillage - spring moldboard; fertilizer - 210# N (split applic. via center pivot irrigation; herbicide - Dual (2#) + Bladex (.75#) premerge; irrigation - 9.7 in; planted 11 May, harvested 12 Oct.

NW Exp Stn, Crookston: Crop was discarded due to environment.

Rosemount Exp Stn, Rosemount: Previous crop - alfalfa; primary tillage - spring moldboard; fertilizer 0-0-60 fall, 150# anhydrous spring; herbicide - Bladex (2) + Lasso (2) premerge + Basagram (1 w/oil) post; planted 15 May, harvested 23 Oc

So. Exp Stn, Waseca: Previous crop - soybeans; primary tillage - chisel fall plow; fertilizer - 160# fall anhydrous; herbicide - Lasso (3.5#) + Atrazine (1.5#) + Bladex (2#) premerge; planted 10 May, harvested 12 Oct.

SW Exp Stn, Lamberton: Previous crop - soybeans; primary tillage - soil saver, fall; fertilizer - 164# anhydrous, fall + 0-100-100, spring; herbicide - Eradicane (2.5#) + Bladex (1.5#) PPI plus Lasso (3#) premerge; planted 8 May, harvested 9 Oct.

WC Exp Stn, Morris: Previous crop - wheat; primary tillage - fall moldboard; fertilizer - 100# urea, fall; herbicide - Lasso (3) + Bladex (2) premerge; planted 15 May, harvested 13 Oct.

1989 University of Minnesota Corn Breeding
Expt.381 - Early Hybrid Test

		Staples		
Brand - Variety	RM	Moist %	Yld bu.	Stand
ASGROW RX337	85	20.5	170	27000
ASGROW RX406	95	23.0	174	27000
ASGROW XP3598	90	19.4	188	27000
BETAGOLD ADA	85	20.0	163	27000
BETAGOLD GERDA	90	20.6	167	27000
BETAGOLD GRETCHEN	85	21.7	160	27000
BLANEY B102WX	85	22.3	175	27000
BLANEY B106	85	21.3	181	27000
BLANEY B11	85	20.0	168	27000
BLANEY B15	85	19.3	168	27000
BROWN 2070	85	19.8	137	27000
CARGILL SX108	80	19.4	176	27000
CARGILL 1927	85	20.1	158	27000
CARGILL 2127	85	19.8	167	27000
CARGILL 2227	85	21.9	161	27000
CARGILL 809	80	21.2	164	27000
DAHLGREN DC430	85	19.4	175	27000
DAHLGREN K1114	80	23.1	151	27000
DAHLGREN K127	80	21.5	138	27000
DAHLGREN K730	70	16.3	129	27000
DAIRYLAND DX1181	80	19.8	161	27000
DAIRYLAND DX1186	85	21.9	161	27000
GOLDEN HARVEST H2229	85	20.1	165	27000
HYLAND HL2219	75	18.8	158	27000
HYLAND HL2260	80	18.4	158	27000
HYLAND HL2275	85	20.5	186	27000
HYLAND HL3282	70	20.3	133	27000
HYLAND LG2273	85	20.9	127	27000
HYLAND LG3	70	21.5	111	27000
JACQUES 2750	80	20.7	152	27000
JACQUES 2950	80	20.2	165	27000
JACQUES 3630	85	23.0	159	27000
KELTGEN KS80	85	19.0	143	27000
KELTGEN KT75	80	19.5	136	27000
KELTGEN KT80	80	19.4	156	27000
KELTGEN 2185	85	19.0	172	27000
L. HERRIED 8880	80	22.2	157	27000
L. HERRIED 8884	85	20.6	173	27000
MN. FARM BUREAU FB78	75	18.0	171	27000
MN. FARM BUREAU FB80	80	18.4	186	27000

1989 University of Minnesota Corn Breeding
Expt.381 - Early Hybrid Test (Continued)

Brand - Variety	RM	Staples Moist %	Yld bu.	Stand
PAYCO 248	85	18.3	168	27000
PHOENIX PH2192	75	18.3	138	27000
PHOENIX PH2244	80	17.8	164	27000
PHOENIX PH2312	85	19.4	164	27000
PHOENIX PH2313	85	20.3	170	27000
PIONEER 3929	85	20.0	153	27000
PIONEER 3954	80	19.1	145	27000
PIONEER 3963	80	21.1	107	27000
PRODUCERS 500	90	18.8	171	27000
SCHWITTERS 1085	85	22.3	167	27000
SIGCO 1786	80	19.7	157	27000
SIGCO 1876	75	19.0	148	27000
SIGCO 1885	85	18.9	160	27000
SIGCO 1985	85	21.2	159	27000
SUPER CROST 1348	80	18.4	182	27000
SUPER CROST 1548	85	19.4	176	27000
SUPER CROST 1594	85	22.5	177	27000
SUPER CROST 1649	85	20.4	173	27000
TERNING SPRINT	85	23.1	149	27000
TOP FARM SX1181	80	18.6	172	27000
TOP FARM SX1185	85	18.1	168	27000
TOP FARM SX87	85	20.5	163	27000
TOP FARM 1177	80	17.8	117	27000
MEAN		20.0	160	
C.V.(%)		5.6	8	
LSD(.05)		1.8	20	

1989 University of Minnesota Corn Breeding
Expt. 361 - Medium Hybrid Test

		Rosemount			Morris		
Brand - Variety	RM	Moist %	Yld bu.	Stand	Moist %	Yld bu.	Stand
AG VENTURE 292	100	13.0	161	24156	17.2	155	23364
AG VENTURE 303	100	13.8	167	23892	20.7	154	22176
AG VENTURE 344	105	15.8	166	22836	20.1	176	23892
AG VENTURE 8060	95	12.7	155	23100	16.3	166	23100
AGRI PRO AP148	95	13.8	154	22704	14.6	165	23496
AGRIGENE AG3200	95	15.0	172	23496	16.8	166	23628
AGRIGENE AG3860	100	13.8	178	22704	17.7	159	23364
AGRIGENE AG3955	100	14.1	175	23232	15.8	182	24156
AGRIGENE AG4500	110	18.0	172	23232	24.1	144	23496
ANDERSON MS6000	100	15.4	157	24024	20.6	171	22836
ANDERSON 7200	95	13.9	157	23628	17.1	153	21912
ASGROW RX409	95	12.9	172	24288	18.1	151	22836
ASGROW RX406	95	13.3	167	23760	16.2	168	23100
ASGROW RX469	100	16.0	155	23628	21.0	165	23364
ASGROW RX498	100	14.3	157	23364	18.9	170	22176
ASGROW XP3598	90	13.2	153	22836	15.0	139	22968
BETAGOLD INGRID	95	13.5	166	24024	16.2	154	23496
BETAGOLD IRENE	95	13.9	165	24024	17.5	162	24552
BETAGOLD KARLA	100	15.0	169	23760	18.3	166	24288
BETAGOLD KATRINA	100	15.9	170	22968	20.7	170	24156
BLANEY B22	90	13.8	160	23496	15.6	164	22968
BLANEY B305	95	13.9	168	23892	16.4	156	23628
BLANEY B405	105	16.0	172	24420	20.7	161	23628
CARGILL 3027	95	13.1	153	23496	17.5	163	22176
CARGILL 3477	95	15.7	149	23100	19.2	169	22836
CARGILL 4327	105	18.2	159	24552	26.9	143	24156
CENEX/LAND O'LAKES 385	95	13.9	149	23232	17.0	166	22704
CROWS 195	95	17.6	150	22704	18.6	171	22044
CROWS 199	105	17.4	166	23364	23.0	149	23496
CROWS 210	105	18.2	155	23496	23.6	150	24156
CUSTOMAIZE CFS2223	95	13.8	155	22968	15.6	156	23364
DAHLGREN DC492	95	13.3	147	22704	17.0	139	22704
DAHLGREN DC494	95	14.9	167	23496	21.8	141	23100
DAHLGREN K2204	90	13.4	147	24024	15.1	164	23760
DAIRYLAND DX1095	95	13.6	148	22572	16.6	183	23760
DAIRYLAND DX1101	100	16.8	159	23628	21.0	126	23364
DAIRYLAND DX1190	90	13.7	142	23760	15.7	152	22176
DAIRYLAND DX1194	95	12.9	163	23892	16.7	161	23496
DEKALB-PFIZER 397	90	12.1	142	23232	15.9	145	22836
DEKALB-PFIZER 461	95	15.5	147	23892	15.0	173	23628

1989 University of Minnesota Corn Breeding
Expt. 361 - Medium Hybrid Test (Continued)

		Rosemount			Morris		
Brand - Variety	RM	Moist %	Yld bu.	Stand	Moist %	Yld bu.	Stand
DEKALB-PFIZER 464	100	15.8	155	24156	17.9	142	22044
DEKALB-PFIZER DK435	95	13.1	171	24420	17.5	140	23628
DEKALB-PFIZER DK485	100	14.6	176	22440	22.2	143	19008
DEKALB-PFIZER DK535	105	18.0	159	23760	29.3	150	22440
FOUR STAR 5408	100	15.1	172	24024	20.7	165	23496
FUNKS G4027	90	15.8	153	23232	20.1	144	24420
FUNKS G4140	90	12.9	157	24156	17.7	140	23760
FUNKS G4234	100	14.1	156	23496	17.8	145	23496
FUNKS G4299	100	15.0	157	23760	17.7	163	24156
FUNKS G4309	105	16.6	157	23364	22.8	158	22968
GEORGE'S 8098	100	13.2	166	24552	16.0	163	23628
GEORGE'S 8099	100	15.0	162	24024	21.5	156	23232
GOLDEN HARVEST H2295	95	14.0	183	23232	17.0	138	23232
GOLDEN HARVEST H2327	95	14.5	154	23232	19.0	151	22836
GOLDEN HARVEST H2343	100	15.0	183	22968	20.7	176	23760
GOLDEN HARVEST H2344	100	15.0	167	24024	18.9	178	23496
GREAT LAKES 424	95	13.0	164	24684	17.3	144	22572
GREEN FIELD GFS9100	100	15.4	152	23892	19.8	141	23100
HY PERFORMER HS25	100	12.6	159	22968	17.5	157	23364
INTERSTATE 343A	85	11.1	127	24552	14.9	144	21780
INTERSTATE 406	90	14.1	155	23232	15.0	160	23100
INTERSTATE 443	95	14.5	157	24288	17.7	143	22704
INTERSTATE 463	95	13.8	162	22968	17.8	172	23760
JACQUES 4100	90	14.0	141	22308	16.5	167	22836
JACQUES 4170	90	12.9	158	23892	17.0	162	23496
JACQUES 4550	95	14.3	160	23496	17.4	161	23496
JACQUES 4750	100	15.3	142	24420	19.0	134	23364
JACQUES 4900	100	15.3	165	23760	18.4	159	23496
KALTENBERG K4300	90	13.9	157	23232	17.3	173	23364
KALTENBERG K4800	95	15.7	176	24156	19.6	160	23232
KALTENBERG K5200	95	16.6	176	23628	19.9	179	23496
KELTGEN 2310	95	13.7	162	23628	14.8	158	24024
KELTGEN 2400	95	14.7	171	22704	18.0	149	22308
KELTGEN 2460	100	15.0	175	23496	18.4	138	23364
KELTGEN 2490	100	14.8	170	23232	18.9	176	23628
L. HERRIED 8800	100	15.6	145	22968	19.7	140	23628
L. HERRIED 8892	90	14.4	170	21252	16.6	139	22704
L. HERRIED 8894	95	13.1	175	23760	15.7	157	23496
L. HERRIED 8898	95	14.3	165	23760	15.9	156	22572
LYNKS 2310	90	14.2	161	23892	15.2	171	23892

1989 University of Minnesota Corn Breeding
Expt. 361 - Medium Hybrid Test (Continued)

		Rosemount			Morris		
Brand - Variety	RM	Moist %	Yld bu.	Stand	Moist %	Yld bu.	Stand
LYNKS 2490	100	14.6	165	23364	19.5	158	23760
MALLARD UC397	90	11.7	149	22836	14.6	150	22968
MALLARD UC403	95	13.7	164	22704	16.7	152	23232
MALLARD UC411A	95	14.2	152	24288	16.4	155	23628
MALLARD UC540	100	14.3	162	23496	19.3	159	23892
MM. FARM BUREAU FB89	90	12.5	161	23232	16.6	161	24024
MM. FARM BUREAU FB99	100	15.9	160	22968	20.4	153	23232
NC+ 1577	95	14.2	149	23628	16.2	148	23892
NORTHRUP KING N3624	95	13.8	152	23496	18.2	163	22704
NORTHRUP KING N4350	100	14.3	164	22704	20.5	155	22176
NORTHRUP KING N4545	105	17.6	172	22704	23.5	141	22308
NORTHRUP KING PX9151	90	13.3	136	23760	15.1	159	22044
NORTHRUP KING PX9292	100	14.2	174	24024	18.9	143	23364
PAYCO SX686	100	15.4	165	23892	18.0	147	22704
PAYCO SX687	100	16.7	179	24288	21.7	173	23496
PAYCO 408	90	12.8	169	23760	15.3	158	23892
PAYCO 448	95	14.6	157	23364	15.2	185	24156
PAYCO 508	95	13.5	156	23100	17.1	153	22836
PHOENIX PH2391	95	13.5	167	24156	16.1	147	23760
PHOENIX PH2431	95	15.4	135	24420	22.3	153	23364
PHOENIX PH2432	95	16.4	159	21912	20.1	159	22704
PHOENIX PH2501	100	14.6	161	23760	17.2	162	24156
PIONEER 3737	100	13.5	168	22836	18.4	133	23760
PIONEER 3751	100	11.7	160	23364	15.5	153	24420
PIONEER 3772	95	14.7	173	23496	17.3	136	22704
PIONEER 3790	95	17.6	165	22440	17.5	131	23364
PIONEER 3794	95	12.6	144	23496	15.0	155	23760
PIONEER 3897	90	11.6	176	22440	15.3	154	23100
PIONEER 3902	90	13.6	150	23496	16.6	142	22440
PIONEER 3906	95	14.3	162	22968	19.3	138	23628
PRODUCERS 509	95	13.4	152	23760	16.4	149	22176
PRODUCERS 521	100	14.7	166	24024	16.0	158	23100
PRODUCERS 534	100	17.7	155	23760	19.2	150	22572
PRODUCERS 560	100	15.9	162	24816	20.3	169	23628
RENK RK412	95	16.9	134	22836	17.8	171	23232
RENK RK528	95	16.0	153	22308	23.3	135	20328
RENK RK534	95	14.5	159	22968	19.7	127	22572
RENK RK650	100	15.6	156	22704	22.6	126	23232
RENK R310	90	13.5	143	22836	16.6	146	22836
SCHWITTERS W3090	100	15.8	161	22440	21.5	143	22308

1989 University of Minnesota Corn Breeding
Expt. 361 - Medium Hybrid Test (Continued)

		Rosemount			Morris		
Brand - Variety	RM	Moist %	Yld bu.	Stand	Moist %	Yld bu.	Stand
SCHWITTERS W3100	100	16.9	160	23232	22.2	142	21780
SCHWITTERS 1090	90	13.4	119	19668	22.3	103	16764
SCHWITTERS 1100	95	13.0	157	23100	19.3	140	22572
SCHWITTERS 1105	100	17.5	162	23496	21.3	147	21252
SCHWITTERS 2100	100	15.1	160	22704	19.2	176	22308
SCHWITTERS 3XA95	95	18.3	124	21912	23.4	127	22044
SEED TEC ST7147	90	11.1	151	22968	14.9	141	20196
SEED TEC ST7255	100	15.4	166	24156	17.4	170	21780
SIGCO 1095	95	14.0	166	23364	18.9	126	22836
SIGCO 1099	100	15.2	154	24024	22.7	151	23364
SIGCO 1588	90	12.4	166	23232	15.3	162	23364
SIGCO 1701	100	16.7	157	23364	19.4	165	22836
SIGCO 1793	95	12.8	164	23364	16.7	180	23496
SIGCO 1799	100	14.7	172	23364	18.1	168	23760
SUPER CROST 1637	90	14.9	176	22968	15.7	142	22836
SUPER CROST 1999	95	16.0	172	22704	19.1	164	23232
SUPER CROST 2277	100	16.8	165	23892	21.6	164	23232
SUPER CROST 2445	100	15.8	173	22704	20.3	165	23100
SUPERCROST 1548	95	13.2	160	23496	15.4	147	22572
SUPERCROST 1594	95	14.2	176	23496	16.8	148	23496
TOP FARM SX1102	100	16.5	155	24288	18.7	158	23628
TOP FARM SX1195	95	13.7	182	23760	15.5	160	23760
TOP FARM SX1195A	95	14.2	162	23232	16.2	161	22176
TOP FARM 1101	100	15.6	155	23232	21.4	167	23760
TOP FARM 1194	95	14.4	152	23496	17.3	147	23232
TOP FARM 397	95	14.3	144	23364	16.3	172	24024
TRACY T2040	105	15.6	168	23760	21.1	169	24024
TRACY T2940	95	14.1	154	23364	19.3	131	22836
TRACY T2990	100	14.3	147	22968	16.1	147	23364
TRELAY 3005	95	12.2	162	23628	15.7	148	23100
TRELAY 4005	100	12.1	162	23760	16.7	170	23628
MEAN		15.1	159		19.2	154	
C.V.(%)		30.7	8		44.7	11	
LSD(.05)		7.5	22		13.8	28	

1989 University of Minnesota Corn Breeding
Expt. 341 - Late Hybrid Test

		Lamberton			Waseca		
Brand - Variety	RM	Moist %	Yld bu.	Stand	Moist %	Yld bu.	Stand
AGRI PRO AP378	105	17.6	174	22836	14.0	200	23892
AGRI PRO AP424	110	16.5	194	23496	13.7	221	23364
AGRIGENE AG3860	100	15.1	201	24156	12.7	191	23892
AGRIGENE AG3955	100	13.4	198	23232	12.2	193	23892
AGRIGENE AG3980	105	16.9	176	22704	14.2	185	24420
AGRIGENE AG4500	110	17.2	210	23892	14.3	209	23628
AGVENTURE 303	100	14.9	183	23232	12.9	192	23760
AGVENTURE 323	105	17.2	209	20592	13.2	198	24420
AGVENTURE 344	105	17.7	195	25080	13.9	197	24288
AGVENTURE 410	110	18.2	232	22308	14.2	215	24156
ANDERSON 550	105	18.0	190	23364	14.0	224	23496
ASGROW RX706	115	21.1	214	23364	15.0	209	23232
ASGROW RX469	100	14.9	198	23892	12.7	174	24156
ASGROW RX498	100	14.6	192	23364	12.8	191	22836
ASGROW RX578	105	17.4	192	22836	13.8	213	23496
ASGROW RX626	110	18.2	198	23892	14.2	214	24420
ASGROW RX746	115	20.3	209	24288	16.1	197	22440
BETAGOLD HANNA	105	17.3	190	24156	13.9	195	23496
BETAGOLD KARLA	100	15.5	177	23760	12.9	204	24948
BETAGOLD KATRINA	100	14.9	194	23496	13.0	196	24816
BETAGOLD MARIA	110	17.6	222	24816	13.8	206	24420
BLANEY B607	110	17.8	214	22968	15.0	216	24288
BLANEY B607WX	110	22.4	209	22836	15.0	202	22704
BLANEY 505	105	18.1	173	24552	13.9	196	23760
BROWN 6355	105	19.3	194	22440	15.2	203	24288
BROWN 6440	105	16.4	187	23760	14.0	204	23232
CARGILL 4227	105	16.9	183	23760	14.2	189	23760
CARGILL 4327	105	17.3	224	23760	13.5	214	23628
CARGILL 5157	105	18.1	177	23496	14.1	208	23892
CARGILL 6027	115	19.7	198	22572	14.0	193	24024
CROWS 210	105	16.4	179	22176	14.1	193	23628
CROWS 414	110	17.8	208	23892	15.3	199	23232
CROWS 482	115	21.7	176	22308	16.0	183	23100
CROWS 488	115	24.8	206	22572	16.1	213	24024
CUSTOMAIZE CFSW7551	115	26.5	207	23892	19.5	208	24024
CUSTOMAIZE CFS6309	110	20.3	190	23232	14.9	208	24024
CUSTOMAIZE W5753	110	17.9	178	23892	14.6	199	24420
CUSTOMAIZE W5851	110	21.1	177	23628	15.6	186	23496
CUSTOMAIZE 5510	105	18.1	176	23628	14.7	192	23496
DAIRYLAND DX1014	115	19.8	190	23892	16.1	196	22968

1989 University of Minnesota Corn Breeding
Expt. 341 - Late Hybrid Test (continued)

		Lamberton			Waseca		
Brand - Variety	RM	Moist %	Yld bu.	Stand	Moist %	Yld bu.	Stand
DAIRYLAND DX1104	105	15.8	209	24156	12.7	201	23364
DAIRYLAND DX1106	105	16.9	183	22968	13.9	209	23100
DAIRYLAND DX1110	110	20.1	220	23496	14.4	216	24156
DEKALB-PFIZER DK464	100	15.0	177	23760	12.9	171	23892
DEKALB-PFIZER DK485	100	15.8	187	21912	12.7	214	20460
DEKALB-PFIZER DK524	105	16.7	200	23628	13.6	214	22836
DEKALB-PFIZER DK535	105	15.8	215	23628	13.0	217	23760
DEKALB-PFIZER DK547	105	18.1	203	23628	13.9	215	24420
FOUR STAR 5613	105	20.3	198	23628	16.0	193	23232
FOUR STAR 5744	110	21.1	197	23232	17.2	206	23364
FUNKS G4299	100	18.9	183	22836	12.6	188	23760
FUNKS G4309	105	13.6	204	23628	12.1	189	23628
FUNKS G4340	105	14.4	207	22572	15.3	188	23892
FUNKS G4385	105	15.5	217	24156	13.4	201	24684
FUNKS G4393	105	16.8	208	23760	13.4	219	24024
GARST 8555	115	19.7	211	23496	15.5	221	23232
GARST 8599	115	16.4	204	24420	12.7	194	22440
GARST 8707	105	18.1	174	24288	14.5	185	24024
GEORGE'S 7109	110	18.6	201	23892	15.1	205	23232
GEORGE'S 8105	105	18.5	189	23100	15.4	204	24552
GEORGE'S 8109	110	21.8	193	24288	15.2	221	23892
GEORGE'S 8110	110	20.9	224	24420	17.8	208	24420
GOLDEN HARVEST H2343	100	15.1	185	23628	12.3	199	21912
GOLDEN HARVEST H2344	100	13.8	186	23232	12.2	196	23364
GOLDEN HARVEST H2404	105	16.6	169	24156	14.3	196	23628
GOLDEN HARVEST H2486	110	20.3	183	23232	14.6	227	23892
GREAT LAKES 482	105	17.0	201	23760	14.2	200	24156
GREAT LAKES 509	105	15.9	219	24024	13.0	210	23364
GREAT LAKES 514	105	16.9	201	23628	13.7	200	23760
GREAT LAKES 582	110	21.6	202	22440	14.4	225	23364
GREEN FIELD GFS9107	110	18.0	178	23496	13.9	200	23628
HOEGEMEYER SX2617	110	16.3	194	23232	14.6	200	22836
HY PERFORMER HS35	105	15.3	193	24288	12.5	195	22704
HY PERFORMER HS45	110	17.8	206	23232	15.1	201	22968
HY PERFORMER HS49	110	22.1	186	23232	17.0	213	23628
HY PERFORMER HS59	115	24.5	209	24420	18.3	218	24156
JACQUES 5310	105	14.6	200	23628	13.7	204	23760
JACQUES 5700	105	17.1	194	23628	13.6	197	24024
JACQUES 6770	110	17.6	217	23628	13.9	209	24156
JACQUES 7770	110	20.8	194	21120	16.5	207	22836

1989 University of Minnesota Corn Breeding
Expt. 341 - Late Hybrid Test (continued)

			Lamberton			Waseca	
Brand - Variety	RM	Moist %	Yld bu.	Stand	Moist %	Yld bu.	Stand
JACQUES 7820	115	23.1	201	23760	17.3	222	23892
JUNG 2503	105	15.5	184	24420	12.8	194	24420
JUNG 2688	105	16.5	188	23892	13.6	191	23628
KALTENBERG K4201	95	13.8	209	22704	12.7	173	24948
KALTENBERG K5200	95	17.1	201	22968	14.2	183	24156
KALTENBERG K5400	100	16.1	201	23496	12.7	198	24156
KELTGEN 2550	105	14.1	195	23232	12.6	195	22440
KELTGEN 2590	105	17.3	185	24024	14.1	195	24420
KELTGEN 2670	110	16.4	218	23496	14.5	213	23628
KELTGEN 2700	110	18.2	212	23760	14.9	216	23232
L. HERRIED 8304	115	17.2	215	24420	14.4	218	23628
L. HERRIED 8611	110	19.3	192	22440	15.9	216	23628
L. HERRIED 8702	105	16.4	195	23628	13.6	199	25476
LYNKS 2585	105	16.4	200	24024	13.3	211	23892
MALLARD UC616G	105	15.4	182	23760	12.9	186	23496
MALLARD UC624	110	19.3	200	25080	15.7	207	23364
MALLARD UC655B	115	21.2	203	23760	17.4	215	23628
McCURDY 4945	110	16.8	206	24288	14.2	190	23760
NC+ 2190	105	16.3	180	23760	13.5	195	23628
NC+ 3088	110	16.4	218	23628	13.3	220	24024
NC+ 3813	110	17.2	188	23760	14.1	208	23100
NORTHRUP KING N4545	105	16.5	199	24552	12.9	199	24156
NORTHRUP KING S4590	105	17.5	190	23892	14.0	204	23496
NORTHRUP KING S5340	110	19.3	205	23232	15.0	215	24288
NORTHRUP KING S5750	110	17.9	194	23100	15.1	205	23628
PAYCO SX686	100	13.9	175	24156	12.8	184	24552
PAYCO SX687	100	14.9	198	25608	13.0	195	24156
PAYCO SX872	110	18.7	211	26004	14.4	212	24684
PAYCO 648	105	17.0	192	24684	14.2	200	24288
PAYCO 748	110	18.2	210	22968	13.9	200	23496
PFISTER 1575	110	16.0	201	22968	14.1	191	23496
PFISTER 2265	115	17.7	199	23496	14.3	199	23760
PFISTER 2375	115	20.5	198	24024	14.9	201	22176
PHOENIX PH2501	100	15.4	189	24024	13.2	198	23760
PHOENIX PH2531	105	17.3	198	24288	14.3	195	23628
PHOENIX PH2551	110	19.8	205	24024	15.0	220	23892
PIONEER 3467	115	17.8	194	22440	15.1	211	24024
PIONEER 3475	115	17.3	206	22572	14.8	217	23892
PIONEER 3578	110	15.1	210	23232	13.6	202	23628
PIONEER 3585	105	16.3	198	23760	13.3	206	23760

1989 University of Minnesota Corn Breeding
Expt. 341 - Late Hybrid Test (continued)

		Lamberton			Waseca		
Brand - Variety	RM	Moist %	Yld bu.	Stand	Moist %	Yld bu.	Stand
PIONEER 3615	105	13.9	200	23232	13.4	201	23364
PIONEER 3733	100	14.3	207	23760	13.6	210	24420
PRODUCERS 595	105	17.7	193	23232	14.3	193	23892
RENK RK702	110	18.4	188	24024	15.0	212	23232
RENK RK803	110	23.8	181	23364	16.8	220	22968
ROBINSON H2438	105	19.2	189	23364	15.2	218	24156
SCHWITTERS 2095	105	12.2	160	23100	12.0	169	21252
SCHWITTERS 3XA100	105	18.6	194	24024	14.1	203	23760
SCHWITTERS 3XA108	110	19.1	174	23100	15.8	190	23364
SEED TEC ST7344	110	17.0	175	21384	13.9	190	23892
SIGCO 1099	100	14.8	199	22836	13.2	192	22704
SIGCO 1701	100	16.7	195	23760	14.2	196	23364
SIGCO 1799	100	14.9	192	23628	12.8	194	24288
SUPER CROST 2979	110	17.4	219	23628	13.5	206	23892
SUPER CROST 3130	110	16.6	219	23628	14.1	194	23628
SUPER CROST 4366	110	20.0	195	23760	15.7	216	23100
SUPER CROST 4386	115	20.1	202	22176	16.4	212	23628
TOP FARM SX1103	105	17.3	195	23760	14.2	206	23100
TOP FARM 1112	115	21.0	201	21912	16.7	210	23232
TRELAY 5006	105	16.4	189	24024	13.6	200	24288
MEAN		17.6	196		14.3	202	
C.V.(%)		5.8	7		3.3	6	
LSD(.05)		1.6	23		.8	18	

INFLUENCE OF EXPERIMENTAL DESIGNS ON ON-FARM TRIAL INTERPRETATIONS

M.A. Schmitt and S.J. Openshaw[1]

ABSTRACT: Experimental designs used in on-farm research trials are largely responsible for the precision of the research results. Three experimental designs (unreplicated strip, unreplicated strip with "tester", and randomized complete block (RCB)) were compared in terms of the experimental error term each design would give for a given trial. Trials were located at 4 experiment stations and 8 farmer fields. The RCB design provided the lowest experimental error term in all cases while the strip with "tester" design resulted in the highest experimental error term for the trials. Based on these results and the 1988 results the practice of replication and combining results across locations is recommended.

INTRODUCTION

As the trend develops to place increasing emphasis on on-farm trials, the validity of these trial results must be emphasized. The measurement that is used to evaluate the precision of the different experimental designs is the error variance. The relative size of the error variance is inversely related to the degree of precision of the design. The larger the error variance, the less precision the experiment possesses. The precision of an experiment is directly related to the confidence one can give to the data.

For example, a large relative error variance results in larger differences between treatment means in order for the treatments to be significantly different. A 10 bushel per acre difference in two corn treatment means might be significantly different if relatively low error variance was measured, but would not necessarily be different if a relatively high error variance was measured. The objectives of this project are to compare the precision of three experimental designs used in on-farm research.

MATERIALS AND METHODS

Three basic experimental designs commonly used in large plot, on-farm trials were compared. These three designs are: 1) a nonreplicated strip (strip), in which the number of plots equals the number of treatments, 2) a nonreplicated strip that has a common treatment placed in every second (strip with "tester"), in which the number of plots equals the number of treatments times 2 plus 1, and 3) a randomized complete block (RCB), in which the number of plots equals the number of treatments times the number of replications.

The experimental design used in the field trials (Figure 1) incorporated each of the three experimental designs investigated in this study. Eight of the locations in Minnesota were on farmers' fields, with the plot's width between 10-30 feet and length's from 300 to 1447 feet. Four sites were at University of Minnesota experiment stations, with width's of 10-15 feet and the length between 30 and 426 feet. All of the sites were selected based on visual uniformity of the soil.

Management practices were followed at each site that were parallel to that practiced by top corn producers. There were five treatments at each location, consisting of different hybrids: Pioneer brands 3737, 3751, 3732, 3585, and 3733. Pioneer brand 3737 was used as the "tester" in the strip with "tester" design. Grain yields were measured after physiological maturity using a combine (except at one experiment station). Grain yields were adjusted to 15.5% moisture.

The error variance for the plot area using a strip design having as many treatments as there are strips was approximated by calculating the residual mean square from a completely random design (CRD) analysis that used the unadjusted yields of the nontester plots. By using a CRD, only the treatment effects are partitioned from the trial variance--not any block effects.

The strip with "tester" design's error variance is approximated in a similar manner as the strip design's error. First, however, the yields are adjusted according to Eq. 1. The adjusted yields for the nontester hybrids are then used in a CRD analysis, partitioning out the treatment effect, resulting in the error variance associated with the total plot area as if a strip with "tester" design were used.

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Equation 1:

$$Y_A = [Y_U - \frac{(T_L + T_R)}{2}] + T_{Ave}$$

Y_A = Adjusted Treatment Yield
Y_U = Unadjusted Treatment Yield
T_L = Tester Yield on Left Side of Treatment Plot
T_R = Tester Yield on Right Side of Treatment Plot
$T_{Ave.}$ = Tester Yield Average for Entire Trial

The estimated experimental error for a RCB design used on the plot area is calculated by using a randomized complete block analysis. This partitions both replicate and treatment effects from the experimental error term.

1989 RESULTS

The overall error variance of the trial area using an unreplicated strip design was almost one-half the magnitude of the strip with "tester" design's error variance (Table 1). The frequency of the "tester" is not as beneficial in reducing the error variance of the area as some would expect. The best design, in terms of achieving the lowest error variance for the trial area, is the randomized complete block. As well as having the lowest error variance, the range of these values was also the smallest.

The effect of plot size was noted in 1989. The data (Table 1) indicates that the smaller plots tended to have higher experimental error terms than did the larger plots. The confounding factor of this observation is that the smaller plots all had border rows between plots that were not harvested, whereas the larger plots did not have border rows. Therefore, it cannot be fully explained as to whether the border rows do provide a more diverse group of treatment means that truly do have more variance or if the larger plots are less effected by soil variability and do provide a smaller experimental error.

Table 1. The effect of experimental design and plot size on estimating error variances (S^2) of corn hybrid trials, 1989.

Expt'l. Design	Plot Size[1]	# Sites	S^2	Range of S^2
Strip	Small	4	128.1	12.3 - 275.5
	Large	8	22.2	5.3 - 57.1
	Overall	12	57.5	5.3 - 275.5
Strip w/"Tester"	Small	4	239.4	30.5 - 500.2
	Large	8	47.9	12.3 - 129.2
	Overall	12	111.7	12.3 - 500.2
R.C.B.	Small	4	76.3	9.5 - 144.2
	Large	8	16.8	1.7 - 54.0
	Overall	12	36.6	1.7 - 144.2

[1] The "large" plots averaged 0.3012 A per plot and the "small" plots averaged 0.0504 A per plot.

2-YEAR SUMMARY

The overall mean of the strip and RCB design's error variance were not substantially different from 1988 and 1989 (Schmitt and Openshaw, 1989). While there was a large difference in the strip with "tester" design's error variance between the years, this difference should be attributed to the change made in the frequency of the "tester" made in 1989 (see materials and methods).

The RCB design with three replicates provided the lowest error variance of the three designs evaluated. The reduction in error variance was about 40-50% when compared to the unreplicated strip design. However, when using the error term for differentiating treatment means, the RCB error variance will be divided by the number of replicates to arrive at the variance of a treatment mean. The large reduction in error variance provided by the RCB is logistically offset by the fewer number of treatments that can be evaluated--still assuming that the plot size and number are fixed at a site.

To increase the precision and differentiation of treatments in agronomic trials, the practice of replication must be endorsed. Along with this, interpretability can also be improved if the trials are statistically combined from several locations. This will, in effect, increase the number of replications. While the use of the "tester" hybrid may provide an estimate as to the variability within one trial site, the results of this project show that it does not increase (and can decrease) the experimental error precision when adjusting treatment means with it.

References:

Schmitt, M.A. and S. J. Openshaw. 1988. Influence of experimental designs on on-farm trial interpretations. In A report on field research in soils, misc. publ. 2, Minn. Ag. Expt. Stn., Univ., of Minn. pp. 207-210.

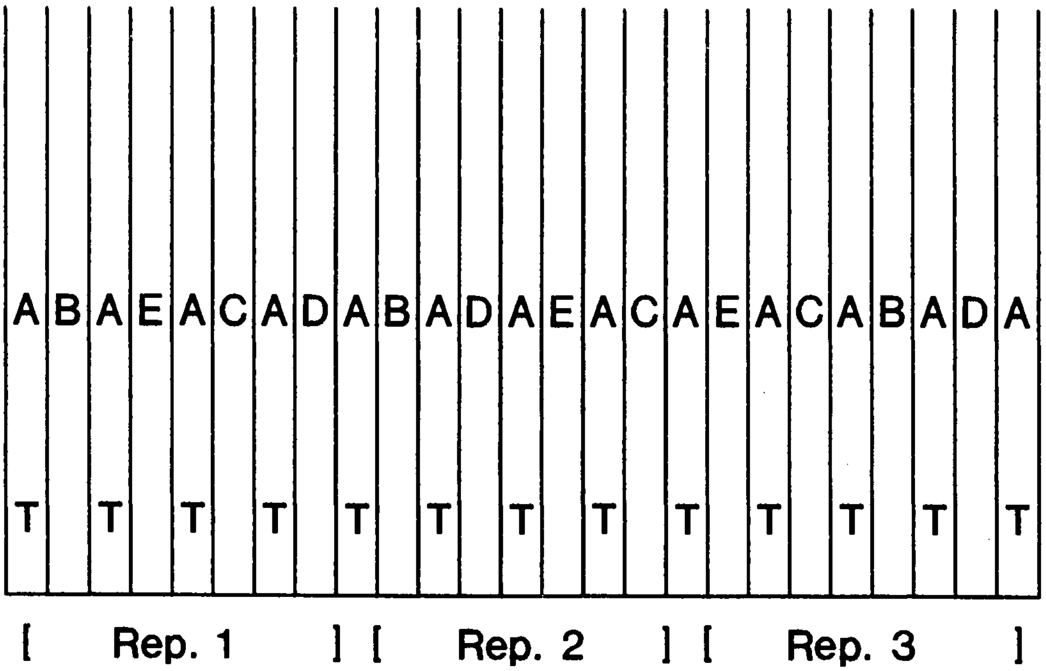

Figure 1. Experimental design used in field trials, 1989.

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

Objectives

The long term effect of various sequences of corn and soybeans has not been investigated. The objectives of this study are: 1) To determine the effect on yield of crop sequences of one to five years of corn following soybeans or one to five years of soybeans following corn and 2) To investigate possible sources of yield differences resulting from different crop sequences. Crop sequences for both Lamberton and Waseca are illustrated in Table 1.

Procedure

The design of the study consists of 16 treatments arranged in a randomized complete block design replicated four times. The sixteen treatments (Table 1) consist of the crop planted in the current year and the four preceding years ('89-'88-'87-'86-'85):

1) 1-4 years of corn following 1 to 4 years of soybeans (ssssc,ssscc, sscсc,scccc).

2) Continuous corn for the duration of the study (ccccc-8 years) and 5 years of continuous corn following soybeans (ccccc-5 years).

3) 1 to 4 years of soybeans following 1 to 4 years of corn (ccccs, cccss, ccsss, csssss).

4) Continuous soybeans for the duration of the study (sssss-8 years) and 5 years of continuous soybeans following corn (sssss-5 years).

5) Continuous corn with hybrids rotated.

6) Continuous soybeans with varieties rotated.

7) Corn/Soybean (scscs) and soybean/corn (cscsc) in alternate years.

Hybrids or Varieties

The principal soybean variety grown was Hodgson 78. It is alternated with Corsoy 79 in treatment 16. The principal corn hybrid grown is Pioneer 3737 which is alternated with Pioneer 3732 in treatment 15.

Waseca - Cultural Practices

The study area was moldboard plowed in the fall of 88 and field cultivated in the spring of 1989. Fertilizer application consisted of N applied as urea at the following rates:

a) 175# N/A to corn following corn.
b) 150# N/A to corn following soybeans.

No additional P or K was applied. Weed control was maintained by application of Lasso (3.5 lb ai/A) and Lorox (1.5 lb ai/A) applied for preemergence weed control. Post emergence weed control consisted of one application of Basagran + oil + 28% N (1# ai+1qt +2 qt). Lorsban (8 oz/1000 ft of row) was applied at planting to plots where corn followed corn. Plots were cultivated and hand weeded as necessary.

Plots are six rows 55 feet long planted at a 30" row spacing. 104 feet of row (2 rows) are harvested. Corn and soybean plots were planted on 13 May, 1989. Corn plots were harvested on 5 October, 1989 and soybean plots on 4 October, 1989.

Nematode Observations

Spring soil samples from both corn and soybean plots were analyzed by the University of Minnesota plant disease clinic for the presence of plant parasitic nematodes. The samples were taken on 1 June, 1989.

Results and Discussion

The growing season at Waseca was warmer than normal with below normal precipitation.

Corn

Corn yields (Table 2) were the highest obtained in the eight years of the study in spite of below normal precipitation. The yield relationship among sequences was similar to the study average of the past four years. Corn planted the first year after four years of soybeans (ssssc) produced the highest yield of the seven sequences, yielding 17% more than continuously planted corn. The lowest yields occurred in plots planted to corn for two years (ssscc). Growing corn in alteration with soybeans (cscsc) resulted in a 15% yield increase when compared to continuous corn. This is similar to the 5 year average.

None of the nematode genera detected in corn (Table 4) were present in numbers thought to be large enough to cause yield losses. Soybean cyst nematode was found in two sequences; ssssc and cscsc.

Soybeans

In soybeans (Table) 3) a yield increase of 17% was produced by soybeans planted the first year after 4 years of corn when compared to continuous soybeans (sssss-5yr). Alternation of corn and soybeans also produced an increase in yield (15%).

Five genera of nematodes were detected at Waseca including soybean cyst nematode (Heterodora) (Table 5).

Table 1. Treatments applied to plots in ten year rotation study. Study began at Lamberton in 1981 and at Waseca in 1982.

Waseca	82	83	84	85	86	87	88	89	90	91
Lamberton	81	82	83	84	85	86	87	88	89	90
TREATMENT #										
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	Hodgson 78 BSR 101	Corsoy 79

Table 2. Long Term Corn/Soybean Rotation - 1989: Corn Yields

Crop Sequence	Yield bu/acre	Yield as % of ccccc (5 Yr)
ssssc	199 a+	117
ssscc	154 c	91
sscсc	173 bc	102
scccc	167 c	98
ccccc (5 yr.)	170 c	100
ccccc (8 yr.)	169 c	99
cscsc	196 ab	115
ccccc*	175	

*Alternate hybrids. In 1989 the hybrid planted was P 3732.
+Yields followed by same letter are not significantly different at 5% level of significance.

Table 3. Long Term Corn/Soybean Rotation - 1989: Soybean Yields

Crop Sequence	Yield bu/acre	Yield as % as of sssss (5 yr)
cccсs	42 a+	117
cccss	40 ab	111
ccsss	37 bc	103
cssss	34 c	94
sssss(5 yr)	36 bc	100
sssss (8 yr)	37 bc	103
scscs	41 a	114
sssss*	33	

*Alternate varieties. In 1989 the variety planted was Corsoy 79.
+Yields followed by same letter are not significantly different at 5% level of significance.

Table 4. Corn Nematode Populations - June 1989.

Crop Sequence	Pratylenchus	Pratylenchus	Helicotylenchus	Xiphenema	Heterodora
ssssc	53	56	8	0	3
ssscc	41	22	3	0	0
sscсc	27	8	16	0	0
scccc	26	0	11	0	0
ccccc(5yr)	247	3	18	6	0
ccccc(8yr)	341	3	13	0	0
cscsc	103	3	22	0	5

Table 5. Soybean - Nematode Populations - June 1989

Crop Sequence	Pratylenchus	Paratylenchus	Helicotylenchus	Xiphenema	Heterodora
ccccs	66	0	33	0	0
cccss	12	25	15	0	0
ccsss	14	162	103	3	0
cssss	3	121	12	0	0
sssss(5yr)	9	502	12	3	10
sssss(8yr)	0	196	0	0	21
scscs	15	5	6	0	0

CORN ROOT HEALTH AND LORSBAN

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OBJECTIVE: The object of this study was to evaluate the effect of Lorsban on corn root health.

PROCEDURE: Five corn hybrids were planted May 3 without and with Lorsban (8 oz/1000 row ft) in a 7 inch T-band. The plots were 4 rows, 30 inch by 125 ft long and six replicates. The plants were hand dug and select roots were collected, returned to the lab for isolation of Fusarium. The primary root, at least 10 cm long was washed and disinfected before isolation on selective media. The Fusarium colonies were counted and recorded. Corn was harvested and yield is presented as Bu/A at 15.5% moisture. No root worm damage was expected in the plot.

RESULTS: A 2.9 bushel yield advantage was recorded for T-band application of Lorsban. The yield advantage for Lorsban may be related to seedling health and to final stand. The relation of root weight and leaf area was not consistently favored by Lorsban treatment. The best yield is associated with the highest plant population and the lowest colony counts. Yield differences, colony counts and plant population differences were small.

The soil insecticide- Lorsban does have an effect on seedling root health and that effect is in general to lower the amount of fungal colonization of roots. The result is not always consistent and may be overcome by additional stress/root worm feeding or nematode damage. A yield response is dependent on corn hybrid and even more importantly on the growing environment for expression. The effect of root health may be overcome by plant population. A low plant population with less root infection produces less than high populations with higher root infection. The decision to use Lorsban, a soil insecticide, must be decided on the benefits gained from insect treatment. The potential additional benefit of root health needs further research.

Table 1. Waseca Data Planted May 3, 1989

Corn Hybrid	Lorsban Treatment	Plant Populations x 1,000			Bu/A Yield	T Band Advantage	H_2O
		5/19	5/22	5/24			
Pioneer 3615	T Band	25.3	26.1	26.4	173.6	+3.0	16.6
	Check	25.7	26.4	26.8	170.6		16.7
Pioneer 3737	T Band	26.2	27.2	27.5	149.5	-1.7	13.2
	Check	25.9	27.0	27.3	151.2		13.3
Hybrid A	T Band	20.9	23.0	23.7	183.9	-1.1	24.6
	Check	21.9	23.7	24.3	185.0		25.0
Hybrid B	T Band	23.3	24.6	24.8	159.8	+7.6	17.8
	Check	23.4	24.1	24.5	152.2		18.1
Hybrid C	T Band	21.9	23.6	24.3	143.7	+6.7	13.7
	Check	19.6	21.6	22.0	137.0		14.1
Hybrid Average	Relative Maturity						
P3615	105	25.5	26.3	26.6	172.1		16.7
P3737	100	26.1	27.1	27.4	150.4		13.3
Hybrid A	115	21.4	23.4	24.0	184.5		24.8
Hybrid B	110	23.4	24.4	24.7	156.0		18.0
Hybrid C	105	20.8	22.6	23.2	140.4		13.9
	LSD (0.05)	1.3	1.5	1.5	6.7		0.6
Average for Lorsban Treatment							
	T Band	23.5	24.9	25.3	162.1		17.2
	Check	23.3	24.6	25.0	159.2		17.4
Level of Significance (P>F)		0.62	0.33	0.25	0.08		0.02
Hybrid x Lorsban							
Level of Significance (P>F)		0.11	0.01	0.04	0.25		0.76

Table 2. Growth Measurements and Root Colonies/Fusarium

Hybrid	P3615	P3737	Hybrid C
Root Dry Weight (gm)			
Lorsban	162	119	146
None	160	123	127
Leaf Area (cm^2)			
Lorsban	1645	1478	1346
None	1309	1550	1486
Colony #/10 cm Root			
Lorsban	2.90	3.77	3.41
None	3.47	3.41	4.83
Yield (Bu/A)			
Lorsban	173.6	149.5	143.7
None	170.6	151.2	137.0
Plant Population (x 1000)			
Lorsban	26.4	27.5	24.3
None	26.8	27.3	22.0

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EFFECTS OF CULTIVATION ON CORN WEED CONTROL

W. E. Lueschen and J. Gunsolus

1989 was the third year this study has been conducted. The objectives of this study were: 1) to evaluate the effects of cultivation on weed control in corn with and without herbicide application, 2) to evaluate the effects of band vs. broadcast herbicide applications, and 3) to evaluate the effectiveness of a rotary hoe for improving weed control in corn.

This experiment was deigned as a randomized complete block with a split plot arrangement of treatments and four replications. The main plots were a combination of cultivation treatment and a rotary hoe treatment. Subplots were four herbicide treatments. There were three cultivations treatments : 1) no cultivation , 2) one cultivation 4 weeks after planting, and 3) two cultivations, one 3 weeks after planting with a repeat cultivation 5 weeks after planting. Herbicide treatments evaluated included Lasso 2.5 lb/A broadcast, Lasso 2 lb/A + Bladex 2 lb/A broadcast, Lasso 2 lb/A + Bladex 2 lb/A applied in a 15-inch band, and a check treatment with no herbicide. These herbicide rates are below the labeled use rate in an effort to evaluate the use of mechanical weed control in combination with low herbicide inputs to see if herbicide inputs could be effectively reduced without a substantial decrease in production. All herbicide and cultivation treatments were evaluated with and without rotary hoeing. The rotary hoeing was done approximately one week after planting when weeds were emerging to 1/2-inch tall and corn was just below the soil surface. All herbicides were applied pre-emergence.

The 1989 results from this study are presented in Table 1. Averaged over all cultivation treatments, the best weed control was obtained with broadcast herbicide applications in 1989. With either one or two cultivations, however, excellent weed control was obtained with banded herbicides. On average, cultivation improved weed control 40 to 60 percent and yield 50 bu/A. There was little difference between one and two cultivations. Averaged over all Herbicide treatments, the rotary hoe improved weed control 10 to 30 percent and yield 25 bu/A. The rotary hoe effects were most significant where cultivation was not used, although the rotary hoe improved weed control and yield regardless of cultivation treatment.

Table 2 shows the effects of cultivation and rotary hoeing on corn weed control in 1988 and 1989. Although very low yields in 1988 minimized the effects of cultivation and rotary hoeing the pattern has remained the same. Averaged over the two years, the best weed control is resulting from broadcast herbicide applications. We are able to get levels of weed control equal to broadcast applications with banded application with cultivation. Cultivation is consistently improving levels of weed control and yield. One rotary hoeing approximately one week after planting is accounting for a 10 to 20 percent increase in weed control averaged over the two years. The response to rotary hoeing is more pronounced where no cultivation is done. It should be noted that the herbicide rates in this study are below the labeled use rate and the effects of cultivation and rotary hoeing should be maximized because weed control from herbicides is less than could be expected.

Table 3 shows the effects of cultivation on corn yield at Waseca in 1987 through 1989. The effects of the rotary hoe were not evaluated in 1987. Averaged over the three year period, broadcast herbicide applications are resulting in the best weed control. With two cultivations, however, weed control and corn yields are just as good with banded herbicide applications as with broadcast applications. A second cultivation is most critical with the banded herbicides. With broadcast herbicides the second cultivation improved weed control 5 to 10 percent and yield approximately 10 bu/A. With banded herbicides the second cultivation improved weed control 15 to 25 percent and yield 25 bu/A to levels equal to the broadcast application.

With three years of data, we have observed that cultivation and rotary hoeing are important tools for weed control in corn. The value of these tools are most important with banded herbicide applications. The value of two cultivations is most important with banded herbicides and is minimal with broadcast herbicide applications. One rotary hoeing approximately one week after planting accounted for about a 10 percent improvement in weed control. The effects of the rotary hoe are most pronounced where other means of weed control like cultivation and herbicides are used to a lesser degree. But rotary hoeing did improve weed control in all situations and should be considered an additional weed control tool and not a substitute for either cultivation or herbicides. The rotary hoe and cultivation can be especially effective in situations where herbicide inputs have been reduced. With careful management and proper use of these tools it is likely that herbicide inputs can be reduced slightly without suffering a substantial decrease in production.

Table 1. Effects of Cultivation and Rotary Hoe on Weed Control in Corn at Waseca in 1989.

Herbicide	Rate	Method of Application	Cult.	Rotary Hoe	GIFT	RRPW	COLQ	VELE	Yield
	(lb/A)				(% control)				(bu/A)
Lasso	2.5	Brcst	0	0	38	58	10	0	93.1
Lasso + Bladex	2.0 + 2.0	Brcst	0	0	60	64	35	19	100.3
Lasso + Bladex	2.0 + 2.0	Band	0	0	20	45	15	12	63.1
Weedy Check	---	---	0	0	2	15	5	0	43.0
Lasso	2.5	Brcst	1	0	75	90	74	70	160.8
Lasso + Bladex	2.0 + 2.0	Brcst	1	0	89	95	72	66	140.3
Lasso + Bladex	2.0 + 2.0	Band	1	0	81	86	64	69	141.6
Weedy Check	---	---	1	0	71	75	69	65	103.4
Lasso	2.5	Brcst	2	0	82	82	76	50	165.6
Lasso + Bladex	2.0 + 2.0	Brcst	2	0	94	92	76	69	158.3
Lasso + Bladex	2.0 + 2.0	Band	2	0	84	90	80	74	140.5
Weedy Check	---	---	2	0	75	88	78	78	104.9
Lasso	2.5	Brcst	0	1	72	69	71	10	131.6
Lasso + Bladex	2.0 + 2.0	Brcst	0	1	71	80	81	25	149.1
Lasso + Bladex	2.0 + 2.0	Band	0	1	35	51	45	20	118.4
Weedy Check	---	---	0	1	45	64	66	50	90.8
Lasso	2.5	Brcst	1	1	97	99	94	85	162.2
Lasso + Bladex	2.0 + 2.0	Brcst	1	1	85	85	82	85	163.4
Lasso + Bladex	2.0 + 2.0	Band	1	1	89	96	90	80	153.4
Weedy Check	---	---	1	1	71	80	91	74	138.6
Lasso	2.5	Brcst	2	1	76	92	78	78	155.8
Lasso + Bladex	2.0 + 2.0	Brcst	2	1	97	100	96	89	167.5
Lasso + Bladex	2.0 + 2.0	Band	2	1	92	92	91	89	154.2
Weedy Check	---	---	2	1	84	89	89	81	149.0
Average for Herbicide:									
Lasso	2.5	Brcst			73	82	67	49	144.9
Lasso + Bladex	2.0 + 2.0	Brcst			83	86	74	59	146.5
Lasso + Bladex	2.0 + 2.0	Band			67	77	64	57	128.5
Weedy Check	---	---			58	69	66	58	105.0
			LSD (0.05)		8	11	10	9	11.0
Average For Cultivation:									
			0		43	56	41	17	98.7
			1		82	88	80	74	145.5
			2		86	91	83	76	149.5
			LSD (0.05)		10	14	9	11	11.2
Average for Rotary Hoe:									
				0	64	73	55	48	117.9
				1	76	83	81	64	144.5
Level of Significance (p-value)					0.0052	0.0798	0.0001	0.0015	0.0001

TAble 2. Effects of Cultivation and Rotary Hoe on Weed Control in Corn at Waseca 1988-1989.

Herbicide	Rate	Method of Application	Cult.	Rotary Hoe	GIFT	RRPW	COLQ	VELE	Yield
	(lb/A)				----------(% control)			--------	(bu/A)
Lasso	2.5	Brcst	0	0	35	32	9	0	46.6
Lasso + Bladex	2.0 + 2.0	Brcst	0	0	42	39	21	9	50.2
Lasso + Bladex	2.0 + 2.0	Band	0	0	21	28	8	10	31.5
Weedy Check	---	---	0	0	1	8	2	0	21.5
Lasso	2.5	Brcst	1	0	71	75	67	65	86.8
Lasso + Bladex	2.0 + 2.0	Brcst	1	0	76	78	66	62	75.9
Lasso + Bladex	2.0 + 2.0	Band	1	0	71	74	62	64	75.8
Weedy Check	---	---	1	0	61	65	62	60	53.4
Lasso	2.5	Brcst	2	0	74	71	68	55	89.0
Lasso + Bladex	2.0 + 2.0	Brcst	2	0	79	77	69	65	85.2
Lasso + Bladex	2.0 + 2.0	Band	2	0	74	77	72	68	76.2
Weedy Check	---	---	2	0	68	73	68	68	55.9
Lasso	2.5	Brcst	0	1	57	52	48	9	65.8
Lasso + Bladex	2.0 + 2.0	Brcst	0	1	54	40	41	12	75.5
Lasso + Bladex	2.0 + 2.0	Band	0	1	29	29	26	14	59.2
Weedy Check	---	---	0	1	25	32	33	25	45.4
Lasso	2.5	Brcst	1	1	83	82	79	72	86.6
Lasso + Bladex	2.0 + 2.0	Brcst	1	1	75	74	73	72	89.6
Lasso + Bladex	2.0 + 2.0	Band	1	1	79	82	79	72	88.1
Weedy Check	---	---	1	1	64	69	75	66	71.8
Lasso	2.5	Brcst	2	1	74	79	72	72	89.8
Lasso + Bladex	2.0 + 2.0	Brcst	2	1	85	88	85	79	92.8
Lasso + Bladex	2.0 + 2.0	Band	2	1	82	82	81	79	88.4
Weedy Check	---	---	2	1	74	76	76	72	80.0
Average for Herbicide:									
Lasso	2.5	Brcst			66	65	57	46	77.4
Lasso + Bladex	2.0 + 2.0	Brcst			69	66	59	50	78.2
Lasso + Bladex	2.0 + 2.0	Band			59	62	55	51	69.9
Weedy Check	---	---			49	54	53	49	54.7
			LSD (0.05)		4	6	5	5	5.7
Average For Cultivation:									
			0		33	33	24	10	49.5
			1		73	75	70	67	78.5
			2		76	78	74	70	82.2
			LSD (0.05)		6	7	5	5	5.6
Average for Rotary Hoe:									
				0	56	58	48	44	62.3
				1	65	65	64	54	77.8
	Level of Significance (p-value)				0.0004	0.0113	0.0001	0.0001	0.0001

Table 3. Effects of Cultivation on Weed Control in Corn at Waseca 1987-1989.

Herbicide	Rate	Method of Application	Cult.	GIFT	RRPW	COLQ	VELE	Yield
	(lb/A)			-----------(% control)			--------	(bu/A)
Lasso	2.5	Brcst	0	32	38	24	26	51.5
Lasso + Bladex	2.0 + 2.0	Brcst	0	40	49	40	28	68.5
Lasso + Bladex	2.0 + 2.0	Band	0	22	40	19	32	43.4
Weedy Check	---	---	0	1	13	10	8	39.0
Lasso	2.5	Brcst	1	60	71	63	62	93.1
Lasso + Bladex	2.0 + 2.0	Brcst	1	72	78	71	69	92.6
Lasso + Bladex	2.0 + 2.0	Band	1	55	73	58	68	75.8
Weedy Check	---	---	1	53	62	65	67	65.2
Lasso	2.5	Brcst	2	71	74	72	68	102.3
Lasso + Bladex	2.0 + 2.0	Brcst	2	74	82	73	69	102.0
Lasso + Bladex	2.0 + 2.0	Band	2	75	82	78	75	100.2
Weedy Check	---	---	2	59	63	64	72	63.3

Average for Herbicide Treatment :

Lasso	2.5	Brcst	54	61	53	52	82.3
Lasso + Bladex	2.0 + 2.0	Brcst	62	70	61	55	87.7
Lasso + Bladex	2.0 + 2.0	Band	51	65	52	58	73.1
Weedy Check	---	---	38	46	46	49	55.8
		LSD (0.05)	6	11	11	8	10.2

Average for Cultivation :

0	24	35	23	24	50.6
1	60	71	64	67	81.7
2	70	75	72	71	92.0
LSD (0.05)	4	8	7	7	7.2

Herbicide x Cultivation (p-value)	0.0010	0.784	0.3036	0.0826	0.1309

Herbicide performance in corn at Waseca, MN-1989. Gunsolus, Jeffrey L. and William E. Lueschen. The purpose of this experiment was to evaluate various soil applied and postemergence herbicides and herbicide combinations for efficacy and corn tolerance. Timing of postemergence grass and broadleaf herbicide applications were also evaluated. Oats were grown in 1988 and the plot area was chisel plowed in the fall of 1988 and field cultivated in the spring of 1989. The plot area received 150 lb/A of urea N, incorporated in the spring of 1989. The study was conducted on a Webster clay loam soil with 6.6% organic matter, pH 7.2, and soil test P and K levels of 70 and 440 lb/A, respectively. All herbicides were applied with a self-propelled plot sprayer that delivered 20 gpa at 30 psi and 3 mph, using 8002 flat-fan nozzles. On May 10, 'Pioneer 3906' corn was planted 1.5 inches deep at 27,500 seeds/A. The entire postemergence broadleaf herbicide study (see Table 3) was sprayed on May 11 with 5 lb/A of propachlor to prevent grass weeds from interfering with the study. The treatment did not provide complete control. A randomized complete block design with four replications was used. Plots were 10 by 30 ft and contained four 30-inch rows. The entire postemergence grass study (see Table 2) was treated on June 8 with 0.25 lb/A of bromoxynil to prevent broadleaf weeds from interfering with the study. In the preemergence study, weed densities/ft^2 were 30 giant foxtail, 5 common lambsquarters, 5 redroot pigweed, and 12 common ragweed. In the postemergence studies, weed densities/ft^2 were 50 giant foxtail, 18 common lambsquarters, 1 common ragweed, and 1 redroot pigweed. Weed control evaluations were taken visually June 21 for all soil applied treatments. All postemergence grass herbicide evaluations were taken June 22 and the postemergence broadleaf evaluations were taken June 22 and July 3, for the early and late applications respectively. Plots in the second through fourth replication were cultivated after visual ratings were taken. Yield data were obtained from 25 ft of the two center rows and corrected to 15.5% moisture. Application dates, environmental conditions, and plant sizes are listed below:

Date	May 11	June 2	June 8	June 16	June 19
Treatment	Pre	E. post grass	E. post bdlf	L. post grass	L. post bldf
Temperature (F)					
air	60	74	58	68	90
soil (4 inch)	67	69	62	69	87
Soil moisture	-	-	-	-	-
Wind (mph)	-	-	10-15 NW	0-5 N	0-5 S
Sky	-	-	-	-	-
Relative humidity (%)	55	50	75	45	35
Rainfall before application					
Week 1 (inch)	0.67	T	0.10	0.33	0.12
Rainfall after application					
Week 1 (inch)	0.16	0.10	0.33	0.04	0.04
Week 2 (inch)	0.70	0.33	0.03	-	-
Corn					
leaf no.	-	2-3	4	4	5
height (inch)	-	4	7	7-8	10-12
Foxtail spp.					
leaf no.	-	1-3	1-2	5	3-4
height (inch)	-	1-3	0-1	4-6	3-4
Common lambsquarters					
leaf no.	-	2-4	4-8	-	8-10
height (inch)	-	1-2	2-4	-	4-6
Redroot pigweed					
leaf no.	-	2-4	4-8	-	6-8
height (inch)	-	1-2	2-4	-	4-6
Common Ragweed					
leaf no.	-	2-4	4-6	-	6-8
height (inch)	-	1-2	2-3	-	4-6

Dry weather conditions early in the growing season significantly influenced herbicide efficacy and crop yields. Early season weed control with the preemergence herbicides was adequate but late season grass and broadleaf flushes contributed to poor corn yields. Postemergence grass herbicides were more efficacious at the early application dates. Also, grass control in the post broadleaf study was not complete. Therefore, crop yields are lower than the broadleaf efficacy data would indicate. In the postemergence grass and broadleaf studies, crop injury ratings are not a reflection of herbicide injury, but rather reflect drought stress that was enhanced by weed competition. (Minn. Agric. Exp. Stat., University of Minnesota, St. Paul).

Table 1. Waseca corn preemergence herbicide screening - 1989 (Gunsolus and Lueschen).

		Weed Control (6/21)				Corn		
						(6/21)		
Treatment	Rate	Gift	Colq	Corw	Rrpw	Injury	Stand[a]	Yield
	(lb/A)	(%)						(Bu/A)
Preemergence (May 11)								
CGA-180937[b] & cyanazine[c]	2.5 & 2.5	87	91	79	80	0	0	31
CGA-180937 + cyanazine	2.5 + 2.5	90	92	73	78	3	0	41
Tridiphane	1.0	93	91	35	91	1	0	9
Tridiphane + atrazine	1.0 + 2.0	94	98	77	98	3	0	72
Atrazine	2.0	30	93	48	91	3	0	10
Alachlor + atrazine	2.5 + 2.0	90	98	87	98	1	0	76
Alachlor + AC-310,488 + atrazine	2.5 + 0.1 + 1.0	90	95	74	88	4	0	25
Alachlor + AC-310,488 + atrazine	2.5 + 0.1 + 0.5	91	89	69	84	0	0	24
Pendimethalin + AC-310,488 + atrazine	1.5 + 0.1 + 1.0	81	93	65	78	6	0	22
Pendimethalin + AC-310,488 + atrazine	1.5 + 0.1 + 0.5	83	88	63	65	9	0	9
Pendimethalin + atrazine	1.5 + 2.0	81	94	66	76	0	0	39
Acetochlor	2.3	94	93	90	93	4	0	32
Acetochlor	1.9	89	88	84	88	5	0	14
Alachlor WDG[d]	3.0	92	81	63	86	4	0	13
Alachlor EC[e]	3.0	91	81	68	86	0	0	8
Weedy check		--	--	--	--	-	-	7
Weedfree check		--	--	--	--	-	-	185
LSD (0.05)		10	7	14	ns	ns	ns	29

[a] Stand = stand reduction.
[b] metolachlor & safener (CGA-154281).
[c] Premix.
[d] WDG = water dispersible granule.
[e] EC = emulsifiable concentrate.

Table 2. Waseca postemergence grass control in corn - 1989 (Gunsolus and Lueschen).

		Gift Control	Corn		
			6-22		
Treatment[a]	Rate	6/22	Injury	Stand[b]	Yield
	(lb/A)	(%)			(Bu/A)
Postemergence (June 2)					
DPX-V9360 + surf[c]	0.016 + 0.25%	79	49	0	96
DPX-V9360 + surf	0.031 + 0.25%	83	55	0	124
DPX-V9360 + surf	0.047 + 0.25%	84	58	0	119
DPX-V9360 + surf	0.062 + 0.25%	83	60	0	131
Postemergence (June 16)					
DPX-V9360 + surf	0.016 + 0.25%	30	66	0	63
DPX-V9360 + surf	0.031 + 0.25%	34	66	0	80
DPX-V9360 + surf	0.047 + 0.25%	36	65	0	76
DPX-V9360 + surf	0.062 + 0.25%	33	70	0	76
Weedy check		--	--	--	17
Weedfree check		--	--	--	183
LSD (0.05)		13	7	ns	15

[a] All treatments received a postemergence application of bromoxynil (0.25 lb/A) on June 8.
[b] Stand = stand reduction.
[c] surf = X-77 surfactant from Chevron.

Table 3. Waseca postemergence broadleaf weed control in corn - 1989 (Gunsolus and Lueschen).

		Weed control						Corn		
		6/22			7/3			6/22		
Treatment[a]	Rate	Colq	Corw	Rrpw	Colq	Corw	Rrpw	Injury	Stand[b]	Yield
	(lb/A)				(%)					(Bu/A)
Postemergence (June 8)										
Atrazine + COC[c]	0.5 + 1.25%	97	63	100	--	--	--	24	0	111
Bentazon & atrazine[d] + COC	0.52 & 0.52 + 1.25%	87	83	91	--	--	--	25	0	104
Dicamba	0.25	79	63	61	--	--	--	30	0	104
Dicamba & atrazine[e]	0.27 & 0.51	98	95	96	--	--	--	23	0	119
Bromoxynil	0.25	100	83	94	--	--	--	23	0	95
Bromoxynil + atrazine	0.25 + 0.5	100	100	100	--	--	--	21	0	132
2,4-D dimethylamine	0.25	70	53	53	--	--	--	29	0	101
2,4-D dimethylamine + dicamba	0.125 + 0.25	76	75	74	--	--	--	24	0	107
Pyridate	0.94	88	59	100	--	--	--	24	0	113
Pyridate + atrazine	0.47 + 0.6	97	63	100	--	--	--	23	0	123
Pyridate + atrazine + COC	0.47 + 0.6 + 1.25%	100	74	100	--	--	--	21	0	127
Pyridate + cyanazine	0.47 + 0.6	93	96	96	--	--	--	26	0	132
Clopyralid & 2,4-D amine[f]	0.05 & 0.25	73	59	51	--	--	--	26	0	104
Clopyralid & 2,4-D amine	0.09 & 0.5	74	79	70	--	--	--	26	0	110
Bromoxynil + metribuzin	0.25 + 0.125	100	98	100	--	--	--	29	0	118
Postemergence (June 19)										
Atrazine + COC	0.5 + 1.25%	--	--	--	86	59	78	30	0	91
Bentazon & atrazine + COC	0.52 & 0.52 + 1.25%	--	--	--	96	89	89	26	0	92
Dicamba	0.25	--	--	--	88	91	63	32	0	94
Dicamba & atrazine	0.27 & 0.51	--	--	--	96	95	95	35	0	93
Bromoxynil	0.25	--	--	--	98	98	50	24	0	84
Bromoxynil + atrazine	0.25 + 0.5	--	--	--	98	98	92	31	0	98
2,4-D dimethylamine	0.25	--	--	--	60	70	48	25	0	93
2,4-D dimethylamine + dicamba	0.125 + 0.25	--	--	--	90	91	75	26	0	97
Pyridate	0.94	--	--	--	51	56	93	31	0	92
Pyridate + atrazine	0.47 + 0.6	--	--	--	98	76	98	30	0	103
Pyridate + atrazine + COC	0.47 + 0.6 + 1.25%	--	--	--	97	82	99	30	0	102
Clopyralid & 2,4-D amine	0.05 & 0.25	--	--	--	79	90	62	29	0	89
Clopyralid & 2,4-D amine	0.09 & 0.5	--	--	--	95	96	66	30	0	112
Bromoxynil + metribuzin	0.25 + 0.125	--	--	--	99	97	50	21	0	110
Weedy check		--	--	--	--	--	--	--	-	65
Weedfree check		--	--	--	--	--	--	--	-	174
LSD (0.05)		18	20	20	12	15	24	ns	ns	24

[a] All treatments received a preemergence application of propachlor (4 lb/A) on May 11.

[b] Stand = stand reduction.

[c] COC = Class 17% crop oil concentrate.

[d] Premix = Laddok.

[e] Premix = Marksman.

[f] Premix = Curtail.

DISSIPATION AND MOVEMENT OF ATRAZINE AND ALACHLOR IN TWO MINNESOTA SOILS. Brent Sorenson, Donald Wyse, William Koskinen, William Lueschen, Gyles Randall, James Anderson and Douglas Buhler, Graduate Research Assistant, Professor, Soil Scientist, Professor, Professor, Associate Professor and Research Agronomist, Department of Agronomy and Plant Genetics, U.S. Department of Agriculture, Agricultural Research Service, Soil Science Department, University of Minnesota, St. Paul, MN 55108.

ABSTRACT

Atrazine and alachlor are the herbicides most commonly detected in Minnesota groundwater. Studies were initiated in 1986 to determine the effect of tillage practice on dissipation and movement of atrazine and alachlor under continuous corn in two Minnesota soils (Port Byron silt loam at Rochester and Webster clay loam at Waseca). No-tillage, ridge-tillage, reduced tillage (chisel plow), and conventional tillage (moldboard plow) plots were established during 1986. Primary tillage was conducted in the fall and secondary tillage was completed just prior to corn planting. Yearly applications of atrazine (2.0 lb/A) and alachlor (3.0 lb/A) were made beginning in 1987. Soil samples were taken to a depth of 90 cm immediately after application and five times throughout each growing season using a "zero-contamination" sampling tube with acetate liners. In 1987 there was no effect of tillage on movement and dissipation of either herbicide. This appears to be due to the fact that the tillage practices had not been in place long enough to affect soil properties. Calculated atrazine and alachlor half-lives ($T_{1/2}$) in the silt loam soil were 6 to 7 weeks and 2 weeks, respectively. In the silt loam soil, under conventional tillage atrazine and alachlor were detected at the 60 to 75 cm depth (18 ng/g) and 75 to 90 cm depth (10 ng/g) 10 weeks after 1987 application. Following 1988 application, residual atrazine and alachlor concentrations were 10 ng/g in the 75 to 90 cm depth. Alachlor in the clay loam soil, in contrast to the silt loam soil, had a $T_{1/2}$ of 4 to 6 weeks. In the clay loam soil under conventional tillage alachlor was detected at the 75 to 90 cm depth (< 5 ng/g) 18 weeks after application. Following 1988 application, residual alachlor concentration was 30 ng/g in the 75 to 90 cm depth. Concentrations of residual atrazine and alachlor in both soils at all depths decreased during the second year, apparently due to degradation. Concentrations were not reduced due to leaching because there was insufficient rainfall to move the compounds to lower depths. This research will be continued to evaluate degradation and leaching with continuous use and under varying environmental conditions.

Wild proso millet control in corn, 1989. Lueschen, William E., Thomas R. Hoverstad and Jeffrey L. Gunsolus. The objectives of this study were to evaluate preplant incorporated EPTC plus dichlormid, with and without dietholate, applied alone or in combination with preemergence or postemergence treatments, and to evaluate the effects of time and rate of application of DPX-V9360 and DPX-V9360 + DPX-E9636 on control of wild proso millet in corn. A randomized complete block design with three replications and a plot size of 10 by 25 ft was used. This study was conducted on a Webster clay loam soil containing 5.8% organic matter with a pH of 7.6 and soil test P and K levels of 21 and 255 lb/A, respectively. This site was seeded to a cover crop of oats in 1988 and was heavily infested with wild proso millet. The experimental site was disked in the fall of 1988. In the spring prior to applying any herbicide treatments, 150 lb N/A was applied as ammonium nitrate and was incorporated with a disk. Following the application of the preplant incorporated EPTC treatments, the entire experimental area was disked once to a depth of 3 to 4 inches. The metolachlor preplant incorporated treatment was then applied and the area was again disked to a depth of 3 to 4 inches. The disk was a tandem finishing disk equipped with a three-bar mulcher. Pioneer '3790' single cross hybrid seed corn was planted on May 15, 1989 at a seeding rate of 27,700 seeds/A. The entire experimental area was treated postemergence with 0.25 lb/A bromoxynil on June 1, 1989 for broadleaf weed control. None of the plots were cultivated. Rainfall for May and June of 1989 was below normal however, sufficient rainfall was received after planting for good seed germination and herbicide activation. Plots were evaluated for weed control and crop injury but no yield data was obtained. All treatments were applied with a motorized bicycle sprayer delivering 20 gpa at 32 psi. The sprayer was equipped with 8002 flat-fan nozzles spaced 15 inches apart on the boom. Application dates, environmental conditions, plant sizes and rainfall data are listed below:

Date	May 15	May 16	May 22	June 2	June 1	June 20
Treatment	PPI	Pre	Delayed Pre	E. Post	Post	L. Post
Temperature (F)						
air	75	84	77	78	67	90
soil (4 inch)	67	66	71	73	72	82
Relative Humidity (%)	45	50	50	50	45	30
Wind (mph)	NE 10	SE 10	SW 10	N 10	NW 5	S 20
Soil moisture	medium	medium	medium	medium	medium	medium
Corn						
leaf no.	--	--	--	2	4	5-6
height (inch)	--	--	--	3-4	6-7	12-14
Wild proso millet						
leaf no.	--	--	--	1-2	2-5	6
height (inch)	--	--	--	0.5-1.5	1-4	6-8
infestation	--	--	--	--	--	238/ft^2
Rainfall after application (inch)						
1 week	1.8	1.8	0.3	0.1	0.8	1.1
2 week	0.3	0.3	0.1	1.4	1.1	--
3 week	0.1	0.1	0.2	0.0	--	--

Results from this study are presented in the accompanying table. Preplant EPTC + dichlormid, EPTC + dichlormid + dietholate, or EPTC + dichlormid + cyanazine provided fair to poor control of wild proso millet. Preplant EPTC + dichlormid + dietholate followed by preemergence alachlor or metolachlor resulted in approximately 90% control of wild proso millet by June 7 but only 60% control by July 6. Preplant incorporated metolachlor at 2 lb/A followed by preemergence metolachlor at 2 lb/A provided 79% control of wild proso millet by June 7 but only 57% by July 6. Preemergence alachlor at 4 lb/A followed by an additional 2 lb/A delayed preemergence provided 89% control of wild proso millet by June 7 and 77% control by July 6. Following preplant incorporated EPTC + dichlormid + dietholate at 6 lb/A with early postemergence applications of cyanazine at 2 lb/A alone, cyanazine with vegetable oil at 1.25% v/v, pendimethalin at 1.5 lb/A or DPX-V9360 at 0.031 lb/A + surfactant did control wild proso millet as well as cyanazine at 2 lb/A + tridiphane at 0.75 lb/A, especially when rated July 6. DPX-V9360 + X-77 applied at the two-leaf, four-leaf or six-leaf stage provided poor control of wild proso millet regardless of rate of application. Performance of DPX-V9360 + DPX-E9636 was similar to DPX-V9360 for each stage of application. The addition of 28%N at a rate of 5% v/v increased control of wild proso millet with either DPX-V9360 or DPX-V9360 + DPX-E9636 however, the increase was not statistically significant. Corn injury from later applications of DPX-V9360 and DPX-V9360 + DPX-E9636 was primarily stunting attributed to the competition from wild proso millet and dry weather. (MN Agric. Exp. Sta. Paper No. 17,538; Misc. Journ. Series, University of Minnesota, St. Paul).

Table. Wild proso millet control in corn, 1989 (Lueschen, Hoverstad and Gunsolus).

Herbicide Treatment[a]	Rate	Injury[b]			Wild Proso Millet		
		6/7	6/21	7/6	6/7	6/21	7/6
	lb/A or %	---------%--------			-----%Control-----		
Preplant Incorporated 2X: May 16							
EPTC+dichlormid	6	1	1	3	66	58	33
EPTC+dichlormid+dietholate	6	2	4	10	60	33	23
EPTC+dichlormid+cyanazine	5+2.2	3	2	3	75	67	45
Preplant Incorporate 2X/Preemergence: May 15/May 16							
EPTC+dichlormid+dietholate/ alachlor	6/ 3	1	3	0	90	78	59
EPTC+dichlormid+dietholate/ metolachlor	6/ 2.5	4	2	0	86	78	64
Preplant Incorporated 1X/Preemergence: May 15/May 16							
Metolachlor/ metolachlor	2/ 2	1	1	2	79	67	57
Preemergence/Delayed Preemergence: May 16/May 22							
Alachlor/ alachlor	4/ 2	2	1	0	89	86	77
ICI A5676	2.5	2	1	3	89	82	68
Preplant Incorporated EPTC+Dichlormid+Dietholate (6 lb/A)/Early Postemergence: May 16/June 2							
Cyanazine	2	1	2	2	76	71	53
Cyanazine+Veg oil	2+1.25%	16	21	17	86	71	42
Cyanazine+pendimethalin	2+1.5	18	11	5	89	80	63
Cyanazine+tridiphane	2+0.75	5	2	0	91	89	85
DPX-V9360+Surf	0.031+0.25%	2	3	3	74	72	45
Early Postemergence: June 2							
DPX-V9360+Surf	0.016+0.25%	2	5	18	23	45	23
DPX-V9360+Surf	0.031+0.25%	2	2	3	40	67	48
DPX-V9360+Surf+28%N	0.031+0.25%+5%	1	3	0	42	79	60
DPX-V9360+Surf	0.047+0.25%	2	2	8	43	66	38
DPX-V9360+Surf	0.062+0.25%	2	1	7	40	67	53
DPX-V9360+DPX-E9636+Surf	0.016+0.016+0.25%	2	2	2	48	73	55
DPX-V9360+DPX-E9636+Surf	0.024+0.024+0.25%	1	4	3	43	75	65
DPX-V9360+DPX-E9636+ Surf+28%N	0.024+0.024+ 0.25%+5%	2	1	0	32	79	70
DPX-V9360+DPX-E9636+Surf	0.031+0.031+0.25%	1	2	0	33	80	64
Postemergence: June 13							
DPX-V9360+Surf	0.016+0.25%	2	4	15	8	63	43
DPX-V9360+Surf	0.031+0.25%	1	3	3	7	62	65
DPX-V9360+Surf+28%N	0.031+0.25%+5%	1	4	5	18	67	76
DPX-V9360+COC	0.031+1.25%	2	5	15	13	61	60
DPX-V9360+Surf	0.047+0.25%	1	4	12	8	57	67
DPX-V9360+Surf	0.062+0.25%	1	5	15	17	62	73
DPX-V9360+DPX-E9636+Surf	0.016+0.016+0.25%	2	5	18	5	52	66
DPX-V9360+DPX-E9636+Surf	0.024+0.024+0.25%	1	7	13	7	55	74
DPX-V9360+DPX-E9636+ Surf+28%N	0.024+0.024+ 0.25%+5%	1	1	5	8	62	88
DPX-V9360+DPX-E9636+COC	0.024+0.024+1.25%	2	6	13	8	58	73
DPX-V9360+DPX-E9636+Surf	0.031+0.031+0.25%	2	3	7	10	67	86

(continued)

Table. Wild proso millet control in corn, 1989 (Lueschen, Hoverstad and Gunsolus), continued.

Herbicide Treatment[a]	Rate	Injury[b]			Wild Proso Millet		
		6/7	6/21	7/6	6/7	6/21	7/6
	lb/A or %	----------	%--------		-----	%Control	-----
Early Postemergence/Postemergence: June 2/June 13							
Cyanazine+tridiphane/	2+0.75	5	8	0	64	83	72
atrazine+COC	2+1.25						
Late Postemergence: June 20							
DPX-V9360+Surf	0.016+0.25%	1	3	26	8	20	57
DPX-V9360+Surf	0.031+0.25%	1	4	28	13	0	69
DPX-V9360+Surf	0.047+0.25%	1	2	13	13	2	67
DPX-V9360+Surf	0.062+0.25%	12	2	18	12	0	68
Weedy check		1	3	25	0	0	0
Hand-weeded		1	1	5	100	100	100
	BLSD 0.05	3	4	10	13	14	14

[a] Surf = Orthox X-77 nonionic surfactant, Veg oil = vegetable oil with 93% oil and 7% surfactant. COC = paraffin based crop oil concentrate with 83% oil and 17% surfactant and 28%N = 28% aqueous solution of urea and ammonium nitrate.

[b] Injury - most of the injury by July 6 was due to moisture stress on the crop due to heavy weed pressure and very dry conditions. The exception was cyanazine + vegetable oil which caused significant corn stunting.

Woolly cupgrass control in corn, 1989. Lueschen, William E., Thomas R. Hoverstad and Jeffrey L. Gunsolus. The objectives of this study were to evaluate preplant incorporated EPTC plus dichlormid, with and without dietholate, applied alone or in combination with preemergence or postemergence treatments and to evaluate the effects of time and rate of application of DPX-V9360 and DPX-V9360 + DPX-E9636 on control of woolly cupgrass in corn. A randomized complete block design with three replications and a plot size of 10 by 25 ft was used. This study was conducted on a Hayden loam soil containing 2.6% organic matter with a pH of 5.9 and soil test P and K levels of 75 and 273 lb/A, respectively. This site was seeded to a cover crop of oats in 1988 and was heavily infested with woolly cupgrass. The experimental site was not tilled in the fall of 1988. Prior to applying any herbicide treatments, 150 lb N/A was applied as ammonium nitrate and was incorporated once with a disk. Following the application of the preplant incorporated EPTC treatments, the entire experimental area was disked once to a depth of 3 to 4 inches. The metolachlor preplant treatment was then applied and the site was again disked to a depth of 3 to 4 inches at a right angle to the first disking. The disk was a tandem finishing disk equipped with a three-bar mulcher. Pioneer '3790' single cross hybrid seed corn was planted on May 16, 1989 at a seeding rate of 27,700 seeds/A. The entire experimental area was treated postemergence with 0.25 lb/A of bromoxynil on June 1, 1989 for broadleaf weed control. None of the plots were cultivated. Rainfall for May and June of 1989 was below normal but adequate moisture was received to give good crop emergence and good preemergence herbicide activation. Plots were evaluated for weed control and crop injury but no yield data was obtained. All treatments were applied with a motorized bicycle sprayer calibrated to deliver 20 gpa at 32 psi. The sprayer was equipped with 8002 flat-fan nozzles spaced 15 inches apart on the boom. Application dates, environmental conditions, plant sizes and rainfall data are listed below:

Dates	May 16	May 22	June 2	June 13	June 20
Treatment	PPI and Pre	Delayed Pre	E. Post	Post	L. Post
Temperature (F)					
air	84	74	78	62	83
soil (4 inch)	66	66	67	60	77
Relative Humidity (%)	45	50	40	45	45
Wind (mph)	SE 10-15	SW 10	NW 0-5	NW 0-5	S 20
Soil moisture	medium	medium	medium	medium	medium
Corn					
leaf no.	--	--	1-2	3-4	5
height (inch)	--	--	3	6	8-10
Woolly cupgrass					
leaf no.	--	--	1-2	2-5	5-6
height (inch)	--	--	0.5-1	1-4	6
infestation	--	--	--	--	135/ft^2
Rainfall after application (inch)					
1 week	1.2	0.8	0.4	0.8	1.1
2 week	0.4	0.0	1.4	1.1	0.0
3 week	0.0	0.6	0.0	0.0	0.3

Results from this study are presented in the accompanying table. Preplant EPTC + dichlormid, EPTC + dichlormid + dietholate, or EPTC + dichlormid + cyanazine provided more than 90% control of woolly cupgrass by June 7. Control with these treatments was reduced to 75 to 83% by July 6. Preplant EPTC + dichlormid + dietholate followed by preemergence alachlor or metolachlor resulted in nearly complete and longer term control of woolly cupgrass. Preplant metolachlor at 2 lb/A followed by preemergence metolachlor at 2 lb/A, or preemergence alachlor at 4 lb/A followed by an additional 2 lb/A delayed preemergence provided 90 to 98% control of woolly cupgrass. Following preplant EPTC + dichlormid + dietholate with early postemergence applications of cyanazine at 2 lb/A alone or with vegetable oil at 1.25% v/v, pendimethalin at 1.5 lb/A, or tridiphane at 0.75 lb/A resulted in 92% to 97% control of woolly cupgrass. The cyanazine + vegetable oil caused significant corn injury in the form of chlorosis and stunting. DPX-V9360 + X-77 applied at the two-leaf stage provided better control of woolly cupgrass than the later stage of application. There was little difference in control among the rates of DPX-V9360; addition of 28%N solution significantly improved control of woolly cupgrass. DPX-V9360 + DPX-E9636 compared favorably with DPX-V9360. Corn injury from later applications of DPX-V9360 and DPX-V9360 + DPX-E9636 was primarily stunting of corn attributed to the early season competition from woolly cupgrass and relatively dry conditions. (MN Agric. Exp. Sta. Paper No. 17,541; Misc. Journ. Series, University of Minnesota, St. Paul).

Table. Woolly cupgrass control in corn, 1989 (Lueschen, Hoverstad and Gunsolus).

		Injury[b]			Woolly Cupgrass		
Herbicide Treatment[a]	Rate	6/7	6/21	7/6	6/7	6/21	7/6
	lb/A or %	--------%--------			----%Control----		
Preplant Incorporated 2X: May 16							
EPTC + dichlormid	6	2	3	0	91	88	75
EPTC + dichlormid + dietholate	6	2	3	3	93	91	83
EPTC + dichlormid + cyanazine	5+2.2	2	4	0	94	93	83
Preplant Incorporated 2X/Preemergence: May 16/May 16							
EPTC + dichlormid + dietholate/ alachlor	6 3	2	2	5	99	98	93
EPTC + dichlormid + dietholate/ metolachlor	6 2.5	1	3	0	99	98	97
Preplant Incorporated 1X/Preemergence: May 16/May 16							
Metolachlor/ metolachlor	2 2	5	7	0	98	91	89
Preemergence/Delayed Preemergence: May 16/May 22							
Alachlor/ alachlor	4 2	3	3	0	97	94	90
Preemergence: May 16							
ICI A5676	2.5	5	2	0	94	89	84
Preplant Incorporated EPTC + Dichlormid + Dietholate (6 lb/A)/Early Postemergence: May 16/June 2							
Cyanazine	2	2	1	0	93	96	92
Cyanazine + Veg oil	2 + 1.25%	18	32	22	97	99	97
Cyanazine + pendimethalin	2 + 1.5	12	7	3	93	96	92
Cyanazine + tridiphane	2 + 0.75	1	6	3	95	98	96
DPX-V9360 + Surf	0.031 + 0.25%	2	1	0	94	95	92
Early Postemergence: June 2							
DPX-V9360 + Surf	0.016 + 0.25%	4	2	0	53	79	67
DPX-V9360 + Surf	0.031 + 0.25%	3	3	3	55	78	65
DPX-V9360 + Surf + 28%N	0.031 + 0.25% + 5%	4	5	0	61	89	85
DPX-V9360 + Surf	0.047 + 0.25%	8	3	3	66	84	71
DPX-V9360 + Surf	0.062 + 0.25%	4	2	0	53	85	76
DPX-V9360 + DPX-E9636 + Surf	0.016 + 0.016 + 0.25%	5	4	3	63	80	62
DPX-V9360 + DPX-E9636 + Surf	0.024 + 0.024 + 0.25%	6	3	0	72	88	77
DPX-V9360 + DPX-E9636 + Surf + 28%N	0.024 + 0.024 + 0.25% + 5%	4	5	0	74	87	80
DPX-V9360 + DPX-E9636 + Surf	0.031 + 0.031 + 0.25%	3	2	3	68	90	78
Postemergence: June 13							
DPX-V9360 + Surf	0.016 + 0.25%	3	3	27	0	47	20
DPX-V9360 + Surf	0.031 + 0.25%	2	3	22	0	52	50
DPX-V9360 + Surf + 28%N	0.031 + 0.25% + 5%	5	9	17	0	63	75
DPX-V9360 + COC	0.031 + 1.25%	3	4	30	0	57	42
DPX-V9360 + Surf	0.047 + 0.25%	2	3	23	0	53	57
DPX-V9360 + Surf	0.062 + 0.25%	3	4	20	0	50	67
DPX-V9360 + DPX-E9636 + Surf	0.016 + 0.016 + 0.25%	1	4	17	0	55	53

(continued)

Table. Woolly cupgrass control in corn, 1989 (Lueschen, Hoverstad and Gunsolus) continued.

Herbicide Treatment[a]	Rate	Injury[b]			Woolly Cupgrass		
		6/7	6/21	7/6	6/7	6/21	7/6
	lb/A or %	--------%	--------		----%Control	----	
DPX-V9360 + DPX-E9636 + Surf	0.024 + 0.024 + 0.25%	7	5	13	0	62	58
DPX-V9360 + DPX-E9636 + Surf + 28%N	0.024 + 0.024 0.25% + 5%	2	8	20	0	71	86
DPX-V9360 + DPX-E9636 + COC	0.024 + 0.024 + 1.25%	3	7	28	0	61	55
DPX-V9360 + DPX-E9636 + Surf	0.031 + 0.031 + 0.25%	2	3	22	0	57	50
Early Postemergence/Postemergence: June 2/June 13							
Cyanazine + tridiphane/ atrazine + COC	2 + 0.75 2 + 1.25%	5	14	5	80	93	88
Late Postemergence: June 20							
DPX-V9360 + Surf	0.016 + 0.25%	5	7	35	0	3	65
DPX-V9360 + Surf	0.031 + 0.25%	1	2	37	0	0	57
DPX-V9360 + Surf	0.047 + 0.25%	2	4	35	0	0	71
DPX-V9360 + Surf	0.062 + 0.25%	5	3	37	0	0	67
Weedy check		6	4	47	0	0	0
Hand-weeded (EPTC + dichlormid 6 lb/A)		0	2	0	100	100	100
	BLSD 0.05	4	4	10	8	7	13

[a] Surf = Ortho X-77 nonionic surfactant, Veg oil = vegetable oil with 93% oil and 7% surfactant; COC = Cenex/Land O Lakes Class additive, a paraffin base crop oil concentrate with 83% oil and 17% surfactant; and 28%N = 28% aqueous solution of urea and ammonium nitrate.

[b] Injury - most of the injury on 7/6 was due to moisture stress on the crop due to heavy weed pressure and very dry conditions. The exception was the cyanazine + Veg oil treatment which caused significant stunting of the corn.

Effects of a seed-applied safener on corn injury from clomazone, imazaquin and imazethapyr. Lueschen, William E., Jeffery L. Gunsolus and Thomas R. Hoverstad. The objective of this study was to investigate the effects of a seed-applied safener on corn injury from preplant incorporated applications of imazaquin, imazethapyr and clomazone. The experimental design was a randomized complete block with four replications arranged in a split-split plot with sub-subplots 10 by 50 ft. Main plots were herbicide treatments, subplots were two corn hybrids and sub-subplots were two seed treatments. This study was conducted on a Webster clay loam soil containing approximately 7% organic matter with a pH of 7 and soil test P and K levels of 70 and 430 lb/A, respectively. The previous crop was soybeans and the site was chisel plowed in the fall of 1988. Anhydrous ammonia was applied at the rate of 140 lb N/A in the fall of 1988. Prior to applying the herbicide treatments the site was tilled once with a field cultivator. All herbicide treatments were applied on May 10, 1989 and were incorporated once with a field cultivator set to till 4 inches deep. At this time the air temperature was 75 F with 50% relative humidity with south westerly winds at 5 mph. The soil temperature at 4 inches deep was 65 F and the soil moisture level was ideal for tillage. The entire research area was treated preemergence with alachlor at 3.5 lb/A and was cultivated once and hand-weeded to remove all weeds. Two corn hybrids, Cargill '3477' and Pioneer '3737' were planted at approximately 27,500 viable seed/A. No insecticide was applied to any of the plots in this trial. Naphthalic anhydride seed treatment, FMC Corp. F-80 seed treatment, was applied to the seed at a rate of 0.5% w/w. The Cargill hybrid was treated with a slurry of F-80 and the Pioneer hybrid was treated with dry seed treatment. No problems were encountered with planting either hybrid. A John Deere model 7100 planter was used. After planting, an area 20 by 5 ft was randomly selected in each plot and this area was used to monitor plant population. We also marked leaves on 10 plants and staged these plants and measured height of the unextended leaves during the period of May 23 through July 14, 1989. Only part of this data, consisting of the average of 10 plants/plot, is presented in this report.

Stand counts earlier in the season did not show significant stand loss for any of the herbicide treatments. However, when evaluated on June 7, 1989, clomazone at either 0.62 or 1.25 lb/A resulted in significant corn stand loss for both corn hybrids when the seed safener was not applied to the seed. Imazaquin or imazethapyr did not affect corn populations at any time during the season regardless of seed treatment. Clomazone injury, in the form of white leaf tissue, was observed as the corn plants emerged from the soil with both rates of application. These symptoms persisted through the June 23, 1989 evaluations. The presence of the seed safener reduced Clomazone injury by 50% or more at all evaluation dates. Clomazone reduced plant height throughout the growing season even where the seed safener was applied. However, the safener reduced the effects of clomazone on plant height. Stunted plants due to imazaquin or imazethapyr were not observed until June 9, 1989. At this time soil moisture was limited and moisture stress was observed on all treatments, including the atrazine control plots. Corn injury from imazaquin or imazethapyr was decreased when the seed safener was used. Corn yields were equal to the atrazine check for all herbicide treatments where the seed safener was used with the exception of Cargill 3477 planted on plots treated with 0.016 lb/A of imazethapyr. For all clomazone and imazaquin treatments corn yields were significantly higher where the seed safener was used. Corn injury was not as severe with imazethapyr as with imazaquin and less yield response to the seed safener was observed. There were several significant hybrid x herbicide treatment interactions for the parameters evaluated. For all parameters evaluated Pioneer 3737 was more susceptible to clomazone injury but less susceptible to injury from imazaquin and imazethapyr than Cargill 3477. Both hybrids gave similar response to the seed treatment. (MN Agric. Exp. Sta. Paper No. 17,535; Misc. Journ. Series, University of Minnesota, St. Paul).

Table. Effects of a seed-applied safener on corn injury from clomazone, imazaquin and imazethapyr (Lueschen, Gunsolus and Hoverstad).

Treatment[a]	Rate	Hybrid[b]	Seed Trt[c]	Corn injury			Plant height[d]					Plant pop.			Tassel[e]		Silk[e]		Grain	
				5/25	6/9	6/23	5/23	6/7	6/21	6/28	7/14	5/23	5/30	6/7	7/19	7/21	7/19	7/21	Yield	H$_2$O
	lb/A			------%------			---------inches--------					---1000's/A--			----------%---------				bu/A	-%-
Atrazine	1.5	P3737	-	0	11	18	3.0	5.8	12	21	57	24.0	25.3	26.1	10	48	0	22	166	21.1
Atrazine	1.5	P3737	+	2	10	12	2.7	5.8	13	24	65	26.1	27.9	27.4	10	85	0	38	160	20.5
Atrazine	1.5	C3477	-	0	6	12	3.2	6.0	14	25	71	25.3	27.0	26.1	88	100	60	88	155	21.1
Atrazine	1.5	C3477	+	0	6	12	2.9	6.1	14	26	74	27.9	28.3	28.3	70	95	60	75	164	20.9
Clomazone+Atra	1.25+1.25	P3737	-	85	80	78	2.6	3.8	9	17	53	25.3	25.7	7.8	10	50	0	15	74	23.6
Clomazone+Atra	1.25+1.25	P3737	+	39	40	40	2.5	4.2	10	20	54	26.6	27.4	25.7	8	42	0	10	169	22.2
Clomazone+Atra	1.25+1.25	C3477	-	56	55	49	2.8	4.8	12	23	70	24.8	25.3	14.4	82	92	55	85	121	20.8
Clomazone+Atra	1.25+1.25	C3477	+	24	17	25	2.9	5.2	12	21	68	26.6	27.0	25.7	80	100	52	80	169	21.3
Clomazone+Atra	0.62+1.25	P3737	-	59	54	46	2.5	4.6	11	21	58	26.6	27.0	20.0	8	50	0	18	157	21.6
Clomazone+Atra	0.62+1.25	P3737	+	14	18	16	2.8	5.4	12	23	61	26.6	27.4	27.4	10	60	0	20	173	21.3
Clomazone+Atra	0.62+1.25	C3477	-	36	36	32	3.0	4.8	12	23	72	25.3	25.7	20.9	78	92	68	85	152	20.6
Clomazone+Atra	0.62+1.25	C3477	+	11	11	19	2.8	5.4	12	24	72	25.3	27.0	26.1	78	98	52	80	166	21.7
Imazethapyr	0.016	P3737	-	0	6	8	3.3	5.8	13	23	60	27.0	27.9	27.0	12	75	0	28	170	20.4
Imazethapyr	0.016	P3737	+	0	4	10	2.5	5.5	13	23	65	27.0	27.9	27.9	8	62	0	15	172	19.6
Imazethapyr	0.016	C3477	-	0	11	17	3.0	5.6	13	25	74	25.3	25.3	25.3	80	92	52	80	166	21.1
Imazethapyr	0.016	C3477	+	0	8	11	3.0	5.6	13	25	73	25.3	26.6	26.6	80	100	42	82	149	21.6
Imazethapyr	0.031	P3737	-	0	15	19	3.2	5.9	13	23	62	27.9	27.9	27.4	10	70	0	35	165	20.4
Imazethapyr	0.031	P3737	+	0	8	11	2.8	5.4	13	23	63	28.7	28.7	27.0	22	55	12	28	179	20.2
Imazethapyr	0.031	C3477	-	0	14	24	3.4	5.6	12	24	71	24.8	25.7	25.3	80	92	50	80	155	21.3
Imazethapyr	0.031	C3477	+	0	6	13	3.0	5.6	13	25	72	27.9	28.7	28.3	80	98	42	80	158	21.4
Imazaquin	0.031	P3737	-	0	22	29	3.0	5.0	11	21	56	27.9	28.7	28.3	10	65	0	20	161	21.1
Imazaquin	0.031	P3737	+	0	11	18	2.8	5.5	12	23	61	26.6	27.9	27.4	28	62	8	30	171	21.9
Imazaquin	0.031	C3477	-	0	31	37	2.9	5.4	11	21	63	26.1	26.1	26.1	75	95	40	82	146	21.4
Imazaquin	0.031	C3477	+	8	16	24	2.9	5.6	12	22	68	24.0	25.7	26.1	72	90	40	78	156	21.9
Average for herbicide treatments:																				
Atrazine	1.5			1	8	14	3.0	5.9	13	24	67	25.8	27.1	27.0	45	82	30	56	161	20.9
Clomazone+Atra	1.25+1.25			51	48	48	2.7	4.5	11	20	61	25.8	26.4	18.4	45	71	27	48	133	22.0
Clomazone+Atra	0.62+1.25			30	30	28	2.8	5.1	12	23	66	26.0	26.8	23.6	44	75	30	51	162	21.3
Imazethapyr	0.016			0	7	12	3.0	5.6	13	24	68	26.2	26.9	26.7	45	82	24	51	165	20.7
Imazethapyr	0.031			0	11	17	3.1	5.6	13	24	67	27.3	27.8	27.0	48	79	26	56	164	20.8
Imazaquin	0.031			2	20	27	2.9	5.4	12	22	62	26.2	27.1	27.0	46	78	22	53	159	21.6
		BLSD (0.05)		5	8	8	0.2	0.4	1	1	4	1.4	1.2	2.4	13	12	16	16	9	0.6
Average for hybrids:																				
		Pioneer 3737		17	23	25	2.8	5.2	12	22	60	26.7	27.5	25.0	12	60	2	23	160	21.2
		Cargill 3477		11	18	23	3.0	5.5	13	24	71	25.7	26.5	24.9	79	95	51	81	155	21.3
Level of significance (P > F)				0.01	0.11	0.31	0.01	0.06	0.05	0.01	0.01	0.08	0.05	0.98	0.01	0.01	0.01	0.01	0.06	0.73
Average for seed treatments:																				
		Control		20	28	31	3.0	5.3	12	22	64	25.9	26.5	22.9	45	77	27	53	149	21.2
		F-80		8	13	18	2.8	5.4	13	23	66	26.6	27.5	27.0	46	79	26	51	166	21.2
Level of significance (P > F)				0.01	0.01	0.01	0.01	0.10	0.02	0.01	0.64	0.08	0.01	0.01	0.95	0.55	0.79	0.68	0.01	0.98
Interactions (P > F):																				
Herbicide x hybrid				0.01	0.09	0.02	0.09	0.23	0.35	0.13	0.05	0.40	0.43	0.15	0.68	0.48	0.25	0.58	0.01	0.01
Herbicide x seed treatment				0.01	0.01	0.01	0.12	0.15	0.89	0.81	0.62	0.04	0.16	0.01	0.80	0.47	0.98	0.99	0.01	0.46
Hybrid x seed treatment				0.04	0.82	0.36	0.31	0.71	0.40	0.31	0.18	0.70	0.56	0.62	0.29	0.91	0.32	0.61	0.04	0.03

[a] Herbicide formulation = Atra = atrazine = Aatrex 90DF, clomazone = Command 4E, imazaquin = Scepter 1.5L and imazethapyr = Pursuit 2L.

[b] Hybrid = P3737 = Pioneer 3737 and C3477 = Cargill 3477.

[c] Seed Trt = (-) = no seed treatment other than normal seed treatment and (+) = treated with FMC Corp. F-80 Naphthalic anhydride seed treatment at a rate of 0.5% w/w.

[d] Plant height = average height of unextended leaves of 40 plants/treatment.

[e] Tassel = % of the plants with the center axis of tassel shedding pollen. Silk = % of plants with silks emerged.

[f] Yield = bu/A corrected to 15.5% grain moisture.

Effects of rate of DPX-V9360 and terbufos insecticide on injury to field corn and sweet corn at Waseca, MN in 1989. Lueschen, William E., Vincent A. Fritz and Thomas R. Hoverstad. This study was conducted as a cooperative project with Dr. Gordon Harvey from the University of Wisconsin and Dr. James Kells from Michigan State University. The objectives of this study were to investigate the effects of rate of application of DPX-V9360 on injury to both field corn and sweet corn, and to evaluate the possible interaction between DPX-V9360 and terbufos insecticide. A randomized complete block design with four replications and a split-split plot arrangement of treatments was used. Corn type was the main plot, insecticide treatment was the subplot, and rate of DPX-V9360 was the sub-subplot. The data were analyzed as a split-split plot for all parameters except for those associated with yield. Yield components were analyzed separately for each type of corn. Individual plots were 10 by 30 ft and data was collected only on the two center rows of a four row plot. The soil type at the site of this research was a Webster clay loam containing approximately 7% organic matter with a pH of 7 and soil test P and K levels of 70 and 430 lb/A, respectively. The previous crop was soybeans and the site was fall chisel plowed. Anhydrous ammonia was fall applied at the rate of 140 lb N/A. Just prior to planting the site was tilled once with a field cultivator set to till 4 inches deep. Planting of both types of corn was done on May 11, 1989. Seeding rates for 'Jubilee' sweet corn and Pioneer '3751' field corn were 24,000 and 27,700 viable seeds/A, respectively. Planting depth was 1.5 to 2 inches. The terbufos was applied at planting as an in-furrow treatment with the delivery tubes set to direct the insecticide into the seed furrow before it closed. The entire experimental site was treated with metolachlor + atrazine at 3 + 3 lb/A as a preplant incorporated treatment; incorporation was done with a field cultivator set to till 4 inches deep. All of the DPX-V9360 treatments were applied on June 6, 1989 when the air temperature was 87 F and the relative humidity was 45% with westerly winds at 0 to 5 mph. The soil temperature at 4 inches deep was 83 F. At the time of application the field corn was 6 inches tall and had four leaves with the collars visible and the sweet corn was 5 inches tall with four leaves with visible collars. All herbicide treatments included 0.25% v/v nonionic surfactant and 4% v/v 28%N solution and were applied at a spray volume of 20 gpa at 30 psi using flat-fan nozzle tips. All plots were hand-weeded to maintain them in a weed-free condition.

Field corn was very tolerant of DPX-V9360 even at highest rates of application in the presence of terbufos insecticide. Visual injury ratings did not exceed 10% for any evaluation date for field corn and only minor differences were observed in plant height among all of the DPX-V9360 treatments. Likewise, this herbicide did not affect tasseling, silking or grain yield of field corn. Sweet corn was much more susceptible to injury from DPX-V9360 than field corn. Sweet corn injury was observed at the 1 oz/A rate of DPX-V9360 with increased levels of injury that persisted throughout the evaluation period for the two highest rates of application. Injury symptoms included chlorosis, stunting and leaf malformation. In-furrow terbufos insecticide generally resulted in more sweet corn injury for DPX-V9360 as compared to the same rates applied in the absence of the insecticide. When compared to the atrazine check, tasseling and silking of sweet corn was delayed significantly where rates of DPX-V9360 exceeded 1 oz/A. For the highest rates of application tasseling and silking was delayed four to five days. This only delayed sweet corn harvest by one day. DPX-V9360 did not affect plant populations of sweet corn with final stands averaging 20,000 to 23,000 plants/A. There was a trend for reduced sweet corn stands, about 1600 plants/A, where terbufos insecticide was applied but the herbicide x insecticide interaction was not significant for this parameter. The percentage of useable ears of sweet corn and length of ears was reduced at the two highest rates of DPX-V9360 compared to the control. Snapped ear weights and cut corn recovery were also reduced significantly for the two highest rates of application of DPX-V9360 compared to the control. (MN Agric. Exp. Sta. Paper No. 17,533; Misc. Journ. Series, University of Minnesota, St. Paul).

Table 1. Effects of rate of DPX-V9360 and terbufos insecticide on injury to field corn and sweet corn at Waseca, MN in 1989 (Lueschen, Fritz and Hoverstad).

Ins[a]	V-9360[b] Rate	Injury[c]				Plant height[d]					Tasseling[e]			Silking[f]			Yield[g]	Grain H_2O
		6/13	6/20	6/28	7/3	6/13	6/20	6/28	7/3	7/26	7/17	7/19	7/21	7/17	7/19	7/21		
	oz/A	%				inches					%						bu/A	%
Sweet corn																		
-	---	0	4	0	2	8.4	11.3	19	35	86	100	100	100	25	100	100	--	--
-	0.5	6	4	4	3	7.3	10.2	18	34	88	98	100	100	10	95	100	--	--
-	1.0	16	7	4	6	7.4	10.2	19	33	91	100	100	100	15	100	100	--	--
-	2.0	22	15	14	14	6.9	10.5	17	31	88	82	100	100	12	88	100	--	--
-	4.0	20	23	24	22	6.5	8.4	16	27	85	65	82	98	5	72	95	--	--
+	---	5	5	4	8	8.0	10.8	19	33	89	100	100	100	18	100	100	--	--
+	0.5	8	11	6	5	7.1	10.2	19	33	88	98	100	100	18	100	100	--	--
+	1.0	14	16	12	12	6.9	9.6	17	30	88	92	100	100	10	100	100	--	--
+	2.0	18	20	19	19	6.7	8.9	16	29	87	85	100	100	12	100	100	--	--
+	4.0	18	35	34	29	6.3	7.1	14	24	82	42	82	95	2	42	85	--	--
Field corn																		
-	---	0	0	4	4	9.6	13.3	24	42	107	0	38	92	0	12	78	173	18.5
-	0.5	1	1	0	1	9.6	13.8	25	43	105	0	48	98	0	22	82	175	19.4
-	1:0	2	0	4	3	9.6	14.0	25	44	105	0	68	95	0	22	95	186	17.8
-	2.0	3	1	4	2	8.8	13.8	25	45	103	0	78	98	0	35	92	182	17.8
-	4.0	6	0	0	1	8.9	13.3	24	42	105	0	58	100	0	22	88	189	18.5
+	---	2	2	1	0	10.6	14.0	25	43	105	0	60	95	0	22	88	183	18.6
+	0.5	4	1	4	6	8.2	12.9	23	42	103	2	52	92	2	22	75	178	19.4
+	1.0	4	1	1	1	8.5	13.0	24	43	104	2	60	95	1	25	88	186	18.4
+	2.0	6	4	4	5	8.6	12.7	23	41	103	0	52	98	0	22	78	188	18.6
+	4.0	10	4	6	8	8.2	12.8	23	41	103	0	55	92	0	35	78	193	19.1
Average for corn type:																		
Sweet		13	14	12	12	7.2	9.6	17	31	87	86	98	90	13	90	98		
Field		4	1	3	3	9.1	13.4	24	43	104	0	57	24	0	24	84		
Level of sign. (P >F)		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04		
Average for insecticides:																		
-		8	6	6	6	8.3	11.2	20	36	96	45	79	98	7	57	93	181	18.4
+		9	10	9	9	7.9	12.8	21	38	95	42	76	97	6	57	89	186	18.8
Level of sign. (P >F)		0.51	0.01	0.08	0.05	0.01	0.01	0.02	0.01	0.03	0.36	0.23	0.09	0.81	1.0	0.1	0.10	0.11
Average for herbicide rates:																		
	---	2	3	2	4	9.2	12.4	22	38	97	50	75	97	11	59	92	178	18.6
	0.5	5	4	4	4	8.1	12.8	21	38	96	50	75	98	8	60	89	177	19.4
	1.0	9	6	5	6	8.1	11.7	21	37	97	49	82	98	7	62	96	186	18.1
	2.0	12	10	10	10	7.8	11.2	20	36	95	42	83	99	6	61	93	185	18.2
	4.0	14	16	16	15	7.5	10.4	19	33	94	27	73	96	2	43	87	191	18.8
BLSD (0.05)		3	2	3	3	0.4	0.4	0.9	1.3	2	7	12	3	4	12	10	ns	1.0
Interactions (P >F):																		
corn type x insect		0.30	0.03	0.18	0.25	0.21	0.87	0.82	0.20	0.51	0.27	0.67	0.28	0.61	0.51	0.37	--	--
corn type x herb		0.01	0.01	0.01	0.00	0.75	0.01	0.01	0.01	0.02	0.01	0.40	0.33	0.01	0.01	0.56	--	--
insect x herb		0.59	0.13	0.10	0.48	0.02	0.11	0.43	0.35	0.39	0.29	0.31	0.33	0.25	0.83	0.59	0.99	0.92

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[a] Ins.: (-) = no terbufos insecticide. (+) = terbufos, American Cyanamide Counter 15G, applied at 8 oz/1000 ft of row placed in seed furrow at planting.

[b] V9360: DPX-V9360 applied postemergence with 0.25% v/v nonionic surfactant, X-77, + 4% v/v 28%N, an aqueous solution of urea and ammonium nitrate solution. Rates are oz/A active ingredient.

[c] Injury: visual estimate of injury consisting of chlorosis, stunted plants and malformed leaves.

[d] Plant height: average height of the nonextended corn leaves of 10 plants/plot.

[e] Tasseling: % of tassels shedding pollen.

[f] Silking: % of plants with emerged silks.

[g] Yield: bu/A adjusted to 15.5% grain moisture.

Table 2. Effects of rate of DPX-V9360 and terbufos insecticide on injury to field corn and sweet corn at Waseca, MN in 1989 (Lueschen, Fritz and Hoverstad).

Ins[a]	V9360[b] Rate	Harv[c] Date	Kernel[d] H_2O	Plant Pop.	Ears	Use[e] Ears	Ear Length	Snap[f] Ears	Cut Corn
	oz/A		%	--1000's/A--		%	inch	----T/A-----	
Sweet corn									
-	---	10	74.44	23	23	49.9	8.7	7.30	3.34
-	0.5	11	74.77	22	21	58.2	8.6	7.09	3.34
-	1.0	10	75.14	24	24	40.2	8.6	7.10	3.34
-	2.0	10	75.20	22	20	39.3	8.6	5.88	2.65
-	4.0	11	75.01	22	20	26.3	8.4	5.34	2.02
+	---	10	74.34	21	21	53.1	8.8	6.99	3.43
+	0.5	10	74.03	22	20	44.5	8.8	6.90	3.11
+	1.0	11	72.78	21	19	51.2	8.8	6.36	3.01
+	2.0	10	73.71	22	19	37.1	8.6	6.10	2.64
+	4.0	11	73.95	20	19	39.9	8.4	5.55	2.40
Average for insecticide:									
-		10	74.91	23	21	42.8	8.6	6.54	2.94
+		10	73.76	21	20	45.2	8.7	6.38	2.92
Level of sign. (P >F)		ns	0.05	0.04	0.01	0.22	0.11	0.35	0.71
Average for herbicide rate:									
	---	10	74.39	22	22	51.5	8.8	7.15	3.39
	0.5	11	74.40	22	20	51.4	8.7	7.00	3.23
	1.0	11	73.96	22	21	45.7	8.7	6.73	3.18
	2.0	10	74.46	22	19	38.2	8.6	5.99	2.65
	4.0	11	74.48	21	20	33.1	8.4	5.45	2.21
BLSD (0.05)		ns	1.19	2	3	15.4	0.2	1.05	0.54
Interaction (P >F): insect. x herb.		ns	0.39	0.51	0.68	0.39	0.47	0.87	0.69

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[a] Ins: (-) = no terbufos insecticide, (+) = terbufos, American Cyanamide Counter 15G, applied at 8 oz/1000 ft of row placed in seed furrow at planting.

[b] V9360: DPX-V9360 applied postemergence with 0.25% v/v nonionic surfactant, X-77, + 4% v/v 28%N, an aqueous solution of urea and ammonium nitrate. Rates are oz/A active ingredient.

[c] Harv Date: date in August when treatments were harvested.

[d] Kernel H_2O = kernel moisture at harvest.

[e] Use Ear = % of ears at harvest that were at least 5.25 inches long, completely filled with straight kernel rows.

[f] Snap Ears = weight of ears/A prior to husking.

Influence of environment, corn hybrid, and rootworm insecticide on phytotoxicity of DPX-V9360 study. Morton, Cathy A. and Robert G. Harvey. This study is part of a cooperative project conducted at three sites by the authors listed above and W.E. Lueschen, Univ. of Minnesota and J.J. Kells, Michigan State Univ. The objective was to evaluate the potential for corn injury from DPX-V9360 under different environmental conditions and with and without prior application of turbufos. This experimental site had a Plano silt loam soil with 3.6% organic matter and pH 6.8 near Arlington, WI in 1989. The seedbed was prepared and field corn ('Pioneer 3475') and sweet corn ('Jubilee') were planted in rows spaced 30 inches apart with and without in-furrow applications of turbufos insecticide. The field corn hybrid was presumably tolerant to DPX-V9360, while the sweet corn hybrid was the most susceptible of 10 hybrids to DPX-V9360 as reported in a 1988 Wisconsin trial. Herbicide treatments were made to 10 by 30 ft plots arranged in a split block, factorial design with four replications. A preplant incorporated (PPI) application of metolachlor + atrazine at 2.5 + 1.5 lb/A was applied to all plots on May 3 in an attempt to eliminate weed competition. All plots were hand hoed as needed to further reduce weed competition. DPX-V9360 treatments were applied postemergence (Post) on June 2. All herbicides were applied with a tractor-mounted compressed air sprayer delivering 20 gpa at 25 psi at 3.0 mph using SS-8002 flat fan nozzles spaced 15 inches apart and 14 inches above the soil or vegetation canopy. Crop injury was rated and plant heights measured 7, 14, 21, 28, and 56 days after treatment (DAT). Sweet corn was machine harvested on August 14 and shelled field corn was machine harvested September 27 from the center two rows of each plot. Application, environmental, crop, and weed data for 1989 are listed below:

Date	May 3	Jun 2
Treatment	PPI	Post
Soil moisture		
surface	moist	moist
Temperature-F		
soil (2 inch)	52	83
air	70	74
Wind (mph dir)	8-10 NE	10-14 SW
Sky	p.cloudy	clear
Relative humidity (%)	44	40
Field corn		
height (inch)	0	3-5
leaves	0	4-5
Sweet corn		
height (inch)	0	4-5
leaves	0	4-5
Common lambsquarters		
height (inch)	0	1-2
leaves	0	4-7
Redroot pigweed		
height (inch)	0	1-2
leaves	0	4-6
Velvetleaf		
height (inch)	0	1-2
leaves	0	2-4
Giant foxtail		
height (inch)	0	1-4
leaves	0	2-5

Results of this study are summarized in the accompanying table. Greater visual crop injury occurred to 'Jubilee' sweet corn than to 'Pioneer 3475' field corn. Injury symptoms ranged from faint yellowing in whorl area to slow unfurling of whorl, "buggy whipping." Injury to both hybrids increased as the DPX-V9360 rates rose. Prior application of turbufos increased injury at 7, 14, 21, and 28 DAT in both hybrids from DPX-V9360 compared to similar treatments without turbufos. Little injury occurred to either hybrid when DPX-V9360 was applied at rates of 1.0 oz/A or less without prior turbufos application. Dry weather in May and June slowed field and sweet corn development, and may have contributed to visual ratings of crop injury in untreated plots. Sweet corn yields were reduced as rate increased, but were not affected by turbufos interaction. Field corn yields were not affected by rates of DPX-V9360, and use of turbufos actually increased field corn yields. (Dept. of Agronomy, University of Wisconsin - Madison.)

Table. Influence of environment, corn hybrid, and rootworm insecticide on phytotoxicity of DPX-V9360 study (C.A. Morton and R.G. Harvey).

Treatment[a]	Time of application	Rate of application	Vigor reduction[bc]					Corn heights[c]					Yield[d]
			7	14	21	28	56	7	14	21	28	56	
		(oz/A)	-------- (%) ---------					--------- (in) -------					
'Jubilee' Sweet corn													
Check w/o turbufos	----	---	6	3	5	5	1	8	11	19	28	83	9.4
DPX-V9360 w/o turbufos	Post	0.5	11	9	7	5	1	7	11	19	30	83	8.9
DPX-V9360 w/o turbufos	Post	1.0	14	8	3	5	3	7	11	19	29	80	9.3
DPX-V9360 w/o turbufos	Post	2.0	19	18	6	6	1	7	10	19	28	83	9.0
DPX-V9360 w/o turbufos	Post	4.0	25	20	19	5	0	6	9	17	25	81	8.4
AVERAGE			15	12	8	5	1	7	10	19	28	82	9.0
Check w/ turbufos	----	---	8	9	2	0	1	8	11	20	28	82	8.8
DPX-V9360 w/ turbufos	Post	0.5	16	13	4	5	2	7	10	18	28	83	10.1
DPX-V9360 w/ turbufos	Post	1.0	17	16	15	10	0	6	10	17	26	82	8.5
DPX-V9360 w/ turbufos	Post	2.0	20	26	17	9	2	7	9	16	26	79	8.6
DPX-V9360 w/ turbufos	Post	4.0	26	33	42	22	2	6	8	16	23	79	7.2
AVERAGE			17	19	16	9	1	7	10	17	26	81	8.6
'Pioneer 3751' Field corn													
Check w/o turbufos	----	---	4	2	1	2	1	10	13	23	34	98	150
DPX-V9360 w/o turbufos	Post	0.5	4	2	1	3	0	10	13	20	33	102	179
DPX-V9360 w/o turbufos	Post	1.0	5	4	2	3	0	9	13	22	34	106	161
DPX-V9360 w/o turbufos	Post	2.0	1	6	3	8	0	9	12	20	31	103	178
DPX-V9360 w/o turbufos	Post	4.0	5	2	4	5	0	8	12	20	32	102	169
AVERAGE			4	3	2	4	0	9	13	21	33	102	167
Check w/ turbufos	----	---	5	0	0	1	0	10	13	23	35	102	183
DPX-V9360 w/ turbufos	Post	0.5	5	1	1	3	0	9	12	22	35	104	167
DPX-V9360 w/ turbufos	Post	1.0	10	5	1	3	0	8	13	22	34	103	173
DPX-V9360 w/ turbufos	Post	2.0	10	7	1	0	0	9	13	21	35	101	168
DPX-V9360 w/ turbufos	Post	4.0	17	7	2	4	0	9	13	21	33	103	184
AVERAGE			9	4	1	2	0	9	13	22	34	103	175
		LSD (0.05) =	5	6	7	4	2	1	1	2	3	6	---

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[a] All treatments of DPX-V9360 included X-77 and 28%N at 4.0% and 4.0%. X-77 is a nonionic surfactant by Valent U.S.A.; 28%N is an aqueous nitrogen solution containing urea and NH_4NO_3.

[b] Vigor reduction is a visual rating of 0 to 100, where 100 is complete crop destruction.

Influence of corn hybrid and rootworm insecticide on phytotoxicity of DPX-V9360. Kells, James J., Geoffrey A. List, Joseph A. Bruce, and Jay R. Schmidt. The study reported here was conducted in East Lansing, MI. The same study was conducted in Waseca, MN, and Madison, WI. The objective of this research was to examine the interaction of DPX-V9360 and terbufos on two corn hybrids under different environments. The field corn hybrid 'Pioneer 3751' and the sweet corn hybrid 'Jubilee' were selected to represent two levels of corn tolerance to DPX-V9360. Corn was planted either with or without terbufos applied in-furrow at 8 oz/1000 ft of row. The study at East Lansing, MI, was conducted on a sandy loam soil with 2.0% organic matter and pH 6.6. Corn was planted on May 4, 1989, following conventional tillage. The entire experimental area was treated with metolachlor at 2.0 lb/A and atrazine at 1.2 lb/A to maintain a weed-free environment. No additional weed control practices were required. Fertilization included 272 lb/A of 46-0-0 and 200 lb/A of 6-24-24. The study was designed as a split-split plot with four replications. DPX-V9360 was applied on June 8, 1989. All applications included X-77 surfactant at 0.25% (v/v) and 28% liquid nitrogen fertilizer at 4.0% (v/v). Corn was evaluated visually and corn heights determined at 7, 14, 21, 28, and 56 days after treatment. Corn was harvested and yields determined. Sweet corn yield was calculated on a fresh weight basis and reported as T/A. Field corn yield was calculated and reported as bu/A. June rainfall at the experimental location included: 0.68, 0.59, 0.16, 0.35, 0.03, 0.51, 0.84, 0.12, 0.23, and 0.43 inches on June 1, 4, 9, 13, 14, 15, 20, 21, 23, and 27, respectively. Application information is listed below.

Date	June 8
Treatment	Post
Sprayer	
gpa	20
psi	24
nozzle	8003
Temperature (F)	
soil (2 inch)	75
air	89
Relative humidity (%)	35
Soil moisture	moist
Wind (mph)	0-5 SW
Field corn	
height (inch)	9
leaf no.	4-6
Sweet corn	
height (inch)	7
leaf no.	4-6

Results of this study are summarized in the accompanying table. The sweet corn hybrid Jubilee was significantly more sensitive to DPX-V9360 than the field corn hybrid Pioneer 3751. Corn injury was expressed as stunting, leaf twisting and malformation, and chlorosis followed in severe cases by necrosis. In both corn hybrids, injury from DPX-V9360 was significantly greater when terbufos had been applied in-furrow at planting. Significant yield reduction occurred in both hybrids but was much more severe with the sweet corn. This study demonstrates that significant differences exist in corn tolerance to DPX-V9360. This study also demonstrates that the use of terbufos increases sensitivity of corn to DPX-V9360. (Dep. of Crop and Soil Sciences, Michigan State University, East Lansing)

Table. Corn injury and yield following application of DPX-V9360 (Kells, List, Bruce, and Schmidt).

		Sweet corn						Field corn					
Terbutos	DPX-V9360[a]	Injury (DAT)[b]						Injury (DAT)					
rate	rate	7	14	21	28	56	Yield	7	14	21	28	56	Yield
(oz/1000 ft)	(oz/A)	(%)					(T/A)	(%)					(Bu/A)
0	0	0	0	0	0	0	4.7	0	0	0	0	0	189
	0.5	28	21	15	10	2	3.7	6	0	0	1	2	181
	1.0	29	26	34	15	4	3.9	6	1	0	1	1	178
	2.0	39	32	40	38	2	3.9	11	5	5	5	2	180
	4.0	31	40	44	33	7	3.5	16	7	6	6	0	169
8	0	0	0	0	0	0	3.7	0	0	0	0	0	176
	0.5	44	68	74	53	19	1.0	23	13	24	10	1	158
	1.0	55	78	79	61	70	0.6	31	25	34	23	3	170
	2.0	51	81	89	84	78	0.2	24	31	36	23	4	157
	4.0	45	80	73	84	59	0.1	31	36	44	26	4	155
LSD$_{.05}$													
Between DPX-V9360 rates within a terbufos rate		11	6	11	13	13	0.8	7	3	5	3	2	13
Between terbufos rates within a DPX-V9360 rate		11	6	12	23	17	1.0	8	3	8	4	3	14

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[a] All treatments included X-77 at 0.25% (v/v) and 28% liquid nitrogen fertilizer at 4% (v/v).

[b] Days after treatment.

1989 Herbicide Carryover

William Lueschen and Jeff Gunsolus

Two studies were conducted in 1989 to evaluate the effects of soybean herbicides applied in 1988 on a corn crop in 1989. This was accomplished by planting corn in two areas that were soybean weed control trials in 1988. The two sites selected were the 1988 soybean herbicide screening trial and the 1988 soybean no-till weed control trial. The soybean herbicide screening trial was fall chisel plowed in 1988 and spring tillage consisted of two passes with a field cultivator. The 1988 soybean no-till trial was not tilled in the fall of 1988 and corn was planted no-till in the spring of 1989. Table 1 shows 1988 planting dates and herbicide application dates along with 1989 planting dates and data collected for the soybean herbicide screening trial. Table 2 shows the 1988 planting dates and herbicide application dates along with the 1989 planting dates and data collected on the no-till trial.

With the relatively dry conditions that have persisted in 1988 and 1989 it was a concern that herbicide breakdown in the soil would be reduced and cause greater potential for carryover. 1989 growing conditions were favorable with timely rains and mild temperatures resulting in excellent corn yields. Corn yields in 1989 following the 1988 soybean herbicide screening trial showed no significant difference in corn yields due to any soybean herbicide treatment. Very small differences in visual injury, plant height, plant population and grain moisture were not substantial and did not reflect any yield difference. The no-till trial did show corn yield depressions in 1989. It appears the yield depressions in 1989 were correlated to poor weed control in 1988. A likely explanation for this could be that where weeds were not controlled in 1988 less moisture remained in 1989 for the corn crop. Although weed control in these plots was good and growing conditions were favorable in 1989 moisture was below normal throughout the season and small differences in available moisture from the 1988 season could have translated into yield differences in 1989

Table 1. 1989 Corn Performance Following Various Soybean Herbicide Treatments in 1988 at Waseca, MN.

1988 Soybean Herbicide Screening:

Planting Date: May 13, 1988

Variety: Hardin

Soil: Organic matter = 6.5%, pH = 6.3, P = 78 K = 410 lb/A

Application Dates 1988:

Date	May 13	June 2
Treatment	PPI	Post
Temperature (F)		
air	52	84
soil (4 inch)	62	75
Soil moisture	dry	dry
Wind (mph)	0-5 E	0-5 S
Sky	clear	clear
Rainfall after application		
Week 1 (inch)	0.10	0
Week 2 (inch	0	0.12
Relative humidity (%)	40	40
Soybeans		
leaf no.	--	1
height (inch)	--	2
Giant foxtail		
leaf no.	--	1-3
height (inch)	--	1-3
Common lambsquarters		
leaf no.	--	Cotyl-4
height (inch)	--	0.5-2
Redroot pigweed		
leaf no.	--	2-6
height (inch)	--	1-3
Velvetleaf		
leaf no.	--	Cotyl-2
height (inch)	--	0.5-2

1989 Corn Planting Date: May 3, 1989

Hybrid: Pioneer 3737

1989 Weed control: Lasso 3.5 lb/A + Bladex 3 lb/A - Pre
Bladex 2.0 lb/A - Post

Table 1. cont.

1988 Soybean Herbicide Screening			1989 Corn Data				
Trt.	Herbicide	lb/A	Inj 6/28	Plant Height 7/17	Plant Pop 7/17	H2O	Yield
			(%)	in	(x1000/A)	(%)	(bu/A)
PPI 2X							
1	Prowl + Pursuit	0.88+0.63	6	74	23.6	12.9	177.4
2	Pursuit	0.063	5	73	24.5	13.1	185.9
3	CGA-180937 + Sencor	2.5 + 0.5	5	73	24.0	13.2	182.4
4	Dual + Sencor	2.5 + 0.5	3	73	24.6	13.2	176.9
5	Pursuit + Command	0.045 + 0.75	3	73	23.6	13.0	183.4
6	Pursuit + Command	0.031 + 0.75	2	74	23.1	13.2	186.1
7	Sonalan + Pursuit	0.94 + 0.063	5	75	23.8	13.2	173.8
8	Sonalan + Pursuit	0.94 + 0.045	3	74	24.6	12.9	178.6
9	Treflan + Pursuit	1.0 + 0.063	8	73	23.4	12.9	184.3
10	Treflan + Pursuit	1.0 + 0.045	1	74	24.0	12.9	182.9
11	Commence	1.75	2	75	25.5	12.8	184.0
12	Commence + Sencor	1.75 + 0.5	2	74	24.0	13.3	174.8
13	Pursuit + Sencor	0.063 + 0.5	5	73	24.5	13.4	180.4
14	Weedy Check	---	2	75	22.4	13.5	188.2
PPI 1X							
15	Cannon	2.25	4	75	22.4	13.3	178.9
16	Cannon	3.0	4	75	22.5	13.3	186.9
17	Cannon + Command	2.25 + 0.5	3	76	22.6	13.3	189.7
18	Cannon + Command	3.0 + 0.5	4	75	22.8	13.3	173.5
19	Cannon + Sencor	2.25 + 0.5	4	74	22.9	13.7	179.2
20	Cannon + Sencor	3.0 + 0.5	2	76	21.8	13.3	191.1
21	Treflan	0.75	4	74	22.2	13.6	189.8
22	Dual	3.0	4	76	23.8	13.7	170.3
23	Dual + Command	2.5 + 0.5	4	76	23.4	13.1	185.0
24	Dual + Sencor	2.5 + 0.5	2	77	22.1	13.2	187.7
25	Treflan + Command	0.75 + 0.5	3	75	23.6	13.1	171.3
26	Treflan + Sencor	0.75 + 0.5	3	75	22.8	13.3	193.8
27	Lasso + Command	3.0 + 0.5	1	77	23.1	13.3	190.0
28	Weedy Check	---	3	76	23.0	13.7	193.6
29	Prowl + Pursuit	0.88 + 0.063	6	73	23.3	13.4	180.5
30	Pursuit	0.063	5	74	22.4	13.5	175.5
Dual 2.5 lb/A Pre + Post 2-3 lf Broadleaf:							
31	Cobra + COC	0.2 + 0.312%	7	72	22.6	13.6	180.6
32	Cobra + COC	0.2 + 0.625%	5	72	22.2	13.6	183.9
33	Cobra + 28%N	0.2 + 5.0%	5	71	22.8	13.9	176.4
34	Cobra + Basagran + COC	0.15 + 0.5 + 0.625%	4	72	24.1	13.9	195.7
35	Pinnacle + X-77 + 28%N	0.003 + 0.125% +1.25%	3	73	23.3	13.9	180.1
36	Pinnacle + X-77 + 28%N	0.004 + 0.125% +1.25%	5	72	23.2	14.0	172.7
37	Pinnacle + X-77 + 28%N	0.009 + 0.125% +1.25%	5	71	23.2	13.9	176.2
38	Classic + X-77 + 28%N	0.002 + 0.125% +1.25%	7	71	21.8	14.0	181.4
39	Classic + X-77 + 28%N	0.003 + 0.125% +1.25%	4	72	21.2	13.7	173.1
40	Classic + X-77 + 28%N	0.004 + 0.125% +1.25%	5	72	21.4	14.0	182.5
41	Pinnacle + Classic + X-77 + 28%N	0.003 + 0.002 + 0.125% +1.25%	5	72	22.2	14.1	190.0
42	Pinnacle + Classic + X-77 + 28%N	0.003 + 0.003 + 0.125% +1.25%	4	72	21.8	13.8	181.7
43	Pinnacle + Classic + X-77 + 28%N	0.003 + 0.004 + 0.125% +1.25%	4	73	22.0	14.2	178.9
44	Pinnacle + Classic + X-77 + 28%N	0.004 + 0.002 + 0.125% +1.25%	6	70	22.9	14.1	186.6
45	Pinnacle + Classic + X-77 + 28%N	0.004 + 0.003 + 0.125% +1.25%	5	72	23.3	14.0	183.7
46	Pinnacle + Classic + X-77 + 28%N	0.004 + 0.004 + 0.125% +1.25%	4	72	24.1	13.8	184.9
47	None	---	2	72	21.9	13.9	179.8
48	Weedfree	---	2	73	23.6	14.0	182.3
49	Basagran + 28%N + COC	0.5 + 1.25% + 5%	6	71	21.8	13.7	174.3
50	Basagran + Pinnacle + X-77 + 28%N	0.5 + 0.004 + 0.25% + 1.25%	6	72	22.2	13.6	180.2
51	Basagran + Pursuit + X-77 + 28%N	0.5 + 0.063 + 0.25% + 1.25%	4	72	22.7	13.7	169.8
52	Pinnacle + Cobra + X-77 + 28%N	0.004 + 0.2 + 0.25% +1.25%	2	72	22.0	14.4	187.1
53	Pinnacle + Pursuit + X-77 + 28%N	0.004 + 0.063 + 0.25% +1.25%	3	73	23.6	13.6	182.4
54	Pursuit + X-77 + 28%N	0.063 + 0.25% +1.25%	7	72	22.3	13.8	193.6
Post 2-3 lf Broadleaf:							
55	Cobra + Fusilade 2000 + COC	0.2 + 0.25 + 1.25%	2	73	23.1	13.8	187.6
56	Cobra + Select + COC	0.2 + 0.0625 + 1.25%	3	75	22.2	13.8	167.8
57	Cobra + Select + COC	0.2 + 0.125 + 1.25%	2	74	23.0	14.0	172.3
58	Basagran + Select + COC	0.5 + 0.1 + 1.25%	3	74	22.5	14.0	183.1
59	Basagran + Select + COC	0.5 + 0.15 + 1.25%	5	71	23.1	13.6	171.8
60	Weedy Check	---	7	71	22.4	14.0	185.0
		LSD (0.05)	4	4	1.7	0.7	ns

Table 2. 1989 Herbicide Carryover on Corn From 1988 No-till Soybean Weed Control Trial at Waseca, MN.

1988 No-till Soybean Weed Control:

Planting Date: May 13, 1988

Variety: Hardin

Soil: Organic matter = 6.3%, pH = 7.5, P = 69 K = 429 lb/A

Application Dates 1988:

Date	April 14	May 12	May 14	May 31	June 8
Treatment	EPP	Burndown	Pre	E. Post	Post
Sprayer					
gpa	20	10	20	20	20
psi	30	30	30	40	40
Temperature (F)					
air	44	77	58	92	72
soil (4 inch)	40	65	60	83	82
Soil moisture	moist	moist	moist	dry	very dry
Wind (mph)	15NW	10-15NW	10-15SE	10-15S	15-20NW
Sky	clear	cloudy	cloudy	clear	clear
Relative humidity (%)	60	40	47	16	40
Soybeans					
leaf no.	--	--	--	unif.	1-2
height (inch)	--	--	--	3-4	6-7
Giant foxtail					
leaf no.	--	1	1	2-3	3-5
height (inch)	--	0.5-1	0.5-1	2-3	2-5
infestation	--	--	--	--	13/ft^2
Common lambsquarters					
leaf no.	--	cotyl	cotyl	2-6	2-8[a]
height (inch)	--	0.5	0.5	1-2	1-2
infestation	--	--	--	--	0.3/ft^2
Redroot pigweed					
leaf no.	--	cotyl-2	cotyl-2	2-3	2-6[a]
height (inch)	--	0.5	0.5-1	1-1.5	1-2
infestation	--	--	--	--	0.1/ft^2
Velvetleaf					
leaf no.	--	cotyl	cotyl	cotyl-2	2-6[a]
height (inch)	--	0.5	0.5	0.5-1.5	1-3
infestation	--	--	--	--	4/ft^2
Rainfall after application (inch)					
week 1	0.02	0.10	0.10	0.0	0.05
week 2	1.63	0.0	0.27	0.05	0.58
week 3	0.0	0.27	0.0	0.58	0.27

1989 Corn Planting Date: May 3, 1989

Hybrid: Pioneer 3737

1989 Weed control: Lasso 3.5 lb/A + Bladex 3 lb/A - Pre
Buctril 0.25 + atrazine 0.4 lb/A - Post

1989 Insecticide: Lorsban 4E 2 pt/A, 10 DAP

Table 2. Cont'd

University Of Minnesota
Southern Experiment Station

1988 No-till Soybean Weed Control

			1989 Corn Data				
Trt.	Herbicide	lb/A	Inj 6/28	Plant Height 7/12	Plant Pop 7/12	H2O	Yield
EPP - APPLY APPOXIMATELY APRIL 15			(%)	(in)	(x1000/A)	(%)	(bu/A)
1	Clomazone + Imazethepyr	0.75+0.06	3	54	24.3	17.5	174.6
2	Imazethepyr	0.06	6	55	20.9	17.6	175.8
3	Imazethepyr	0.09	8	52	24.8	18.0	153.5,
4	Imazethepyr + Pendimethalin	0.06+1.5	3	56	23.5	16.8	168.9
EPP / PRE - APPLY EPP APPROXIMATELY APRIL 15 / APPLY PRE AFTER PLANTING							
5	Alachlor + Metribuzin / Alachlor + Metribuzin	2.5+0.38 / 1.5+0.38	17	51	23.4	22.6	161.1
6	Clomazone / Imazethepyr	0.75+0.06	13	53	25.1	17.7	159.2
7	Imazethepyr / Imazethepyr	0.03+0.03	9	55	24.8	17.8	159.2
8	Imazethepyr / Imazethepyr	0.05+0.04	8	54	24.3	17.2	171.6
9	Imazethepyr + Metribuzin / Imazethepyr + Metribuzin	0.03+0.38 / 0.03+0.38	7	56	24.5	17.0	189.4
10	Metolachlor + Metribuzin / Metolachlor + Metibuzin	2+0.38 / 1+0.38	10	54	24.5	21.1	156.9
PRE - NO BURNDOWN - APPLY 1 TO 3 DAYS BEFORE PLANTING							
11	Imazethepyr	0.06	2	55	25.3	16.9	171.4
12	Imazethepyr + Surf.	0.06+0.25%	5	55	25.7	17.1	163.7
13	Imazethepyr + Surf. + 28% N	0.06+0.25%+4 qt	6	55	25.0	17.2	173.9
14	Imazethepyr + DPX-M6316 + Surf. + 28% N	0.06+0.008+0.25%+4 qt	7	55	24.3	17.2	166.2
15	Imazethepyr + Metribuzin + Surf. + 28% N	0.06+0.5+0.25%+4 qt	3	54	25.0	17.4	164.5
16	Imazethepyr + Pendimethalin + Surf. + 28% N	0.06+1.5+0.25%+4 qt	16	50	22.9	18.6	150.1
PRE : BURNDOWN (10 gpa) :(Glyphosate 0.28 + 2,4-D(amine) 0.25 + AMS 3.4 + surf 0.5%) APPLIED 1 TO 3 DAYS BEFORE PLANTING							
17	Alachlor + Metribuzin	3.5+0.5	4	53	24.8	17.4	149.1
18	Imazethepyr	0.06	4	52	22.5	18.2	172.5
19	Imazethepyr + Chloramben	0.06+2	10	52	24.2	18.4	172.7
20	Imazethepyr + Metribuzin	0.06+0.5	8	54	25.1	17.2	149.0
21	Imazethepyr + Pendimethalin	0.06+1.5	2	56	25.5	16.9	175.9
22	Metolachlor + Metribuzin	3+0.5	7	56	24.3	17.6	159.9
BURNDOWN (10 gpa) / EARLY POSTEMERGENCE 18-21 DAP (days after planting) / / LATE POSTEMERGENCE 25-28 DAP							
23	Acifluorfen + 2,4-D(E) + Dash +28% N / Acifluorfen + Bentazon + COC / Bentazon + Sethoxydim + Dash + 28% N	0.13+0.5+1qt+4qt 0.13+0.5+1qt 0.38+0.15+1qt+4qt	5	53	24.2	17.4	148.8
24	Acifluorfen + 2,4-D(E) + Sethoxydim + Dash +28% N / Acifluorfen + Bentazon + COC / Bentazon + Sethoxydim + Dash + 28% N	0.06+0.5+0.05+1qt+4qt 0.13+0.5+1qt 0.38+0.15+1qt+4qt	2	56	23.5	18.0	170.8
25	2,4-D(E) + Sethoxydim + Dash +28% N / Acifluorfen + Bentazon + COC / Bentazon + Sethoxydim + Dash + 28% N	0.5+0.1+1qt+4qt 0.13+0.5+1qt 0.38+0.15+1qt+4qt	3	56	24.8	16.8	165.8
26	Acifluorfen + 2,4-D(E) + Imazethepyr + Dash +28% N / Bentazon + COC / Bentazon + Sethoxydim + Dash + 28% N	0.13+0.5+0.03+1qt+4qt 0.5+1qt 0.38+0.15+1qt+4qt	8	53	24.4	17.0	179.7
27	2,4-D(E) + Imazethepyr + Dash +28% N / Bentazon + COC / Bentazon + Sethoxydim + Dash + 28% N	0.5+0.03+1qt+4qt 0.5+1qt 0.38+0.15+1qt+4qt	2	55	25.1	18.4	171.6
28	2,4-D(E) + Imazethepyr + Sethoxydim + Dash +28% N / Bentazon + COC / Bentazon + Sethoxydim + Dash + 28% N	0.5+0.03+0.1+1qt+4qt 0.5+1qt 0.38+0.15+1qt+4qt	3	56	24.7	17.4	182.8
29	2,4-D(E) + Sethoxydim + Dash +28% N / Bentazon + DPX-M6316 + Surf / Sethoxydim + Dash	0.5+0.1+1qt+4qt 0.5+0.008+0.25% 0.15+1qt	12	54	24.0	18.4	155.4
CHECK PLOTS							
30	Weedy Check		11	53	24.4	17.9	179.9
31	Weedy Check		18	50	25.0	19.2	148.4
32	Hand-weeded (Burndown :[Glyphosate 0.28 + 2,4-D(amine) + AMS 3.4 + surf 0.5%) (Pre : Metolachlor + Chloramben 3 + 2.5)		2	56	24.4	16.5	173.3
		BLSD (0.05)	10	4	ns	2.5	26.0

<u>The effects of bentazon, terbufos and a seed safener on DPX-V9360 and DPX-V9360 + DPX-E9636 induced corn injury.</u> Lueschen, William E. and Jeffrey L. Gunsolus. The objectives of this study were to determine the relationships between bentazon, terbufos and naphthalic anhydride on corn injury resulting from postemergence applications of DPX-V9360 and DPX-V9360 + DPX-E9636. This study was conducted as a randomized complete block design with a split-split plot arrangement of treatments, four replications and a sub-subplot size of 5 by 15 ft. An appropriate analysis of variance was performed on the data and the results are listed in the accompanying table. The two main plots were either terbufos as an in-furrow treatment at 8 oz of 15G per 1000 ft of row or plots that received no insecticide. Subplots were either untreated seed corn or seed corn treated at the rate of 0.5% w/w basis with FMC Corporation F-80, naphthalic anhydride, seed treatment. Sub-subplots were postemergence application of DPX-V9360 or DPX-V9360 + DPX-E9636 applied alone or in a tank mixture with bentazon. A nonionic surfactant, Ortho X-77, and 28%N solution were used as additives for all herbicide treatments at the rate of 0.25% and 4% v/v. The experimental area was in winter wheat prior to establishment of this study. After harvesting the wheat the entire area was treated with glyphosate at the rate of 0.75 lb/A with 0.5% nonionic surfactant. Ammonium nitrate was applied at the rate of 100 lb N/A just prior to planting. Pioneer '3585' single cross hybrid seed corn was planted no-till on July 31, 1989 at a seeding rate of 27,400 seeds/A. Due to dry conditions 1 inch of irrigation was applied on August 11, 1989 when the corn was in the two-leaf stage. All herbicide treatments were applied on August 22, 1989 when the air temperature was 85 F with 60% relative humidity. At this time the corn had 4 to 5 leaves with collars visible and was 6 to 7 inches tall. Five plants were randomly selected in each plot and marked on August 23. These same plants were used to determine the height of unextended leaves and the number of leaves with visible collars for each sampling date.

Averaged over seed treatments and herbicide treatments terbufos insecticide significantly increased corn injury, when rated on August 29, September 5 and September 12, compared to the same treatments which did not receive terbufos. However, plant height and number of leaves were not affected by terbufos during this period. The seed treatment frequently resulted in slightly higher injury ratings and shorter plants, although the differences were generally small. Bentazon applied as a tank mixture with either DPX-V9360 or DPX-V9360 + DPX-E9636 significantly increased corn injury and decreased plant height compared to these herbicides applied without bentazon. Plant height was reduced 1 to 3 inches for nearly all DPX-V9360 and DPX-V9360 + DPX-E9636 treatments compared to the untreated control. Plant height was decreased more with DPX-V9360 + DPX-E9636 than with DPX-V9360. Only the DPX-V9360 + DPX-E9636 treatments resulted in reduced corn leaf numbers. The only significant interaction among the variables studied occurred with the insecticide x herbicide treatment interaction. In-furrow terbufos caused more corn injury and reduced corn height more with DPX-V9360 + DPX-E9636 than with DPX-V9360. (MN Agric. Exp. Sta. Paper No. 17,536; Misc. Journ. Series, University of Minnesota, St. Paul).

Table. The effects of bentazon, terbufos and a seed safener on DPX-V9360 and DPX-V9360 + DPX-E9636 induced corn injury (Lueschen and Gunsolus).

			Seed[c]	Corn injury				Plant height[d]				Leaves[e]			
Herbicide Treatment[a]	Rate	Insect[b]	Trt	8/30	9/5	9/12	9/19	8/23	8/29	9/5	9/12	8/23	8/29	9/5	9/12
	lb/A			-----------	-----------	%	-----------	---------	---------	inches	---------	------	------	number/plant	------
None		-	-	0	0	0	0	10	16	26	29	4.9	6.4	8.1	9.2
None		-	+	10	11	6	7	9	15	24	27	4.9	6.4	8.1	9.0
None		+	-	2	0	0	0	11	17	27	29	5.2	6.6	8.2	9.3
None		+	+	5	4	3	2	11	16	25	28	5.0	6.4	8.1	9.2
DPX-V9360	0.047	-	-	25	15	10	10	10	13	24	28	4.9	6.4	8.3	9.3
DPX-V9360	0.047	-	+	20	10	4	6	9	14	24	28	4.9	6.7	8.3	9.3
DPX-V9360	0.047	+	-	30	10	7	7	9	13	24	29	4.8	6.3	8.3	9.2
DPX-V9360	0.047	+	+	27	18	11	13	10	13	23	27	4.9	6.3	8.1	9.1
DPX-V9360+bentazon	0.047+1	-	-	31	17	14	11	10	11	21	26	4.8	5.9	8.1	9.3
DPX-V9360+bentazon	0.047+1	-	+	34	24	15	12	9	11	21	26	4.9	6.0	8.1	8.8
DPX-V9360+bentazon	0.047+1	+	-	31	31	25	22	11	13	24	29	5.1	5.9	8.2	9.4
DPX-V9360+bentazon	0.047+1	+	+	39	28	22	19	10	12	22	28	4.9	5.8	8.4	9.3
DPX-V9360+bentazon	0.063+1	-	-	34	21	18	15	9	11	22	27	4.9	6.0	8.2	9.2
DPX-V9360+bentazon	0.063+1	-	+	42	26	21	18	9	11	22	27	4.9	5.9	8.3	9.1
DPX-V9360+bentazon	0.063+1	+	-	32	26	20	17	9	13	24	29	5.1	5.9	8.4	9.3
DPX-V9360+bentazon	0.063+1	+	+	44	39	31	28	9	11	21	26	4.8	5.8	7.8	8.9
DPX-V9360+DPX-E9636	0.024+0.024	-	-	29	13	8	7	10	13	25	29	4.9	6.5	8.2	9.3
DPX-V9360+DPX-E9636	0.024+0.024	-	+	36	17	16	10	9	12	22	27	4.9	6.4	8.2	9.0
DPX-V9360+DPX-E9636	0.024+0.024	+	-	36	32	24	21	10	12	23	27	5.0	5.7	8.3	9.3
DPX-V9360+DPX-E9636	0.024+0.024	+	+	41	35	25	23	9	11	21	25	4.9	5.7	8.1	8.8
DPX-V9360+DPX-E9636 +bentazon	0.024+0.024 +1	-	-	44	37	28	28	9	11	20	25	5.0	5.5	8.1	9.1
DPX-V9360+DPX-E9636 +bentazon	0.024+0.024 +1	-	+	52	49	42	36	9	11	20	24	5.0	5.4	8.0	9.3
DPX-V9360+DPX-E9636 +bentazon	0.024+0.024 +1	+	-	40	60	44	41	10	11	19	23	4.9	4.9	7.2	8.8
DPX-V9360+DPX-E9636 +bentazon	0.024+0.024 +1	+	+	48	54	43	39	9	9	19	22	4.6	5.1	7.2	8.8
Averages for insecticide:															
No Insecticide				30	20	15	13	9	13	23	27	4.9	6.1	8.2	9.2
Insecticide				30	27	21	19	10	13	23	27	4.9	5.9	8.0	9.1
Significance P> F				.34	.001	.001	.001	.07	.82	.97	.83	.41	.001	.06	.58
Average for seed treatments:															
No Seed Treatment				28	22	17	15	10	13	23	27	5.0	6.0	0.1	9.2
Seed Treatment				32	25	20	18	9	12	22	26	4.9	6.0	8.1	9.1
Significance P> F				.001	.029	.05	.05	.01	.009	.02	.01	.189	.75	.25	.023
Average for herbicide treatments:															
None	--			4	4	2	2	10	16	25	28	5.0	6.4	8.2	9.2
DPX-V9360	0.047			26	13	8	9	9	13	24	28	4.9	6.4	8.3	9.2
DPX-V9360+bentazon	0.047+1			34	25	19	16	10	12	22	27	4.9	5.9	8.2	9.2
DPX-V9360+bentazon	0.063+1			38	28	23	19	9	11	22	27	4.9	5.9	8.2	9.2
DPX-V9360+ DPX-E9636	0.024+ 0.024			36	24	18	15	9	12	23	27	4.9	6.0	8.2	9.1
DPX-V9360+DPX-E9636 +bentazon	0.024+0.024 +1			46	50	40	36	9	11	19	23	4.9	5.3	7.6	9.0
BLSD (0.05) for herbicide treatments				5.2	6.6	6.1	5.0	0.7	0.9	1.4	1.6	0.2	0.2	0.3	0.3

[a] All herbicide treatments applied with 0.25% v/v nonionic surfactant, Ortho X-77, and 4% v/v 28%N, an aqueous solution of urea and ammonium nitrate.

[b] Insect = terbufos American Cyanamid Co. Counter 15G applied at the rate of 8`oz/1000 ft of row in the seed furrow.

[c] Seed Trt = Naphthalic anhydride seed treatment, F-80 seed treatment by FMC Corp., applied at the rate of 0.5% w/w.

[d] Plant Height = Average of 5 plants/plot, height of unextended leaves.

[e] Leaves = number of leaves present with visible collars.

1988 Soybean Breeding

James Orf, Thomas Hoverstad and William Lueschen

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 at Waseca include new experimental line tests, preliminary yield trials, 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 are published in 'Varietal Trials of Farm Crops'.

All soybean breeding trials were designed as randomized complete blocks. The previous crop for each trial was oats. Each site was fall chisel plowed after applying P and K fertilizer based on soil tests. Seed for each trial was packaged for individual plots and planted with a cone type planter. Weeds were controlled in all plots with Treflan at 0.75 lb/A plus Command at 0.75 lb/A PPI followed by Amiben at 2.5 lb/A Pre. Publicly developed variety evaluations included three studies: (1) late maturing varieties planted on May 10, (2) medium maturing varieties planted on May 3 and (3) a range of maturities planted on June 15. All these tests were planted in 10-inch row spacings. Privately developed varieties were tested in 10-inch rows planted on May 10. New experimental line tests and preliminary yield trials were all planted in 10-inch rows on May 11. Planting date was evaluated in 1988 by planting several varieties at dates ranging from May 2 to June 23. In the planting date trial we evaluated varietal performance in 10 and 30-inch rows. Uniform regional trials for both group I and group II maturity soybeans were planted on May 11. Harvested plot size for 30-inch rows was 5 (two 30-inch rows) by 8 feet. Harvested plot size for 10-inch rows was 5 (six 10-inch rows) by 8 feet. All plots were harvested with a modified plot combine.

Notes on maturity, lodging and plant height were taken on all yield trials. Evaluation of early generation material for maturity, plant type, disease resistance and other agronomic traits 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 20 consecutive years. No yields were taken on these very small plots.

Soybean yields in 1989 were excellent. Many trials had varieties average over 60 bu/A. Yield of medium maturity varieties ranged from 41.9 to 61.6 bu/A (table 1) with Sibley being the highest yielding of the varieties in this trial. The highest yielding variety in the late maturity trial Weber 84 (table 2). Two experimental varieties yielded higher than Weber 84 in this trial. In a trial planted on June 15, 1989 Dawson yielded 52.5 bu/A and was the highest yielding variety in this test (table 3). In the planting date trial (table 4) yields ranged from 29.1 to 62.8 bu/A. The highest yields were with the earliest planting dates, May 2 and May 12. Table 5 shows the results of over 100 privately developed varieties along with several public varieties. Yields in this trial ranged from 38.1 to 66.6 bu/A. The highest yielding variety was KE228, a variety from Kruger Seed Company. The highest yielding public variety was BSR 101 at 62.7 bu/A. Experimental lines being tested with several named varieties in a Uniform Regional Trial of group I maturity soybeans performed very well in 1989 with one experimental line yielding 71.8 bu/A (table 6). The highest yielding named varieties were BSR 101 and Sturdy at 61.8 bu/A. Group II experimental lines were also evaluated in a Uniform Regional Trial (table 7). Two experimental varieties yielded over 70 bu/A in this trial while the highest yielding named variety was Kenwood at 69.3 bu/A.

The University of Minnesota released two new Varieties in 1989, Kato and Sturdy. Kato is a medium maturity soybean similar in maturity to Hodgson 78. Kato has outstanding protein levels, good lodging resistance and good iron chlorosis resistance. Sturdy is later in maturity than Kato but earlier than Corsoy 79. Sturdy has excellent yield potential, good lodging resistance and good iron chlorosis resistance. Both Kato and Sturdy have phytopthora root rot resistance. Data collected on several of these trials are published in 'Varietal Trials of Farm Crops'. Recommended public soybean varieties for Southern Minnesota are: Simpson, Kato, Hodgson 78, Sibley, Weber 84, Hardin, BSR 101 and Corsoy 79.

Table 1. Medium Maturing Soybean Variety Trial. Waseca 1989.

	DF	SS	MS	F
REP	2	85.05	42.52	0.78
TRT	20	1915.20	95.76	1.76
ERROR	40	2178.08	54.45	

CV = 13.8
LSD.05 = 12.2
YIELD MEAN = 53.5

RANKING BY YIELD

ENT	NSN	PEDIGREE	1 PHY-CHL	2 MEAN%	3 YIELD	4 MAT	5 LDG	6 HT	7 QUAL	8 SDWT	9 PRO	10 OIL
9	SIBLEY	M68-256 X HODGSON	R40	115.2	61.6	21	3.3	40	1.3	19.6	33.5	20.0
12	M83-766	EVANS X II-74-394	R35	115.1	61.5	15	2.0	35	1.7	17.3	34.5	19.1
10	SIMPSON	STEELE X HODGSON	R38	113.2	60.6	10	2.3	36	1.7	15.5	33.7	19.8
15	M84-414	II-75-243 X II-76-260	R27	111.7	59.8	9	1.7	33	1.3	16.4	33.6	19.9
18	M84-748	II-75-274 X II-76-151	R25	111.1	59.4	12	2.3	37	2.3	16.9	34.3	19.2
19	M84-833	II-76-142 X WEBER	R20	107.8	57.7	12	2.0	34	1.7	14.0	33.6	19.8
5	HODGSON 78	HODGSON*7 X MERIT	R30	104.4	55.8	16	2.7	39	1.7	15.7	33.1	20.4
11	M83-744	II-73-129 X II-73-37	R22	102.0	54.6	10	2.0	31	1.3	17.1	34.4	19.1
21	MAPLE DONOVAN	MAPLE ARROW X HARCOR	RPS6 R38	102.0	54.6	11	2.7	37	1.3	14.6	34.3	19.5
6	KATO	II-70-127 X CENTURY	R23	99.7	53.3	17	2.0	39	1.7	20.5	36.2	17.4
1	DASSEL	EVANS X M66-18	RPS6 R26	99.5	53.2	8	1.7	33	1.7	16.6	34.7	18.9
17	M84-574	WEBER X II-75-299	R25	99.3	53.1	10	2.0	36	1.3	14.9	32.9	20.3
4	GLENWOOD	EVANS X PETERSON 85	R30	99.0	52.9	6	2.0	31	2.3	15.2	34.5	19.1
14	M84-395	II-75-243 X DAWSON	R25	98.5	52.7	7	2.7	37	1.7	16.4	33.4	20.1
16	M84-449	SIMPSON X M71-148	R37	97.1	51.9	3	2.0	30	1.7	14.8	35.1	18.5
13	M84-293	M71-148 X M75-2	R40	96.9	51.9	7	2.0	35	1.3	14.4	33.1	20.2
2	DAWSON	EVANS X II-63-217Y	R20	94.2	50.4	6	2.3	31	2.0	15.7	33.7	20.0
8	PROTO	M70-504 X M69-42	HP S30	88.3	47.2	5	2.0	29	1.7	18.0	37.6	16.1
20	MINNATTO	EVANS X PI437.267	SMALL SEED	86.9	46.5	8	1.7	31	1.7	10.1	35.9	17.9
7	OZZIE	WILKIN X II-63-217Y	R26	79.6	42.6	2	1.3	31	2.0	15.9	35.2	18.3
3	EVANS	MERIT X HARDSOY	R31	78.3	41.9	5	2.0	33	1.7	14.6	34.3	19.2

See footnote at bottom of Table 7.

Table 2. Late Maturing Soybean Variety Trial. Waseca 1989.

	DF	SS	MS	F
REP	2	919.89	459.95	21.69
TRT	26	1509.86	58.07	2.74
ERROR	52	1102.80	21.21	

CV = 8.1
LSD,05 = 7.5
YIELD MEAN = 56.8

RANKING BY YIELD

				1	2	3	4	5	6	7	8	9	10
ENT	MSN	PEDIGREE		PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
20	M84-916	A79-136012 X DAWSON		R35	119.6	67.9	22	3.0	47	1.3	19.7	33.0	20.6
26	A85-193023	A79-135010 X ASGROW A1937		30	115.3	65.4	23	2.3	37	1.3	16.0	32.3	21.3
13	WEBER 84	WEBER*5 X CENTURY		R22	109.0	61.9	20	3.3	46	1.3	13.8	31.5	22.0
4	ELGIN 87	ELGIN*5 X WILLIAMS 82	1K	R36	107.2	60.8	26	2.7	38	1.3	17.2	32.6	20.9
14	KENWOOD	ELGIN X ASGROW A1937		44	106.9	60.7	27	2.7	41	1.3	14.6	33.6	20.0
19	M83-899	II-74-270 X A78-123018		R39	104.7	59.4	22	3.0	44	1.3	16.7	32.1	21.4
17	M83-108	HODGSON 78 X PELLA		R35	104.5	59.3	21	2.3	41	1.3	18.8	33.1	20.6
23	M85-647	OZZIE X FAYETTE	SCN 0.4	R35	104.2	59.1	23	2.3	40	1.3	15.6	34.3	19.5
8	HOYT	HARCOR X ELF	dt1	R38	103.9	59.0	25	1.3	26	1.3	14.0	33.7	19.9
1	BSR 101	L69U40016-4 X A76-304020		R29	103.8	58.9	23	2.7	41	2.3	17.9	32.1	21.3
25	M81-381	M70-127 X CENTURY		R32	101.9	57.8	20	2.0	39	1.3	18.2	33.9	19.7
24	LN85-874	FAYETTE X LN80-10398			100.9	57.3	22	3.0	39	1.3	19.0	34.8	19.0
16	M82-559	VICKERY X CENTURY	1C	R34	99.5	56.5	18	1.3	34	1.3	18.4	34.5	19.3
15	M82-106	II-73-105 X VICKERY	1C	R24	99.2	56.3	19	2.0	36	1.3	16.3	34.5	19.4
18	M83-830	EVANS X CENTURY		R24	98.5	55.9	22	2.0	35	1.3	17.6	33.4	20.3
3	CORSOY 79	CORSOY*6 X LEE 68	1C	R40	98.3	55.8	22	2.7	45	1.3	15.8	32.5	21.0
21	M84-1034	M75-2 X K1062	? RPS3 RPS(HIGAN)	R35	95.9	54.4	19	1.7	34	1.3	16.7	32.6	20.9
5	HACK	L70T-5438 X K1028		R40	95.8	54.4	27	2.0	38	1.3	18.1	32.7	21.0
6	HARDIN	CORSOY*3 X CUTLER 71		R41	95.2	54.1	18	2.3	41	2.0	15.0	32.8	20.8
11	STURDY	II-70-127 X CENTURY		R22	95.0	53.9	22	2.3	36	1.3	18.3	32.9	20.8
12	VICKERY	CORSOY*4 X (HACK X L55-1342 OR ANOKA)		R36	94.9	53.9	20	3.0	43	1.3	16.4	32.5	21.1
2	CENTURY 84	CENTURY*5 X WILLIAMS 82	1K	R34	94.9	53.8	27	2.3	41	1.3	18.2	36.6	17.4
27	BURLISON	K74-113-76-486 X CENTURY	RPS3+1B	R25	94.2	53.5	28	2.0	39	1.3	18.2	36.3	17.4
22	M85-610	FAYETTE X MCCALL	SCN 0.0	S32	92.0	52.2	21	3.0	44	1.3	15.2	35.1	18.6
9	KATO	II-70-127 X CENTURY		R23	90.8	51.5	17	2.0	40	1.3	20.2	35.1	18.7
7	HODGSON 78	HODGSON*7 X MERIT		R30	86.9	49.3	16	2.3	38	1.3	15.9	32.4	21.2
10	SIBLEY	M68-256 X HODGSON		R40	86.7	49.2	18	2.7	40	1.3	17.9	33.3	20.3

See footnote at bottom of Table 7.

Table 3. Soybean Variety Trial - Mid June Planting Date. Waseca 1989.

	DF	SS	MS	F
REP	2	59.45	29.72	1.67
TRT	17	782.73	46.04	2.59
ERROR	34	606.56	17.84	

CV = 9.1
LSD.05 = 7.0
YIELD MEAN = 46.4

RANKING BY YIELD

				1	2	3	4	5	6	7	8	9	10
ENT	NSN	PEDIGREE		PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
3	DAWSON	EVANS X II-63-217Y		R20	113.2	52.5	24	2.7	36	1.3	15.1	33.9	19.6
19	M87-106	II-73-105 X VICKERY	1C	R24	110.5	51.3	29	1.0	35	1.3	16.9	37.3	16.4
5	EVANS	MERIT X HARDSOY		R31	108.7	50.5	24	2.7	40	1.3	16.4	33.9	19.5
12	WEBER 84	WEBER*5 X CENTURY		R22	106.8	49.6	30	2.3	40	1.3	14.6	33.7	19.7
11	SIMPSON	STEELE X HODGSON		R38	105.8	49.1	24	1.0	35	1.0	15.1	34.8	18.8
2	DASSEL	EVANS X II-66-18	RPS6	R26	104.6	48.6	25	1.0	31	1.3	16.9	34.3	19.2
6	HARDIN	CORSOY*3 X CUTLER 71		R41	104.3	48.4	31	2.3	44	1.7	15.6	34.4	19.1
7	HODGSON 78	HODGSON*7 X MERIT		R30	102.9	47.8	27	2.3	42	1.3	17.0	34.7	18.8
16	KATO	II-70-127 X CENTURY		R23	102.1	47.4	29	1.0	39	1.3	22.3	38.0	15.7
9	OZZIE	WILKIN X II-63-217Y		R26	101.3	47.0	22	1.0	35	1.3	16.0	34.7	18.8
10	SIBLEY	M58-256 X HODGSON		R	101.2	47.0	29	2.7	39	1.3	17.1	35.5	18.0
8	MCCALL	(ACME X CHIPPEWA) X HARK		R28	100.5	46.7	20	1.7	35	2.0	16.8	33.7	20.0
15	STURDY	II-70-127 X CENTURY		R22	94.5	43.9	32	1.0	40	1.3	16.7	34.9	18.5
14	GLENWOOD	EVANS X PETERSON 85		R30	93.6	43.5	25	1.0	31	1.3	17.1	34.5	19.0
1	CORSOY 79	CORSOY*6 X LEE 68	1C	R40	90.7	42.1	33	2.7	44	2.0	14.6	34.5	19.9
4	ELGIN 87	ELGIN*5 X WILLIAMS 82	1K	R36	86.7	40.3	33	1.7	39	3.0	16.2	34.8	18.6
17	KENWOOD	ELGIN X ASGROW A1937		44	86.7	40.3	33	1.0	40	1.7	15.3	34.6	18.3
13	BSR 101	L69U40016-4 X A76-304020		R29	85.8	39.8	33	1.0	43	1.3	17.1	34.6	18.8

See footnote at bottom of Table 7.

Table 4. Effects of Planting Date on Soybean Yield. Waseca 1989.

	DF	SS	MS	F
REP	3	148.88	49.63	2.83
TRT	39	11750.00	301.28	17.21
ERROR	117	2048.78	17.51	

CV = 9.0
LSD.05 = 5.9
YIELD MEAN = 46.3

RANKING BY YIELD

ENT	NSN	PEDIGREE	1	2	3	4	5	6	7	8	9	10
			PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
7	CORSOY 79 10" 2			135.6	62.9	24	2.0	48	1.5	15.7	34.2	18.3
17	BSR 101 10" 2			129.5	60.0	25	2.0	42	1.5	16.6	33.3	18.9
16	BSR 101 10" 1			121.2	56.1	23	2.0	40	1.0	17.3	33.1	19.1
6	CORSOY 79 10" 1			120.9	56.0	22	2.0	46	2.0	15.8	33.7	18.7
28	HARDIN 10" 3			120.9	56.0	25	2.8	45	1.0	15.5	33.4	18.9
11	BSR 101 30" 1			118.9	55.1	24	2.0	40	1.5	17.2	33.2	18.9
12	BSR 101 30" 2			116.0	53.7	24	2.0	41	1.5	17.0	33.2	18.9
23	HARDIN 30" 3			115.2	53.4	24	2.3	48	1.0	16.2	33.3	18.8
27	HARDIN 10" 2			110.3	51.1	20	2.0	45	1.2	15.0	33.1	19.1
21	HARDIN 30" 1			110.2	51.1	17	2.5	42	1.5	14.4	33.6	18.7
1	CORSOY 79 30" 1			110.1	51.0	23	2.3	47	1.8	15.4	33.9	18.6
37	SIBLEY 10" 2			109.5	50.7	20	3.5	42	1.0	18.6	33.8	19.7
22	HARDIN 30" 2			109.1	50.5	20	2.3	47	1.0	13.9	33.6	19.7
2	CORSOY 79 30" 2			108.5	50.3	22	2.5	48	1.9	16.0	33.9	19.5
8	CORSOY 79 10" 3			107.5	49.8	29	3.0	48	1.5	15.7	34.7	18.0
18	BSR 101 10" 3			107.5	49.8	30	2.0	42	1.5	17.3	34.6	18.0
3	CORSOY 79 30" 3			107.5	49.8	29	2.8	50	1.8	16.3	34.7	18.0
26	HARDIN 10" 1			106.5	49.4	17	2.0	40	1.2	14.4	33.6	18.8
38	SIBLEY 10" 3			106.0	49.1	24	2.8	41	1.0	19.1	34.8	18.0
33	SIBLEY 30" 3			104.7	48.5	23	2.3	41	1.0	18.6	34.6	18.2
29	HARDIN 10" 4			104.4	48.4	32	2.0	43	1.0	15.1	34.2	19.2
13	BSR 101 30" 3			104.2	48.3	29	2.0	41	1.8	16.8	34.2	18.3
32	SIBLEY 30" 2			101.2	46.9	18	3.0	43	1.5	17.8	34.5	18.3
31	SIBLEY 30" 1			100.8	46.7	15	3.3	42	1.2	17.2	34.6	18.2
39	SIBLEY 10" 4			99.3	46.0	30	2.0	36	1.0	17.3	35.2	17.7
36	SIBLEY 10" 1			99.3	46.0	15	2.5	38	1.2	17.1	34.2	18.4
4	KATO 30" 4			99.1	45.9	28	2.0	37	1.9	21.1	37.9	15.9
34	SIBLEY 30" 4			97.8	45.3	30	2.5	37	1.0	17.3	35.6	17.5
9	KATO 10" 4			97.7	45.3	29	2.0	38	1.2	22.4	37.5	16.1
24	HARDIN 30" 4			94.9	44.0	30	2.3	43	1.0	14.7	35.1	17.7
19	EVANS 10" 4			91.1	42.2	24	1.5	36	1.0	15.6	32.9	19.2
14	EVANS 30" 4			85.8	39.8	23	2.0	38	1.2	14.7	33.5	18.8
20	EVANS 10" 5			81.4	37.7	31	1.3	31	1.0	14.5	34.4	18.1
10	KATO 10" 5			75.0	34.7	33	1.0	34	2.5	19.2	37.9	15.8
40	SIBLEY 10" 5			70.9	32.8	34	1.8	33	1.8	15.0	35.6	17.4
35	SIBLEY 30" 5			67.1	31.1	35	1.3	34	1.8	15.2	35.1	17.7
30	HARDIN 10" 5			65.8	30.5	34	1.5	37	1.5	12.9	34.0	18.3
5	KATO 30" 5			63.3	29.3	34	1.5	32	2.2	20.2	37.6	16.1
25	HARDIN 30" 5			62.8	29.1	35	2.0	38	1.8	13.7	34.7	18.0
15	EVANS 30" 5			62.7	29.1	31	1.3	33	1.0	15.0	34.5	18.1

See footnote at bottom of Table 7.

Table 5. Public and Private Soybean Variety trial. Waseca 1989.

	DF	SS	MS	F
REP	2	456.00	228.00	5.52
TRT	152	9967.13	65.57	1.59
ERROR	304	12555.00	41.30	

CV = 12.3

WASECA

LSD.05 = 10.3

YIELD MEAN = 52.1

RANKING BY YIELD

ENT	NSN	PEDIGREE		1 PHY-CHL	2 MEAN%	3 YIELD	4 MAT	5 LDG	6 HT	7 QUAL	8 SDWT	9 PRO	10 OIL
50	KE229	KRUGER SEED COMPANY		P S	127.8	66.6	24	1.3	39	0.0	0.0	35.6	19.5
79	PS 1152	PROFISEED INC.		P S32	122.9	64.1	25	2.3	42	0.0	0.0	33.8	20.1
143	BSR 101	IOWA A.E.S.		R28	120.4	62.7	23	2.0	40	0.0	0.0	33.1	20.9
83	SOI 296	SAND SEED SERVICE, INC.		P S	119.2	62.1	23	2.3	38	0.0	0.0	33.6	20.1
105	THOMPSON EX3190	THOMPSON AGRONOMICS INC.		P S	117.6	61.3	23	2.3	39	0.0	0.0	34.6	19.5
90	STAR 8819	STAR BRAND SEEDS		P S42	116.6	60.8	21	2.0	38	0.0	0.0	34.6	19.5
21	CX259	DEKALB - PFIZER GENETICS		P S40	115.6	60.2	25	3.0	39	0.0	0.0	32.9	21.0
1	AGRIPRO AP1989	AGRIPRO SEEDS EX1969	1C	P R	115.3	60.1	21	2.3	40	0.0	0.0	32.2	21.4
117	S BRAND 540C	SCHECHINGER SEED COMPANY		P S28	115.2	60.0	23	1.3	39	0.0	0.0	33.5	20.4
108	THOMPSON T-3180	THOMPSON AGRONOMICS		P S32	114.5	59.7	21	2.3	37	0.0	0.0	34.1	19.9
93	STAR EXP 8921	STAR BRAND SEEDS		P S	113.6	59.2	22	2.3	42	0.0	0.0	33.3	20.4
34	PB 1928	PRAIRIE BRAND SEED INC		P S	113.4	59.1	21	2.3	39	0.0	0.0	34.2	19.6
39	JACQUES J-161	JACQUES SEED COMPANY		P S22	112.6	58.7	20	2.0	39	0.0	0.0	32.4	21.4
153	KENWOOD	IOWA A.E.S.		44	112.5	58.6	25	3.0	42	0.0	0.0	33.1	20.5
9	ATLAS 225	ATLAS SEED COMPANY		P S	112.3	58.5	23	2.0	39	0.0	0.0	32.7	21.0
95	STINE 2915	STINE SEED FARM, INC.		P S	111.4	58.1	24	2.3	38	0.0	0.0	32.3	21.6
53	LATHAM 570	LATHAM BROTHERS FARMS		P S45	111.2	57.9	22	2.0	36	0.0	0.0	33.9	19.8
7	ASGROW A2234	ASGROW SEED CO.	1K	P R30	110.5	57.5	23	2.0	38	0.0	0.0	33.9	20.2
5	ASGROW A1929	ASGROW SEED CO.	1K	P R	110.3	57.5	22	3.0	40	0.0	0.0	32.8	21.0
28	MUSTANG 1150	MUSTANG BRAND SEED		R	109.7	57.1	20	1.7	40	0.0	0.0	32.9	20.9
4	AGRIPRO AP2292	AGRIPRO	1C	P R	109.6	57.1	23	1.7	36	0.0	0.0	34.5	19.2
135	TF 1994	TILNEY FARMS		P S	109.3	57.0	19	2.3	40	0.0	0.0	34.8	19.1
64	MO 2960	MIDWEST OILSEEDS INC.		P S	109.2	56.9	26	2.3	38	0.0	0.0	34.9	19.2
145	ELGIN 87	IOWA A.E.S.	1K	R32	109.1	56.8	23	2.7	39	0.0	0.0	32.7	21.0
107	THOMPSON EX3200	THOMPSON AGRONOMICS INC. EX366		P S44	109.0	56.8	23	2.7	45	0.0	0.0	32.5	21.4
24	DIAMOND 89-1101	DIAMOND BRAND SEED COMPANY		P S	108.6	56.6	22	2.0	37	0.0	0.0	34.9	19.1
41	JACQUES 8824	JACQUES SEED CO.		P S	108.5	56.5	24	2.0	40	0.0	0.0	33.8	20.3
91	STAR 8820	STAR BRAND SEEDS		P S30	108.4	56.5	22	2.3	41	0.0	0.0	31.9	21.7
125	APACHE	SCHWITTERS SEED INC		P S	108.4	56.5	24	2.0	39	0.0	0.0	33.3	20.6
54	LATHAM 650	LATHAM SEED CO.		P S28	108.3	56.4	24	2.0	40	0.0	0.0	33.2	20.6
134	TF 1683	TILNEY FARMS EX-168		P S30	107.9	56.2	20	2.3	37	0.0	0.0	34.5	19.5
58	KE EXP.121023	KAISER ESTECH	1K	P R	107.4	56.0	22	1.3	39	0.0	0.0	32.4	21.3
42	JACQUES 8719	JACQUES SEED CO.		P S	107.4	56.0	19	2.0	38	0.0	0.0	32.9	21.1
45	K2100+	KRUGER SEED COMPANY		P S	107.2	55.8	22	2.0	41	0.0	0.0	33.2	20.8
99	TR 2318+	TERRA INTERNATIONAL, INC.		P R28	107.0	55.8	23	2.3	42	0.0	0.0	34.2	19.8
85	SX 1090	THE SEXAUER COMPANY		P R42	106.3	55.4	23	2.7	39	0.0	0.0	35.2	18.9
14	DSR-165	DAIRYLAND SEED COMPANY, INC.		P S	106.2	55.3	15	1.7	35	0.0	0.0	33.7	20.2
74	PIONEER 9202	PIONEER HI-BRED INTERNATIONAL INC.		P S38	105.5	55.0	23	2.0	40	0.0	0.0	32.3	21.3
97	STINE 2035	STINE SEED FARM, INC.		P S	105.4	54.9	23	2.3	40	0.0	0.0	34.2	19.8
103	THOMPSON T-30P	THOMPSON FARMS SEEDS	1C+SUS	P M	105.2	54.8	20	2.0	39	0.0	0.0	32.9	20.8
2	AGRIPRO AP1776	AGRIPRO		P R35	105.1	54.8	16	1.0	35	0.0	0.0	32.2	21.3
47	K1012+	KRUGER SEED COMPANY		P S	105.0	54.7	20	2.0	33	0.0	0.0	33.9	20.1
63	MO EX2110	MIDWEST OILSEEDS INC.		P S	105.0	54.7	24	2.0	38	0.0	0.0	33.4	20.6
76	SNSGRD EXP2062	SANSGAARD SEED FARMS.INC		P S	104.6	54.5	23	2.0	37	0.0	0.0	34.2	19.7
17	DSR-206	DAIRYLAND SEED COMPANY, INC.		P S	104.3	54.3	22	2.0	38	0.0	0.0	33.8	20.0
11	SBS-124	CUSTOM FARM SEED		P S	104.1	54.2	19	2.3	39	0.0	0.0	34.7	19.1
71	NK S20-26	NORTHRUP KING CO.	1C	P R	103.6	54.0	22	2.0	39	0.0	0.0	34.2	19.7
31	E-184	EHRICH SEED FARMS		P S	103.5	53.9	22	1.7	37	0.0	0.0	33.8	20.1
92	STAR EXP 8923	STAR BRAND SEEDS		P S	103.5	53.9	24	3.3	39	0.0	0.0	32.4	21.4

			1	2	3	4	5	6	7	8	9	10
ENT	HSN	PEDIGREE	PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL.
88	SIGCO 94	SIGCO RESEARCH INC.	P S	103.0	53.7	20	2.0	40	0.0	0.0	34.2	19.8
68	NK S15-50	NORTHRUP KING CO. 1C	P R45	102.9	53.6	23	2.3	44	0.0	0.0	32.2	21.6
19	CX264	DEKALB - PFIZER GENETICS	P S25	102.7	53.5	24	2.0	* 41	0.0	0.0	34.3	19.5
112	ZILLER EXP.652	ZILLER SEED CO.	P S	102.7	53.5	21	1.7	34	0.0	0.0	33.9	20.1
25	MUSTANG 1280BL	MUSTANG BRAND SEED	B M	102.6	53.4	23	2.3	40	0.0	0.0	34.0	20.9
114	ZILLER BT 1790	ZILLER SEED CO. EXP.43 1C	P R38	102.5	53.4	10	2.3	32	0.0	0.0	34.0	20.0
105	THOMPSON T-3187	THOMPSON FARMS SEEDS	B S	102.5	53.4	19	2.0	39	0.0	0.0	33.4	20.5
59	KE EXP. 510011	KAISER ESTECH	B S30	102.3	53.3	23	2.0	40	0.0	0.0	33.5	20.3
110	WIL'N BLEND 1880	WILSON HYBRIDS INC.	B M28	102.2	53.2	21	1.7	38	0.0	0.0	33.8	20.2
56	LATHAM 561	LATHAM SEED CO.	B S	102.1	53.2	25	2.3	41	0.0	0.0	34.1	19.8
49	K3220++	KRUGER SEED COMPANY	B S	101.9	53.1	22	2.0	40	0.0	0.0	33.1	20.5
104	THOMPSON T-3175	THOMPSON FARMS SEEDS	P S	101.9	53.1	17	2.0	39	0.0	0.0	32.4	21.4
16	DSR-196	DAIRYLAND SEED COMPANY, INC.	P S	101.8	53.0	22	2.0	36	0.0	0.0	33.5	20.1
38	GFS 101	GREEN FIELD SEED	P S	101.5	52.9	18	2.0	38	0.0	0.0	33.7	20.0
147	HARDIN	IOWA A.E.S.	R42	101.4	52.8	17	2.7	42	0.0	0.0	33.5	20.4
20	CX174	DEKALB - PFIZER GENETICS	P S40	101.3	52.8	23	2.7	39	0.0	0.0	33.4	20.4
75	SNSGRD EXP 1924	SANSGAARD SEED FARMS INC	P S	101.0	52.6	19	1.3	32	0.0	0.0	33.7	20.2
87	SX 2080	THE SEXAUER COMPANY	P R	101.0	52.6	23	2.0	38	0.0	0.0	34.5	19.5
138	ISGD 1888	ISGD	P S	100.9	52.6	23	2.0	41	0.0	0.0	33.9	19.9
94	STINE 1065	STINE SEED FARM, INC.	B S	100.8	52.5	23	2.3	35	0.0	0.0	33.0	20.9
62	MO 2500	MIDWEST OILSEEDS INC.	B S42	100.3	52.2	23	2.7	40	0.0	0.0	32.3	21.4
43	GOLD HVST H1170B	J.C.ROBINSON SEED CO.	B S	100.0	52.1	20	2.0	38	0.0	0.0	32.9	20.9
81	SDI 198	SAND SEED SERVICE, INC.	P S	100.0	52.1	23	2.0	39	0.0	0.0	31.5	22.2
36	PB 1818	PRAIRIE BRAND SEED INC	B S	99.9	52.0	19	2.3	38	0.0	0.0	33.1	20.8
122	HARTLAND	GOLD COUNTRY SEED 1K	P R	99.8	52.0	23	2.0	35	0.0	0.0	36.6	17.4
51	LATHAM 401	LATHAM BROS. FARM	B S22	99.7	51.9	21	1.3	37	0.0	0.0	33.8	19.9
89	SRF EXP 61830	SOYBEAN RESEARCH FOUNDATION RPS3	P R45	99.6	51.9	23	2.3	40	0.0	0.0	34.4	19.6
46	KALTENBERG KB231	KALTENBERG SEED FARMS	P S30	99.4	51.8	24	2.0	38	0.0	0.0	33.6	20.3
80	PS 1294	PROFISEED INC.	P R	99.4	51.8	24	3.0	47	0.0	0.0	34.0	19.9
116	S BRAND S42C	SCHECHINGER SEED COMPANY	P S	99.4	51.8	23	2.0	39	0.0	0.0	31.8	21.7
111	ZILLER EXP.57	ZILLER SEED CO.	P S	99.2	51.7	18	2.0	41	0.0	0.0	33.0	20.8
100	TERRA EXP.180+	TERRA INTERNATIONAL, INC.	B S32	99.0	51.6	19	2.0	37	0.0	0.0	33.5	20.2
109	PRESCOTT 108	WILLETTE SEED FARM INC. 1C+1	B R35	99.0	51.6	22	3.0	50	0.0	0.0	33.0	20.8
65	MO 1095	MIDWEST OILSEEDS INC.	B S	98.9	51.5	25	2.0	37	0.0	0.0	33.6	20.3
133	FUNKS G-3255	FUNK SEEDS INTERNATIONAL	P R	98.8	51.5	23	1.7	39	0.0	0.0	33.6	20.2
127	CHEROKEE	SCHWITTERS SEED INC	P S	98.5	51.3	19	2.0	38	0.0	0.0	33.2	20.6
115	S BRAND S170	SCHECHINGER SEED COMPANY	P S	98.1	51.1	21	1.3	32	0.0	0.0	33.1	20.7
37	GFS 206	GREEN FIELD SEED	P S38	97.9	51.0	18	1.7	37	0.0	0.0	34.1	19.6
131	LAKESIDE 106	ROESBACH LAKESIDE SEEDS	B R38	97.9	51.0	21	2.0	37	0.0	0.0	32.9	20.8
10	C/LOL L1700	CENEX/LAND O LAKES RPS6/RPS1	B R	97.8	51.0	21	2.0	36	0.0	0.0	32.7	20.9
32	E-240	EHRICH SEED FARMS	P S	97.7	50.9	22	2.0	42	0.0	0.0	33.5	20.4
66	NC+ 1L81	NC+ HYBRIDS	P S38	97.5	50.8	19	1.7	38	0.0	0.0	33.2	20.5
95	STINE EX1130	STINE SEED FARM, INC.	B S38	97.5	50.8	19	2.0	37	0.0	0.0	34.3	19.5
72	DIAMOND D150	DIAMOND BRAND SEED CO.	P S28	97.4	50.7	21	2.0	37	0.0	0.0	33.0	20.7
128	DS-3220	DAHLGREN & COMPANY INC	B S	97.1	50.6	24	2.0	37	0.0	0.0	31.3	22.3
60	KE 259	KAISER ESTECH	P S	96.8	50.4	26	1.3	35	0.0	0.0	35.4	18.7
102	THOMPSON T-11	THOMPSON FARMS SEEDS	P S42	96.7	50.4	19	1.7	34	0.0	0.0	32.5	21.2
76	ASGROW A2187	ASGROW SEED CO.	P R30	96.6	50.3	23	2.0	41	0.0	0.0	32.4	21.3
149	SIBLEY	MINNESOTA A.E.S.	R40	96.2	50.1	17	3.3	39	0.0	0.0	34.0	19.8

			1	2	3	4	5	6	7	8	9	10
ENT	HSN	PEDIGREE	PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
57	KE199	KAISER ESTECH KE EXP 111C09 1C	P R30	96.0	50.0	25	2.7	41	0.0	0.0	33.7	20.3
85	SX 1020	THE SEXAUER COMPANY	P R	96.0	50.0	24	3.0	45	0.0	0.0	34.7	19.2
35	PB 223B	PRAIRIE BRAND SEED INC	B S	95.9	50.0	24	2.3	40	0.0	0.0	34.3	19.7
132	FUNKS G-3197	FUNK SEEDS INTERNATIONAL	P S30	95.9	50.0	20	1.3	36	0.0	0.0	32.6	21.2
146	HACK	ILLINOIS A.E.S.	R40	95.9	50.0	25	2.0	38	0.0	0.0	33.4	20.4
69	NK S17-18	NORTHRUP KING CO.	P R	95.8	49.9	24	4.0	40	0.0	0.0	32.8	20.6
70	NK S19-90	NORTHRUP KING CO. 1C	P R	95.8	49.9	23	1.3	37	0.0	0.0	33.0	20.8
9	ASGROW A2543	ASGROW SEED CO. 1K	P R	95.6	49.8	25	1.3	33	0.0	0.0	36.7	17.4
118	S BRAND B170	SCHECHINGER SEED COMPANY	B S	95.4	49.7	23	2.0	38	0.0	0.0	33.2	20.4
77	MUSTANG 1180BL	MUSTANG BRAND SEED	P M	95.3	49.7	17	2.0	38	0.0	0.0	32.9	20.8
40	JACQUES J-231	JACQUES SEED CO. J-2386 EB4100	P R30	95.3	49.6	23	2.3	39	0.0	0.0	33.7	20.1
16	CX187	DEKALB-PFIZER GENETICS	P S35	95.1	49.6	19	1.3	38	0.0	0.0	33.3	20.6
67	NC+ 1K98	NC+ HYBRIDS	P R32	94.9	49.5	23	2.7	42	0.0	0.0	34.1	19.7
29	E-167	EHRICH SEED FARMS INC	P S	94.9	49.4	16	2.0	37	0.0	0.0	33.9	19.6
152	STURDY	MINNESOTA A.E.S.	R22	94.9	49.4	22	1.7	38	0.0	0.0	33.4	20.5
121	PROSPER	GOLD COUNTRY SEED	P R	94.8	49.4	18	2.0	38	0.0	0.0	35.0	18.9
99	RUNNER III+	TERRA INTERNATIONAL	B S30	94.8	49.4	18	2.0	35	0.0	0.0	32.6	21.1
44	GOLD HVST X235	J.C.ROBINSON SEED CO.	B S30	94.5	49.2	22	2.3	38	0.0	0.0	33.7	20.0
72	PIONEER 9161	PIONEER HI-BRED	P S40	94.4	49.2	17	2.0	37	0.0	0.0	33.6	20.1
136	ISGD 2450	ISGD 1C	P R	94.4	49.2	14	2.0	35	0.0	0.0	33.5	20.2
150	WEBER 84	IOWA A.E.S.	R25	94.4	49.2	20	3.3	42	0.0	0.0	32.3	21.4
139	ISGD BSR 2530	ISGD 1C	P R	94.3	49.1	20	1.7	41	0.0	0.0	35.2	18.9
140	KE 156	KAISER ESTECH	P S38	94.2	49.1	20	1.7	38	0.0	0.0	33.1	20.7
45	KALTENBERG KB116	KALTENBERG SEED FARMS	P S35	94.0	49.0	20	2.0	38	0.0	0.0	32.7	21.1
144	CORSOY 79	ILLINOIS A.E.S. 1C	R40	93.5	48.7	21	2.3	44	0.0	0.0	33.6	20.2
126	COMMANCHE	SCHWITTERS SEED INC	P S	93.5	48.7	17	1.7	36	0.0	0.0	33.8	20.0
129	ROWKING	HY-VIGOR SEEDS, INC. 1C	P R	92.8	48.4	20	2.3	45	0.0	0.0	33.2	20.5
73	PIONEER 9181	PIONEER HI-BRED INTERNATIONAL 1C	P R28	92.2	48.0	19	2.3	34	0.0	0.0	35.3	18.5
141	KE 212	KAISER ESTECH	P S38	92.2	48.0	25	2.7	42	0.0	0.0	34.3	19.5
77	PS 1140	PROFISEED INC.	P R	92.1	48.0	21	2.3	40	0.0	0.0	34.7	19.4
117	ZILLER ST 2650	ZILLER SEED CO.	P S28	91.8	47.8	18	2.0	38	0.0	0.0	33.4	20.3
142	CENTURY 84	INDIANA A.E.S.	S38	91.6	47.7	24	2.0	39	0.0	0.0	37.0	17.2
123	ECHO	GOLD COUNTRY SEED 1C	P R	91.3	47.6	19	2.0	40	0.0	0.0	34.2	19.8
97	SSI 285	SAND SEED SERVICE, INC.	P S32	91.1	47.4	21	2.3	41	0.0	0.0	33.0	20.9
25	DIAMOND 89-2102	DIAMOND BRAND SEED COMPANY	P S	90.1	47.0	21	1.7	33	0.0	0.0	33.1	20.6
13	CFS 213	CUSTOM FARM SEED	P S28	90.0	46.9	22	2.0	42	0.0	0.0	33.7	20.1
124	ACTION	GOLD COUNTRY SEED	P S	90.0	46.9	22	1.7	36	0.0	0.0	32.4	21.3
94	SSI 166	SAND SEED SERVICE INC	P S	89.9	46.8	19	1.7	37	0.0	0.0	33.3	20.6
78	PS 2199	PROFISEED INC.	P S32	88.9	46.3	18	2.0	38	0.0	0.0	33.0	20.9
33	PB 171B	PRAIRIE BRAND SEED INC	B S	88.6	46.2	20	2.0	36	0.0	0.0	32.7	21.1
3	AGRIPRO AP2021	AGRIPRO 1C	P R28	88.3	46.0	20	1.7	39	0.0	0.0	32.6	21.2
130	H-V K-A2190	HY-VIGOR SEEDS, INC.	P S	88.3	46.0	22	2.3	38	0.0	0.0	33.3	20.4
55	LATHAM 2008	LATHAM SEED CO.	P S30	87.7	45.7	17	2.0	36	0.0	0.0	33.5	20.1
53	LATHAM 120	LATHAM BROTHERS FARMS EX120	P S45	87.5	45.6	16	2.0	34	0.0	0.0	34.5	19.6
131	TERRA EXP.085+	TERRA INTERNATIONAL, INC.	B R20	86.6	45.1	7	2.0	39	0.0	0.0	35.1	18.9
151	KATO	MINNESOTA A.E.S.	R23	85.9	44.8	16	1.7	39	0.0	0.0	35.4	18.6
120	DAHLMAN 1990	DAHLMAN SEED COMPANY	P S	85.6	44.6	17	1.3	40	0:0	0.0	33.1	20.9
143	HODGSON 78	MINNESOTA A.E.S.	R30	85.5	44.5	13	2.3	40	0.0	0.0	33.6	20.5
15	DSR-170	DAIRYLAND SEED COMPANY, INC.	P S	85.0	44.3	17	1.7	39	0.0	0.0	33.5	20.4
23	DIAMOND D200	DIAMOND BRAND SEED COMPANY	P S28	84.9	44.2	20	1.7	38	0.0	0.0	34.8	19.3
137	ISGD 2290	ISGD 1C	P R	84.3	43.9	17	1.0	36	0.0	0.0	34.3	19.6
36	E-198	EHRICH SEED FARMS	P S	82.9	43.2	21	2.0	37	0.0	0.0	34.8	19.2
61	RIVERSIDE 1405	MCCURDY SEED CO.	P S32	81.2	42.3	22	2.3	40	0.0	0.0	33.4	20.4
119	SUMMIT	LUNDQUIST SEED INC	P S	80.7	42.1	10	3.0	44	0.0	0.0	33.0	20.9
12	CFS 159	CUSTOM FARM SEED	P S30	73.2	38.1	21	1.7	40	0.0	0.0	~~33.4~~ 6.1	20.4

Table 6. Uniforn Regional Trial - Group I Varieties. Waseca 1989.

	DF	SS	MS	F
REP	2	4263.56	2131.78	34.32
TRT	20	1744.78	87.24	1.40
ERROR	40	2484.30	62.11	

CV = 13.4
LSD.05 = 13.0
YIELD MEAN = 58.7

RANKING BY YIELD

			1	2	3	4	5	6	7	8	9	10
ENT	NSN	PEDIGREE	PHY-CHL	MEAN%	YIELD	MAT	LDG	HT	QUAL	SDWT	PRO	OIL
16	M84-916	A79-136012 X DAWSON	R35	122.3	71.8	22	3.0	45	1.3	19.1	32.2	19.3
17	M84-1034	M75-2 X K1062	? RPS3 RPS(HIGAN) R35	113.0	66.3	21	2.7	37	1.3	18.1	32.7	18.9
13	M83-108	HODGSON 78 X PELLA	R35	110.3	64.7	21	2.7	41	1.0	17.9	33.0	18.8
15	M83-899	II-74-270 X A78-123018	R39	106.3	62.4	22	3.7	48	1.3	16.4	31.5	19.7
2	BSR 101	L69U40-16-4 X A76-304020	R30	105.3	61.9	24	3.0	40	1.3	18.2	31.7	19.5
5	STURDY	II-70-127 X CENTURY	R22	105.3	61.8	23	3.0	40	1.3	19.1	33.1	18.8
8	A87-198005	A80-244003 X HARPER	35	103.5	60.7	20	3.0	38	1.3	18.0	33.6	18.4
12	M82-559	VICKERY X CENTURY	1C R34	103.3	60.6	17	1.7	35	1.7	17.7	34.4	17.9
1	ABSR 101			102.6	60.2	24	3.0	42	1.7	17.8	32.8	18.9
21	HARDIN	CORSOY*3 X CUTLER 71	R41	102.2	60.0	19	3.3	47	1.3	15.3	32.2	19.4
20	KATO	II-70-127 X CENTURY	R23	100.3	58.9	16	2.7	43	1.0	21.1	35.6	17.2
19	ORC 8601			100.0	58.7	14	3.3	40	1.3	17.1	32.4	19.1
4	SIBLEY	M68-256 X HODGSON	R40	97.6	57.3	19	3.3	40	1.3	17.3	33.5	18.5
9	E86-237	PROSOY P5104 X HW8028	35	95.9	56.3	19	2.7	43	1.3	16.7	32.9	18.9
14	M83-830	EVANS X CENTURY	R24	94.6	55.5	19	2.0	36	1.3	17.1	32.9	18.9
18	M85-610	FAYETTE X MCCALL	SCN 0.0 S32	93.5	54.9	22	3.3	42	1.3	15.1	34.2	18.0
6	A87-195024	A81-157024 X CN 290	SCN	92.1	54.1	24	3.3	39	1.3	19.0	32.3	19.2
10	LN85-874	FAYETTE X LN80-10398	28	91.8	53.9	23	3.7	38	1.3	19.9	34.0	18.2
7	A87-195034	BSR 101 X CN 210		91.0	53.4	27	3.0	42	1.3	17.6	31.8	19.5
11	M82-106	II-73-105 X VICKERY	1C R24	86.9	51.0	19	2.3	38	1.7	15.5	34.5	17.9
3	GLENWOOD	EVANS X PETERSON 85	R30	82.4	48.4	3	1.7	32	2.0	16.7	34.2	18.0

See footnote at bottom of Table 7.

Table 7. Uniforn Regional Trial - Group II Maturity. Waseca 1989.

	DF	SS	MS	F
REP	2	1023.66	511.83	11.67
TRT	32	3667.16	114.60	2.61
ERROR	64	2807.91	43.87	

CV = 10.8
LSD.05 = 10.9
YIELD MEAN = 61.4

RANKING BY YIELD

ENT	NSN	PEDIGREE	1 PHY-CHL	2 MEAN%	3 YIELD	4 MAT	5 LDG	6 HT	7 QUAL	8 SDWT	9 PRO	10 OIL
23	MN84-6247	ZANE (3) X MN79149	38	119.1	73.2	27	3.0	44	1.3	17.3	32.8	19.4
17	E86315			118.0	72.5	25	2.3	45	1.7	18.4	32.4	19.6
2	KENWOOD	ELGIN X ASGROW A1937	44	112.8	69.3	26	3.0	46	1.3	15.4	31.9	19.8
20	MN8625			110.2	67.7	27	2.0	42	1.3	20.1	33.4	19.0
12	A87-198015			107.0	65.7	26	2.3	40	1.3	16.4	33.8	18.7
11	A87-196014			106.9	65.7	26	2.0	44	1.0	15.9	32.1	19.7
24	LN84-8147			106.9	65.7	28	2.7	41	1.3	17.2	33.1	19.1
5	A86-103002	JACQUES J103 X A81-356022	30	106.4	65.4	27	1.7	41	1.7	17.5	34.4	18.3
18	E86339			106.4	65.3	25	2.3	41	2.0	17.2	32.8	19.3
7	A86-204022	HACK X ZANE	32	106.1	65.2	30	3.0	45	1.7	17.7	33.9	18.6
6	A86-203034	A81-356022 X ZANE	35	105.6	64.9	30	3.7	47	1.3	18.7	33.7	18.9
29	ORC-8502			105.5	64.8	23	1.3	44	1.3	18.5	33.4	19.0
3	STURDY	11-70-127 X CENTURY	R22	104.8	64.3	23	2.7	43	1.3	18.5	32.9	19.3
33	M85-1292	BSR 201 X DAWSON	R32	103.1	63.3	23	4.0	44	1.3	16.9	31.5	20.2
9	A87-187020			102.7	63.1	25	2.7	39	1.7	15.2	32.5	19.5
32	M85-647	OZZIE X FAYETTE	SCN 0.4 R35	101.0	62.0	24	3.0	43	1.3	15.5	35.0	18.0
27	LN85-10234			100.7	61.9	30	3.3	46	2.0	17.4	32.8	19.2
19	E86349			99.3	61.0	27	2.7	44	1.7	18.7	32.3	19.7
25	LN85-6253			98.5	60.5	29	3.0	47	1.7	16.8	33.9	18.6
30	U85-63023			97.6	60.0	26	3.0	40	2.0	20.1	34.6	18.2
8	A87-187007			97.3	59.7	24	3.0	40	2.3	15.9	33.4	19.8
28	LN85-10524			97.0	59.6	25	3.7	40	1.7	16.4	32.8	19.3
31	U85-64055			96.5	59.3	29	3.0	50	2.0	18.8	32.7	19.4
26	LN85-6377			96.4	59.2	30	3.0	45	2.0	16.4	34.4	18.4
22	MN8735			94.9	58.3	23	4.0	49	1.3	16.7	35.6	17.6
15	C1732			93.8	58.2	30	2.3	43	1.3	18.8	35.3	17.7
16	C1736			94.2	57.9	30	2.3	47	1.7	16.2	34.1	18.5
4	LN83-3824-1	FAYETTE X HARDIN	SCN	94.2	57.8	30	3.0	49	1.3	13.8	32.0	19.8
1	BURLISON	K74-113-76-436 X CENTURY	RPS3+1B R25	91.9	56.5	30	3.0	42	1.3	19.1	36.1	17.0
13	A87-297015			91.8	56.4	30	2.3	42	1.7	19.0	33.3	19.0
21	MN8734			85.1	52.3	27	3.0	47	1.3	16.1	33.3	19.0
10	A87-195032			74.7	45.9	27	3.7	50	1.7	16.9	30.9	20.6
14	A87D20			72.6	44.6	25	1.3	41	1.7	15.2	33.0	19.2

1 = Phytopthora - Chlorosis score; R=resistant S=susceptible
1=excellent 5=poor.

2 = % of Average yield.

3 = Yield bu/A.

4 = Maturity; days after Aug 30.

5 = Lodging; 1=erect 5=flat.

6 = Plant height in inches.

7 = Seed quality Score; 1=excellent 5=poor.

8 = Seed weight; grams/100 seeds.

9 = Protein %.

10 = oil %.

EFFECT OF SOYBEAN SEED TREATMENTS ON PHYTOPHTHORA ROOT ROT

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OBJECTIVE: The object of this study was to evaluate seed treatment products for the control of Phytophthora Root Rot (PRR) on stand and yield.

PROCEDURES: Seed of three varieties: Corsoy 79, BSR 101 and II-54-254 were treated, counted, prepackaged and planted (May 9) in a randomized complete block design. Four replicates were planted with a plot size of 10 x 12 ft. The seeding rate was 7 seeds per foot and seeds were planted with a cone-type seeder, 4 rows at 30 inches. Most seed treatments were applied with a Gustafson laboratory batch seed treater at the recommended rates. All seed was produced in 1988 and only II-54-254 was not certified. Prior to emergence of the soybeans a 5 foot section of each of two center rows was staked. This area was used for taking stand counts throughout the season. The study was on a Webster clay loam soil with high organic matter, adequate P and K levels, well drained and tiled. Little rain fell early in the season. The three soybean varieties: Corsoy 79 is most resistant-Rps 1c gene and BSR 101 is intermediate-Rps 1 gene, while II-54-254 is least resistant-no major gene for PRR control.

RESULTS: Disease level at this site was very low and few plants were observed with PRR. While above ground symptom are scarce some loss due to PRR was present. The addition of more untreated seed (10 seeds/ft) did produce higher plant populations all season long it did not result in a yield increase. Significant yield difference is reported for the biological treatment-Nitragin-Peat Powder only. The reason for this is not clearly understood as other formulations of the same bacteria did not perform as well. The response is not believed to be entirely due to disease. Seed treatment did not generally affect plant stand, height, lodging or yield. Final populations near 100,000 plants per acre are adequate for maximum yields, yet root damage from PRR can reduce soybean yield.

1989 Soybean Seed Treatment Study Waseca

			Plant Population						Plant			
Trt	Variety	Seed Treatment	5/15	5/22	5/24	5/26	5/30	Mature	Height	Lodg	Yield	H20
			1000's/A					(1)	inches	(2)	bu/A	%
1	II-54-254	Apron	15.6	81.0	106.3	111.1	123.7	100.6	37.8	1.5	49.0	7.9
2	II-54-254	Nitragin - Peat Powder	13.9	65.8	88.0	91.5	103.7	90.6	38.0	2.0	54.8	7.8
3	II-54-254	Nitragin - Clay Gran	14.8	66.2	92.8	97.6	105.4	90.2	37.5	1.5	48.1	7.8
4	II-54-254	Nitragin - Peat Gran	22.6	70.6	93.2	94.5	112.4	97.1	39.5	1.8	52.3	7.8
5	II-54-254	Nitragin - Co. Applied	10.0	72.3	94.5	97.6	107.2	93.2	37.2	1.8	45.4	8.0
6	II-54-254	Vitavax	12.2	79.7	98.9	101.9	117.2	100.2	38.2	1.5	44.1	8.0
7	II-54-254	Rival	7.4	61.0	76.2	81.0	91.9	85.8	39.8	2.0	50.9	7.9
8	II-54-254	Rival + Apron	8.7	77.1	107.2	110.2	123.7	107.6	37.5	1.5	46.8	7.8
9	II-54-254	Rival + Apron + Anchor	12.2	68.0	94.1	97.1	103.2	95.4	39.2	1.8	52.7	8.1
10	II-54-254	Rival + Magnum	9.6	68.9	93.6	99.3	109.8	98.4	38.0	1.2	43.4	7.8
11	II-54-254	Thiram + TBZ + PCNB	14.0	72.3	99.3	101.9	111.5	109.4	38.0	1.8	49.8	7.9
12	II-54-254	Apron + Captan	5.2	54.4	79.7	85.8	92.8	91.0	39.2	1.8	46.5	8.0
13	II-54-254	YEA	10.0	55.8	84.1	87.5	92.3	93.2	38.5	1.5	46.4	7.9
14	II-54-254	Check 7 seeds/ft	14.4	60.1	84.1	84.1	97.6	88.4	38.2	2.0	51.0	7.7
15	II-54-254	Check 10 seeds/ft	15.3	90.6	123.3	129.0	138.5	105.0	39.0	1.8	47.4	7.9
16	BSR 101	Apron	12.2	71.4	95.0	97.6	104.5	98.9	40.5	1.5	58.5	7.9
17	BSR 101	Nitragin - Peat Powder	13.5	69.7	90.2	94.5	101.5	93.6	39.5	1.8	63.8	7.9
18	BSR 101	Nitragin - Clay Gran	9.2	75.4	93.2	96.7	103.2	89.3	39.0	1.8	57.8	8.0
19	BSR 101	Nitragin - Peat Gran	14.8	68.4	91.5	93.6	101.5	93.8	34.5	1.2	52.6	7.8
20	BSR 101	Nitragin - Co. Applied	16.6	84.1	105.4	102.8	108.0	89.7	37.8	1.0	57.6	7.8
21	BSR 101	Vitavax	10.9	73.6	98.4	99.4	111.9	95.0	37.2	1.0	57.2	8.0
22	BSR 101	Rival	10.4	67.0	94.6	97.6	110.2	93.2	39.5	1.5	58.6	8.1
23	BSR 101	Rival + Apron	6.6	69.2	90.6	95.4	103.7	91.0	38.5	1.2	62.7	8.2
24	BSR 101	Rival + Apron + Anchor	6.1	56.2	88.9	91.0	98.0	90.6	37.2	1.0	57.9	7.9
25	BSR 101	Rival + Magnum	6.5	75.4	101.1	104.1	115.4	101.5	38.5	1.2	59.5	8.0
26	BSR 101	Thiram + TBZ + PCNB	19.2	87.1	113.7	115.0	119.4	101.9	38.5	1.5	55.5	8.0
27	BSR 101	Apron + Captan	9.6	78.4	116.8	122.4	129.8	100.2	36.2	1.0	59.4	8.0
28	BSR 101	YEA	12.6	64.9	87.6	90.2	103.7	88.4	37.2	1.2	61.4	7.8
29	BSR 101	Check 7 seeds/ft	10.9	78.8	105.8	111.0	116.8	97.0	38.8	1.5	62.5	7.9
30	BSR 101	Check 10 seeds/ft	16.6	95.0	128.9	133.7	147.6	109.8	37.8	1.2	58.2	7.9
31	Corsoy 79	Apron	22.6	95.8	115.0	113.2	117.6	101.1	44.2	2.0	53.5	7.9
32	Corsoy 79	Nitragin - Peat Powder	28.8	78.4	91.0	92.4	97.1	87.1	46.0	2.2	62.3	7.9
33	Corsoy 79	Nitragin - Clay Gran	27.4	81.9	93.2	93.7	97.6	86.7	46.8	2.0	57.3	7.9
34	Corsoy 79	Nitragin - Peat Gran	31.4	96.3	110.2	108.5	112.4	97.1	44.8	2.0	48.2	7.7
35	Corsoy 79	Nitragin - Co. Applied	20.0	88.4	105.4	107.6	109.8	95.8	45.0	2.0	55.9	8.0
36	Corsoy 79	Vitavax	27.9	94.1	112.8	113.7	112.8	94.5	45.8	2.2	60.4	7.9
37	Corsoy 79	Rival	26.2	89.3	105.0	108.4	115.0	97.2	45.2	1.5	48.9	7.9
38	Corsoy 79	Rival + Apron	18.7	90.6	105.0	107.6	115.0	101.1	44.4	2.0	55.6	7.8
39	Corsoy 79	Rival + Apron + Anchor	22.2	93.6	107.2	106.7	114.2	102.0	42.0	2.0	50.2	7.8
40	Corsoy 79	Rival + Magnum	19.6	99.8	115.4	117.2	120.6	109.8	45.5	2.2	56.3	7.8
41	Corsoy 79	Thiram + TBZ + PCNB	28.7	98.9	110.6	109.4	113.7	98.9	45.5	2.2	55.8	7.9
42	Corsoy 79	Apron + Captan	30.5	87.1	102.4	102.8	109.4	95.4	44.2	2.2	52.9	7.9
43	Corsoy 79	YEA	28.8	82.3	98.4	100.2	102.4	90.2	45.2	1.8	55.4	7.7
44	Corsoy 79	Check 7 seeds/ft	23.5	85.8	101.5	103.2	107.2	93.6	44.8	2.2	51.3	7.8
45	Corsoy 79	Check 10 seeds/ft	47.9	114.6	145.0	137.6	149.0	118.0	45.8	2.5	58.2	7.8

Average for Variety:

II-54-254	12.4	69.6	94.4	98.0	108.7	96.4	38.4	1.7	48.6	7.9
BSR 101	11.7	74.3	100.1	103.0	111.7	95.6	38.0	1.3	58.9	7.9
Corsoy 79	26.9	91.8	107.9	108.1	112.9	97.9	45.0	2.1	54.8	7.8
LSD (0.05)	2.9	4.5	5.0	4.7	ns	ns	0.9	0.1	2.2	0.1

Average for Seed Treatment:

Apron	16.8	82.7	105.4	107.3	115.3	100.2	40.8	1.7	53.7	7.9
Nitragin - Peat Powder	18.7	71.3	89.7	92.8	100.8	90.4	41.2	2.0	60.3	7.9
Nitragin - Clay Gran	17.1	74.5	93.1	96.0	102.1	88.7	41.1	1.8	54.4	7.9
Nitragin - Peat Gran	22.9	78.4	98.3	98.9	108.8	96.0	39.6	1.7	51.0	7.8
Nitragin - Co. Applied	15.5	81.6	101.8	102.7	108.3	92.9	40.0	1.6	53.0	7.9
Vitavax	17.0	82.5	103.4	105.0	114.0	96.6	40.4	1.6	53.9	8.0
Rival	14.7	72.4	91.9	95.7	105.7	92.1	41.5	1.7	52.8	8.0
Rival + Apron	11.3	79.0	100.9	104.4	114.1	99.9	40.1	1.6	55.0	7.9
Rival + Apron + Anchor	13.5	72.6	96.7	98.3	105.1	96.0	39.5	1.6	53.6	7.9
Rival + Magnum	11.9	81.4	103.4	106.9	115.3	103.2	40.7	1.5	53.1	7.9
Thiram + TBZ + PCNB	20.6	86.1	107.9	108.8	114.9	103.4	40.7	1.8	53.7	7.9
Apron + Captan	15.1	73.3	99.6	103.7	110.7	95.5	39.9	1.7	52.9	8.0
YEA	17.1	67.7	90.0	92.6	99.5	90.6	40.3	1.5	54.4	7.8
Check 7 seeds/ft	16.3	74.9	97.1	99.4	107.2	93.0	40.6	1.9	54.9	7.8
Check 10 seeds/ft	26.6	100.1	132.4	133.4	145.0	110.9	40.9	1.8	54.6	7.9
LSD (0.05)	6.4	10.0	11.2	10.6	10.6	9.6	ns	ns	4.9	ns

Variety x Seed Treatment:

Level of Significance (P>F)	0.33	0.38	0.19	0.08	0.04	0.93	0.51	0.36	0.16	0.86

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(1) Mature = Days past July 31 when 90% of pods were brown

(2) Lodg = Lodging score: 1 = erect; 5 = flat

Herbicide performance in soybeans at Waseca, MN - 1989. Gunsolus, Jeffrey L. and William E. Lueschen. The purpose of this experiment was to evaluate various soil applied and postemergence herbicides and herbicide additive combinations for efficacy and soybean tolerance. Oats were grown in 1988 and the plot area was chisel plowed in the fall of 1988 and field cultivated in the spring of 1989. No fertilizer was applied. The soil was a Webster clay loam with 6.6% organic matter, pH 7.2, and a P and K soil test of 70 and 440, respectively. All herbicides were applied with a self-propelled plot sprayer that delivered 20 gpa at 3 mph, using 8002 flat-fan nozzles. Postemergence broadleaf herbicides were applied at 40 psi and soil-applied herbicides were applied at 30 psi. Preplanting herbicide applications were incorporated to a depth of 2 to 3 inches by two passes with a field cultivator and harrow set 3 to 4 inches deep. The two incorporations were done in opposite directions to each other. On May 12, 'Glenwood' soybeans were planted 1.5 inches deep at 150,000 seeds/A. A randomized complete block design with four replications was used. Plots were 10 by 30 ft and contained four 30-inch rows. The entire postemergence broadleaf herbicide study (see Table 2) was treated on May 26 with 0.19 lb/A of sethoxydim + COC to prevent grass weeds from interfering with the study. Control with sethoxydim + COC was not complete. In the preplant incorporated study weed densities/ft^2 were 50 giant foxtail, 3 common lambsquarters, 2 common ragweed, and 1 velvetleaf. In the postemergence studies, weed densities/ft were 30 giant foxtail, 9 common lambsquarters, 15 common ragweed, 0.5 velvetleaf, and 3 redroot pigweed. Weed control, crop injury, and stand reduction evaluations were taken visually on June 13 and September 19 for all preplant incorporated treatments. Postemergence broadleaf herbicide applications were evaluated on June 13 for crop injury and stand reduction and were evaluated June 13 and July 3 for weed control. Total postemergence herbicide applications were evaluated on July 3 and September 19. Plots in the second through fourth replications were cultivated after the visual ratings were taken and yield data were obtained from 25 ft of the two center rows of these plots. Yield data were corrected to 13% moisture and are presented in the table. Application dates, environmental conditions, and plant sizes are listed below:

Date	May 12	May 26	June 5	June 6	June 9	June 16
Treatment	PPI	E. post	Post bdlf	Total post	Post sequential	Total post
Temperature (F)						
air	68	70	77	79	62	70
soil (4 inch)	61	65	72	75	63	72
Soil moisture	medium	medium	dry	dry	dry	dry
Wind (mph)	5 E	15-20 SW	22 SW	0-5 NW	0-5 NW	0-5 NE
Sky	-	-	-	-	-	-
Relative humidity (%)	55	50	35	45	55	45
Rainfall before application						
Week 1 (inch)	0.37	0.50	0.10	0.10	0.10	0.33
Rainfall after application						
Week 1 (inch)	0.36	T	0.21	0.21	0.33	0.04
Week 2 (inch)	0.50	0.10	0.12	0.12	0.04	-
Soybeans						
leaf no.	-	cotyl	1 trifol	1 trifol	1 trifol	2 trifol
height (inch)	-	1	3	3	4	5
Giant Foxtail						
leaf no.	-	1-2	-	1-3	1-3	1-2
height (inch)	-	0.5-1	-	1-3	1-3	0.5-1
Redroot pigweed						
leaf no.	-	-	2-6	2-6	2-6	4-8
height (inch)	-	-	1-2	1-2	1-2	3-4
Common Ragweed						
leaf no.	-	-	2-4	2-4	2-4	2-6
height (inch)	-	-	1-2	1-2	1-2	3-4
Velvetleaf						

leaf no.	-	-	1-4	1-4	2-3	3-4
height (inch)	-	-	1-2	1-2	1-2	2-4
Common lambsquarters						
leaf no.	-	-	1-6	1-6	4-8	4-8
height (inch)	-	-	1-2	1-2	1-2	2-3

Dry weather conditions reduced the efficacy and crop yield of many soil and postemergence treatments. DPX-M6316 + X-77 + 28% N at 0.004 lb/A + 0.125% + 1.25% provided good control of common lambsquarters and redroot pigweed, however, common ragweed and velvetleaf control was poor. The tank mixture of DPX-M6316 + bentazon + X-77 +28%N resulted in excellent control of all four broadleaf species. In the total postemergence study, the early postemergence treatments were more efficacious and resulted in higher grain yields than the late postemergence treatments. At the early postemergence application date, the additive combination of Sun-It + 28% N improved the performance of imazethapyr when compared to imazethapyr + X-77. Imazethapyr + bentazon + X-77 + 28% N, when applied early postemergence, was also one of the more efficacious total postemergence treatments. (Minn. Agric. Exp. Stat., University of Minnesota, St. Paul).

Table 1. Waseca preplant incorporated soybean treatments - 1989 (Gunsolus and Lueschen).

		Weed control						Soybean		
		Gift		Colq	Corw		Vele	Injury	Stand[a]	
Treatment[b]	Rate[b]	6/13	9/19	6/13	6/13	9/19	6/13	6/13	6/13	Yield
	(lb/A)				(%)					(Bu/A)
Preplant incorporated (May 12)										
CGA-144155	3.0	94	85	48	20	26	18	0	0	7
Metolachlor & CGA-144155[c]	1.5 & 1.5	98	89	73	15	25	15	0	0	7
Metolachlor	3.0	98	95	75	10	10	13	0	0	5
Clomazone	1.0	93	81	73	62	54	92	0	0	15
Trifluralin	0.75	90	95	86	8	18	20	0	0	6
Imazethapyr	0.063	83	71	93	77	70	88	0	0	24
Clomazone + metribuzin	1.0 + 0.38	95	89	94	91	88	92	1	0	28
Clomazone + imazethapyr	1.0 + 0.032	91	91	95	76	71	96	0	0	22
Clomazone + trifluralin	0.75 + 0.75	97	91	91	44	44	87	0	0	16
Preplant incorporated (May 12) and Postemergence (June 6)										
(Imazethapyr) + (imazethapyr + surf[d] + 28%N[e])	(0.032) + (0.032 + 0.25% + 1.25%)	78	65	90	60	88	76	4	0	27
(Clomazone) + (chlorimuron + surf)	(1.0) + (0.003 + 0.25%)	92	74	93	73	83	97	1	0	25
(Clomazone) + (chlorimuron + surf)	(1.0) + (0.005 + 0.25%)	91	66	94	73	92	93	5	0	26
(Clomazone) + (imazethapyr + surf + 28%N)	(1.0) + (0.032 + 0.25% + 1.25%)	92	92	85	72	81	93	1	0	25
(Clomazone) + (lactofen + COC[f])	(1.0) + (0.125 + 0.625%)	95	76	78	99	96	99	24	0	29
Weedy check		--	--	--	--	--	--	--	-	5
Weedfree check		--	--	--	--	--	--	--	-	31
LSD (0.05)		8	19	24	18	22	11	7	ns	6

[a] Stand = stand reduction.
[b] Treatments and rates in parenthesis represent a single application.
[c] Premix.
[d] surf = X-77 surfactant from Chevron.
[e] 28%N = 28% UAN fertilizer solution.
[f] COC = Class 17% crop oil concentrate.

Table 2. Waseca postemergence broadleaf study - 1989 (Gunsolus and Lueschen).

		Weed control								Soybean		
		Colq		Corw		Rrpw		Vele		Injury	Stand[a]	
Treatment	Rate	6/13	7/3	6/13	7/3	6/13	7/3	6/13	7/3	6/13	6/13	Yield
	(lb/A)	----------	----------	----------	----------	(%)	----------	----------	----------	----------	----------	(Bu/A)
Postemergence (June 5)[b]												
Lactofen + COC[c]	0.2 + 0.312%	80	--	100	--	100	--	98	--	25	0	23
Lactofen + COC	0.2 + 0.625%	62	--	98	--	100	--	96	--	28	0	20
Lactofen + COC	0.2 + 1.25%	83	--	100	--	100	--	99	--	29	0	23
Lactofen + 28%N[d]	0.2 + 5.0%	50	--	99	--	100	--	96	--	18	0	22
Bentazon + COC	0.5 + 1.25%	94	--	86	--	69	--	95	--	0	0	19
Bentazon + COC + 28%N	0.5 + 1.25% + 5.0%	94	--	90	--	61	--	94	--	0	0	19
Bentazon + acifluorfen + COC	0.5 + 0.25 + 1.25%	99	--	98	--	99	--	99	--	6	0	26
DPX-M6316 + surf[e] + 28%N	0.004 + 0.125% + 1.25%	83	93	60	53	96	98	78	58	0	0	14
DPX-M6316 + surf + 28%N	0.003 + 0.125% + 1.25%	79	86	50	43	97	97	71	43	0	0	11
DPX-M6316 + surf + 28%N	0.002 + 0.125% + 1.25%	63	63	45	33	94	96	60	35	0	0	12
Bentazon + DPX-M6316 + surf + 28%N	0.5 + 0.004 + 0.125% + 1.25%	99	97	94	91	94	96	98	95	1	0	23
Lactofen + DPX-M6316 + surf	0.2 + 0.004 + 0.125%	78	82	97	97	98	98	98	84	15	0	25
acifluorfen + DPX-M6316 + surf	0.25 + 0.004 + 0.125%	69	61	76	53	96	98	70	39	0	0	15
Lactofen + bentazon + COC	0.15 + 0.5 + 0.625%	100	--	100	--	100	--	100	--	23	0	24
Lactofen + bentazon + 28%N	0.15 + 0.5 + 5.0%	100	--	100	--	100	--	100	--	16	0	25
Lactofen + bentazon + surf + 28%N	0.15 + 0.5 + 0.25% + 5.0%	99	--	100	--	100	--	99	--	23	0	25
Fomesafen + COC	0.188 + 1.0%	74	--	86	--	98	--	89	--	3	0	23
Fomesafen + bentazon + surf	0.188 + 0.5 + 0.5%	99	--	96	--	100	--	98	--	5	0	26
Fomesafen + bentazon + COC	0.188 + 0.5 + 1.0%	98	--	98	--	100	--	99	--	3	0	24
Fomesafen + bentazon + surf + 28%N	0.188 + 0.5 + 0.5% + 5.0%	100	--	100	--	100	--	100	--	10	0	27
Fomesafen + bentazon + COC + 28%N	0.188 + 0.5 + 1.0% + 5.0%	100	--	100	--	100	--	100	--	14	0	27
Acifluorfen + surf	0.25 + 0.25%	60	--	86	--	98	--	63	--	5	0	18
Weedy check		--	--	--	--	--	--	--	--	--	-	6
Weedfree check		--	--	--	--	--	--	--	--	--	-	31
LSD (0.05)		16	16	8	16	6	ns	13	20	6	ns	5

[a] Stand = stand reduction.
[b] All treatments received a postemergence application of sethoxydim + COC (0.19 lb/A + 1.25%) on May 26.
[c] COC = Class 17% crop oil concentrate.
[d] 28%N = 28% UAN fertilizer solution.
[e] surf = X-77 surfactant from Chevron.

Table 3. Waseca total postemergence weed control study - 1989 (Gunsolus and Lueschen).

		Weed control						Soybean	
		Gift		Colq	Corw		Vele	Injury	
Treatment	Rate	7/3	9/19	7/3	7/3	9/19	7/3	7/3	Yield
	(lb/A)	----------	----------	----------	(%)	----------	----------	----------	(Bu/A)
Postemergence (June 6)									
Imazethapyr + surf[a]	0.063 + 0.25%	31	20	40	36	23	65	0	7
Imazethapyr + Sun-It[b]	0.063 + 1.25%	56	40	61	51	25	93	0	12
Imazethapyr + BCH-815--S[c]	0.063 + 1.25%	60	46	53	56	33	88	0	14
Imazethapyr + surf + 28%N[d]	0.063 + 0.25% + 1.25%	60	40	51	56	33	88	0	13
Imazethapyr + Sun-It + 28%N	0.063 + 1.25% + 1.25%	74	47	64	66	43	90	0	20
Imazethapyr + BCH-815--S + 28%N	0.063 + 1.25% + 1.25%	68	48	58	68	33	88	0	14
Imazethapyr + DPX-M6316 + surf + 28%N	0.063 + 0.004 + 0.125% + 1.25%	60	23	90	58	38	95	0	12
Imazethapyr + bentazon + surf + 28%N	0.063 + 0.5 + 0.25% + 1.25%	54	33	96	85	87	95	0	20
Postemergence (June 16)									
Imazethapyr + surf	0.063 + 0.25%	29	18	35	31	30	91	0	6
Imazethapyr + Sun-It	0.063 + 1.25%	41	33	57	43	33	73	0	10
Imazethapyr + BCH-815--S	0.063 + 1.25%	34	18	55	41	30	78	0	8
Imazethapyr + surf + 28%N	0.063 + 0.25% + 1.25%	33	23	56	36	38	90	0	6
Imazethapyr + Sun-It + 28%N	0.063 + 1.25% + 1.25%	49	29	68	49	28	85	0	10
Imazethapyr + BCH-815--S + 28%N	0.063 + 1.25% + 1.25%	38	15	65	40	53	91	0	8
Imazethapyr + DPX-M6316 + surf + 28%N	0.063 + 0.004 + 0.125% + 1.25%	30	15	81	35	55	93	0	8
Imazethapyr + bentazon + surf + 28%N	0.063 + 0.5 + 0.25% + 1.25%	23	18	79	41	85	93	0	9
Weedy check		--	--	--	--	--	--	--	2
Weedfree check		--	--	--	--	--	--	--	28
LSD (0.05)		15	20	24	21	23	16	ns	6

[a] surf = X-77 surfactant from Chevron.
[b] Sun-It = methylated sunflower oil.
[c] BCH-815--S = Dash, additive from BASF.
[d] 28%N = 28% UAN fertilizer solution.

Weed control in no-till soybeans at Waseca, MN in 1989. Lueschen, William E., Jeffrey L. Gunsolus and Thomas R. Hoverstad. The primary objective of this study was to evaluate the effects of time of application of imazethapyr on weed control in a no-till soybean production system. This trial was conducted on a Webster clay loam soil containing 6.3% organic matter with a pH of 7.5 and soil test P and K levels of 69 and 429 lb/A, respectively. Corn was the previous crop and this site has been in a no-till corn and soybean rotation for the past six years. The corn stalks were not chopped and residue cover on the soil surface at planting averaged 80 to 85%. A randomized complete block design with four replications and a plot size of 10 by 28 ft was used. On May 10, 1989 'Hardin' soybeans were planted in rows 7.5 inches apart with a no-till grain drill at a seeding rate of 175,000 seeds/A. Three imazethapyr treatments were applied on October 10, 1988 when the air temperature was 50 F and soil temperature at 4 inches deep was 48 F. No significant rainfall occurred for 3 weeks following these applications. In November 1988 we received 3.98 inches of rainfall which was rather evenly distributed throughout the month. Early preplant I treatments were applied on April 13, 1989 when the air temperature was 55 F with 35% relative humidity and the soil temperature at 4 inches deep was 48 F. Rainfall was 0.01, 1.65 and 1.11 inches for the first, second and third week, respectively, following application. The early preplant II treatments were applied on April 24, 1989 when air temperature was 55 F with 65% relative humidity and the soil temperature at 4 inches deep was 52 F. Subsequent rainfall was 2.27, 0.35 and 0.35 inches for the first, second and third weeks, respectively, following this date of application. No weeds were emerged when either the early preplant I or early preplant II treatments were applied. All of the above treatments were applied using a spray volume of 20 gpa and 30 psi. Additional treatment dates, sprayer settings, environmental conditions, rainfall data and plant sizes are listed below:

Date	May 9	May 10	June 8	June 16
Treatment	Burndown	Pre	Post I	Post II
Sprayer				
gpa	10	20	20	20
psi	30	30	40	40
Temperature (F)				
air	65	72	60	74
soil (4 inch)	55	58	62	70
Soil moisture	---moderate---		dry	dry
Wind (mph)	SE 15	E 10	N 10	S 5
Sky	p.cloudy	clear	p.cloudy	clear
Relative humidity (%)	40	30	35	40
Soybeans				
leaf no.	--	--	1st trif	2nd trif
height (inch)	--	--	3	4
Giant foxtail				
leaf no.	1	1	2-4	2-4
height (inch)	0.5	0.5	2-4	1-5
Common lambsquarters				
leaf no.	coty	coty	2-4	4-6
height (inch)	0.5	0.5	1-2	2-3
Redroot pigweed				
leaf no.	--	--	2-6	2-6
height (inch)	--	--	1-2	1-2
Velvetleaf				
leaf no.	coty	coty	2-3	2-3
height (inch)	0.5	0.5	1-2	1-2

Common ragweed				
leaf no.	coty	coty	4-6	4-6
height (inch)	0.5	0.5	2-3	2-3
Rainfall after application (inch)				
week 1	0.0	0.0	0.33	0.03
week 2	0.52	0.52	0.03	1.75
week 3	0.34	0.34	1.75	0.10

None of the treatments in this study caused significant soybean injury and these data are not reported in the table. Fall applied imazethapyr did not provide adequate weed control, especially late in the growing season. Applying approximately one half of the imazethapyr in the fall and the remainder on April 24, 1989 provided better weed control than a single fall application of either 0.06, 0.09 or 0.12 lb/A. The most consistant control of common ragweed and giant foxtail with single applications of imazethapyr occurred when treatments were applied on April 24, 1989. Our most consistent weed control and highest yields were obtained with early preplant applications of imazethapyr at 0.03 lb/A plus metribuzin at 0.38 lb/A applied either on April 13 or April 24 followed by a preemergence application of these same herbicide treatments. A combination of imazethapyr at 0.04 lb/A applied on April 13, 1989 followed by a postemergence application of sethoxydim at 0.15 lb/A + bentazon at 0.5 lb/A gave excellent control of all weed species except common ragweed. A split application of 0.03 lb/A of imazethapyr on April 13, 1989 followed by an additional 0.03 lb/A applied postemergence gave excellent control of all species except common lambsquarters and common ragweed, however, soybean yield with this treatment was excellent. Imazethapyr applied preemergence without a burndown treatment gave very poor performance. (MN Agric. Exp. Sta. Paper No. 17,534; Misc. Journ. Series, University of Minnesota, St. Paul).

Table. Weed control in no-till soybeans at Waseca, MN in 1989 (Lueschen, Gunsolus and Hoverstad).

Herbicide treatments[a]	Rates	Gift		Colq		Rrpw		Vele		Corw		Yield[b]
		7/14	9/15	7/14	9/15	7/14	9/15	7/14	9/15	7/14	9/15	
	lb/A or %	% Control										bu/A
Fall applied: October 10, 1988												
Imazethapyr	0.06	72	41	76	65	90	75	90	72	40	45	14.8
Imazethapyr	0.09	77	40	88	50	100	50	94	50	38	41	17.4
Imazethapyr	0.12	90	71	100	68	100	68	94	74	42	25	19.6
Fall applied/spring applied: October 10, 1988/April 24, 1989												
Imazethapyr/imazethapyr	0.03/0.03	81	81	100	100	100	100	98	99	42	54	27.1
Imazethapyr/imazethapyr	0.05/0.04	95	98	100	100	100	95	97	100	88	85	35.0
Imazethapyr+clomazone/ imazethapyr	0.03+0.75/ 0.03	92	85	100	95	100	100	94	95	72	68	28.4
Early preplant I: April 13, 1989												
Imazethapyr	0.06	79	70	100	80	100	100	90	90	65	76	34.6
Imazethapyr	0.09	87	83	100	92	100	100	96	95	70	68	32.6
[Imazethapyr+pendimethalin]	0.06+0.88	88	72	100	72	100	75	94	73	55	58	35.7
Early preplant II: April 24, 1989												
Imazethapyr	0.06	91	95	100	100	100	100	96	92	86	72	26.6
Imazethapyr	0.09	96	100	100	100	100	100	98	100	84	65	30.6
[Imazethapyr+pendimethalin]	0.06+0.88	94	95	100	92	100	100	98	99	82	79	42.0
Early preplant I/preemergence: April 13, 1989/May 10, 1989												
Imazethapyr/imazethapyr	0.03/0.03	82	69	81	95	100	100	95	82	68	72	32.9
Imazethapyr/imazethapyr	0.05/0.04	82	71	70	68	100	75	98	90	62	55	28.6
Imazethapyr+metribuzin/ imazethapyr+metribuzin	0.03+0.38/ 0.03+0.38	93	91	100	100	100	100	96	90	87	70	39.7
Metolachlor+metribuzin/ metolachlor+metribuzin	2+0.38/ 1+0.38	50	22	100	35	100	50	52	16	79	36	18.0
Early preplant II/preemergence: April 24, 1989/May 10, 1989												
Imazethapyr/imazethapyr	0.03/0.03	92	88	95	82	100	100	96	85	82	69	35.0
Imazethapyr/imazethapyr	0.05/0.04	93	99	97	100	100	100	99	100	88	80	33.8
Imazethapyr+metribuzin imazethapyr+metribuzin	0.03+0.38/ 0.03+0.38	96	95	100	100	100	100	100	100	100	82	47.2
Metolachlor+metribuzin/ metolachlor+metribuzin	2+0.38/ 1+0.38	64	38	81	45	95	50	52	39	82	66	25.2
Early preplant I/postemergence: April 13, 1989/June 8, 1989												
Imazethapyr/ Bent+Seth+BCH-815-S+28%N	0.04/ 0.5+0.15+1.25%+5%	91	98	94	95	100	100	95	100	70	44	26.0
Imazethapyr/ imazethapyr+surf+28%N	0.03/ 0.03+0.25%+1.25%	90	100	75	89	100	100	100	100	65	74	41.0
Preemergence - no burndown: May 10, 1989												
Imzaethapyr+BCH-815-S+28%N	0.06+1.25%+1.25%	41	35	52	45	70	72	38	32	44	50	13.7
Burndown[c]/preemergence: May 9, 1989/May 10, 1989												
Metolachlor+metribuzin	3.0+0.5	39	30	70	32	77	62	45	31	66	48	11.4
Burndown[c]/postemergence I/postemergence II: May 10, 1989/June 8, 1989/June 16, 1989												
Acifluorfen+bentazon+COC/ Bent+Seth+BCH-815-S+28%N	0.5+0.13+1.25%/ 0.38+0.15+1.25%+5%	51	61	81	58	88	88	89	85	100	68	23.8
Check plots												
Weedy check		0	0	0	0	0	0	0	0	0	0	3.6
Weedy check		0	0	0	0	0	0	0	0	0	0	2.3
Hand-weeded		100	99	100	100	100	100	100	100	100	96	41.8
	BLSD (0.05)	20	37	20	37	16	42	21	37	27	38	14.7

[a] Formulation used: Acif = acifluorfen = Blazer 2L, Bent = bentazon = Basagran 4S, clomazone = Command 4E, BCH-815-S = Dash, an adjuvant by BASF Corp., imazethapyr = Pursuit 2S, imazethapyr + pendimethalin = Pursuit Plus 3L, metolachlor = Dual 8E, metribuzin = Sencor 75DF, Seth = sethoxydim = Poast 1.5E and 28%N = an aqueous solution of urea and ammonium nitrate.

[b] Yields adjust to 13.5% seed moisture.

[c] Burndown = glyphosate 0.38 lb/A + X-77 nonionic surfactant 0.5% + ammonium sulfate 3.4 lb/A. Total spray volume was 10 gpa for this treatment.

Influence of time and rate of application of acifluorfen, bentazon and sethoxydim on weed control in soybeans in Waseca, MN - 1989. Schmitt, Robert M., William E. Lueschen, and Jeffrey L. Gunsolus. The objectives of this study were to investigate: (a) the effects of below label rates of acifluorfen, bentazon and sethoxydim, (b) the effects of time of application, and (c) the effects of cultivation on weed control in soybeans. The study was conducted on a Webster clay loam soil containing 6.5% organic matter with a pH of 6.1 and soil test P and K of 95 and 387, respectively. A randomized complete block design with a split-split plot arrangement of treatments was used with four replications, with split-split plot size of 10 by 30 ft. Main plots were the three times of application, subplots were the three cultivation regimes and sub-subplots were rates of herbicide application. The site for this experiment was in corn the previous year; no herbicide was used which resulted in heavy weed pressure. Primary tillage consisted of fall moldboard plowing 8 inches deep. Prior to planting 'Hardin' soybeans on May 17, the site was cultivated three times to prepare the seedbed. The seeding rate was 150,000 seeds/A in 30 inch rows. A row crop cultivator with sweeps set to till about 2 inches deep was used for all row cultivation treatments. The three cultivation regimes were: no cultivation, one cultivation 14 days after the last herbicide treatment and cultivation 7 and 14 days after the last herbicide treatment. Cultivation dates were June 14 and June 7 + June 14 following herbicides applied 14 days after planting (DAP), June 21 and June 14 + June 21 for the herbicides applied 21 DAP and June 28 and June 21 + June 28 for the herbicides applied 28 DAP. On July 3, 1989 all the treatments that had received a previous cultivation were cultivated again to control a late flush of weeds. Weed densities/ft^2 were 65 giant foxtail, 4 common lambsquarters 13 redroot pigweed, and 11 velvetleaf. Application dates, sprayer settings, environmental conditions, plant sizes and rainfall data are listed below:

Date	May 30	May 31	June 6	June 7	June 13	June 15
Treatment	Post	Post	Post	Post	Post	Post
Sprayer						
gpa	20	20	20	20	20	20
psi	40	40	40	40	40	40
Temperature (F)						
air	57	62	88	80	61	63
soil (4 inch)	65	65	75	75	71	68
Wind (mph)	10 S	5 NW	10 NW	15 SW	10 W	5-10 N
Rainfall after application (inch)						
Week 1	0.1	0.1	0.21	0.21	.12	0.0
Week 2	0.21	0.33	0.12	0.12	.81	1.78
Week 3	0.12	0.0	1.77	1.78	1.07	0.56
Rel Humidity (%)	80	60	38	55	73	58
Soybeans						
leaf no.	coty	coty	unif	unif	1 trif	2 trif
height (inch)	1-1.5	1-1.5	2-3	2-3	3-4	3-4
Giant foxtail						
leaf no.	1-3	1-3	1-4	1-4	2-4	2-4
height (inch)	0.5-2	0.5-2	2-4	2-4	2-4	2-4
Common lambsquarter						
leaf no.	coty-2	coty-2	coty-5	coty-5	coty-6	coty-6
height (inch)	0.5-1	0.5-1	0.5-2	0.5-2	0.5-4	0.5-4
Redroot pigweed						
leaf no.	coty-2	coty-2	coty-5	coty-5	coty-6	coty-6
height (inch)	0.5-1	0.5-1	0.5-2	0.5-2	0.5-4	0.5-4
Velvetleaf						
leaf no.	coty-1	coty-1	coty-2	coty-2	coty-5	coty-5
height (inch)	0.5-1.5	0.5-1.5	0.5-2	0.5-2	0.5-4	0.5-4

Rainfall from May through August was nearly 6 inches below normal. Seedling blight throughout the experiment resulted in a poor soybean stand; this reduced soybean competitiveness with weeds. Yield of the weed free check was significantly higher than the best herbicide treatments. The best control of weeds occurred when the herbicides were applied on June 6 and 7, 1989. The earlier date of application resulted in generally poor control when uncultivated, due to cool dry conditions; the later application date resulted in poor weed control without cultivation because of cool dry conditions and larger weeds. As rates of herbicide increased, weed control also increased. However, the lowers rates, approximately one-fourth of the labeled rate, plus two or three cultivations gave 80% control of giant foxtail and nearly 90% control of common lambsquarter when applied at the earliest stage of application. The intermediate rates of application gave nearly 90% control of these species when applied at either the first or second date of application and combined with two or three cultivations. Cultivation enhanced yields for all herbicide treatments. (MN Ag. Expt. Sta., Paper No. 17,565, Misc. Journ. Series, University of Minnesota, St. Paul).

Table. Influence of time and rate of application of acifluorfen, bentazon, and sethoxydim on weed control in soybeans at Waseca MN - 1989 (Schmitt, Lueschen, and Gunsolus).

				Weed control								
		Application	Soybean	Glft		Colq		Rrpw		Vele		Soybean
Treatment[a]	Rate[a]	timing	Injury	7/4	9/20	7/4	9/20	7/4	9/20	7/4	9/20	Yield
	(lb/A)	(DAP[b])	(%)									(Bu/A)
No cultivation												
(Seth[c] + COC[d])	(0.05 + 1.25%)	13	2	34	16	52	54	15	69	5	65	4
(acif[e] + bent[f] + COC)	(0.06 + 0.25 + 1.25%)	14										
(Seth + COC)	(0.05 + 1.25%)	20	3	44	45	39	50	28	42	23	50	4
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	21										
(Seth + COC)	(0.05 + 1.25%)	27	3	19	14	21	74	18	79	20	62	0
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	28										
(Seth + COC)	(0.10 + 1.25%)	13	2	40	62	36	44	3	58	6	64	7
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	14										
(Seth + COC)	(0.10 + 1.25%)	20	4	78	73	86	37	60	60	65	66	11
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	21										
(Seth + COC)	(0.10 + 1.25%)	27	3	25	6	49	68	30	83	25	82	0
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	28										
(Seth + COC)	(0.20 + 1.25%)	13	2	49	58	49	48	16	60	18	62	14
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	14										
(Seth + COC)	(0.20 + 1.25%)	20	5	93	89	92	19	61	73	88	81	13
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	21										
(Seth + COC)	(0.20 + 1.25%)	27	6	44	26	88	49	29	71	51	80	1
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	28										
Weed Free Check			0	100	100	100	100	100	100	100	100	40
Weedy check			0	-	-	-	-	-	-	-	-	0
Weedy check			0	-	-	-	-	-	-	-	-	0
Cultivated 21 and 28 DAP												
(Seth + COC)	(0.05 + 1.25%)	13	1	83	68	90	67	76	76	78	85	18
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	14										
(Seth + COC)	(0.10 + 1.25%)	13	4	86	76	89	70	73	72	82	80	27
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	14										
(Seth + COC)	(0.20 + 1.25%)	13	3	92	79	95	68	80	74	85	89	26
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	14										
No Herbicide			0	60	42	60	55	60	58	60	59	2
Cultivated 28 DAP												
(Seth + COC)	(0.05 + 1.25%)	13	2	82	69	88	54	73	63	73	66	18
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	14										
(Seth + COC)	(0.10 + 1.25%)	13	2	88	78	89	77	78	75	84	80	27
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	14										
(Seth + COC)	(0.20 + 1.25%)	13	3	90	79	85	57	75	64	90	85	28
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	14										
No Herbicide			0	60	48	60	63	60	56	60	78	1
Cultivated 28 and 35 DAP												
(Seth + COC)	(0.05 + 1.25%)	20	2	71	52	74	59	66	52	64	59	7
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	21										
(Seth + COC)	(0.10 + 1.25%)	20	4	89	78	94	47	75	55	91	78	21
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	21										
(Seth + COC)	(0.20 + 1.25%)	20	6	96	91	97	65	84	77	98	95	31
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	21										
No Herbicide			0	60	46	60	68	60	41	60	56	1
Cultivated 35 DAP												
(Seth + COC)	(0.05 + 1.25%)	20	2	69	59	67	52	63	41	64	54	8
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	21										
(Seth + COC)	(0.10 + 1.25%)	20	2	93	80	93	52	79	65	89	63	24
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	21										
(Seth + COC)	(0.20 + 1.25%)	20	4	95	90	88	39	76	53	93	84	20
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	21										
No Herbicide			0	60	52	60	69	60	67	60	75	2
Cultivated 35 and 42 DAP												
(Seth + COC)	(0.05 + 1.25%)	27	3	63	50	61	73	63	68	64	70	2
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	28										
(Seth + COC)	(0.10 + 1.25%)	27	4	74	48	85	56	69	64	73	65	6
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	28										
(Seth + COC)	(0.20 + 1.25%)	27	6	82	53	91	54	83	67	91	82	9
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	28										
No Herbicide			0	60	48	60	71	60	46	60	74	1
Cultivated 42 DAP												
(Seth + COC)	(0.05 + 1.25%)	27	2	61	46	66	70	64	64	64	77	3
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	28										
(Seth + COC)	(0.10 + 1.25%)	27	3	65	48	76	62	71	63	67	66	2
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	28										
(Seth + COC)	(0.20 + 1.25%)	27	6	76	55	83	48	72	66	91	93	3
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	28										
No Herbicide			0	60	49	60	63	60	60	60	65	0

[a] Treatments and rates in parenthesis represent a single application.
[b] DAP = days after planting.
[c] Seth = sethoxydim.
[d] COC = Class 17% crop oil concentrate.
[e] acif = acifluorfen.
[f] bent = bentazon.

Influence of time and rate of application of acifluorfen, bentazon and sethoxydim and cultivation on weed control in soybeans at Lamberton, MN - 1989. Schmitt, Robert M., William E. Lueschen, Jeffrey L. Gunsolus, and J. Harlan Ford. The objectives of this study were to investigate: (a) the effects of below label rates of acifluorfen, bentazon and sethoxydim, (b) the effects of time of application and (c) the effects of cultivation on weed control in soybeans. The study was conducted on a Normania loam soil containing 4.5% organic matter with a pH of 7.2 and soil test P and K levels of 55 and 265 lb/A respectively. A randomized complete block design with a split-split plot arrangement of treatments was used with four replications with split-split plot size of 10 by 30 ft. Main plots were three times of application, subplots were three cultivation regimes and sub-subplots were rates of herbicide application. The site for this experiment was in corn the previous year and was fall moldboard plowed 8 inches deep. Prior to planting 'Hardin' soybeans on May 17, 1989, the site was field cultivated twice to prepare the seedbed. The seeding rate was 150,000 seeds/A in 30 inch rows. A row crop cultivator with sweeps set to till about 2 inches deep was used for all row cultivation treatments. The three cultivation regimes were: no cultivation, one cultivation 14 days after the last herbicide treatment and cultivation 7 and 14 days after the last herbicide treatment. Cultivation dates were June 21 and June 14 + June 21 for the cultivation following herbicide applied 21 days after planting (DAP), June 28 and June 21 + June 28 for the herbicide applied 28 DAP, and July 5 and June 28 + July 5 for the herbicide applied 35 DAP. Weed density was 28 green foxtail/ft^2. Application dates, sprayer settings, environmental conditions, plant sizes, and rainfall data are listed below.

Date	June 6	June 7	June 13	June 14	June 21	June 22
Treatment	Post	Post	Post	Post	Post	Post
Sprayer						
gpa	20	20	20	20	20	20
psi	30	30	30	30	30	30
Temperature (F)						
air	56	53	46	46	90	65
soil (2 inch)	71	73	61	60	71	66
Wind (mph)	5 NW	20 SW	3 NW	10 W	10 S	3 W
Sky	clear	P cloudy	cloudy	cloudy	cloudy	cloudy
Relative Humidity	40	58	65	83	75	80
Rainfall after application (inch)						
week 1	0.06	0.06	0.26	0.26	1.79	1.55
week 2	0.26	0.26	1.79	1.79	0.00	0.00
week 3	1.79	1.79	0.00	0.00	0.60	0.60
Soybeans						
leaf no.	unif	unif	2 trif	2 trif	3 trif	3 trif
height (inch)	2	3	4	4	5-6	5-6
Green foxtail						
leaf no.	1-2	1-2	4	4	5	5
height (inch)	0.5-1	0.5-1	1-2	1-2	5-6	5-6

The primary weed species was green foxtail. Broadleaf weed populations were not sufficiently high to evaluate. Cultivation without any herbicides provided only 50 to 60% control of green foxtail early in the season and only 13 to 31% control late in the season. Because of this low level of control, soybean yields were less than half of the hand-weeded plots. Cultivation improved green foxtail control and soybean yields at all rates of herbicide application and at all times of application. With the lowest and intermediate rates of application, control of green foxtail decreased as herbicide applications were delayed. With the highest rate of application green foxtail control was not influenced by time of application. (Mn. Agric. Exp. Sta., Paper No. 17,566, Misc. Journ. Series, University of Minnesota, St. Paul).

Table. Influence of time and rate of application of acifluorfen, bentazon, and sethoxydim and cultivation on weed control in soybeans at Lamberton, Mn. (Schmitt, Lueschen, Gunsolus, and Ford).

Treatment[a]	Rate[a]	Application timing	Soybean Injury	Grft control 14 DAT[b]	7/20	9/21	Soybean Yield
	(lb/A)	DAP[c]		----------- (%)	-----------	-----------	(Bu/A)
No cultivation							
(Seth[d] + COC[e])	(0.05 + 1.25%)	20	2	79	0	25	22.6
(acif[f] + bent[g] + COC)	(0.06 + 0.25 + 1.25%)	21					
(Seth + COC)	(0.05 + 1.25%)	27	0	54	23	35	26.5
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	28					
(Seth + COC)	(0.05 + 1.25%)	34	0	30	15	25	20.4
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	35					
(Seth + COC)	(0.10 + 1.25%)	20	3	98	86	74	41.0
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	21					
(Seth + COC)	(0.10 + 1.25%)	27	1	83	61	60	42.0
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	28					
(Seth + COC)	(0.10 + 1.25%)	34	1	59	43	54	35.7
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	35					
(Seth + COC)	(0.20 + 1.25%)	20	6	99	87	86	44.2
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	21					
(Seth + COC)	(0.20 + 1.25%)	27	3	91	88	86	48.6
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	28					
(Seth + COC)	(0.20 + 1.25%)	34	3	94	91	90	51.2
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	35					
Hand weeded check			0	100	100	100	49.7
Weedy check			0	-	-	-	9.8
Weedy check			0	-	-	-	7.0
Cultivated 28 DAP and 35 DAP							
(Seth + COC)	(0.05 + 1.25%)	20	1	87	84	59	39.8
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	21					
(Seth + COC)	(0.10 + 1.25%)	20	3	99	100	95	51.6
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	21					
(Seth + COC)	(0.20 + 1.25%)	20	6	100	100	97	38.6
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	21					
No herbicide			0	75	60	25	20.0
Cultivated 35 DAP							
(Seth + COC)	(0.05 + 1.25%)	20	1	87	80	48	36.3
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	21					
(Seth + COC)	(0.10 + 1.25%)	20	3	99	90	83	47.7
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	21					
(Seth + COC)	(0.20 + 1.25%)	20	5	100	93	95	49.6
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	21					
No herbicide			0	64	53	13	13.1
Cultivated 35 DAP and 42 DAP							
(Seth + COC)	(0.05 + 1.25%)	27	1	86	88	69	39.8
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	28					
(Seth + COC)	(0.10 + 1.25%)	27	0	87	95	78	49.0
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	28					
(Seth + COC)	(0.20 + 1.25%)	27	2	96	98	96	50.4
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	28					
No herbicide			0	66	50	31	21.4
Cultivated 42 DAP							
(Seth + COC)	(0.05 + 1.25%)	27	0	76	80	56	35.5
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	28					
(Seth + COC)	(0.10 + 1.25%)	27	1	88	93	85	47.9
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	28					
(Seth + COC)	(0.20 + 1.25%)	27	3	98	100	97	48.8
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	28					
No herbicide			0	56	50	23	19.9
Cultivated 42 DAP and 49 DAP							
(Seth + COC)	(0.05 + 1.25%)	34	1	64	70	43	27.8
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	35					
(Seth + COC)	(0.10 + 1.25%)	34	0	91	96	81	52.3
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	35					
(Seth + COC)	(0.20 + 1.25%)	34	1	96	98	95	51.3
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	35					
No herbicide			0	63	50	24	20.4
Cultivated 49 DAP							
(Seth + COC)	(0.05 + 1.25%)	34	0	68	73	49	36.1
(acif + bent + COC)	(0.06 + 0.25 + 1.25%)	35					
(Seth + COC)	(0.10 + 1.25%)	34	0	86	96	84	49.6
(acif + bent + COC)	(0.13 + 0.50 + 1.25%)	35					
(Seth + COC)	(0.20 + 1.25%)	34	2	87	99	88	46.0
(acif + bent + COC)	(0.25 + 1.0 + 1.25%)	35					
No herbicide			0	54	50	18	11.9

[a] Treatments and rates in parenthesis represent a single application.
[b] DAT = days after treatment.
[c] DAP = days after planting.
[d] Seth = sethoxydim.
[e] COC = Class 17% crop oil concentrate.
[f] acif = acifluorfen.
[g] bent = bentazon

Effects of reduced herbicide rates, rotary hoeing and row spacing on weed control in soybeans at Waseca, MN - 1989. Schmitt, Robert M., William E. Lueschen and Jeffrey L. Gunsolus. The objectives of this study were to investigate: (a) reduced rates of soil applied and postemergence herbicides, (b) rotary hoeing and cultivation and (c) row spacing effects on weed control in soybeans. This study was conducted on a Webster clay loam soil containing 6.5% organic matter with a pH of 7 and soil test P and K levels of 48 and 417, respectively. A randomized complete block design with a split-split plot arrangement of treatments was used with three replications and a plot size of 10 by 30 ft. Row spacing was the main plot, rotary hoeing was the subplot and herbicide treatment was the sub-subplot. On May 16, trifluralin was applied preplant with 20 gpa and 40 psi pressure. Air temperature was 83° F and 4-inch soil temperature was 72° F. Relative humidity was 32% and winds were southwest at 17 mph. The herbicide was incorporated twice with a field cultivator. On May 17 alachlor was applied preemergence with 20 gpa and 40 psi pressure. Air temperature was 77° F and 4-inch soil temperature was 64° F. Relative humidity was 43% and winds were south at 12 mph. Rainfall following applications were 0.46 inches the first week. 0.40 inches the second week and 0.10 inches the third week. 'Hardin' soybeans were planted on May 17, 1989 at a population of 180,000 seeds/A in the 10-inch rows and 150,000 seeds/A in the 30-inch rows. The first rotary hoeing was done on May 22 with no soybeans emerged. The second rotary hoeing was done on May 24 with the soybeans just beginning to emerge. The 30-inch row spacings receiving no rotary hoeing were cultivated on June 9 and June 16. The treatments receiving one rotary hoeing with 30-inch row-spacings were cultivated on June 13 and June 20 and the treatments receiving two rotary hoeings were cultivated on June 15 and June 22. On June 16 weed counts taken. In the checks with no rotary hoeing infestations were 70 giant foxtail/ft^2, 4 common lambsquarter/ft^2, 1 redroot pigweed/ft^2 and 2 velvetleaf/ft^2. With one rotary hoeing infestationa were 26 giant foxtail/ft^2, 3 common lambsquarter/ft^2, 0 redroot pigweed/ft^2 and 2 velvetleaf/ft^2. With two rotary hoeings infestations were 19 giant foxtail/ft^2, 1 common lambsquarter/ft^2, 1 redroot pigweed/ft^2 and 1 velvetleaf/ft^2. Application dates, sprayer settings, environmental conditions and rainfall data are listed below:

Date	June 1	June 2	June 5	June 6	June 7	June 8
Treatment	Post	Post	Post	Post	Post	Post
Sprayer						
gpa	20	20	20	20	20	20
psi	40	40	40	40	40	40
Temperature (F)						
air	68	70	75	79	80	54
soil (4 inch)	65	71	69	69	75	70
Relative Humidity (%)	55	50	35	39	55	89
Wind (mph)	15 NW	5-10 W	22 SW	5 NW	15-20 SW	15 NW
Soil moisture	dry	dry	dry	dry	dry	dry
Soybeans						
leaf no.	unif	unif	unif	unif	1 trif	1 trif
height (inch)	1-1.5	1-1.5	2-3	2-3	2-3	2-3
Giant foxtail						
leaf no.	1-2	1-2	1-3	1-3	2-3	2-3
height (inch)	1-2	1-2	0.5-2	0.5-2	1.5-2	1.5-2
Common lambsquarter						
leaf no.	coty-2	coty-2	2-4	2-4	2	2
height (inch)	0.5-1	0.5-1	0.5-1.5	0.5-1.5	1	1
Redroot pigweed						
leaf no.	coty-2	coty-2	coty-3	coty-3	2	2
height (inch)	0.5-1	0.5-1	0.5-1	0.5-1	1	1

Velvetleaf						
leaf no.	coty-1	coty-1	coty-2	coty-2	2	2
height (inch)	0.5-1	0.5-1	0.5-1	0.5-1	1.5-2	1.5-2
Rainfall after application (inch)						
Week 1	0.10	0.10	0.00	0.21	0.21	0.33
Week 2	0.33	0.33	0.33	0.12	0.12	0.00
Week 3	0.00	0.00	1.77	1.77	1.78	1.78

Rotary hoeing improved weed control in this study by increasing the activity of the soil applied herbicides. This was probably due to better soil incorporation of the herbicide since soil conditions were dry early in the season. Weed control from the postemergence herbicides were equal regardless of the rotary hoeing although the rotary hoeing delayed weed emergence, hence delaying application since herbicide application timing was based on weed stage. Row spacing had little effect on weed control and crop yield, except with the use of alachlor, where the 30-inch row spacing gave better weed control and increased yields. This was probably due to cultivation increasing the level of weed control. One and two rotary hoeings alone gave 32 and 47% foxtail control, respectively. Overall, rotary hoeing increased the activity of the soil applied herbicides and delayed weed emergence, which allowed postemergence herbicide application to be delayed and cultivation improved weed control when herbicide and rotary hoeing didn't supply adequate control. (MN Ag. Expt. Sta., Paper No. 17,567, Misc. Journ. Series, University of Minnesota, St. Paul).

Table. Effects of reduced herbicide rates, rotary hoeing, and row spacing on weed control in soybeans at Waseca, Mn. 1989 (Schmitt, Lueschen, and Gunsolus).

			Weed control								
	Rotary	Soybean	Gift		Colq		Rrpw		Vele		Soybean
Treatment	Hoe	Injury	6/19	9/21	6/19	9/21	6/19	9/21	6/19	9/21	Yield
	(#)		(%)								(Bu/A)
Trifluralin (0.75 lb/A)[a]											
10 inch rows	0	0	72	63	90	82	96	92	62	40	44.2
	1	0	86	86	91	91	93	89	67	72	42.1
	2	0	88	86	97	98	98	98	65	82	45.4
30 inch rows	0	0	92	91	96	95	95	97	81	88	42.7
	1	0	90	95	96	95	97	95	88	94	49.2
	2	0	89	90	98	98	98	98	92	87	51.7
Alachlor (2.5 lb/A)[b]											
10 inch rows	0	0	33	33	18	43	47	38	33	37	26.6
	1	0	70	22	47	72	84	67	32	25	29.1
	2	0	73	20	76	79	81	35	60	55	34.0
30 inch rows	0	0	68	61	72	68	85	66	77	58	33.6
	1	0	83	71	89	82	95	82	76	80	43.9
	2	0	90	87	97	98	97	95	78	95	48.9
[Seth + COC (0.05 lb/A + 1.25%)][c] + [acif + bent + COC (0.06 + 0.25 + 1.25%)][d]											
10 inch rows	0	1	82	87	93	87	96	86	77	88	40.4
	1	8	85	84	97	93	98	98	91	90	51.2
	2	8	83	96	97	98	97	98	94	98	48.9
30 inch rows	0	2	87	90	98	95	99	93	92	95	44.0
	1	6	92	93	97	100	98	100	92	100	47.9
	2	5	94	95	96	100	97	97	95	97	47.9
Weedy check											
10 inch rows	0	0	0	0	0	0	0	0	0	0	10.5
	1	0	32	0	22	33	22	0	30	30	18.2
	2	0	47	5	25	20	20	3	27	25	15.9
30 inch rows[e]	0	0	62	33	62	47	63	52	62	55	20.2
	1	0	70	57	83	82	92	59	79	65	37.4
	2	0	85	73	87	87	96	91	87	98	35.4
(not cultivated)	0	0	0	0	0	0	0	0	0	0	12.8
Weed free check											
10 inch rows	0	0	100	100	100	100	100	100	100	100	52.8
30 inch rows	0	0	100	100	100	100	100	100	100	100	60.4

[a] Applied preplant incorporated on May 16.

[b] Applied preemergence on May 17.

[c] Seth = sethoxydim. Applied postemergence June 1, June 5, and June 7 on 0X, 1X, and 2X rotary hoe treatments, respectively.

[d] acif = acifluorfen and bent = bentazon. Applied postemergence sequentially June 2, June 6, and June 8 on 0X, 1X, and 2X rotary hoe treatments, respectively.

[e] Weedy checks in 30 inch rows were cultivated June 9 and 16; June 13 and 20; and June 15 and 22 on 0X, 1X, and 2X rotary hoe treatments, respectively, except where noted.

Postemergence weed control in soybeans with acifluorfen, bentazon and sethoxydim at Waseca, MN in 1989. Lueschen, William E., Jeffrey L. Gunsolus and Thomas R. Hoverstad. The objectives of this study were to investigate the effects of rate of postemergence sequential applications of acifluorfen, bentazon and sethoxydim and the effects of additive on weed control in soybeans. This study was conducted as a randomized complete block design with four replications and a plot size of 10 by 28 ft. The soil type was a Webster clay loam with 7% organic matter, a pH of 6.1 and soil test P and K levels of 95 and 387 lb/A, respectively. 'Hardin' soybeans were planted on May 13, 1989 in rows 30 inches apart at a seeding rate of 150,000 seeds/A. The first postemergence treatments were applied on June 1, 1989 when the air temperature was 67 F with 45% relative humidity and northernly winds at 5 mph; soil temperature at a depth of 4 inches was 67 F. At this time the soybeans were in the unifoliolate leaf stage and were 2 to 3 inches tall, giant foxtail had one to two leaves and was 0.5 to 1.5 inches tall and common lambsquarters, redroot pigweed and velvetleaf were all in the cotyledonary to two-leaf stage and were 0.5 to 1 inch tall. Soil conditions were dry at the time of application since rainfall for the month of May was 2.2 inches below normal. The second postemergence treatments were applied on June 9, 1989 when the air temperature was 53 F with 60% relative humidity and winds were from the northwest at 5 to 10 mph; soil temperature at a depth of 4 inches was 60 F. Soybeans were in the first trifoliolate leaf stage and were 3 inches tall, giant foxtail had one to three leaves and was 1 to 3 inches tall, common lambsquarters and redroot pigweed had two to six leaves and were 1 to 2 inches tall and velvetleaf had two to four leaves and was 1 to 2 inches tall. All herbicide treatments were applied at a total spray volume of 20 gpa at 40 psi using 8002 flat-fan nozzle tips. Weed populations in plants/ft^2 in the weedy check plots on July 3, 1989 were as follows: giant foxtail 138, common lambsquarters 2, redroot pigweed 20 and velvetleaf 1.5. All plots were cultivated twice.

Severe soybean injury, leaf necrosis and stunting, occurred with all but two of the postemergence treatments. This injury persisted for several weeks, due in part to dry conditions and cool temperatures after herbicide application. Injury was not significantly influenced by additive, either crop oil concentrate or BCH-815-S. Although certain treatments provided good control of giant foxtail when rated in early July, control of this species was poor for many treatments when evaluated in September. Excellent control of common lambsquarters and velvetleaf was observed with all treatments throughout the season. Early season control of redroot pigweed was excellent for all treatments with the exception of those that received a single application of 0.06 lb/A of acifluorfen + 0.38 lb/A of bentazon + 28%N solution and either crop oil concentrate or BCH-815-S as the additive. Poor late season weed control was probably the result of poor soybean growth following treatment application that reduced the competitiveness of the soybeans. (MN Agric. Exp. Stat. Paper No. 17,545; Misc. Journ. Series, University of Minnesota, St. Paul).

Table. Postemergence weed control in soybeans with acifluorfen, bentazon and sethoxydim at Waseca, MN in 1989 (Lueschen, Gunsolus and Hoverstad)

Herbicide treatment[a]	Rate	Stage[b] Applied	Soybean Injury		Giant Foxtail			Common Lambsquarters			Redroot Pigweed			Velvetleaf			Yield
			6/21	7/3	6/21	7/3	9/15	6/21	7/3	9/15	6/21	7/3	9/15	6/21	7/3	9/15	
	lb/A or %		---%---		-----------------% Control											-----------------------------	(Bu/A)
Acif+Bent+COC	0.13+0.5+1.25%	Post 1	21	25	80	94	45	100	100	100	86	74	45	95	99	95	27.9
Bent+Seth+BCH-815-S+28%N	0.38+0.15+1.25%+2.5%	Post 2															
Acif+Bent+COC	0.06+0.5+1.25%	Post 1	29	36	86	87	41	98	100	100	94	76	41	100	99	100	19.3
Acif+Bent+Seth+BCH-815-S +28%N	0.06+0.38+0.15+1.25%+ 2.5%	Post 2															
Acif+Bent+Seth+COC	0.06+0.5+0.05+1.25%	Post 1	30	28	75	51	84	99	100	100	98	82	84	100	98	100	9.9
Acif+Bent+Seth+COC+28%N	0.06+0.38+0.1+1.25%+2.5%	Post 2															
Acif+Bent+Seth+BCH-815-S	0.06+0.5+0.05+1.25%	Post 1	22	32	84	72	74	98	100	96	86	72	74	100	96	91	22.6
Acif+Bent+Seth+BCH-815-S +28%N	0.06+0.38+0.1+1.25%+ 2.5%	Post 2															
Acif+Bent+Seth+COC	0.06+0.5+0.1+1.25%	Post 1	30	30	80	65	68	100	99	100	98	81	68	100	99	100	23.8
Acif+Bent+Seth+COC+28%N	0.06+0.38+0.1+1.25%+2.5%	Post 2															
Acif+Bent+Seth+BCH-815-S	0.06+0.5+0.1+1.25%	Post 1	29	35	96	90	35	100	99	96	93	70	35	99	94	98	28.9
Acif+Bent+Seth+BCH-815-S +28%N	0.06+0.38+0.1+1.25%+ 2.5%	Post 2															
Acif+Bent+Seth+COC+28%N	0.06+0.38+0.05+1.25%+2.5%	Post 1	24	32	78	59	76	100	99	100	98	86	76	100	95	100	16.9
Acif+Bent+Seth+COC+28%N	0.06+0.38+0.1+1.25%+2.5%	Post 2															
Acif+Bent+Seth+BCH-815-S +28%N	0.06+0.38+0.05+1.25%+ 2.5%	Post 1	25	35	96	81	74	100	99	99	97	81	74	91	92	89	23.2
Acif+Bent+Seth+BCH-815-S +28%N	0.06+0.38+0.1+1.25%+ 2.5%	Post 2															
Acif+Bent+Seth+COC	0.06+0.38+0.1+1.25%	Post 1	14	20	82	81	36	99	100	99	68	59	36	100	100	100	23.4
Bent+Seth+COC+28%N	0.38+0.1+1.25%+2.5%	Post 2															
Acif+Bent+Seth+BCH-815-S	0.06+0.38+0.1+1.25%	Post 1	9	14	91	97	10	94	100	100	55	52	10	100	98	100	23.7
Bent+Seth+BCH-815-S+28%N	0.38+0.1+1.25%+2.5%	Post 2															
Weedy Check			0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.8
Hand-weeded			0	0	100	100	100	100	100	100	100	100	100	100	100	100	39.6
Significance Level	BLSD (0.05)		11	14	18	14	22	21	18	20	24	22	34	21	21	21	8.9

[a] Herbicide treatments: Acif = acifluorfen, Blazer 2L; Bent = bentazon, Basagran 4S; Seth = sethoxydim, Poast 1.5E; COC = crop oil concentrate, Cenex/Land O Lakes Class Additive with 83% paraffin based oil + 17% surfactant; BCH-815-S = Dash, an adjuvant from BASF Corp.; and 28%N = an aqueous solution of urea and ammonium nitrate.

[b] Post 1 applied June 1, 1989 and Post 2 applied June 9, 1989.

Use of Winter Rye to Help in Weed Control in Soybeans in Minnesota, 1985-89. D.D. Warnes, C.V. Eberlein, J.H. Ford, and W.E. Lueschen.

Concern for controlling erosion potential mandates the need for improved cultural systems for soybean production in Minnesota. Many reduced tillage systems in other areas of the country include the use of a cover crop. Cover crops in the northern great plains would help reduce erosion, but the cover crop would also cause cooler soils in the spring, compete with soybeans for moisture, and compete with soybeans for nutrients. Winter rye is the only cover crop that is winter hardy enough to consistently survive Minnesota winters.

Most Minnesota soybean acreage has 2, 3, or 4 herbicides applied in combination or singly in one year to obtain adequate control of weeds. Because of the high cost of herbicides, it would be desirable to find ways to reduce the cost of weed control without major reduction in weed control. One way would be to find alternate methods to control weeds that are less costly and yet provide effective weed control. Cover crops have been identified that produce natural chemicals(allelochemicals) which affect the growth of other plants. Researchers have identified that the allelochemical effect plus the competitive effect is equal to the interference effect of the cover crop.

The purpose of this work was to further determine the interference effect (allelopathy + competitive) of a winter rye cover crop in soybeans, and to identify the sources of risk by comparing best planting date of winter rye, best killing dates of the winter rye, and best planting dates of soybeans when planted no-till into the winter rye residue killed by a glyphosate herbicide.

The five years of this experiment in table 1 and 2 were conducted at the West Central Experiment Station, Morris, Minnesota. Each year the experimental areas were fall plowed and a seedbed was prepared by cultivation and harrowing. Winter rye was either planted in the fall or in the spring. Many killing dates were compared in these experiments but the treatments presented in table 1 and 2 were all where the winter rye was killed with glyphosate(Roundup) 2-3 days before planting soybeans no-till into the killed winter rye residue. Evans soybeans were sown in 10 inch rows at 90 lb/A with a planter with waffle coulters in front of each planter unit. Glyphosate was applied at .75 lb/A in 1985, and .38 or .50 lb/A in the years 1986-89.

Data from 1985-89 indicate that soybeans do have tolerance to the winter rye cover crop and that the winter rye cover crop does control weeds for awhile after it have been killed by an herbicide. The data in table 2 indicate that the weed control from a winter rye cover crop is effective. Squares were harvested from each plot, separated into grass weeds, broadleaf weeds. soybeans, dried, and converted to pounds of dry matter acre. The interference effect, which includes both allelopathy and competition, provided about 90% weed control each year compared to the weedy check.

The fall planted winter rye cover crop (killed 2 days before planting soybeans) treatment produced soybean yields equal to handweeded check in 1985-86 which were two wet years, slightly lower yields than handweed check in 1987 and 1989 which were two drier years, and no soybean yield in 1988 the year of the drouth. The spring planted winter rye cover crop (killed 2 days before planting soybeans) produced soybean yields equal to handweeded check in 1987, but slightly lower yields than handweeded check in 1985,1986,1989, and only 2 bushels per acre of soybeans in 1988 the year of the drouth.

Further field studies were conducted in Minnesota in 1988 and 1989 to evaluate the use of a winter rye cover crop in soybean production. Trials (table 3) were conducted at Morris in 1988-89, at Lamberton in 1988-89, at Rosemount in 1988, at Waseca with a high weed population in 1988-89, and at Waseca with a low weed population in 1988-89. Winter rye was planted in the fall, glyphosate was applied at .25 or .50 lb/A to kill the winter rye, and soybeans were planted no-till into the killed residue.

Four of the 9 location years which were very dry years and the winter rye competed very seriously for moisture with the soybeans (Morris 1988, Lamberton 1988 and 1989, and Rosemount in 1988). Significantly lower yields were produced than the handweeded or herbicide checks in these dry locations. At Waseca in 1988 and 1989 with the high weed populations, soybean yields were significantly reduced due to the excessive weed pressure. Only at Morris in 1989, and the 1988 and 1989 Waseca low weed population tests did the winter rye cover crop treatment produce soybean yields slightly lower than the handweeded or herbicide checks. The .50 lb/A rate of glyphosate was more effective in killing the winter rye and generally produced higher yields than the .25 lb/A rate of glyphosate.

Low precipitation and high weed pressure are the major risks to using a winter rye cover crop system with soybeans in Minnesota. More research will be needed to find ways to minimize the competition of the winter rye cover crop, such as delaying the planting date of winter rye in the fall, killing the winter rye earlier in the spring and then planting the soybeans earlier, or else find other cover crops that do not compete as seriously as winter rye.

Table 1.
Soybean Rye Cover Crop System Morris, 1985-89

	Soybean Yield Bu/A					Ave
Treatement	85	86	87	88	89	85-89
			---bu/A--			
Fall Rye,. Gly 2db	54	40	25	0	39	32
Spr Rye, Gly 2db	39	32	33	2	36	28
Weedy Check	27	2	8	0	17	11
Handweeded Check	51	36	36	17	45	37

Table 2.
Soybean Rye Cover Crop System Morris, 1985-89

	Weed Yield			lb/A	
Treatement	85	86	87	88	89
		--------lb/A--------			
Fall Rye, Gly 2db	150	697	814	0	510
Spr Rye, Gly 2db	430	449	965	0	738
Weedy Check	1103	2699	9329	8976	3888
Handweeded Check	57	136	22	0	6

Table 3.
Soybean Yield with Winter Rye Cover Crop System in Soybeans 1988-1989
at Morris, Waseca(2 locations), Lamberton, and Rosemount(1 location.

	Morris		Waseca H. Weed		Waseca L. Weed		Lamberton		Rosemount
Treatment	88	89	88	89	88	89	88	89	88
		----------------			bu/A	----------------			
Rye, Gly .25 2Bf	0	19	13	13	29	42	4	2	0
Rye, Gly .50 2Bf	0	23	10	17	38	42	4	25	18
No Rye,Gly .25 2Bf	0	22	7	9	38	37	2	31	1
No Rye,Gly .50 2Bf	0	18	7	12	37	46	6	39	3
No Rye,Ala + Met(3+.25)	2	10	9	33	32	46	9	34	4
Weedy Check	0	11	6	1	31	29	0	21	1
Handweed,Ala + Met(3+.25)	14	29	25	41	45	48	15	47	27

Wild proso millet and volunteer corn control in soybeans, 1989. Lueschen, William E., Thomas R. Hoverstad and Jeffrey L. Gunsolus. The objectives of this study were to evalute preplant, preemergence and postemergence herbicides for wild proso millet and volunteer corn control in soybeans and to evaluate additives for postemergence herbicides. This study was conducted on a Webster clay loam soil containing 5.8% organic matter with a pH of 7.6 and soil test P and K levels of 21 and 255 lb/A, respectively. This site was not cropped in 1988 but was seeded to a cover crop of oats and was heavily infested with wild proso millet. The experimental site was disked in the fall of 1988. In the spring prior to applying any treatments the site was disked once. A randomized complete block design with three replications and a plot size of 10 by 25 ft was used. Following application of the preplant treatments, the entire experimental area was disked twice to a depth of 3 to 4 inches; the second pass was at a right angle to the first. The disk was a tandem finishing disk equipped with a three-bar mulcher. 'Hardin' soybeans were planted on May 15, 1989 in rows 30 inches apart at a seeding rate of 150,000 seeds/A. On May 16, 1989 F2 corn seed, referred to as volunteer corn, was planted with a hand planter at a rate of 10 kernels/hill with hills spaced 5 ft apart between the two center soybean rows. The entire experimental area was treated postemergence on June 1, 1989 with bentazon at 0.75 lb/A + acifluorfen at 0.13 lb/A + oil concentrate at 1.25% v/v + 28%N solution at 1.25% v/v for broadleaf weed control. None of the plots were cultivated. Rainfall for May and June of 1989 was below normal but sufficient rainfall was received for good crop emergence. Plots were evaluated for weed control and crop injury but no yield data was obtained. All treatments were applied with a motorized bicycle sprayer calibrated to deliver 20 gpa at 32 psi. The sprayer was equipped with 8002 flat-fan nozzles spaced 15 inches apart on the boom. Application dates, environmental conditions and rainfall data are listed below:

Date	May 15	June 13	June 20
Treatment	PPI and Pre	Post	L. Post
Temperature (F)			
air	74	65	90
soil (4 inch)	67	72	82
Relative Humidity (%)	45	40	30
Wind (mph)	NE 10	NW 5	S 20
Soil moisture	medium	medium	medium
Soybeans			
leaf no.	--	2 trif	3 trif
height (inch)	--	4	6-7
Wild proso millet			
leaf no.	--	1-5	5-6
height (inch)	--	0.5-3	5-6
infestation	--	--	176
Volunteer corn			
leaf no.	--	4	4-5
height	--	6-7	10-12
Rainfall after application (inch)			
1 week	1.8	0.8	1.1
2 week	0.3	1.1	--
3 week	0.1	--	--

Results from this study are presented in the accompanying table. Preplant incorporated treatments generally provided poor control of wild proso millet with the exception of trifluralin + imazethapyr at 1 + 0.06 lb/A which provided fair control. Following the preplant incorporated trifluralin with preemergence alachlor or metolachlor did not improve wild proso millet control. Preplant incorporated trifluralin followed by postemergence fluazifop-P, imazethapyr or sethoxydim resulted in good control of wild proso millet. Of the postemergence herbicides evaluated, clethodim and sethoxydim provided the best control of wild proso millet. The addition of 28%N to postemergence herbicides did not enhance control of wild proso millet. None of the preplant or preemergence treatments provided acceptable control of volunteer corn. Following preplant trifluralin with fluazifop-P resulted in better volunteer corn control than following trifluralin with either imazethapyr or sethoxydim postemergence. Acceptable volunteer corn control was obtained with all postemergence herbicide treatments with the exception of all imazethapyr treatments, quizalofop with surfactant, and all of the sethoxydim treatments. The addition of 28%N solution enhanced volunteer corn control with clethodim, quizalofop and sethoxydim + COC. An application of sethoxydim at 0.1 lb/A + BCH-815-S + 28%N applied June 13 and repeated on June 20 gave excellent volunteer corn control. It should be noted that the rates of postemergence herbicides were selected to represent the rates to control wild proso millet and may represent rates below that recommended for volunteer corn control. (MN Agric. Exp. Sta. Paper No. 17,540; Misc. Journ. Series, University of Minnesota, St. Paul).

Table. Wild proso millet and volunteer corn control in soybeans, 1989 (Lueschen, Hoverstad and Gunsolus).

Herbicide Treatments[a]	Rate	Injury[b]			Wild Proso Millet			Volunteer Corn		
		6/7	6/21	7/6	6/7	6/21	7/6	6/7	6/21	7/6
	(lb/A) or(%)	-----(%)------			---(% Control)--			--(% Control)-		
Preplant Incorporated 2X: May 15										
Clomazone	1	0	7	0	45	52	17	7	12	0
Ethalfluralin	1.13	0	4	0	57	64	30	15	32	20
Ethalfluralin+clomazone	1.13+0.75	0	4	0	54	67	40	18	38	30
Imazethapyr	0.06	0	5	0	62	77	64	6	13	15
Pendimethalin	1.5	0	4	0	58	65	43	8	18	27
Pendimethalin+clomazone	1.5+0.75	0	4	0	67	71	48	9	34	25
Trifluralin	1	0	3	0	55	58	27	10	13	13
Trifluralin+clomazone	1.0+.75	0	7	0	50	61	33	8	22	15
Trifluralin+imazethapyr	1.0+0.06	0	5	0	74	86	77	6	17	22
Preplant Incorporated 2X/Preemergence: May 15/May15										
Trifluralin/alachlor	1/3	0	6	0	79	78	55	10	18	13
Trifluralin/metolachlor	1/2.5	0	7	0	73	74	48	8	20	22
Preplant Incorporated 2X/Postemergence: May 15/June 13										
Trifluralin/ fluazifop-P+COC	1/ 0.09+1.25%	0	3	0	58	81	78	11	73	100
Trifluralin/ imazethapyr+Surf+28%N	1/ 0.06+0.25%+1.25%	0	8	0	62	81	81	13	33	30
Trifluralin/ sethoxydim+BCH-815-S	1/ 0.1+1.25%	0	6	0	58	81	89	8	58	68
Postemergence: June 13										
Clethodim+COC	0.075+1.25%	--	4	0	--	71	89	--	53	83
Clethodim+COC+28%N	0.075+1.25%+5%	--	7	0	--	75	90	--	58	97
Fenoxaprop+COC	0.1+1.25%	--	7	0	--	65	74	--	48	88
Fenoxaprop+COC+28%N	0.1+1.25%+5%	--	6	0	--	73	73	--	39	80
Fluazifop-P+COC	0.09+1.25%	--	6	0	--	68	79	--	52	100
Fluazifop-P+COC+28%	0.09+1.25%+5%	--	4	0	--	71	72	--	48	100
HOE 46360+COC	0.05+1.25%	--	3	0	--	73	71	--	30	84
HOE 46360+COC+28%N	0.05+1.25%+5%	--	5	0	--	70	74	--	45	85
HOE 46360+COC	0.075+1.25%	--	6	0	--	83	80	--	65	95
HOE 46360+COC+28%N	0.075+1.25%+5%	--	8	0	--	77	79	--	58	100
Imazethapyr+Surf	0.06+0.25%	--	6	0	--	66	63	--	17	17
Imazethapyr+Surf+28%N	0.06+0.25%+1.25%	--	11	0	--	66	73	--	20	20
Quizalofop+Surf	0.06+0.25%	--	4	0	--	63	35	--	50	53
Quizalofop+COC	0.06+1.25%	--	10	0	--	68	72	--	50	82
Quizalofop+COC+28%N	0.06+1.25%+5%	--	8	0	--	71	69	--	55	100
Sethoxydim+BCH-815-S	0.1+1.25%	--	5	0	--	72	84	--	38	63
Sethoxydim+BCH-815-S+28%N	0.1+1.25%+5%	--	11	0	--	66	86	--	37	78
Sethoxydim+COC	0.1+1.25%	--	6	0	--	69	78	--	25	38
Sethoxydim+COC+28%N	0.1+1.25%+5%	--	5	0	--	69	88	--	30	52
Postemergence/Postemergence: June 13/June 20										
Sethoxydim+BCH-815-S+28%N/ sethoxydim+BCH-815-S+28%N	0.05+1.25%+5%/ 0.05+1.25%+5%	--	4	0	--	69	88	--	43	58
Sethoxydim+BCH-815-S+28%N/ sethoxydim+BCH-815-S+28%N	0.1+1.25%+5%/ 0.1+1.25%+5%	--	9	0	--	67	97	--	48	91
Late Postemergence: June 20										
Sethoxydim+BCH-815-S+28%N	0.1+1.25%+5%	--	4	0	--	7	91	--	12	72
Quizalofop+COC+28%N	0.06+1.25%+5%	--	8	0	--	17	88	--	3	97
Weedy check	--	--	5	0	--	0	0	--	0	0
Hand-weeded	--	0	4	0	100	100	100	100	100	100
Significance Level: BLSD (0.05)		ns	6	ns	14	10	12	7	17	18

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[a] COC = Crop Oil Concentrate, Cenex/Land O Lakes Class additive with 83% paraffin base oil + 17% surfactant; 28%N = aqueous solution of urea and ammonium nitrate; Surf = Surfactant, Ortho X-77 nonionic surfactant; BCH-815-S = Dash, an additive from BASF Corp.

[b] Injury primarily consisted of leaf burn from the bentazon + aciflurofen applied on June 1.

Woolly cupgrass and volunteer corn control in soybeans, 1989. Lueschen, William E., Thomas R. Hoverstad and Jeffrey L. Gunsolus. The objectives of this study were to evalute preplant, preemergence and postemergence herbicides for woolly cupgrass control, to evaluate additives for postemergence herbicides and to evaluate volunteer corn control in soybeans. This study was conducted on a Hayden loam soil containing 2.5% organic matter with a pH of 5.8 and soil test P and K levels of 71 and 263 lb/A, respectively. This site was seeded to a cover crop of oats in 1988 and was heavily infested with woolly cupgrass. The experimental site was not tilled in the fall of 1988. Prior to applying any treatments the site was disked once in early May. This experiment was designed as a randomized complete block with three replications and a plot size of 10 by 25 ft. Following application of the preplant treatments the entire experimental area was tilled twice with a tandem disk set to till 3 to 4 inches deep; the second pass was at a right angle to the first. The disk was a finishing disk equipped with a three-bar mulcher. 'Hardin' soybeans were planted on May 16, 1989 at a seeding rate of 150,000 seeds/A. On May 16, 1989 F2 corn seed, referred to as volunteer corn, was planted with a hand planter at a rate of 10 kernels/hill with hills spaced 5 ft apart between the two center soybean rows. The entire experimental area was treated postemergence on June 1, 1989 with bentazon at 0.75 lb/A + acifluorfen at 0.13 lb/A + oil concentrate at 1.25% v/v + 28%N solution at 1.25% v/v for broadleaf weed control. None of the plots were cultivated. Rainfall for May and June of 1989 was below normal but adequate moisture was received for good germination and good herbicide activation. Plots were evaluated for weed control and crop injury but no yield data was obtained. All treatments were applied with a motorized bicycle sprayer calibrated to deliver 20 gpa at 32 psi. Application dates, environmental conditions, plant sizes and rainfall data are listed below:

Date	May 16	June 13	June 20
Treatment	PPI and Pre	Post	L. Post
Temperature (F)			
air	84	62	85
soil (4 inch)	66	60	77
Relative Humidity (%)	45	45	40
Wind (mph)	SE 10	NW 10	S 20
Soil moisture	medium	medium	medium
Soybeans			
leaf no.	--	1 trif	3 trif
height (inch)	--	4	6
Woolly cupgrass			
leaf no.	--	2-4	3-5
height (inch)	--	1-3	4
infestation	--	--	36
Volunteer corn			
leaf no.	--	4	5
height	--	6-7	8-9
Rainfall after application (inch)			
1 week	1.2	0.8	1.1
2 week	0.4	1.1	0.0
3 week	0.0	0.0	0.3

Results from this study are presented in the accompanying table. At the early evaluation date, preplant incorporated treatments, with the exception of imazethapyr, provided good control of woolly cupgrass. Following preplant incorporated trifluralin with preemergence alachlor or metolachlor significantly improved control of woolly cupgrass compared to trifluralin applied alone.

Following preplant incorporated trifluralin with postemergence fluazifop-P, imazethapyr or sethoxydim resulted in excellent control of woolly cupgrass. Of the postemergence herbicides evaluated, clethodim and sethoxydim provided the best control of woolly cupgrass. The addition of 28%N solution to postemergence herbicides enhanced control of woolly cupgrass, especially with sethoxydim + BCH-815-S. None of the preplant or preemergence treatments provided acceptable control of volunteer corn. Following preplant incorporated trifluralin with postemergence fluazifop-P resulted in better volunteer corn control than following with either imazethapyr or sethoxydim. Postemergence fenoxaprop, fluazifop-P, HOE46360 and quizalofop provided better control of volunteer corn than the other postemergence herbicides evaluated. Addition of 28%N solution significantly improved performance of sethoxydim + BCH-815-S and sethoxydim + crop oil concentrate. (MN Agric. Exp. Sta. Paper No. 17,537; Misc. Journ. Series, University of Minnesota, St. Paul).

Table. Woolly cupgrass and volunteer corn control in soybeans, 1989 (Lueschen, Hoverstad and Gunsolus).

Herbicide[a]		Injury[b]			Woolly Cupgrass			Volunteer Corn		
Treatment	Rate	6/7	6/21	7/6	6/7	6/21	7/6	6/7	6/21	7/6
	lb/A or %	--------%-------			----%Control----			----%Control----		
Preplant Incorporated 2X: May 16										
Clomazone	1	0	2	0	91	89	75	10	8	3
Ethalfluralin	1.13	7	2	0	95	95	89	18	38	33
Ethalfluralin+clomazone	1.13+0.75	3	2	0	94	94	85	15	33	28
Imazethapyr	0.06	0	4	0	76	68	68	8	18	20
Pendimethalin	1.5	2	4	0	90	85	78	3	17	15
Pendimethalin+clomazone	1.5+0.75	0	3	0	90	91	85	10	17	13
Trifluralin	1	0	2	0	88	88	81	12	32	32
Trifluralin+clomazone	1+0.75	0	2	0	91	89	78	11	27	32
Trifluralin+imazethapyr	1.0+0.06	0	3	0	94	95	91	13	27	27
Preplant Incorporated 2X/Preemergence: May 16/May 16										
Trifluralin/alachlor	1/3	2	3	0	97	98	91	17	35	38
Trifluralin/metolachlor	1/2.5	2	2	0	97	96	94	24	47	38
Preplant Incorporated 2X/Postemergence: May 16/June 13										
Trifluralin/ fluazifop-P+COC	1/ 0.19+1.25%	0	2	0	87	98	96	17	73	99
Trifluralin/ imazethapyr+Surf+28%N	1/ 0.06+0.25%+1.25%	0	3	0	88	95	93	9	33	22
Trifluralin/ sethoxydim+BCH-815-S	1/ 0.2+1.25%	0	3	3	94	98	95	17	62	68
Postemergence: June 13										
Clethodim+COC	0.1+1.25%	--[c]	3	0	--	70	91	--	47	83
Clethodim+COC+28%N	0.1+1.25%+5%	--	2	0	--	77	94	--	55	93
Fenoxaprop+COC	0.15+1.25%	--	3	0	--	74	69	--	47	92
Fenoxaprop+COC+28%N	0.15+1.25%+5%	--	2	0	--	70	73	--	47	95
Fluazifop-P+COC	0.19+1.25%	--	4	0	--	74	83	--	52	100
Fluazifop-P+COC+28%N	0.19+1.25%+5%	--	3	0	--	77	85	--	58	100
HOE 46360+COC	0.10+1.25%	--	4	0	--	71	78	--	43	97
HOE 46360+COC+28%N	0.10+1.25%+5%	--	3	0	--	70	84	--	52	100
HOE 46360+COC	0.15+1.25%	--	3	0	--	69	85	--	58	100
HOE 46360+COC+28%N	0.15+1.25%+5%	--	3	0	--	74	92	--	57	100
Imazethapyr+Surf	0.06+0.25%	--	4	0	--	48	53	--	10	10
Imazethapyr+Surf+28%N	0.06+0.25%+1.25%-		3	0	--	65	72	--	18	17
Quizalofop+Surf	0.09+0.25%	--	2	0	--	66	60	--	48	86
Quizalofop+COC	0.09+1.25%	--	8	0	--	75	78	--	57	100
Quizalofop+COC+28%N	0.09+1.25%+5%	--	9	0	--	74	83	--	53	100
Sethoxydim+BCH-815-S	0.2+1.25%	--	4	0	--	72	83	--	40	53
Sethoxydim+ BCH-815-S+28%N	0.2+ 1.25%+5%	--	3	0	--	83	92	--	50	77
Sethoxydim+COC	0.2+1.25%	--	2	0	--	71	88	--	38	45
Sethoxydim+COC+28%N	0.2+1.25%+5%	--	3	0	--	68	89	--	45	65
Postemergence/Late Postemergence: June 13/June 20 each treatment below includes 1.25% BCH-815-S + 5% 28%N.										
Sethoxydim/sethoxydim	0.1/0.1	--	2	0	--	76	94	--	38	52
Sethoxydim/sethoxydim	0.15/0.15	--	3	0	--	81	96	--	38	82

(continued)

Table. Woolly cupgrass and volunteer corn control in soybeans, 1989 (Lueschen, Hoverstad and Gunsolus) continued.

Herbicide[a]		Injury[b]			Woolly Cupgrass			Volunteer Corn		
Treatment	Rate	6/7	6/21	7/6	6/7	6/21	7/6	6/7	6/21	7/6
	lb/A or %	--------%-------			----%Control----			----%Control----		
Late Postemergence: June 20										
Sethoxydim+ BCH-815-S+28%N	0.2+ 1.25%+5%	--	3	0	--	18	89	--	5	85
Quizalofop+COC+28%N	0.09+1.25%+5%	--	3	0	--	22	83	--	2	98
Weedy check	--	--	3	0	0	0	0	0	0	0
Weed-free	--	0	3	0	100	100	100	100	100	100
	BLSD (0.05)	6	6	3	6	18	7	11	16	15

[a] COC = Crop oil concentrate, Cenex/Land O Lakes Class additive with 83% paraffin base oil plus 17% surfactant; Surf = Ortho X-77 and 28%N = aqueous solution of urea and ammonium nitrate; BCH-815-S = Dash, an additive from BASF Corp.

[b] Injury was primarily leaf burn caused by the bentazon + acifluorfen treatment.

[c] Postemergence treatments were not applied at the time of the first rating.

Effects of time of application and adjuvants with bentazon and lactofen for velevetleaf control in soybeans in 1989. Lueschen, William E. and Thomas R. Hoverstad. The objectives of this study were to determine the influence of time of application of bentazon and lactofen and the effects of spray additives on these herbicides for velvetleaf control in soybeans. This trial was conducted on a Webster clay loam soil containing 7.0% organic matter with a pH of 7.6 and soil test P and K levels of 69 and 387 lb/A, respectively. The experimental area was in corn in 1988 and was moldboard plowed following harvest. Prior to establishing the study, the site was field cultivated once to level the surface. On May 13, 1989 trifluralin was applied at the rate of 0.75 lb/A and incorporated twice with a field cultivator set to till 3 to 4 inches deep. The field cultivator was equipped with 7-inch sweeps and a three-bar mulcher. 'Glenwood' soybeans were planted in rows 30 inches apart at a seeding rate of 150,000 seed/A on May 13, 1989. A randomized complete block design with four replications and a plot size of 10 by 30 ft was used. Early postemergence treatments were applied on June 7, 1989 when the soybeans were in the first trifoliolate leaf stage and were four inches tall; the velvetleaf plants had three to four leaves and were 1 to 3 inches tall. Temperature at the time of application was 83 F with 60% relative humidity and a soil temperature of 79 F at 4 inches deep; winds were northwest at 10 to 15 mph. Dry conditions occurred prior to and after postemergence treatments were applied. May and June rainfall was 2.2 and 2.7 inches below normal, respectively. No significant rainfall occurred until June 25 and 26. The late postemergence treatments were applied on June 19, 1989 when the soybeans were in the second trifoliolate leaf stage and were 6 inches tall; velvetleaf plants had five to six leaves and were 4 to 5 inches tall. At the time of this application the temperature was 80 F with 50% relative humidity with southerly winds at 0 to 5 mph and the soil temperature was 78 F at 4 inches deep. The first significant rainfall following application occurred on June 25 and 26 when a total of 1.73 inches was received. All herbicide treatments were applied with a total spray volume of 20 gpa. The sprayer was equipped with 8002 flat-fan nozzle tips spaced 15 inches apart on the boom. Sprayer pressure was 40 psi at the boom. All additives were applied on a v/v basis as listed in the accompanying table. The velvetleaf population in the weedy check plots averaged 1.25 plants/ft^2. None of the treatments were cultivated.

Significant crop injury, 20 to 25%, in the form of leaf burning and stunted soybean plants was observed in late June for both stages of application where lactofen was applied with either crop oil concentrate, V16508 surfactant or a nonionic surfactant + 28%N. Use of 28%N as the only additive with lactofen caused approximately 20% soybean injury when applied on June 19 but only 10% injury when applied on June 7. Neither 2.5 or 5% v/v of 28%N influenced soybean injury with lactofen. Bentazon applied alone, with crop oil concentrate or with 28%N caused no significant soybean injury. However, bentazon applied in combination with lactofen and 28%N caused a moderate level of soybean injury at both stages of application. The early stage of application of all treatments provided better velvetleaf control than the later stage of application. Larger weeds and increased moisture stress on weeds at the later stage of application is the probable cause of this response. Lactofen did not provide adequate velvetleaf control regardless of the additive or stage of application. All of the treatments including bentazon applied on June 7 provided 86 to 100% control of velvetleaf. These same treatments applied June 19 provided only partial control of velvetleaf, 43 to 75%. At the later application date, 28%N as the additive with bentazon or a tank mixture of bentazon + lactofen + 28%N gave 20 to 30 percentage points better velvetleaf control than where bentazon was applied alone or with crop oil concentrate. (MN Agric. Exp. Sta., Paper No. 17,539; Misc. Jour. Series, University of Minnesota, St. Paul).

Table. Effects of time of application and adjuvants with bentazon and lactofen for velvetleaf control in soybeans in 1989 (Lueschen and Hoverstad).

Treatment[a]	Rate	Injury[b] 6/28	Velvetleaf 6/28	Velvetleaf 9/15	Yield[c]
	lb/A or %	-%-	- % Control -		- bu/A-
Postemergence: June 7, 1989					
Bentazon	0.75	0	78	88	44.0
Bentazon + COC	0.75+1.25%	7	75	86	40.8
Bentazon + 28%N	0.75+5%	3	87	90	44.2
Bentazon + lactofen + 28%N	0.5+0.15+5%	12	95	100	44.5
Lactofen	0.2	9	61	60	41.2
Lactofen + COC	0.2+0.31%	23	70	53	35.4
Lactofen + COC	0.2+0.63%	29	75	43	32.8
Lactofen + V16508	0.2+0.63%	26	66	34	32.9
Lactofen + 28%N	0.2+2.5%	9	75	73	44.3
Lactofen + 28%N	0.2+5%	10	78	73	40.5
Lactofen + Surf + 28%N	0.2+0.13%+2.5%	26	77	68	39.9
Lactofen + Surf + 28%N	0.2+0.13%+5%	25	76	55	34.5
Lactofen + Surf + 28%N	0.2+0.25%+2.5%	22	71	50	37.7
Lactofen + Surf + 28%N	0.2+0.25%+5%	26	80	68	38.1
Late Postemergence: June 19, 1989					
Bentazon	0.75	2	59	50	41.5
Bentazon + COC	0.75+1.25%	6	53	43	38.6
Bentazon + 28%N	0.75+5%	4	71	75	38.9
Bentazon + lactofen + 28%N	0.5+0.15+5%	15	72	74	37.4
Lactofen	0.2	18	49	31	31.1
Lactofen + COC	0.2+0.31%	21	46	33	32.2
Lactofen + COC	0.2+0.63%	23	45	28	28.0
Lactofen + V16508	0.2+0.63%	25	48	35	34.0
Lactofen + 28%N	0.2+2.5%	18	53	30	31.1
Lactofen + 28%N	0.2+5%	20	63	46	37.7
Lactofen + Surf + 28%N	0.2+0.13%+2.5%	19	61	46	34.2
Lactofen + Surf + 28%N	0.2+0.13%+5%	20	50	18	26.4
Lactofen + Surf + 28%N	0.2+0.25%+2.5%	21	53	28	32.0
Lactofen + Surf + 28%N	0.2+0.25%+5%	21	50	28	31.3
Hand-weeded		0	100	100	46.5
Weedy check		0	0	0	23.4
Significance BLSD(.05)		9	12	21	7.8

[a] Formulations: bentazon = Basagran 4S, Lactofen = Cobra 2L, COC = Class Additive from Cenex/Land O Lakes containing 83% paraffin based oil and 17% surfactant, Surf = Ortho X-77 nonionic surfactant, V16508 = an experimental surfactant from the Valent Co. and 28%N = an aqueous solution of urea and ammonium nitrate containing 28%N.

[b] Injury: visually estimated injury consisting of leaf burn and stunting of soybeans.

[c] Yield: adjusted to 13.5% moisture

Cereal Rust Epidemiology

Roelfs, A. P., Long, D. L., Hughes, M. E. and Hitman, B. A.

Rust epidemics depend on four major factors, pathogen presence and virulence, host susceptibility, environment favorable for disease development and time for disease development. Cereals are generally spring planted in Minnesota. This results in the necessity of the pathogen arriving from external sources each spring.

Puccinia graminis f. sp. *tritici* causes wheat stem rust, *P. graminis* f. sp. *avenae* oat stem rust, *P. graminis* f. sp. *secalis* rye stem rust. Depending on inoculum densities either *P. graminis* f. sp. *tritici* or f. sp. *secalis* causes barley stem rust. Minnesota developed cultivars have the T gene for resistance to *P. graminis* f. sp. *tritici*. The leaf rusts are caused by individual pathogens *P. recondita* f. sp. *tritici*, *P. coronata*, *P. hordei* and *P. recondita* f. sp. *secalis* for the leaf rusts of wheat, oat, barley and rye, respectively.

In Table 1 the time of appearance is given for the small grain cereal rust diseases on susceptible cultivars at six Minnesota locations. Most cultivars currently are susceptible to barley leaf rust, oat crown rust and oat stem rust. Thus, a virulent pathogen and susceptible host exist annually. Epidemics fail to develop due either to the lack of time from the arrival of inoculum to crop maturity or from unfavorable environmental conditions. Thus, by knowing the average date when the disease appears it can be determined in an individual year whether the disease appears earlier than normal which enhances the chance of an epidemic.

Wheat cultivars grown in Minnesota are usually protected against leaf and stem rust by resistance. Thus, it makes no difference when the inoculum arrives and in what amount it arrives as far as the commercial crop is concerned. However, the pathogen population is constantly evolving and in the future the cultivars may not be resistant. Thus, it is useful to know about when the disease arrives at various locations in Minnesota. Wheat leaf rust during the last ten years has appeared in mid-June in southern Minnesota and later northward. However, leaf rust has appeared in early June and this has resulted in losses on the commercial cultivars when the cultivars were more susceptible. It would appear that with the current maturity levels severe leaf rust would develop on susceptible cultivars most years if the inoculum arrived on or before the mean dates given in Table 1. Thus, it is essential for Minnesota farmers to utilize resistant cultivars. Stem rust appears to have adequate time to result in moderate to severe losses when it is present by the first week in July.

Table 1. Stem and leaf rust onset dates and number of years rust found in twelve years, 1978 through 1989, on susceptible trap plots in Minnesota locations.

Stem rusts

	wheat			oat			barley			rye		
Location	mean	1989	years	mean	1989	years	mean	1989	years	mean	1989	years
Waseca	7/03	7/11	10	7/18	7/11	7	7/14	7/11	8	7/28	-[2]	2
Rosemount	7/06	7/07	11	7/18	7/07	8	7/16	7/07	7	7/18	-	8
Lamberton	7/08	7/11	10	7/25	7/11	4	7/21	7/11	5	7/30	-	1
Morris	7/16	7/11	9	7/20	7/11	8	7/26	7/11	3	7/30	7/31	2
Staples	7/16	7/14	10	7/23	7/14	7	7/25	7/14	5	7/26	7/14	5
Crookston	7/20	7/13	7	7/29	8/02	5	7/27	7/13	3	7/30	-	1

Leaf rusts

	wheat			oat			barley			rye		
Location	mean	1989	years	mean	1989	years	mean	1989	years	mean	1989	years
Waseca	6/13	6/19	12	7/01	7/11	9	7/03	7/11	8	6/27	6/19	10
Rosemount	6/11	6/01	12	6/29	7/07	11	7/07	-	6	6/28	7/07	11
Lamberton	6/18	6/19	11	7/06	7/11	7	7/04	7/11	5	6/30	7/11	11
Morris	6/23	6/22	11	7/06	7/11	8	7/13	7/11	4	7/03	7/11	10
Staples	7/08	6/21	8	7/14	-	4	7/14	-	4	7/10	6/21	7
Crookston	7/13	7/13	9	7/15	-	6	7/15	7/13	2	7/13	7/13	6

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[1] The number of years rust found in twelve years, 1978 through 1989, at this location.

[2] - indicates disease not observed at this location in 1989.

1989 OAT BREEDING

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

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

Procedures: Three oat evaluation trials were grown at Waseca in 1989. They included: (1) a statewide uniform oat variety trial, (2) a three-location early advanced nursery, and (3) a multiple-location-year evaluation of the cycle four parents from the project's recurrent selection program.

The variety trial included 9 named varieties, 2 probable releases from other states and 29 lines from the project's breeding program. This test serves three purposes: (1) provides information for producers on currently available varieties, (2) provides a review of the Minnesota production potential for other states releases, and (3) provides a testing of the advanced lines from the projects breeding program as the material moves through the variety trial and entered into regional testing.

The early advanced nursery contained 134 advanced lines which are in the earliest one-half of the breeding material; three checks: Don, Hazel, Starter and one Minnesota line MN81229, which is under seed increase. These lines are in "stage II" of the testing and the better ones will advance to the 1989 variety trial.

The recurrent selection parents trial is part of an evaluation program designed to compare the original C0 parents with the latest cycle, C4 parents to determine the amount of progress for grain yield and to determine what has happened to other important traits when yield was the primary trait under selection. A second objective is to determine the stability or consistency of the performance of these lines.

All trials were planted on April 14, 1989. The previous crop was soybeans and the site was fall chisel plowed. Prior to planting 30 lb N/A was applied and incorporated with a field cultivator to prepare a seedbed. Seed was packaged for planting individual plots at a rate of 80 lb/A using a cone planter. Plot size was 4 (four 12 inch rows) x 12 feet. All plots were trimmed to a length of 10 feet for harvest. Bromoxynil (0.25 lb/A) plus MCPA (0.25) lb/A was applied when the oats were in the 4-leaf stage. All plots were also hand-weeded to remove any escaped weeds.

Table 1. 1989 Oat Variety Trial Waseca

Variety	Heading Date	Plant Height	Lodging	Yield
	(6/1=1)	(in)	(1-5)	(bu/A)
84231	20	29	1	91.9
81229	19	29	1	95.9
86108	18	30	1	96.3
Preston	18	30	1	90.1
86109	19	28	1	96.3
86209	19	28	1	99.9
86226	20	30	1	86.9
Moore	21	34	1	94.4
86228	22	30	1	98.0
86231	22	27	1	103.4
87135	16	28	1	83.7
810104	20	28	1	100.8
87180	16	30	1	99.4
87185	19	27	1	97.1
87187	18	28	1	92.5
4872-2	20	30	1	101.2
87189	19	31	1	95.5
87192	17	30	1	89.9
87194	18	29	1	94.2
Don	17	27	1	98.0
87229	21	29	1	100.0
87230	19	27	1	91.6
87176	21	30	1	93.4
Starter	16	28	1	90.0
87244	19	26	1	83.9
88137	15	30	1	98.3
88117	19	29	1	100.0
Steele	20	32	1	94.2
88147	19	28	1	82.4
Valley	22	27	1	98.0
88156	18	30	1	87.2
Hamilton	19	27	1	88.7
88210	19	29	1	91.6
88215	19	29	1	96.4
88229	18	29	1	96.0
Trucker	20	31	1	91.2
88231	19	28	1	82.1
88233	20	28	1	95.8
88236	19	28	1	97.9
Hazel	19	25	1	106.0
LSD(0.05)	2	2	ns	10.4

1989 SPRING WHEAT VARIETY TRIAL

Robert Busch, Thomas Hoverstad and William Lueschen

Two cooperative trials were grown at Waseca in 1989. Both of these trials are grown each year to assess genotype performance for yield and quality. The Uniform Regional Northern Winter Wheat Nursery is a trial designed to test experimental lines throughout the upper-midwest from winter wheat breeding programs in Nebraska, North Dakota, South Dakota, Idaho, Montana, Canada and some hybrids from Hybri-Tech. Yield and Agronomic performance data are sent to the University of Nebraska for compilation into a comprehensive report. This research report provides wide-area testing in a single year of new lines and is of considerable help in determining if an experimental line will be released for production. Because none of the varieties included in this trial are available for commercial production results of the Uniform Regional Northern Winter Wheat Nursery are not presented in this report.

A spring wheat variety trial was grown at Waseca in 1989. This test is grown each year to assess the agronomic performance of spring wheat varieties and experimental lines before they are released. This trial is grown at six other locations which represent the wheat growing areas in Minnesota. The seed produced is sent to the USDA Spring Wheat Quality Laboratory in Fargo, ND to Assess bread making quality. The spring wheat variety trial was planted on April 14, 1989. The entire plot area was fertilized with 80 lb N/A as urea. Broadleaf weeds were controlled with .25 lb/A bromoxynil + .25 lb/A MCPA applied when the wheat was in the four-leaf stage. Plot size was 4 (four 12-inch rows) by 12 feet and were trimmed to 10 feet for harvest. All plots were harvested on July 31, 1989 using a modified plot combine. Agronomy results from the spring wheat variety trial from Waseca in 1989 are presented in Table 1.

Table 1. 1989 Spring Wheat Variety Trial Waseca

Variety	Test Weight	Heading Date	Plant Height	Lodging	Yield
	(lb/bu)	(6/1=1)	(in)	(1-5)	(bu/A)
Chris	57.7	18	31	1	51.4
Era	57.5	21	26	1	44.2
Marshall	55.5	22	27	1	43.2
Wheaton	57.0	20	27	1	45.9
Minnpro	56.5	18	29	1	42.1
Vance	56.3	21	27	1	42.2
Len	55.3	22	28	1	36.3
Butte 86	58.1	18	30	1	46.3
Stoa	58.8	20	32	1	46.9
Grandin	58.5	19	30	1	43.0
Gus	56.7	20	29	1	47.6
Amidon	58.1	18	31	1	44.6
Prospect	57.0	19	29	1	53.2
Guard	58.2	18	28	1	41.5
SD2980	59.7	17	32	1	48.5
Norsman	55.7	22	25	1	38.8
Celtic	56.5	20	30	1	46.1
Nordic	57.0	22	28	1	42.7
Telemark	55.7	20	29	1	50.1
Fjeld	58.1	17	29	1	49.6
2369	55.0	20	29	1	41.5
2385	56.3	18	30	1	39.2
2375	58.4	18	31	1	49.1
W2501	56.3	19	27	1	45.4
W2502	57.1	19	27	1	43.9
A99AR	54.8	21	33	1	37.0
Tammy	56.6	20	27	1	40.6
HS85-902	55.9	21	25	1	40.8
Leif	57.2	20	27	1	43.6
Shield	56.4	16	32	1	47.1
MN86018	57.8	18	26	1	36.5
MN86151	57.1	19	27	1	39.4
MN86329	57.2	19	30	1	40.6
MN86383	58.1	18	27	1	47.4
MN85324	58.5	19	29	1	48.0
MN86165	59.2	22	25	1	39.1
LSD(0.05)	2.5	1.7	3.3	ns	8.3

Weed control in spring wheat at Waseca, MN - 1989. Durgan, Beverly R., William E. Lueschen, and Douglas W. Miller. The objective of this experiment was to evaluate weed control in hard red spring wheat with various herbicides. Following fallow, the experimental area was fall chisel plowed, and disked and harrowed in the spring. The soil was a Webster clay loam with 6.5% organic matter and pH 6.3. On April 18, the area was seeded to 'Marshall' wheat at 90 lb/A. All herbicides were applied with a self-propelled plot sprayer using 20 gpa, 3 mph, and 8002 flat-fan nozzles. The experimental design was a randomized complete block with four replications. Herbicides were applied May 25 with air temperature 71 F, soil temp (4 inches) 66 F and dry, and wind from the southwest at 15-20 mph. Wheat was in the 4-leaf stage and tillering, redroot pigweed, common lambquarters, and velvetleaf were 1-3 inches tall, and giant foxtail was in the 1-3 leaf stage. Total precipitation for a one week period before application was 0.70 inches and only a trace of precipitation was received for a one week period after application. Weed control was rated visually.

Diclofop giant foxtail control was antagonized by the addition of DPX-M6316 & DPX-L5300 (Harmony Extra). Fenoxaprop & 2,4-D & MCPA (Tiller) provided excellent giant foxtail control. DPX-M6316 & DPX-L5300 (Harmony Extra) gave slight wheat injury. (Minn. Agric. Exp. Sta. Sci. Jour. Series, University of Minnesota, St. Paul).

		Control					Wheat	
		6/6		6/28			Injury	
Treatment	Rate	Colq	Vele	Colq	Gift	Rrpw	6/6	Yield
	(lb/A)			(%)				(Bu/A)
Postemergence (May 25)								
DPX-M6316 & DPX-L5300[a] + surf[b]	0.009 & 0.005 + 0.25%	83	73	96	0	94	1	33
DPX-M6316 & DPX-L5300 + surf	0.0125 & 0.0063 + 0.25%	93	81	93	0	92	1	33
DPX-M6316 & DPX-L5300 + surf	0.019 & 0.009 + 0.25%	89	76	96	0	99	8	23
MCPA butoxyethyl ester + bromoxynil	0.25 + 0.25	100	95	98	0	98	0	34
MCPA butoxyethyl ester + dicamba	0.25 + 0.09	88	78	99	0	99	0	40
Clopyralid & MCPA amine[c]	0.09 & 0.50	80	78	90	0	91	0	36
Bromoxynil	0.25	100	100	96	0	94	0	33
Bromoxynil & MCPA isooctyl ester[d]	0.188 & 0.188	100	100	100	0	99	0	36
DPX-M6316 + surf	0.016 + 0.25%	81	71	100	0	78	1	31
Diclofop + COC[e]	0.75 + 2.5%	0	0	0	69	0	0	39
Diclofop + DPX-M6316 & DPX-L5300	0.75 + 0.0125 & 0.0063	84	76	98	21	99	0	32
Diclofop + DPX-M6316 & DPX-L5300	0.75 + 0.015 & 0.008	88	80	99	21	99	1	30
Diclofop	1.0	0	0	0	82	0	0	40
Diclofop + DPX-M6316 & DPX-L5300	1.0 + 0.015 & 0.008	93	89	100	26	100	3	37
Clopyralid & 2,4-D amine[f]	0.09 & 0.50	81	70	86	0	86	0	40
Fenoxaprop & 2,4-D isooctyl ester & MCPA butoxyethyl ester[g] + DPX-M6316 & DPX-L5300	0.09 & 0.08 & 0.22 + 0.015 & 0.008	86	78	100	98	100	0	33
Fenoxaprop & 2,4-D isooctyl ester & MCPA butoxyethyl ester	0.09 & 0.08 & 0.22	78	73	43	95	44	0	39
Fenoxaprop & 2,4-D isooctyl ester & MCPA butoxyethyl ester	0.11 & 0.09 & 0.27	83	71	70	98	69	0	38
Fenoxaprop & 2,4-D isooctyl ester & MCPA butoxyethyl ester DPX-M6316 & DPX-L5300	0.09 & 0.08 & 0.22 + 0.0125 & 0.0063	90	90	100	96	100	0	37
Weedy check		--	--	--	--	--	--	40
LSD (0.05)		11	12	7	7	16	3	8

[a] Premix - Harmony Extra.
[b] surf - X77 surfactant from Chevron.
[c] Premix - Curtail-M.
[d] Premix - Bronate.
[e] COC - Class 17% crop oil concentrate.
[f] Premix - Curtail.
[g] Premix - HOE-7125.

Alfalfa Variety Yield Trials

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The objective of this research is to evaluate new alfalfa varieties for yield and persistence. All new alfalfa varieties that are eligible for certification or Plant Variety Protection and that are potentially adapted to Minnesota, are included in yield trials at each branch experiment station. Those varieties sold in Minnesota each year are described in Varietal Trials of Farm Crops (Minnesota Report 24).

Two variety trials were present at the Waseca Agricultural Experiment Station during 1989. These trials were seeded in 1986 (51 entries) and 1988 (44 entries). Most new varieties were developed by private industry. However, the 1986 trial included three MN experimental populations that were selected for improved nitrogen fixation characteristics and the 1988 trial included five MN experimental populations that were selected in cooperation with the University of Wisconsin for increased resistance to the root-lesion nematode and Aphanomyces root rot. The two trials were planted on 5-7-86 and 5-6-88. Both trials used 1#/Balan for preemergence weed control. The experimental design was a randomized complete block with 4 replicates. Plot size was 6' x 20'. Both trials were harvested four times.

The three-year total yields for the 1986 Alfalfa Variety Yield trial (Table attached) ranged between 18.02 and 22.00 T DM/A (20.2 and 24.6 T 12% moisture hay/A). These yields are exceptional for Minnesota. This is in part due to the first year test average of 10.0 T hay/A. Most of the older check varieties: Agate, DuPuits, Ranger, Saranac and Vernal were slightly lower yielding (21.0 T hay/A) than the more recently developed varieties (22.4 T hay/A). The high yields and relatively small differences among varieties after three years illustrates that intensive management (high fertilization, 4-5 harvests/year) and good weather will produce yields on most alfalfa varieties. Nevertheless, it should be noted that the better varieties yielded about 3T hay/A more than the old check varieties.

Forage yields for the first year after seeding in the 1988 Alfalfa Variety Yield Trial (Table attached) ranged between 7.05 and 5.31 T DM/A (7.9 and 5.9 T 12% moisture hay/A). These were typical first year yields for Waseca. It was interesting to notice the superior performance of MNGRN-14. This is an experimental population selected for resistance to the root-lesion nematode at Grand Rapids, MN. A related experimental entry (MNGRN-4) was the top entry after 4 years in the 1984 Waseca Alfalfa Variety Yield Trial. We plan to determine if the lesion-nematode is affecting alfalfa performance at Waseca.

Table 9. NOT FOR PUBLICATION WITHOUT PERMISSION.

Three-year Forage Yields From 1986 Alfalfa Variety Yield Trial, Waseca, Mn.*

	Forage Yield (Tons DM/A)									
			1989							
Entry	1987	1988	6/5	7/5	8/1	9/6	Season Total	3 Year Total	Percent Vernal	% Stand 5/6/88
Voyager	9.81	6.39	2.15	1.26	1.54	0.85	5.80	22.00	119	76
5444	9.80	6.22	2.26	1.18	1.46	0.79	5.69	21.71	117	79
624	9.57	6.35	2.29	1.04	1.36	0.76	5.45	21.38	115	85
MnHiE-Z X Bla	9.00	6.13	2.47	1.16	1.48	0.75	5.86	20.98	113	76
Tomahawk	9.58	5.91	2.14	1.15	1.41	0.73	5.43	20.92	113	74
Elevation	8.86	6.06	2.33	1.28	1.58	0.81	6.00	20.91	113	80
MnHiE-Z X Cit	9.26	6.02	2.38	1.01	1.36	0.68	5.43	20.72	112	74
Anstar	9.08	5.84	2.23	1.22	1.55	0.78	5.78	20.69	112	74
Mich 80-16PGH	8.88	6.26	2.25	1.06	1.43	0.79	5.53	20.67	112	80
DS 510	9.17	6.06	2.07	1.17	1.41	0.67	5.32	20.55	111	74
DS 507	9.04	5.98	2.11	1.11	1.48	0.79	5.49	20.50	111	81
Admiral	9.12	5.98	2.09	1.09	1.45	0.75	5.38	20.49	111	83
Dynasty	8.71	6.21	2.12	1.11	1.43	0.81	5.47	20.39	110	74
Surpass	9.33	6.21	2.11	0.87	1.24	0.63	4.85	20.39	110	84
Commandor	8.96	5.95	2.17	1.18	1.46	0.66	5.47	20.38	110	71
Mohawk	9.00	5.95	2.27	1.01	1.30	0.76	5.34	20.29	110	84
Centurion	9.07	5.88	2.12	1.06	1.36	0.79	5.33	20.28	110	78
Profit	8.99	6.21	2.13	0.95	1.28	0.66	5.02	20.22	109	90
Sure	9.47	5.46	2.10	1.11	1.39	0.69	5.29	20.21	109	68
Bell Ringer	8.99	5.45	2.21	1.20	1.56	0.79	5.76	20.20	109	76
MnHiE-Z X SarAr	8.90	5.62	2.33	1.19	1.45	0.68	5.65	20.17	109	74
Husky	9.21	5.85	2.03	1.03	1.33	0.70	5.09	20.14	109	74
Dart	9.10	6.11	2.13	0.90	1.27	0.59	4.89	20.10	109	84
Thorobred	9.28	5.91	2.08	0.90	1.27	0.62	4.87	20.07	108	83
Arrow	8.98	6.26	2.17	0.85	1.19	0.59	4.80	20.04	108	89
Crown	9.21	5.47	2.22	1.05	1.42	0.61	5.30	19.98	108	73
636	9.11	5.63	2.09	0.98	1.36	0.67	5.10	19.94	108	73
DK 125	9.27	5.33	2.08	1.07	1.48	0.67	5.30	19.90	107	66
630	8.24	5.98	2.30	1.17	1.45	0.74	5.66	19.88	107	83
5432	8.74	6.06	2.07	1.03	1.32	0.65	5.07	19.87	107	85
Sparta	9.13	5.89	2.13	0.78	1.23	0.69	4.83	19.86	107	85
Magnum III	9.11	5.76	2.03	0.97	1.28	0.67	4.95	19.80	107	79
Impact	8.92	6.10	2.08	0.90	1.21	0.56	4.75	19.77	107	84
Agate	8.06	5.76	2.32	1.20	1.51	0.84	5.87	19.68	106	83
Shield	8.73	5.74	2.04	1.05	1.35	0.67	5.11	19.57	106	78
Salute	8.54	6.23	2.05	0.83	1.18	0.69	4.73	19.53	105	89
Target	8.70	5.72	2.09	0.91	1.22	0.72	4.94	19.35	104	84
Saranac	8.60	5.56	2.04	0.99	1.35	0.72	5.10	19.26	104	78
GH737	8.77	6.12	1.90	0.79	1.20	0.46	4.35	19.24	104	83
Edge	8.80	5.74	1.98	0.88	1.22	0.54	4.62	19.16	103	81
Verta +	8.85	5.36	2.03	0.98	1.31	0.60	4.92	19.12	103	81
Summit	8.82	5.30	1.96	0.94	1.30	0.63	4.83	18.94	102	80
Milkmaker	8.52	5.53	1.97	0.92	1.33	0.66	4.88	18.93	102	83
629	8.69	5.67	2.01	0.83	1.21	0.48	4.53	18.90	102	81
G 2852	8.78	5.35	1.80	0.95	1.33	0.67	4.75	18.89	102	74
NAPB 26B	8.85	5.56	1.89	0.69	1.12	0.59	4.29	18.70	101	90
Vernal **	8.28	5.47	2.11	0.84	1.20	0.61	4.76	18.52	100	82
Ranger	8.32	5.81	1.87	0.71	1.12	0.59	4.29	18.43	100	84
Action	8.11	5.38	1.99	0.90	1.28	0.70	4.87	18.37	99	75
DuPuits	7.60	5.42	1.74	1.21	1.49	0.74	5.18	18.20	98	60
LSD .05 %	.88	.66	.26	.37	.35	.24	1.10			12
CV %	7.04	8.16	8.87	26.32	18.54	24.98	15.33			10.7

*Seeded 5-7-86, 1# Balan/A, 50 viable seed/sq ft. , 6' X 20' plots with 4 replicates.

**Average of 2 plots/replication.

Table 10. NOT FOR PUBLICATION WITHOUT PERMISSION.

One-year Forage Yield From 1988 Alfalfa Variety Yield Trial, Waseca, Mn.*

	Forage Yield (Tons DM/A)					
	1989					
Entry	6/6	7/6	8/3	9/11	Season Total	Percent Vernal
Vector	2.06	1.63	1.90	1.46	7.05	111
Mn GRN-14	2.16	1.68	1.72	1.31	6.87	108
Fortress	2.17	1.52	1.76	1.40	6.85	108
Apollo Supreme	2.17	1.56	1.74	1.28	6.75	106
York	2.07	1.47	1.85	1.34	6.74	106
Magnum +	1.97	1.56	1.88	1.31	6.73	106
Ultra	2.09	1.45	1.83	1.35	6.72	106
DS 547	2.03	1.61	1.76	1.31	6.71	106
Flint	2.08	1.58	1.61	1.34	6.61	104
Kingstar	1.89	1.43	1.94	1.34	6.59	104
5331	2.06	1.48	1.73	1.32	6.59	104
Mn AP-12W	2.14	1.36	1.72	1.36	6.58	104
Terminator	1.95	1.59	1.73	1.31	6.58	104
Ultimate	1.91	1.45	1.82	1.37	6.54	103
Mn GRN-15B	2.02	1.47	1.75	1.29	6.52	103
88	2.11	1.40	1.72	1.27	6.51	102
AgriBoss	1.96	1.47	1.76	1.31	6.50	102
Top Ton	1.96	1.44	1.68	1.39	6.46	102
526	2.13	1.39	1.73	1.18	6.43	101
Pro Cut	2.01	1.44	1.69	1.24	6.37	100
GH715	2.14	1.34	1.66	1.22	6.36	100
Vernal **	2.21	1.36	1.59	1.20	6.36	100
Chief	2.14	1.36	1.56	1.20	6.26	99
NAPB 34	2.12	1.35	1.59	1.17	6.23	98
Allstar	2.06	1.35	1.60	1.22	6.22	98
N 35	1.93	1.36	1.72	1.21	6.21	98
3387	2.02	1.35	1.56	1.26	6.19	97
5262	2.01	1.40	1.67	1.11	6.18	97
Clipper	1.97	1.41	1.60	1.18	6.16	97
GT 58	1.59	1.53	1.68	1.35	6.14	97
Oneida VR	2.13	1.28	1.53	1.13	6.07	96
86A44	1.97	1.28	1.56	1.22	6.02	95
Legend	2.09	1.25	1.48	1.20	6.01	95
Mn GRN-16	1.79	1.43	1.71	1.08	6.01	95
98	2.08	1.24	1.46	1.19	5.96	94
break-thru	2.03	1.22	1.48	1.10	5.84	92
G 2841	2.12	1.19	1.46	1.06	5.83	92
Champ	1.91	1.15	1.59	1.15	5.81	91
Mn AP-12G	1.80	1.21	1.61	1.15	5.78	91
Crusader	1.93	1.28	1.43	1.13	5.77	91
WL 225	1.90	1.14	1.53	1.17	5.75	90
AF-21	2.04	1.17	1.37	1.15	5.72	90
GT 13R+	0.99	1.22	1.81	1.29	5.32	84
Allegiance	1.96	1.12	1.26	0.97	5.31	84
LSD .05	.24	.31	.28	.22	.83	
CV %	8.53	16.30	12.32	12.74	9.50	

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*Seeded 5-6-88, 1# Balan/A, 50 viable seed/sq ft. , 6' X 20' plots with 4 replicates.

**Average of 2 plots/replication.

PREDICTION OF ALFALFA VARIETY PERSISTENCE BY SEEDING YEAR CUTTING FREQUENCY TESTS

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Alfalfa cultivars vary in ability to persist under intensive management. Normally 3 or 4 years are required to evaluate persistence of a cultivar. A critical need in alfalfa breeding research is to quickly and economically evaluate the potential persistence of new cultivars. One method of imposing stress on alfalfa has been to increase the cutting frequency. The objective of this study is to determine if it is possible to impose increased cutting stress on alfalfa cultivars during the seeding year and to evaluate the effects during the first production year.

PROCEDURE: Twenty-four cultivars representing a wide range of cold hardiness and fall growth habit were planted at Waseca, Lamberton, Rosemount, and Morris on about May 1, 1987. Alfalfa at one or more of these locations with diverse climatic conditions can be expected to show severe winter injury. All locations were clipped June 25 followed by cutting at intervals of 24 days (5 cuts, last cut 9/28), 30 days (4 cuts, last cut 9/28), 35 days (4 cuts, last cut 10/5), and 45 days (3 cuts, last cut 9/28).

Winter injury scores and percent stand ratings were collected early in the spring of 1988 and 1989. Harvests for dry matter yields were taken in May and at early bud three more times during the summer.

RESULTS: May 1988 dry matter yields and winter injury scores at Waseca are presented in Table 1. The least stressful cutting management during the seeding year (45 day) produced the greatest yields and the least winter injury in the subsequent year. Most cultivars, except non-winter hardy Nitro, performed similarly under the least stress treatment. Under the more stressful cutting managements (24, 30, and 35 day) yield and winter injury varied significantly among cultivars.

Differences in general winter injury were observed at the four locations in the spring of 1988. Lamberton had good snow cover and showed essentially no winter injury on any cultivar under any level of cutting stress. Morris had little snow cover and showed severe winter injury to 8 of the 24 cultivars exposed to the most stressful cutting management.

Winter hardy index (WHI) of the alfalfa cultivars was correlated with May dry matter yields (Yld) taken in 1988, and winter injury scores (WIS) and percent stand ratings (Pstd) taken in 1988 and 1989, (Table 2). Relative differences in cultivar WHI scores indicate a linear relationship with Yld, WIS, and Pstd in the subsequent year after application of 'stress' cutting schedules. The coefficient r values are higher for the more frequent cutting schedules. WHI was positively correlated with Yld and Pstd and negatively correlated with WIS.

This type of seeding year stress testing appears to have the potential to rapidly predict those cultivars with the greatest persistence.

Table 1. May 28, 1988 dry matter yields (tons/acre) and winter injury scores (WIS) of 24 alfalfa cultivars at Waseca, MN. Alfalfa cultivars are listed in order of winter hardy index (WHI).

		1987 Cutting Schedules							
		24-day		30-day		35-day		45-day	
Cultivars	WHI	Yld	WIS*	Yld	WIS	Yld	WIS	Yld	WIS
Rambler	8.0	1.6	2	1.6	3	1.7	2	2.0	2
Wrangler	7.0	1.5	4	2.0	4	1.6	4	2.2	1
526	6.5	1.5	4	1.8	3	1.7	4	2.2	2
636	6.3	1.4	4	1.8	4	1.9	3	2.2	1
WL 225	6.3	1.4	5	1.8	4	1.5	5	2.1	2
Iroquois	6.0	1.5	4	1.8	4	1.6	4	2.3	2
5432	5.7	1.3	5	1.9	3	1.6	3	2.4	1
Thunder	5.7	1.5	4	1.9	3	1.8	4	2.1	1
Valor	5.5	1.3	4	1.9	3	1.7	4	2.2	1
DK 120	5.5	1.3	5	1.7	4	1.6	5	2.2	2
Dart	5.3	1.5	5	2.0	4	1.9	3	2.3	1
Marathon	5.2	1.4	5	1.5	4	1.4	5	2.1	2
Sparta	5.2	1.4	4	1.8	3	1.6	5	2.3	2
Impact	5.1	1.5	4	1.8	4	1.6	5	2.3	2
Vernema	4.8	1.4	5	1.7	3	1.6	4	2.2	1
Dynasty	4.6	1.5	4	1.5	5	1.5	4	2.0	2
Peak	4.5	1.6	4	2.0	3	1.9	3	2.4	1
Saranac	4.5	1.2	5	1.6	4	1.4	5	2.3	2
Crown	4.1	1.4	5	1.6	4	1.9	5	2.0	3
Epic	3.9	.9	6	1.7	5	1.7	5	2.1	3
Victoria	3.9	1.0	7	1.5	5	1.0	7	2.0	4
Cimarron	3.6	1.4	6	1.7	5	1.4	5	2.0	3
Shenandoah	3.6	1.2	5	1.4	5	1.2	6	2.2	2
Nitro	3.3	.1	9	.7	7	.5	8	.8	8
** LSD (.05)		NS	1.2						
** LSD (.10)		.3							

* WIS: 1-No injury, 3-Slight damage, 5-Moderate damage, 7-Severe damage, 9-Dead.

** LSD for comparing treatment means over cutting treatments.

Table 2. Correlation of winter hardy index (WHI) with 1988 and 1989 dry matter yield (Yld), winter injury score (WIS) and percent stand rating (Pstd) variables at Waseca, MN.

Variable correlated with (WHI)	1987 Cutting Schedules			
	24-day	30-day	35-day	45-day
	r values*			
Yld (1988)	.46	.38	.40	.30
WIS (1988)	-.62	-.49	-.59	-.52
WIS (1989)	-.49	-.40	-.50	-.51
Pstd (1988)	.60	.53	.50	.35
Pstd (1989)	.47	.36	.51	.47

* correlation coefficients significant ($p > 0.01$).

Alfalfa herbicide efficacy trial, Waseca, MN - 1989. Becker, Roger L. and William E. Luecshen. The purpose of this study was to evaluate various herbicides and herbicide combinations for efficacy and crop injury during alfalfa establishment. Corn residue from the previous crop was fall moldboard plowed in 1988. Fertilizer was spring applied at 200 lb/A of 0-8-50 incorporated by one field cultivation. Preplant incorporated herbicides were applied and the entire site field cultivated twice on April 23. 'Wrangler' alfalfa was seeded at 15 lb/A on May 3 with a Brillion seeder. 'Steele' oats were drilled prior to alfalfa seeding. Treatments were replicated four times in a randomized complete block design with oat seeded treatments forced into strips within each replication to facilitate seeding. This location was relatively dry before and after application. Application information is as follows:

Date	April 21	May 25	May 26
Treatment	PPI	Post	Post
Temperature (F)			
air	--	71	71
soil (4 inch)	--	66	65
Soil Moisture	--	--	--
Wind (mph)	--	15-20 SW	10-15 SW
Sky	--	--	--
Relative Humidity (%)	--	45	45
Rainfall before Application			
Week 1 (inch)	0.02	0.52	0.42
Rainfall after application			
Week 1 (inch)	2.36	0.34	T
Week 2	0.26	0.10	0.10
Alfalfa			
leaf no.	--	2-3	2-3
height (inch)	--	2-3	2-3
Oats			
leaf no.	--	4	4
height (inch)	--	4-5	4-5
Giant Foxtail			
leaf no.	--	1-3	1-3
height (inch)	--	1-3	1-3
Common lambsquarters			
leaf no.	--	2-6	2-6
height (inch)	--	1-2	1-2
Redroot Pigweed			
leaf no.	--	2-4	2-4
height (inch)	--	0.5-2	0.5-2
Velvetleaf			
leaf no.	--	1-2	1-2
height (inch)	--	0.5-1	0.5-1

All grass herbicide treatments provided adequate giant foxtail control. Bromoxynil and 2,4-DB did not antagonize sethoxydim grass activity. Oat cover crop competition was removed more effectively with sethoxydim than imazethapyr, even at reduced rates, as reflected in visual control and harvest composition. Broadleaf efficacy was generally good with all treatments. However, imazethapyr provided only fair control of common lambsquarters, and bromoxynil erratic control of redroot pigweed. Broadleaf weed pressure was significantly reduced in second cut alfalfa except for erratic redroot pigweed pressure which is reflected in the July 28 ratings. Crop injury was severe when bromoxynil was mixed with adjuvants and sethoxydim. Alfalfa growth reduction when seeded with oats reflects competition for moisture under dry conditions. Both the bromoxynil injury and oat competition significantly reduced alfalfa yield. (Minn. Agric. Exp. Sta. Jour. Series, University of Minnesota, St. Paul).

Table 1. Alfalfa herbicide efficacy trial - Waseca, MN 1989 (Becker and Lueschen).

		Weed Control										
		Gift			Colq		Rrpw			Vele	Oats	
Treatment	Rate	6/6	6/26	7/28	6/6	6/26	6/6	6/26	7/28	6/26	6/6	6/26
	(lb/A)	(%)										
Preplant Incorporated (April 21)												
Benefin	1.125	92	93	93	30	70	39	73	21	51	--	--
EPTC	3.0	94	98	96	73	65	77	71	26	92	--	--
EPTC + (2,4-DB amine[a])[b]	2.0 + (0.5)	86	89	93	88	99	74	95	61	99	--	--
Postemergence (May 26)												
Sethoxydim + 28%N[c] + BCH-815--S[d]	0.1 + 5.0% + 1.25%	76	96	92	0	0	0	0	10	0	--	--
Sethoxydim + 28%N + BCH-815--S	0.15 + 5.0% + 1.25%	76	98	99	0	0	0	0	0	0	--	--
Sethoxydim + 28%N + BCH-815--S	0.2 + 5.0% + 1.25%	84	98	99	0	0	0	0	0	0	--	--
Sethoxydim + 2,4-DB amine + 28%N + BCH-815--S	0.15 + 0.75 + 5.0% + 1.25%	85	99	100	83	99	70	99	85	99	--	--
Sethoxydim + 2,4-DB ester[e] + 28%N + BCH-815--S	0.15 + 0.75 + 5.0% + 1.25%	88	99	99	83	99	71	96	72	99	--	--
Sethoxydim + 2,4-DB amine + COC[f]	0.15 + 0.75 + 1.25%	79	96	92	52	98	68	95	72	99	--	--
Sethoxydim + 2,4-DB amine + COC	0.2 + 0.75 + 1.25%	88	95	96	90	97	68	93	81	98	--	--
Sethoxydim + 28%N + BCH-815--S + bromoxynil	0.15 + 5.0% + 1.25% + 0.25	92	96	90	97	99	94	84	58	95	--	--
Sethoxydim + COC + bromoxynil	0.15 + 1.25% + 0.25	94	93	88	96	92	96	93	72	92	--	--
Imazethapyr + 28%N + surf[g]	0.063 + 1.25% + 0.25%	84	96	100	78	74	95	99	100	99	--	--
Imazethapyr + 28%N + surf + sethoxydim	0.045 + 1.25% + 0.25% + 0.1	76	89	98	63	66	96	98	95	91	--	--
Weedy check		--	--	--	--	--	--	--	--	--	--	--
Postemergence (May 25)[h]												
Imazethapyr + 28%N + surf	0.063 + 1.25% + 0.25%	92	99	100	80	81	92	97	99	96	63	78
Sethoxydim + 28%N + BCH-815--S	0.1 + 5.0% + 1.25%	90	98	95	0	0	0	0	0	3	69	92
Sethoxydim + 28%N + BCH-815--S	0.15 + 5.0% + 1.25%	91	99	96	0	0	0	0	0	0	75	98
Weedy check		--	--	--	--	--	--	--	--	--	--	--
LSD (0.05)		8	6	NS	18	18	15	13	27	18	5	5

[a] 2,4-DB dimethylamine formulation.
[b] Applied postemergence on May 26.
[c] 28%N = 28% UAN fertilizer solution.
[d] BCH-815--S = Dash, additive from BASF.
[e] 2,4-DB butoxyethanol ester formulation.
[f] Class 17% Crop Oil Concentrate.
[g] surf = X-77 surfactant from Chevron.
[h] Applied to oats underseeded with alfalfa.

Table 2. Alfalfa herbicide efficacy trial - Waseca, MN 1989 (Becker and Lueschen).

		Alfalfa				
		Injury[a]	Chlorosis	Growth Reduction		
Treatment	Rate	6/2	6/6	6/6	6/26	7/28
	(lb/A)			(%)		
Preplant Incorporated (April 21)						
Benefin	1.125	0	0	1	0	2
EPTC	3.0	0	0	1	0	0
EPTC + (2,4-DB amine[b])[c]	2.0 + (0.5)	0	0	2	0	0
Postemergence (May 26)						
Sethoxydim + 28%N[d] + BCH-815--S[e]	0.1 + 5.0% + 1.25%	0	0	2	0	1
Sethoxydim + 28%N + BCH-815--S	0.15 + 5.0% + 1.25%	0	0	0	0	7
Sethoxydim + 28%N + BCH-815--S	0.2 + 5.0% + 1.25%	0	0	0	8	12
Sethoxydim + 2,4-DB amine + 28%N + BCH-815--S	0.15 + 0.75 + 5.0% + 1.25%	0	3	3	5	0
Sethoxydim + 2,4-DB ester[f] + 28%N + BCH-815--S	0.15 + 0.75 + 5.0% + 1.25%	0	5	10	7	0
Sethoxydim + 2,4-DB amine + COC[g]	0.15 + 0.75 + 1.25%	0	3	9	1	0
Sethoxydim + 2,4-DB amine + COC	0.2 + 0.75 + 1.25%	0	3	7	0	0
Sethoxydim + 28%N + BCH-815--S + bromoxynil	0.15 + 5.0% + 1.25% + 0.25	43	17	22	15	0
Sethoxydim + COC + bromoxynil	0.15 + 1.25% + 0.25	25	13	15	11	0
Imazethapyr + 28%N + surf[h]	0.063 + 1.25% + 0.25%	0	1	3	1	0
Imazethapyr + 28%N + surf + sethoxydim	0.045 + 1.25% + 0.25% + 0.1	0	0	1	1	0
Weedy check		--	--	--	--	--
Postemergence (May 25)[i]						
Imazethapyr + 28%N + surf	0.063 + 1.25% + 0.25%	0	1	10	34	3
Sethoxydim + 28%N + BCH-815--S	0.1 + 5.0% + 1.25%	0	0	0	28	2
Sethoxydim + 28%N + BCH-815--S	0.15 + 5.0% + 1.25%	0	0	0	25	2
Weedy check		--	--	--	--	--
LSD (0.05)		14	4	3	12	5

[a] Leaf burn and stunting.
[b] 2,4-DB dimethylamine formulation.
[c] Applied postemergence on May 26.
[d] 28%N = 28% UAN fertilizer solution.
[e] BCH-815--S = Dash, additive from BASF.
[f] 2,4-DB butoxyethanol ester formulation.
[g] Class 17% Crop Oil Concentrate.
[h] surf = X-77 surfactant from Chevron.
[i] Applied to oats underseeded with alfalfa.

Table 3. Alfalfa herbicide efficacy trial - Waseca, MN 1989 (Becker and Lueschen).

		1st Cutting (7/7)					2nd Cutting (8/2)			
			Composition					Composition		
Treatment	Rate	Total Yield	Alf[a]	Gift	Brd[b]	Oats	Total Yield	Alf	Gift	Brd
	(lb/A)	Ton/A	---------- (%) ----------				Ton/A	------ (%) ------		
Preplant Incorporated (April 21)										
Benefin	1.125	1.59	88	1	11	--	1.60	98	0	2
EPTC	3.0	1.57	90	1	8	--	1.61	96	0	3
EPTC + (2,4-DB amine[c])[d]	2.0 + (0.5)	1.40	97	1	2	--	1.72	99	0	1
Postemergence (May 26)										
Sethoxydim + 28%N[e] + BCH-815--S[f]	0.1 + 5.0% + 1.25%	1.80	74	2	24	--	1.63	94	2	4
Sethoxydim + 28%N + BCH-815--S	0.15 + 5.0% + 1.25%	2.03	61	0	39	--	1.79	90	0	10
Sethoxydim + 28%N + BCH-815--S	0.2 + 5.0% + 1.25%	1.86	54	0	46	--	1.72	90	0	10
Sethoxydim + 2,4-DB amine + 28%N + BCH-815--S	0.15 + 0.75 + 5.0% + 1.25%	1.51	100	0	0	--	1.76	100	0	0
Sethoxydim + 2,4-DB ester[g] + 28%N + BCH-815--S	0.15 + 0.75 + 5.0% + 1.25%	1.41	99	0	1	--	1.76	100	0	0
Sethoxydim + 2,4-DB amine + COC[h]	0.15 + 0.75 + 1.25%	1.27	99	1	1	--	1.68	98	0	1
Sethoxydim + 2,4-DB amine + COC	0.2 + 0.75 + 1.25%	1.40	99	1	0	--	1.58	98	1	1
Sethoxydim + 28%N + BCH-815--S + bromoxynil	0.15 + 5.0% + 1.25% + 0.25	1.24	94	1	5	--	1.60	95	2	3
Sethoxydim + COC + bromoxynil	0.15 + 1.25% + 0.25	1.19	98	1	1	--	1.67	97	2	1
Imazethapyr + 28%N + surf[i]	0.063 + 1.25% + 0.25%	1.48	97	0	3	--	1.74	100	0	0
Imazethapyr + 28%N + surf + sethoxydim	0.045 + 1.25% + 0.25% + 0.01	1.41	95	1	3	--	1.70	99	1	0
Weedy check		1.78	58	18	23	--	1.55	88	9	3
Postemergence (May 25)[j]										
Imazethapyr + 28%N + surf	0.063 + 1.25% + 0.25%	0.81	40	0	1	60	1.58	100	0	0
Sethoxydim + 28%N + BCH-815--S	0.1 + 5.0% + 1.25%	0.98	72	4	12	12	1.83	95	0	5
Sethoxydim + 28%N + BCH-815--S	0.15 + 5.0% + 1.25%	0.90	80	4	7	8	1.64	96	1	3
Weedy check		2.54	4	0	0	95	0.83	93	5	2
LSD (0.05)		0.27	11	4	11	4	0.18	6	3	5

[a] Alf = alfalfa.
[b] Brd = broadleaf weeds.
[c] 2,4-DB dimethylamine formulation.
[d] Applied postemergence on May 26.
[e] 28%N = 28% UAN fertilizer solution.
[f] BCH-815--S = Dash, additive from BASF.
[g] 2,4-DB butoxyethanol ester formulation.
[h] Class 17% Crop Oil Concentrate.
[i] surf = X-77 surfactant from Chevron.
[j] Applied to oats underseeded with alfalfa.

INFLUENCE OF DIETARY LEVELS OF FAT AND LYSINE ON PIG PERFORMANCE AND ECONOMICS OF MARKET HOG PRODUCTION

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A refinement in our understanding of the quantitative response of market hogs to energy and protein (lysine) levels is needed today in order to maximize performance and economic efficiency of production systems. In order to accomplish this precision, the interrelationship between a biologic response to dietary changes under field conditions and economic implications have to be more clearly defined. The first objective is to design dietary changes that are sufficiently extreme to allow for confident prediction of pig performance under variable conditions imposed. This biological response must be defined quantitatively in order for an economic analysis to be applied.

There is considerable interest in the use of supplemental fat in swine diets, and thus there is a need to provide information about the interactions between increments of fat and protein (lysine) level under various environmental conditions. It is well known that response to fat depends on the level of amino acids in the diet and upon the thermal environment, but there is a dearth of information on the precise interactions between these factors under a variety of changing field conditions in sufficient depth to allow for translation to confident economic interpretation.

The Southern Experiment Station Fat/Lysine/Temperature Study

In an attempt to investigate the response of growing-finishing pigs to a range of levels of supplemental fat, superimposed upon a range of levels of soybean meal (lysine) in the diet, a detailed experiment was initiated 18 months ago. The design was based on multiple levels of fat and lysine to allow a quantitative response curve to be defined. In addition, the experiment was conducted throughout the calendar year to consider interactions with ambient temperature and frequently recording temperatures at several locations within the hog buildings.

A total of 1600 pigs in pens of 10 each were used with barrows and gilts fed separately within each treatment group.

The study was designed for two years with different combinations of fat and lysine in each year. During the first year, fat levels of 0, 3.0, 4.5 and 7.5% were fed with 0.3, 0.6, 0.7 or 1.0% lysine to growing pigs from 8-9 weeks old. Once assigned to treatment diets, pigs remained on the same diet throughout the experiment. Pigs were marketed when the average pen weight was approximately 230 lb. In the second year, fat levels of 0, 2.5, 5.0 and 7.5% were fed with 0.4, 0.567, 0.734 or 0.9% with the same experimental procedure. Pig weights and feed intakes have been recorded weekly in order to relate performance precisely to temperature.

The fat source was an animal-vegetable blend provided by Central By-Products in Redwood Falls. The lysine levels were attained by altering the ratio of corn to soybean meal.

The experiment was supported by the Southern Experiment Station and partially funded for one year by the Fats and Proteins Research Foundation, and for two years by the National Pork Producers Council. Although three-quarters of the data has been collected, all is not in summary form. However, there is sufficient data summarized from the first 80 pens of pigs to allow for an initial evaluation. Because of the limited data, emphasis will be placed upon data for all pigs with minimal reference to differences between barrows and gilts.

One important effect related to this study is the genetic capacity of the pigs to accrete lean tissue. This accretion capacity appears to determine the pig's response to dietary lysine concentration which was recently confirmed by Dr. Tim Stahly of the University of Kentucky. It is, therefore, important to define the lean tissue growth rate (LTGR) of pigs used in this study. The mean LTGR of a sample of 50 barrows fed non-limiting diets was 0.86 lb/day, demonstrating that these pigs are quite lean and grow rapidly, important under today's market requirements for lean quality pork.

Results of an Initial Evaluation

Regression analysis was used to produce smooth curves describing the biological response to dietary levels of lysine and supplemental fat (Figure 1). The feed efficiency estimates are expressed in terms of Gain/Feed rather than Feed/Gain as this provides a more accurate estimate when applying the statistical model. An overview of the performance response suggests that increasing levels of supplemental fat cause a concomitant increase in Gain/Feed response at all lysine levels. The magnitude of this increase does vary with both fat and lysine level. Pigs fed 0.6% lysine appeared to gain at a decreasing rate with increasing fat levels. If fed 1.0% lysine, pigs tended to respond with increasing rates of gain as fat level increased up to 5% fat, then tended to plateau at higher fat levels.

A crude preliminary economic analysis was then applied to the performance data. As each farm production system is somewhat unique, economic considerations should change with each unit and a single analysis will not be appropriate for all farms.

For this first analysis it was assumed that a fixed supply of pigs entered the growing-finishing phase (farrow-to-finish rather than feeder pig finishing) and that market demands were met with pigs of 230 lb. In the future, when more detailed analysis is possible, other sets of assumptions will be considered.

In order to calculate the total variable cost per pig when fed different levels of supplemental fat and lysine, estimates were made of: the total amount of feed required, cost of that feed, days required for the pigs to reach market, and the variable cost of ownership associated with having the pig on the premises for that specific number of days. The results of these estimates gave predicted curves for total variable costs as shown in Figure 2.

An important initial observation from this preliminary analysis suggests lysine levels higher than current National Research Council requirement estimates to optimize pig performance.

Although the data used in this preliminary evaluation is much larger than those used in most complete experiments, it must be emphasized that this summary only represents less than half of the complete data set that will be available later this year. An important omission is incomplete analysis that has been applied to differentiation of sex and season. In addition, the economic analysis reported in this paper is somewhat crude, as it can not be applied to all farms. This will not be the case with the complete data set, where more sophisticated economic analyses can be applied.

Summary

A study to evaluate the interactions between energy (fat), protein (lysine) and environmental temperature has been initiated to allow a quantitative approach to be applied to refine feed formulations to meet optimum pig performance under variable economic considerations. Preliminary data analysis suggests that the market hog of the 1990's may require higher lysine levels than previously thought.

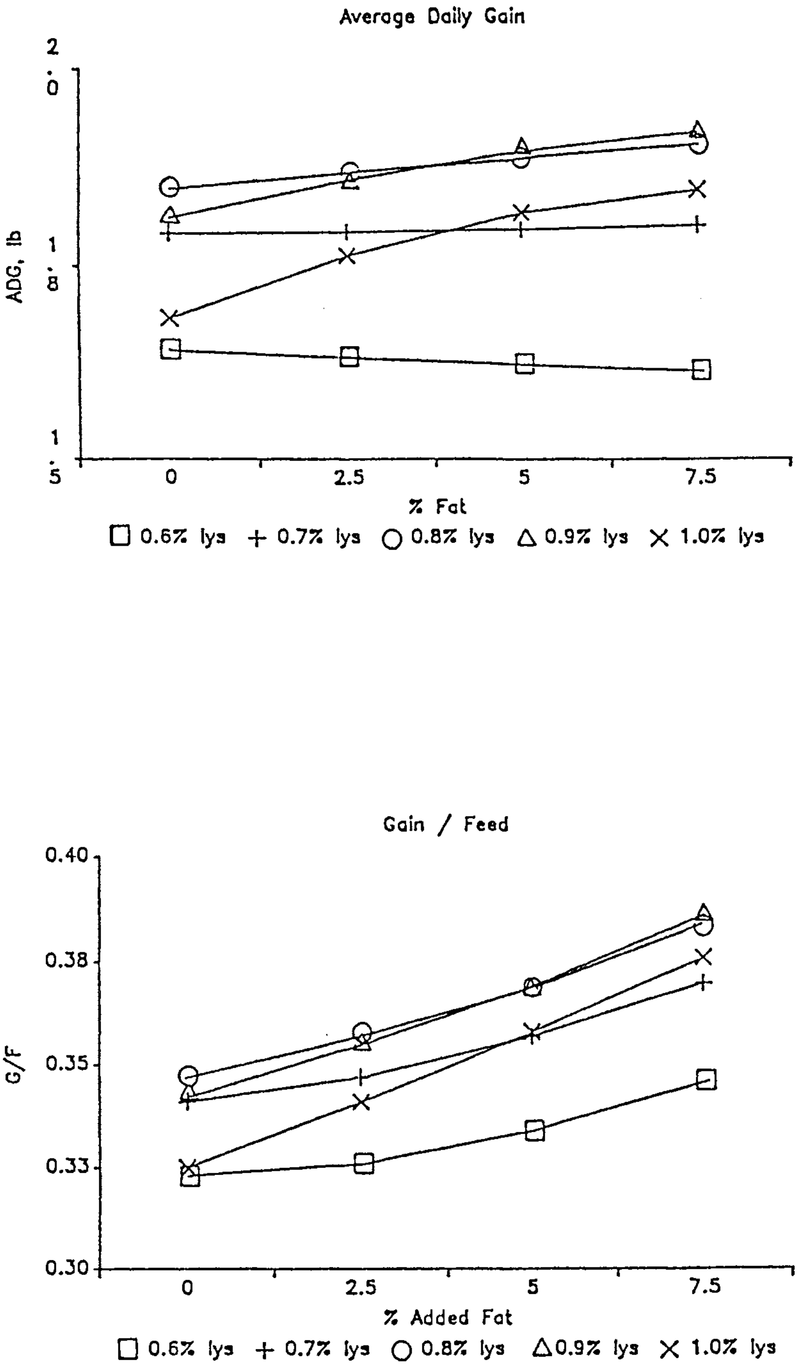
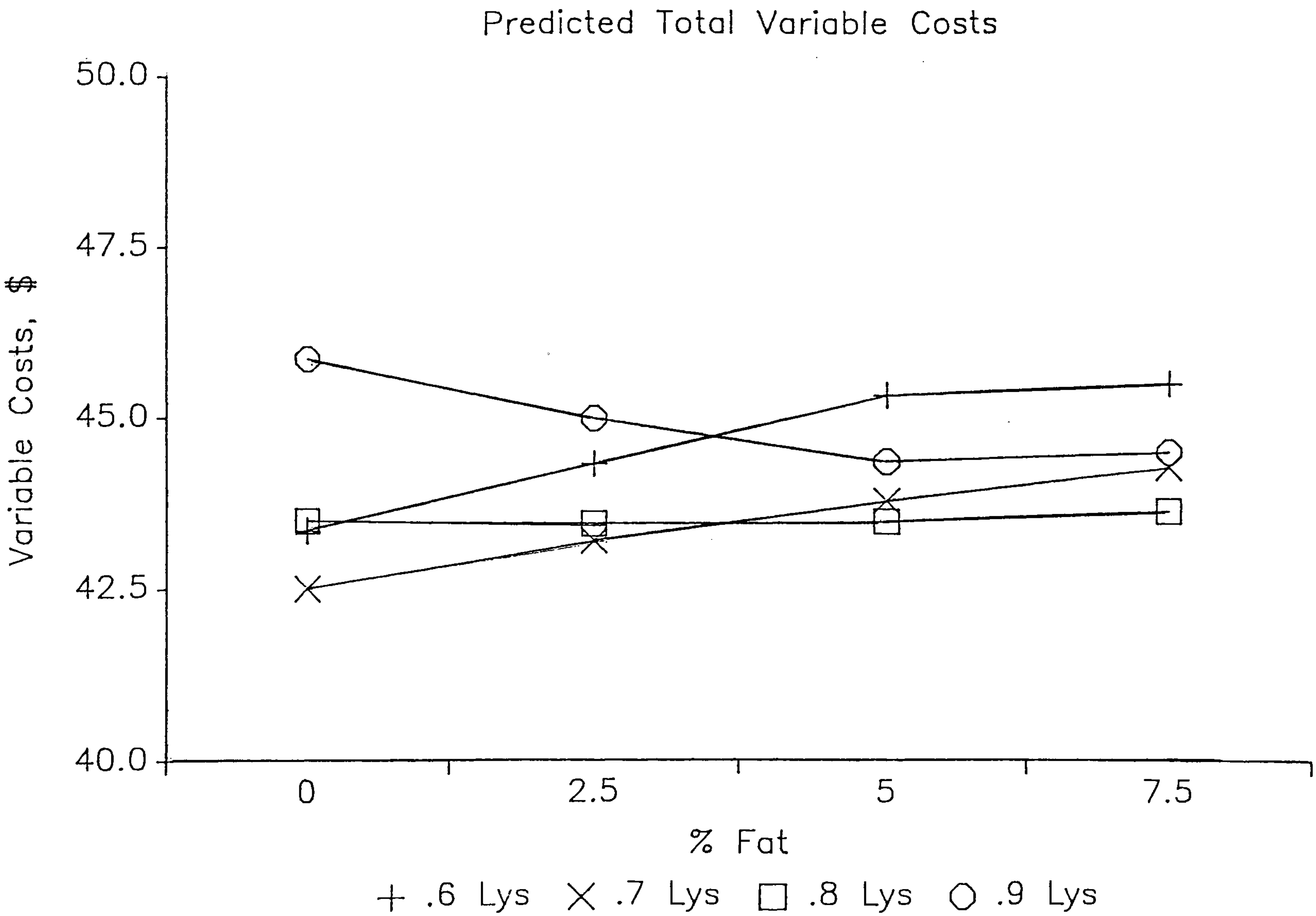


Figure 1. Effects of supplemental fat and lysine level on feed efficiency and rate of gain of growing-finishing pigs.



Corn $2.50 / bu
SBM $200 / ton
Fat $0.15 / lb

Figure 2. Estimated variable costs to produce market weight pigs when fed various levels of lysine and added fat.

Performance of Holstein Steers Fed Starter Diets Containing Rolled Corn and Pelleted Supplements with Protein Level Adjusted Biweekly

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Introduction

Demand for information on feeding young male Holstein calves is increasing as Holstein beef production has become more recognized as a potentially profitable enterprise in the upper Midwest. Recent research at the Southern Experiment Station has shown that average daily gains of 2.40 lbs/day and feed/gain of 3.5 lb could be expected when male Holstein calves are fed high corn diets (rolled or whole corn) with pelleted supplement from 110 to 425 lbs body weight. These diets typically have contained a constant dietary protein percentage base throughout the starter period as being the most practical method of feeding. Dietary protein can represent a substantial cost in starter diet formulation. Therefore, implementation of feeding strategies to allow for more precise feeding of protein levels to meet calf requirements may reduce feed cost/gain in the feedlot.

The objectives of this study were to evaluate the feedlot performance of 7-week old calves fed starter diets of rolled corn and pelleted supplement with the level of protein intake adjusted biweekly to 85, 100 or 115% of predicted NRC (1984) requirements for large frame steers.

Experimental Procedure

Two groups of 36 weanling Holstein steers (av. wt 129 lb) that had been raised in individual crates until 7-8 weeks old, were transferred to group pens (6 steers/pen) in a conventional pole barn feedlot and randomly assigned to one of three diets that contained either 85, 100 or 115% of estimated dietary protein requirements based on NRC (1984) prediction equations. A basal diet was formulated to provide approximately 14% crude protein, dry basis, in the total diet when fed at a constant ratio of 4 pts corn to 1 pt pelleted protein supplement. The composition of the protein supplement is shown in Table 1.

Dietary protein level was adjusted initially and biweekly utilizing estimated daily gains from previous Southern Experiment Station research, predicted dry matter intakes using the equation of Preston (1972: Ref: J. Anim. Sci. 35:153) and factorial equations for estimating protein requirements as described by NRC (1984). Corn gluten meal (av. crude protein content 66%, DM basis) was incorporated in the diet as partial replacement for corn to meet the respective changes of dietary protein levels. Diets were full fed for 126 days and the average protein level fed by treatment group and days on feed is shown in Table 2. Corn gluten meal replaced 1.9, 4.6 and 7.9% of the corn grain for the 85, 100 and 115% protein diets, respectively, averaged over the entire study. A premix of 50:50 corn grain to corn gluten meal was used to enhance efficiency of daily mixing dietary ingredients in the feed bunk.

Diets were full fed daily and daily feed intakes recorded on a pen basis. Feed refusals were recorded at least once weekly. Initial steer weights were taken prior to feeding on the first two consecutive days in the feedlot. Interim weights were taken every 14 days prior to feeding. Final weights were shrunk weights taken at the completion of the 126 day study. Initial and interim weights were adjusted for 4% shrinkage to allow for meaningful comparison to final weights. All steers had been castrated, dehorned and implanted (Ralgro) at 5-6 weeks old. Calves were vaccinated for IBR, PI_3 and BVD and re-implanted with Ralgro on day 77 of the study. On day 120 of the study jugular blood samples were taken from all calves for subsequent blood urea nitrogen analysis.

Results and Discussion

Performance data is summarized in Table 3. During the first 28 days of the study dietary protein level did not affect ($P > .05$) feedlot performance. Steers fed to 100% NRC protein requirements tended to have slightly higher daily feed intake and daily gains during this period. From day 28 to 56, steers fed the 100% diet had higher ($P < .05$) daily DM intake and daily gains than those fed the 115% diet but similar ($P > .05$) performance to steers fed the 85% diet. Steers fed the 100% diet gained 17.5 and 9.6% faster than those fed the 115 and 85% diets, respectively, during this period. Feed/gain from days 85 to 112 was lower ($P < .05$) for steers fed the 115% diet than those fed the other two diets. Average daily feed intake was higher ($P <.05$) for steers fed the 85% protein level than those fed the 115% diet for days 113 to 126. There were no other performance differences in the period from day 51 to 126.

Daily feed intake and average daily gain were similar ($P > .05$) for all cattle when summarized over the entire 126 day study. Feed/gain was higher ($P < .05$) for steers fed the 85% protein level compared to those fed 115% but similar ($P > .05$) to cattle fed the 100% protein level. Steers fed the 115% protein level utilized their feed 4.2 and 6.8% more efficiently than those cattle fed the 100 and 85% protein levels, respectively. Blood urea-N levels taken at 120 days were higher ($P <.05$) for steers fed the 115% diet than those fed the 85% protein level. Values were 8.28, 6.58 and 5.30 mg/dl for steers fed 115, 100 and 85% protein levels, respectively. Estimates of feed cost/lb gain for the overall study indicated very little differences due to protein level fed (Table 3).

Conclusion

The performance of the Holstein steers in the present study was very similar to that of a previous study when steers were fed starter diets containing whole or rolled corn with pelleted protein supplement at a constant protein level of 14.4%, dry basis (Table 4 adapted from 1988 Minnesota Beef Report B-367). In that trial feed costs/gain were slightly higher than those of the present study when compared on an equivalent price basis. Based on the results of the present study, it would appear that adequate feed intake could be attained to allow for feeding of protein level less than the predicted requirement for starter diets fed to Holstein steers up to 6 months of age without affecting overall performance. This further indicates that producers do have some flexibility in protein level fed and can adjust to changing market prices to maintain optimum economic returns.

Table 1. Composition of Pelleted Supplement[a]

Ingredient	Amount lb/ton
	--- as fed --
Soybean meal 46.5%	600.0
Alfalfa meal	1189.1
Limestone	92.4
Dicalcium phosphate	64.0
Trace mineralized salt	50.0
Vitamin A (13,608,000/lb)[b]	1.5
Vitamin D (750,000/lb)[b]	2.7
Vitamin E (226,800/lb)[b]	.3

[a] Fed at 1 pt supplement to 4 pt corn adjusted for protein needs with corn gluten meal as partial replacement for corn.

[b] To supply approximately 2040 IU Vitamin A, 203 IU Vitamin D and 6.8 IU Vitamin E per lb diet.

Table 2. Dietary Protein Level Fed by Days on Feed

	Protein level fed, % estimated requirements[a]			
Item	85	100	115	SE
	-------- % DM basis --------			
Dietary protein, % fed:				
days 1-28	17.13^{b}	20.08^{c}	22.85^{d}	.16
days 29-56	15.45^{b}	17.28^{c}	19.00^{d}	.45
days 57-84	14.75^{b}	15.85^{c}	18.75^{d}	.20
days 85-112	13.83^{b}	$14.80^{b,c}$	16.10^{c}	.44
days 113-126	13.70^{b}	14.65^{c}	15.10^{c}	.14
Overall dietary protein, % av. 126 days	15.08^{b}	16.75^{c}	18.75^{d}	.27

[a] Based on nutrient requirements for beef, NRC (1984)

[b,c,d] Row means with different superscripts differed ($P < .05$)

Table 3. Performance of Steers fed Starter Diets Containing Rolled Corn and Pelleted Supplement with Protein Intake Adjusted Biweekly.

Item	Protein level fed, % estimated requirements[a] 85	100	115	SE
No. steers	24	24	24	
Av. init. age, days	52	52	52	
Av. init. wt, lb[b]	129	129	129	
	------ First 28 days[d] ------			
28 day wt, lb[c]	174	177	174	
Daily Feed Intake, lb DM	4.62	4.77	4.31	.15
Daily Gain, lb	1.61	1.71	1.61	.09
Feed/100 lb gain, lb DM	287	279	268	9.0
	------- Day 29 - 56[d] -------			
56 day wt, lb[c]	232	241	227	
DFI, lb DM	6.49^{g}	6.51^{g}	5.74^{h}	.15
DG, lb	2.07^{gh}	2.29^{g}	1.89^{h}	.07
F/G, lb DM	314	284	304	7.0
	------- Day 57 - 84[d] -------			
84 day wt, lb[c]	314	323	306	
DFI, lb DM	8.56	8.93	7.85	.35
DG, lb	2.93	2.93	2.82	.20
F/G, lb DM	292	305	278	9.0
	------- Day 85 - 112[d] ------			
112 day wt, lb[c]	390	403	385	
DFI, lb DM	10.58^{g}	10.60	9.99	.22
DG, lb	2.71	2.86	2.82	.07
F/G, lb DM	390^{g}	371^{h}	354^{i}	3.0
	------ Day 113 - 126[d] ------			
127 day wt, lb[e]	430	440	426	
DFI, lb DM	11.99^{g}	11.44^{gh}	11.18^{h}	.24
DG, lb	3.08	2.84	3.15	.37
F/G, lb DM	389	403	354	6.0
	Overall performance - 126 days			
Final wt, lb[e]	430	440	426	
Daily Feed Intake, lb DM	8.10	8.14	7.46	.18
Daily Gain, lb	2.39	2.47	2.36	.07
Feed/100 gain, lb DM	339^{g}	330^{gh}	316^{h}	.06
Feed cost/100 lb gain, $[f]	19.80	20.30	20.60	

[a] Based on nutrient requirements for beef cattle, NRC (1984)

[b] Av. two consecutive wt prior to feeding adjusted for 4% shrinkage

[c] Av. wt. prior to feeding adjusted for 4% shrinkage

[d] Rows means without superscripts do not differ ($P > .05$)

[e] Obtained after withholding feed and water for 16 hours

[f] Based on corn @ 4¢/lb, corn gluten meal @ 15¢/lb and pellet @ 12.5¢/lb

[ghi] Row means with different superscripts differ ($P < .05$)

Table 4. Performance of Steers Fed Starter Diets Containing Whole or Rolled Corn with Pelleted Protein Supplement for 127 Days[a].

	Physical form of corn fed			
Item	Rolled	Rolled/ whole[b]	Whole	Sx[c]
No. steers	24	24	24	
Init. wt.[d]	115	116	115	
First 56 days[e]				
56 day wt, lb[d]	220	225	227	6.85
Daily Feed Intake, lb DM	4.80	5.13	5.12	.27
Daily gain, lb	1.88	1.95	2.00	.09
Feed/100 lb gain, lb DM	255	263	256	12.00
Day 57 to 127[e]				
127 day wt, lb[f]	405[g]	421[h]	425[h]	8.15
Daily Feed Intake, lb DM	9.09	9.51	9.37	.47
Daily gain, lb	2.61	2.75	2.79	.09
Feed/100 lb gain, lb DM	348	345	336	19.00
Overall Performance, 127 days[e]				
Final wt, lb[f]	405[g]	421[h]	425[h]	8.15
Daily Feed Intake, lb DM	7.18	7.58	7.50	.36
Daily gain, lb	2.28[g]	2.40[gh]	2.44[h]	.15
Feed/100 lb, lb DM	315	316	307	.06
Feed cost/100 lb gain, $[i]	21.49	21.46	20.82	

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[a] Adapted from 1988 Minnesota Beef Cattle Report B-367.

[b] Steers switched from rolled to whole corn after 56 days on the study.

[c] Standard error.

[d] Average of two consecutive weights prior to feeding.

[e] Row means without superscripts do not differ (P > .05).

[f] Obtained after withholding feed and water for 16 hours.

[gh] Row means with different superscripts differ (P < .05)

[i] Based on corn at $100/ton and pelleted supplement @ $269/ton.

Effect of Feed Flavors and Probiotics on Dry Matter Intake, Performance and Health of Young Male Holstein Calves During the Pre-Weaning and Immediate Post-Weaning Periods - Preliminary Summary

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Introduction

Considerable research has been conducted at the Southern Experiment Station on raising young male Holstein calves for dairy-beef production. Maximizing the efficient growth characteristics of these calves is one of the factors contributing to the profitability of dairy-beef production in addition to sound buying and selling decisions. Use of high energy diets for Holstein calves has become an accepted regimen to promote efficient utilization of available feed energy for maintenance and growth. One of the concerns in raising young calves for dairy-beef, especially if purchased through sale barn auctions, is the high risk in terms of possible chronic health problems. These problems may prevent calves from achieving maximum dry feed intake and reduce their growth potential when faced with additional stress of changing environments.

Despite the success of raising calves for dairy-beef at the Southern Experiment Station over the years, there is still an inconsistency in the ability of individual animals to adapt quickly to dry rations and ensure at least an intake of 2-3 lb daily by weaning at 4 weeks old. There is an indication that oral dosing of lactobacillus organisms (probiotics) at times of stress has enhanced appetite although the precise mode of action and effect on gut flora is not totally clear. In addition, the use of feed flavors in dry starter diets has been suggested as also increasing intake in these young calves. The objectives of this study are to compare the use of probiotics and feed flavors as regimens to enhance dry feed intake in male Holstein calves, purchased at 7 to 14 days old, during the liquid feeding phase and 4 weeks post-weaning before moving to the feedlot. The effect of these regimens on calf health will also be monitored.

Experimental Procedures

Forty-eight 7-14 day old male Holstein calves were purchased from a number of dairy farms in SE Minneosta. Prior to pick-up all calves received a rota-corona virus vaccine and all necessary colostrum immediately after birth. All calves were pre-assigned to 1 of 4 treatment groups of 12 calves in each group. At pick-up two groups of calves received 10 g oral dose of probiotics (Lactobacillus acidophilus, lactobacillus plantarum, streptococcus faecium and lactobacillus casei). Upon arrival at the Southern Experiment Station, all calves were weighed and placed in pre-assigned invidual crates. Calves were conditioned to their new environment. They initially received 2-3 feedings of glucose water and electrolytes as they adapted to their crates. During the first 24 hrs calves were administered Naselgen IBR/P13 modified live vaccine, injections of Vitamins A, D, E & B and iron. All calves were then placed on a 4-day antiobiotic treatment as the final step of the conditioning program. After 48 hours all calves were on full milk replacer limited to 1 lb dry matter maximum daily. Dry starter diets were offered after 24 hours to all calves. Composition of diets are shown in Table 1.

All calves were fed their respective diets ad libitum. Calves were weaned at 4-5 wks old. Those calves on probiotic treatments received a second 10 g oral probiotics gel at weaning. The study continued for a further 35 days after weaning. Initial weaning and final weights were taken on two consecutive days prior to feeding. At the termination of the study all calves were transferred to a conventional pole barn feedlot in group pens (seven steers/pen). Calves on the probiotic treatment received a further oral dose of 10 g within 24 hours after being transfereed to the feedlot. Daily dry feed intake was recorded for each calf. Feed refusals were taken as frequently as necessary to allow for uncontaminated feed to be available to each calf daily. Criteria for evaluation included dry feed intake, daily gain and feed/gain ratio.

Results and Discussion

Performance data is summarized in Table 2. There were two calves that died during the 57 day study as a result of respiratory problems unrelated to dietary treatments imposed. During the pre-weaning period a number of calves were treated for diarrhea and respiratory disorders. As a group these calves did not perform as well as expected, perhaps due to a chronic infection present in the barn. Despite use of amprolium during the first 14 days on the study, there were some cases of coccidiosis that required prompt treatment.

Calves fed the feed flavor starter diet plus probiotics prior to weaning had lower ($P < .05$) total dry feed intake (including milk replacer) than calves fed the control diet with probiotics. There were no other differences ($P > .05$) in performance parameters during this period. Average intakes of milk replacer and dry calf starter across all calves were .69 and .62 lbs/d, respectively. Only 10 calves attained near expected dry feed intakes of at least 1 lb/day calf starter and 1 lb dry matter daily from milk replacer. The average weaning age was 42 days for all calves. Typically in the past, these calves are weaned by 28-35 days of age. This factor reflected the lower than expected performance attained. The poor feed utilization ratio was a good indicator of the debilitation of many calves. Following weaning, all calves appeared to rapidly pick up on dry feed intake. There were no treatment differences ($P > .05$) due to starter diet fed. Average dry feed intakes, daily gains and feed/gains post weaning were 3.50, 1.64 and 2.13 lb, respectively.

Overall performance for the 57 day study was not different ($P > .05$) across dietary treatment groups. Average total dry feed intake for daily gains and feed/gains for the complete study were 2.54, 1.10 and 2.31 lbs, respectively. At the end of the study, all calves were kept in their respective groups designated by probiotic or non-probiotic treatment, and transferred to feedlot pens of 7 steers/pen. Calves were all fed the same control starter diet. Average daily gains for the first 20 days after transferring to the feedlot were 1.94 and 2.00 lbs for calves in the probiotic and non-probiotic groups, respectively.

Conclusions

Under the conditions of the present study, the use of probiotics or feed flavors in starter diets did not appear beneficial. However, the calves did not perform as typically found in previous studies and another trial will be conducted to re-evaluate these dietary treatments.

Table 1. Ingredient Composition of Starter Diets

	Diets, % as fed			
Ingredient	Control	Control 'P'[a]	Calf ADE[b]	Calf ADE'P'[c]
Cracked corn	46.5	46.4	48.6	48.6
Crushed oats	19.9	19.9	19.9	19.9
Alfalfa meal	12.0	12.0	12.0	12.0
Soybean meal	13.0	13.0	12.9	12.9
Soybean hulls	-	-	2.8	2.8
Dry molasses	5.0	5.0	-	-
Calf ADE	-	-	.1	-
Calf ADE'P'	-	-	-	.1
Probiotics	-	.1	-	-
Limestone	.5	.5	.6	.6
Dicalc. Phosph.	1.1	1.1	1.1	1.1
TM salt	1.0	1.0	1.0	1.0
Vitamin pre-mix[d]	1.0	1.0	1.0	1.0

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[a] Control diet plus lactobacillus acidophilus, plantarum and casei, and streptococcus faecium

[b] Control diet with dry feed flavor and soybean hulls to replace molasses

[c] Control diet with feed flavor, probiotics and soybean hulls

[d] To supply 2000 IU Vitamin A and 200 IU Vitamin D/lb diet.

Table 2. Performance of Holstein Calves Fed Starter Diets With/Without Feed Flavors and/or Probiotics During Pre- and Immediately Post-Weaning Periods

	Starter diet fed				
Item	Control	Control 'P'[a]	CADE[b]	CADE 'P'[c]	SE
Av. initial wt, lb[d]	96	92	92	95	3
Av. initial age, days	9	8	8	7	
Av. weaning (W) wt, lb[d]	107	102	100	102	4
Av. age at weaning, days	33	32	32	33	
Av. final (F) wt, lb[d]	161	153	153	156	7
Av. days to weaning (W)	24	24	24	26	1
Dry feed intake (DFI) to W					
Milk replacer	.71	.69	.69	.68	.04
Calf starter	.73	.77	.50	.46	.12
Total DFI to W	1.44^{ef}	1.46^{e}	1.19^{ef}	1.14^{f}	.13
Av. daily gain (ADG) to W, lb	.45	.45	.34	.29	.11
Av. feed/gain to W, lb	4.82	7.87	6.42	2.96	1.98
Av. days post-weaning	32	33	31	31	1
DFI, post-weaning, lb	3.73	3.40	3.43	3.42	.29
ADG, post-weaning, lb	1.66	1.56	1.63	1.71	.12
Feed/gain post-weaning, lb	2.25	2.18	2.10	2.00	.09
Actual days on study	57	56	56	57	.4
Av. total DFI, lb	2.73	2.61	2.48	2.35	.22
Av. total ADG, lb	1.15	1.09	1.07	1.09	.11
Total feed/gain, lb	2.37	2.40	2.32	2.16	.09

[a] Control diet plus probiotics

[b] Control diet plus feed flavor and soybean hulls as replacement for dry molasses

[c] Feed flavor diet plus probiotics

[d] Average of two consecutive weights taken prior to feeding

[ef] Row means with different superscripts differ ($P < .05$).

Performance of Finishing Holstein Steers in the Feedlot With or Without a Final Implant During the Last 100 Days on Feed - Preliminary Summary

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Introduction

Recent studies at the Southern Experiment Station have shown performance differences in groups of feedlot Holstein steers from 800 lbs to market weight. Typically these steers have been fed a 90-95% grain diet from weaning. Reports of a "stall out" period during the final finishing phase are quite common in the field. Partial explanation may be related to body composition as dry matter intake plateaus or decreases when steers approach market weight which will reduce average daily gain. Another affect may be directly related to environmental stress during the summer months. In addition, there also appears to be differences in performance which can be related to when cattle received their last implant before slaughter.

The objectives of these studies were: a) to evaluate if there is an implant effect that may contribute to the decrease in performance after 800 lbs for feedlot Holstein steers, and b) evaluate effect of using Snyovex alone vs combination of Synovex (progesterone and estradiol) and Finaplex (trenbelone acetate) as final implants, on performance of Holstein steers during the final 100 days in the feedlot.

Experimental Procedure

Thirty-six Holstein steers (av. wt. 767 lb) housed in a conventional pole barn feedlot were assigned to two replicate pens (6 steers/pen) of three treatments. Treatments consisted of no implant, Synovex implant alone or in combination with Finaplex (F + S). Treatments were imposed when initial weights were taken. All steers had been implanted with Ralgro at weaning (4 wks old) and re-implanted twice prior to the finishing phase. The steers received their third implant 108 days prior to the initiation of this study.

All steers were full fed a high grain diet based on 3 pt rolled corn to 1 pt corn silage, as fed basis. A protein supplement was fed daily at 1 lb/head. The supplement was mixed in the feed bunk with other ingredients. The composition of the supplement is shown in Table 1. Daily feed intakes were recorded on a pen basis and feed refusals collected and recorded at least once a week. Steers were marketed when average pen weights were approximately 1150 lb. Carcass data was collected for each steer. Initial and final steer weights were taken after withholding feed and water 16 hours. Interim steer weights during the study were taken every 28 days prior to feeding. All final steer weights were adjusted to a common dressing percent before performance parameters were calculated.

Results and Discussion

Performance and carcass data is summarized in Table 2. Steers implanted with Synovex (S) alone attained market wt in 9% less time ($P < .05$) than those receiving the Finaplex and Synovex (F + S) combination implant and 16% less time ($P < .05$) than steers who received no implant. Average daily gains were 19.4% higher ($P < .05$) for steers implanted with S than those receiving no implant and 3.5% higher ($P > .05$) than those steers implanted with F + S. Daily dry feed intakes were highest ($P < .05$) for steers receiving S and lowest ($P < .05$) for steers receiving no implant. There were no differences ($P > .05$) in efficiency of feed utilization. Feed cost/100 lb gain for steers implanted with F + S was 4.9 and 12.4% lower than for steers receiving S or no implant, respectively.

There were no differences ($P > .05$) in carcass characteristics due as implant regimen with the exception of marbling score. Steers receiving no implant had a higher ($P < .05$) marbling score than those receiving S and tended to have a higher marbling score than steers implanted with F + S but the difference was not significant ($P > .05$). The number of steers in the no implant pens grading low choice or higher were 33 and 58% greater than the number in the F + S and S pens, respectively.

Conclusion

A further two replicate pens of cattle will be evaluated with similar treatments imposed during January to April, 1990. However, this first study does confirm the positive effect of Holstein steers receiving an implant 100 days from market weight on rate and cost of gain. The additive effect on steer performance for the combination implant of Synovex and Finaplex, as suggested by other recent university studies, was not evident in this present study. All the steers in the present study utilized their feed relatively efficiently for heavier cattle. Differences in dry matter intake between treatment groups directly affected average daily gain. A marked reduction in performance was noticed in steers receiving no implants when pens averaged 950 to 970 lbs. This effect was apparent with F + S implanted steers but not until pens averaged 1030 - 1070 lbs. Steers implanted with S did not appear to have decreased performance at similar weights.

Implications of differences in carcass quality grade suggest that a refinement in our utilization of implants as management tools may be necessary to allow producers to meet their preferred market needs and still maintain an optimal economic return.

Table 1. Composition of Protein Supplement[a]

Ingredient	Amount lb/ton
Ground corn	900
Urea	310
Limestone	520
Trace mineral salt	200
Vitamin-monensin-sulfur premix[b]	70

[a] Fed at 1 lb per head daily

[b] To supply 25,000 IU Vitamin A, 2500 IU vitamin D, 225 mg monensin, and 1.5 g sulfur per lb supplement

Table 2. Effect of Final Implant on Performance and Carcass Characteristics of Holstein Steers During Final 110-130 days in the Feedlot

	Implant treatment[a]			
Item	No implant	Snyovex	Finaplix + Synovex	SE
No. steers	12	12	12	
Init. wt.[b]	784	767	751	17
Days on feed	131[d]	110[e]	121[f]	.9
Final wt[c]	1116	1112	1117	27
Daily feed, lb DM	17.10[d]	19.75[e]	18.55[f]	.08
Daily gain, lb	2.53[d]	3.14[e]	3.03[e]	.12
Feed/100 lb gain, lb DM	676	629	612	.17
Feed cost/100 lb gain $[g]	32.21	29.68	28.22	
Carcass characteristics:				
Carcass wt	667	665	668	16
Dressing percentage	59.6	59.9	59.9	.4
Rib eye area, sq.in.	9.79	10.26	9.79	.26
Fat depth, in.	.23	.28	.25	.02
KHP, %	2.6	2.7	2.6	.1
Marbling score	5.4[d]	4.6[e]	5.0[de]	.2
Av. Quality Grade	Choice-	Select+	Choice-	
Steers graded choice, %	83.3	25.0	50.0	

[a] All cattle received 3 implants from weaning prior to final implant assignment.

[b] Obtained after withholding feed and water 16 hours.

[c] Adjusted to a common dressing percentage of 59.8.

[def] Row means with different superscripts differ ($P < .05$).

[g] Based on corn @ $80/ton; supplement @ $240/ton; corn silage @ $30/ton.

High Corn Feeding Strategies for Holstein Steers - An Overview of Southern Experiment Station Research

Hugh Chester-Jones, Animal Scientist

Feeding high corn diets to Holstein steers throughout the feeding period is becoming more widely accepted in the Upper Midwest. However, the dynamics of market price for cattle and feed dictate feeding options which demands knowledge of potential steer performance at each phase of production using different forage:concentrate ratios and protein sources. The underlying key, though, is to maximize efficiency of dietary ME utilization to minimize days on feed and proportion of ME used for maintenance which implies high grain diets.

Forage:concentrate ratios and feedlot performance

The effect of feeding Holstein calves different concentrate:forage ratios from 1 week of age to market weight was addressed by early research at the Minnesota Southern Experiment Station summarized by Miller et al. (1986). Starter diets (43-136 kg) contained 0, 15 or 30% ground alfalfa hay; grower diets (136-273 kg) were either all concentrate or 70:30 corn silage to rolled corn (dry basis), and finisher diets either contained all concentrate or 29:71 corn silage to rolled corn (dry basis). Soybean meal was the main protein source in starter diets (total diet 16% crude protein). Urea was incorporated in protein supplements fed at .46 kg daily from 136 kg to market (total diets 11-12% crude protein). Ionophores were not used in these studies but all steers were implanted. Results shown in table 1 include only 0 and 30% hay starter diets as there was no rate of gain difference from steers fed 15% hay. Steers fed all concentrate diets throughout the feeding period had lowest feed/gain ratios. Feeding 30% hay in starter diets enhanced overall daily gains. Feeding high roughage diets in both growing-finishing periods reduced performance. Compensatory growth patterns were observed for all concentrate feeding periods following higher roughage levels. This research established that hay or roughage is desirable in starter diets, 30% being the maximum level. Current research programs at this Station incorporate a minimum of 10% roughage source in all diets from 1 week to market weight. Urea is preferred as the main nitrogen source for growing-finishing. Plant protein is preferred for starter diets unless economics dictate otherwise.

Starter phase feeding strategies (birth to 182 kg)

Whether young calves are purchased or retained on dairy farms to be fed out, it is critical to combine good health management programs with feeding programs to maximize their growth potential. A summary of nutrition and management and example budget during the starter phase is given below:

GOALS: - 41 to 181 kg in 163 days on feed;
* Av. daily gain @ .86 kg; Av. daily feed @ 3.00 kg/
* Av. feed/kg gain @ 3.4 lb.; Feed cost/kg gain = 64 c.
(feed cost include milk replacer - without milk replacer
av. would be about 44 cents/kg gain).

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1. Management for a Healthy Calf:
   Establish a good health program with your local vet. Purchased calves reduce stress upon arrival e.g. give electrolytes & glucose water for 1st 2 feedings and administer health program immediately. Home raised calves 4-5% birth wt. colostrum within 30 min. after birth. Oral calf vaccine within a few hrs after birth. Can manage male & females similarly until move to a feedlot. Minimize chronic respiratory infections.

   Housing: - individual stalls/hutches/crates. 20 sq. ft. in stalls; 24-28 sq. ft. in hutches. Isolate purchase calves from herd calves.

   Ventilation: - 7-10 CFM/calf in winter; 60 CFM/calf in summer. Move to feedlot @ 6-8 wk old (20-30 sq. ft/head - 12 inches of bunk space/calf). Routine castrating/dehorning/implanting during 4-6 week period. (Can implant earlier). If purchase calves ensure a uniform group as possible.

2. Liquid Feeding Strategies:
   Encourage dry feed intake within 2-3 days after birth. Limit liquid intake to .5 kg dry matter/day. Feed whole milk @ 8-10% body weight. Feed twice daily unless calves weak or in severe cold weather. Once a day has been successful. Provide fresh water. If use milk replacer watch for quality-protein @ 20-22% & fat @ 10-20%. At least 50% protein from milk by-products i.e. casein, dried whey etc. Soy isolates are good substitutes up to 50% milk products. Inferior sources include meat solubles, distillers dried solubles, wheat flour etc. If use waste discard mastitic milk - don't use on first day of calf's life. Prevent calves suckling each other if use mastitic milk. If commercial electrolyte not available for sick calves home mixture = 4 teaspoons table salt; 3 teaspoons baking soda; 1/2 cup of 'light' corn syrup; 1 gallon water. If suspect coccidiosis problems can use Bovatec @ 1 mg/kg body weight in starter &/or milk or decoquinate (deccox) @ 22.7 mg/ 100 lb body weight in starter diet for 28 days min. as anticoccidiostats. Wean @ 28 days when calves eating 1.3% body weight in starter. Wean later than 4 wk in cold weather if calf eating less than 1 kg.

3. Dry Feeding Strategies:
   Maximize intake to optimize efficient growth characteristics of young calf. Should be gaining 1 kg/day just after weaning and requiring about 2 kg feed/kg gain on a high energy diet. Gains will increase to well over 1.4 kg/day before 181 kg body weight. Starter should be coarse textured or pelleted, 8-10% fiber, min of 16% protein. Whole, coarsely ground, or rolled grains. Molasses up to 5% of complete diet mixture. Example of Station diets used for home raised calves: a) cracked corn 45.5%, 13% SBM, 5% molasses, 20% whole oats vit & min. b) 50% corn, 30% oats, 15% SBM, vits & min.

Diets for purchased calves & nutrition research

A. High energy diets, e.g. whole/rolled corn fed @ 3 pts to 1 pt pelleted suppl. (alfalfa meal/SBM, vit & min.). Diet to supply 2000 IU vitamin A & 200 IU vitamin D/lb diet. AV. 16% protein. Results are shown in table 2. No problem with calves getting on feed after weaning.

B. Roughage/Fiber Levels: Most research conducted with 10-20% roughage/higher fiber source in a high energy diet (75 to 80% total digestible nutrients). Specific study to look at 0, 15 or 30% hay showed 15% hay higher daily gain but 0 hay highest feed efficiency. 10% minimum higher fiber/roughage source appears desirable.

C. By-Product Feeds: Dry beet pulp included at 0, 15 or 30% replacement for corn with SBM and 10% alfalfa pellets (16% protein), 15% beet pulp most effective level - similar performance to corn/SBM/alfalfa pellet diets. Dry corn gluten feed pellets supplied a medium protein source and fiber substituted up to 40% replacement for corn/SBM in diets with a similar level of oats (25%). No effect on performance. Economics will dictate use of various by-products in starter diets. Important to get a good composition analysis before including in a ration.

D. Supplementary Nitrogen Sources: Station research has shown that plant protein source is preferred to 181 kg. But these calves can utilize urea in high corn diets from 7-14 days old. In diets with 20% ground alfalfa, rolled corn and SBM as control (15% protein) urea was substituted for 33, 67 or 100% of SBM at 1/2 wk old and 7 wk old. Slightly lower performance with calves fed 100% urea suppl. (.82 vs .88 kg/day gain). Cost of gain similar as lower efficiency for urea vs SBM (1.44 vs 1.50 kg/kg gain). Raw soybeans were not used as effectively as SBM. Higher rumen by-pass sources have shown a response in daily gain and days on feed with extruded soybeans + urea in starter diets vs SBM, extruded and urea supplements fed alone. No difference in feed/gain. Economics still favored SBM in these trials. Other by-pass protein sources have shown no benefit vs SBM and they include dried distillers grains, meat meal, formaldehyde treated SBM, and alcohol treated soybeans.

E. Protein level in starter diets: Traditionally one level has been fed in starter diets at the Station. Research showed that feeding a 13, 15 or 17% protein increased daily gain and improved feed/gain as protein increased. When these calves were fed similar growing diets, those fed lower protein starter diets compensated in growth. Current work is feeding weanling Holstein calves protein levels based on predicted requirements as body weight changes adjusted every 2 weeks. Calves fed from 62 to 181 kg averaged 13.8, 15.8 and 18% protein intake for their 85,100 and 115% diets, respectively. Protein levels decreased with age of calves: calves fed 85% diets decreased protein levels from 17% down to 12.4%. Those fed 100% diets from 19% down to 14% and calves fed 115% diets from 22% down to 16%.

Average daily gain & f/g was 2.34/2.96 (85%); 2.55/3.12 (100%) and 2.35/2.85 (115%) up to 181 kg. Results are preliminary but suggest we can refine our protein feeding strategies to save some feed costs especially noticing the good feed efficiency for the calves fed 85% diets.

Preventing sickness at any time during the feeding period is critical. However, if a condition is treated promptly these young calves will usually follow a period of sickness with a growth surge to compensate. This same effect can also be seen after routine vaccinations for example IBR/P13 when gains may drop off but will comeback very quickly. Remember, it is critical if feeding whole corn/rolled corn + pelleted diets to always have feed in front of these calves.

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EXAMPLE OF A BUDGET FOR RAISING CALVES FROM 41 TO 181 KG

Feeder calves gaining av. .9 kg for 163 days from birth	
Feed costs:	
Milk Replacer, 13.6 kg @ $1.54/kg	$ 21.00
Complete Calf starter, 479 kg @ 15.4 cents/kg	$ 73.58
(diets similar to described above)	
Total feed costs - birth to 181 kg	$ 94.58
(If use waste milk can deduct $21 or if use regular whole milk add $9.00)	*******
Non-Feed Costs:	
Original value of the calf	$150.00
Interest (11% on 1/2 feed costs plus total calf value)	$ 10.00
Death loss, 10%	$ 15.00
Labor and Health	$ 22.00
Yardage @ 10 cents/day	$ 16.30
Total Non-Feed costs	$211.30
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Total Costs in this sample budget	$305.88

If use home raised calves then can include just value of semen instead of calf value. Need 79 cents/lb to break even in this example.

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Growing-Finishing Feedlot Strategies (182 kg - market) and Economic Considerations

Nutrition and Performance

Feeding as uniform a group as possible of cattle, whether light or heavy feeders, is critical to maximize growth potential in the feedlot. Ionophores and implants are indispensable production aids for the feedlot. Based on current information on nutrient requirements and expected growing-finishing performance, least cost analysis can be used to predict performance, feed usage and cost of gain with different feed combinations. The example shown in table 3 is based on combinations of corn and corn silage to give different feed energy densities and fed to a 227 kg feeder steer to 500 kg. Costs included in the data were corn at $3/bu; corn silage equal to 9.4 bushels of corn in the feedlot ($28.20/ton) protein supplement at $280/ton and ionophore costs set at 1.8 cents/d. Non-feed costs (excluding labor) were included at 40 cents/d based on information from Schaefer et al. (1986). Performance improved with dietary energy level and cost of gain was over $6 lower for the highest corn vs highest silage diet. Options would be open for feeding the two intermediate level diets depending on actual feed costs. Final weights would be higher than 500 kg for the high silage diets to attain similar carcass fatness.

The estimated feedlot performance data presented in table 3 is in agreement with research by Schaefer (1986) when diets with different amounts of high moisture corn and forage were fed to 196 kg Holstein feeder calves (table 4). The performance data in this study shown for steers fed 90:10 corn to forage diets is similar to performance of 380 kg steers fed whole corn and pelleted supplement in current research at the Minnesota Southern Experiment Station. Miller et al. (1986) reported similar responses for different corn/corn silage diets.

Utilization of by-products and alternative protein sources can be beneficial if economics and nutritional responses dictate. In a recent study at the Southern Experiment Station 209 kg Holstein steers were fed a full feed of rolled/whole corn, 10% corn silage (dry basis) and 1.23 kg pelleted supplement containing urea, feathermeal or a combination of both sources. There were no differences in the nutritional responses seen (Table 5). Urea still appeared to be the economic N-source of choice.

The concern of decreasing feed efficiencies with heavier feedlot cattle has led to an interest in strategies to enhance utilization of feed energy at feed intake levels less than maximum which may have an effect on maintenance requirements and feed conversion. Plegge (1986) improved ME value of high energy diets fed to beef steers at 96 and 92% of ad libitum, by 2.3 and 3.0%, respectively. Feed conversions were improved although daily gains were slightly reduced. A recent preliminary study was conducted with Holstein steers by Chester-Jones et al. (unpublished), results of which are presented in table 6. Steers fed 95% of ad libitum had similar rates of gain with 5.6% less feed/unit gain than those fed 100% full feed. Iterative procedures estimated ME value of the 95% diet to be improved 3.4%. Estimated energetic efficiency was slightly higher for 95% fed steers. Composition of gain and carcass quality grade were unchanged by diet intake level. Further work is indicated in this area for Holstein steers. A summary overview of the research conducted during the growing-finishing phase is given below.

SUMMARY OF RESEARCH CONDUCTED IN GROWING/FINISHING PHASE

1. Forage/concentrate ratios:
   a. High corn diets preferable but recommendations from earlier research indicated a two-phase approach could be more economical
   b. Present approach is feeding high corn diets from birth to market wt. or 523 kg (1150 lb) by 12-13 months of age. (av. quality grade select+).
2. Protein sources:
   a. Urea preferred throughout especially after 318 kg (700 lb). Economics will dictate plant vs NPN before 318 kg (700 lb).
   b. By-pass protein - current research comparing urea vs feathermeal - economics dictate again.
3. Other feeds/strategies:
   a. 0, 15 or 30% beet pulp for corn - no difference
   b. Ensiled sweet corn processing waste: Replace up to 50% of roughage in growing diet.

3. c. Restricted intake for high corn finishing diets - full feed vs 95% full feed. 95% increased feed efficiency by 5.6%. No difference in carcass data.
4. Other Questions:
   a. Use of antibiotics, e.g. tylan? Not used in current research, no problem with liver abscesses.
   b. Ionophore rotation? Morris, 1988 with crossbred steer: - Rumensin (225 mg daily) vs Rumensin/Bovatec (300 mg daily) alternate daily switch. No improvement in performance.

Housing

There continues to be some concern about housing requirements of Holsteins, especially in winter months, based on some suggestions that Holsteins have a lower tolerance to cold than beef steers because of lower external fat cover. Housing studies conducted at the Minnesota West Central Experiment Station at Morris suggest Holsteins do not require confinement when fed during the winter. Data is reported in table 7. Cattle fed in open lots, however, should be protected from wind and mud buildup should be minimized.

Economics

The final three tables (8, 9 and 10) present budget considerations for purchase price of Holsteins and breakeven-prices based on changes in corn costs and sale of cattle and performance on different diets. These details can be considered before decisions are made to feed out Holstein steers.

Marketing

The concern in the Upper Midwest is the number of Holstein steers leaving the area for southern feedlots and the difficulty in obtaining large uniform groups of feeder cattle to be a profitable consideration. Different packers appear to pay premiums for specific type of Holstein steers to meet their market outlets. The differential in the gross return for choice Holsteins vs Beef breeds can be reduced to a minimum by finding a market that will accept steers that fit into your program capabilities.

SUMMARY

The potential for Holstein steers to fulfill the demand for quality lean meat in the Upper Midwest is tremendous as male Holstein calves are an abundant resource. Considerations for feeding Holstein steers should include the main differences from beef breeds in energy requirements for maintenance, growth characteristics and carcass quality. Projected feedlot performance can be accurately estimated based on response to dietary energy level. Adjustment factors are available to refine performance predictions further. High corn diets optimize growth potential of Holstein steers. Alternative feeding options can be considered based on price differentials between corn and forage, protein sources and available feed supply. Close attention to detail in health and feeding management programs are critical for the entire feeding period. Buying and selling decisions determine profitability as with all cattle production. A summary of key points to consider is given below.

GROWING/FINISHING PHASES
181 KG TO MARKET WT. 520+ KG

GENERAL POINTS:

1. Buying/selling decisions critical.
2. Feed as uniform a group as possible.
3. Choice of feeding program:
    a. High corn diets with minimum roughage/fiber level (10-12).
    b. Two phase feeding e.g. 55 to 60% corn silage to 45 to 40% corn (DM basis) to 318 kg and 28.7% corn silage to 72.3% corn (DM) from 318 kg to market.
4. Full feed diets, adjust daily if necessary.
5. Use urea as preferred protein source from 181 kg.
6. Use implants and feed ionophores.
7. Practiced good bunk management.
8. Protect steers from elements, e.g., mud and wind during winter.
9. Maintain a good health program.
10. Keep good records.

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Table 1. Feedlot performance of Holstein steers fed different proportions of forages and concentrates from 1 week of age to market[a]

	All-concentrate[b]				30% hay[b]			
	All-conc.[c]		Silage + corn[c]		All-conc.[c]		Silage + corn[c]	
Item	All-conc.	Silage[d] + corn	All-conc.	Silage[d] + corn	All-conc.	Silage[d] + corn	All-conc.	Silage[d] + corn
No. steers	15	17	19	16	18	16	19	20
Init. wt, kg	45	41	45	53	44	46	43	45
Final wt, kg	454	454	463	443	470	466	464	456
Days fed	418	433	428	431	411	393	422	416
Daily gain, kg	.99	.96	.98	.93	1.03	1.07	1.01	.99
Daily feed, kg DM	4.67	4.91	5.10	5.25	4.98	5.21	5.22	5.56
Feed/100 kg gain, kg DM	472	512	520	566	484	487	517	562

[a] Adapted from Miller et al (1986). Univ. Minn Sta. Bull. Ad-SB-2896

[b] Starter diets: - "all concentrate": 79.6% corn, 17.6% soybean meal (SBM)
(43 - 136 kg) - "30% hay": 54.8% corn, 13.3% SBM, 30% alfalfa hay.

[c] Grower diets: - "all concentrate": Full feed corn plus .46 kg urea suppl.
(136 - 273 kg) - "silage + corn": 6 pt corn silage to 1 pt. corn (as fed) plus .46 kg urea suppl.

[d] Finisher diets:- "all concentrate": Full feed corn plus .46 kg urea suppl.
(273 kg-market)- "silage + corn": 1 pt corn silage to 1 pt corn (as fed) plus .46 kg urea suppl.

Table 2. Performance of steers fed starter diets containing whole or rolled corn with pelleted protein supplement for 127 days.

	Physical form of corn fed			
Item	Rolled	Rolled/ whole[a]	Whole	Sx[b]
No steers	24	24	24	
Init. wt., kg[c]	52	53	52	
First 56 days[d]				
56 day wt, kg[c]	100	102	103	3.11
Daily Feed Intake, kg DM	2.18	2.33	2.32	.12
Daily gain, kg	.86	.89	.91	.04
Feed/100 kg gain, kg DM	254	262	255	12.00
Day 57 to 127[d]				
127 day wt, kg[e]	184[f]	191[g]	113[g]	3.71
Daily Feed Intake, kg DM	4.13	4.32	4.26	.21
Daily gain, kg	1.19	1.25	1.27	.04
Feed/100 lb gain, kg DM	347	346	335	19.00
Overall Performance, 127 days[d]				
Final wt, kg	184[f]	191[g]	193[g]	3.71
Daily Feed Intake, kg DM	3.26	3.57	3.41	.16
Daily gain, kg	1.04	1.09	1.11	.07
Feed/100 kg, kg DM	315	316	307	.06
Feed cost/100 kg gain, $[h]	54.63	54.80	53.24	

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[a] Steers switched from rolled to whole corn after 56 days on the study.

[b] Standard error.

[c] Average of two consecutive weights prior to feeding.

[d] Row means without superscripts do not differ ($P > .05$)

[e] Obtained after withholding feed and water for 16 hours

[fg] Row means with different superscripts differ ($P < .05$)

[h] Based on corn at $100/ton and pelleted supplement $269/ton.

Table 3. Projected performance and cost of gain of Holstein steer calves fed different amounts of corn silage[a]

Item	Mcal ME/kg DM 2.53	2.72	2.90	3.08
Initial wt, kg	227	227	227	227
Final wt, kg	500	500	500	500
Daily gain, kg	1.12	1.32	1.48	1.59
Days to gain 273 kg	244	206	184	171
Daily feed, kg DM				
Corn silage	8.09	5.41	2.12	.29
Corn grain	.41	2.99	6.03	7.52
Supplement	.41	.41	.44	.42
Total	8.91	8.81	8.59	8.23
Feed/100 kg gain, kg DM	796	668	580	517
Feed/273 kg gain, as fed				
Corn silage, ton	6.78	3.83	1.34	.17
Corn grain, bu	4.61	28.16	50.70	58.93
Supplement, kg	244	206	184	171
Feed cost/100 kg gain[b]	$35.98	$32.56	$32.87	$30.66
Non feed cost/100 kg gain, (excluding labor)	$16.27	$13.73	$12.27	$11.33
Total cost/100 kg gain	$52.25	$46.29	$45.14	$41.99

[a] Plegge and Chester-Jones (unpublished).

[b] Corn @ $3/bu; corn silage @ $28.20/ton; supplement @ $280/ton.

Table 4. Performance and feed required by Holstein steers fed three different diets from 190 to 500 kg[a]

Item	High moisture corn:forage[b] 90:10	75:25	60:40
No. steers	24	23	24
Initial wt, kg	196	196	196
Final wt, kg	502	496	503
Days on feed	194	202	229
Daily gain, kg	1.59[c]	1.48[d]	1.34[e]
Daily feed, kg DM	7.55	7.50	7.36
Feed/100 kg gain, kg DM	475[c]	507[c,d]	549[d]
Feed/304 kg gain, as fed			
Corn, bu	54.4	49.9	42.1
Forage, kg	173	455	800
Supplement, kg	269	282	309

[a] Adapted from Schaefer (1986) and Schaefer et al (1986). Univ. WI. Bull. #A3360.

[b] Alfalfa haylage was the forage source until steers averaged 223 kg. Corn silage was the forage source from 223 kg to slaughter.

[c,d,e] Means with unlike superscripts differ ($P < .05$)

Table 5. Performance of steers fed different nitrogen sources in pelleted protein supplements from 450 lb

	Nitrogen source[a]			
Item	U	FM	UFM	Sx[b]
No. steers	24	24	24	
Initial wt, kg[c]	209	209	209	
Final wt, kg[d]	393	399	395	
Daily gain, kg	1.47	1.52	1.49	.05
Days on feed	125	125	125	
Daily feed, kg of DM	7.21	7.34	7.24	
Feed/100 kg gain, kg DM	490	483	486	20.76
Feed costs/kg gain	$39.40	$40.80	$40.10	

[a] Nitrogen source; Urea = Urea; FM = Feathermeal; UFM = 50% supplemental protein supplied each by urea combined with feathermeal.

[b] Standard error.

[c] Obtained as an average of two consecutive weights taken prior to feeding.

[d] Obtained after withholding feed and water 16 hours.

[ef] Row means with different superscripts differ ($P < .05$)

Table 6. Effect of restricting feed intake on performance of Holstein steers from 332 to 500 kg - A Preliminary Study[a]

	Diet, % of Full Feed	
Item	100	95
No. steers	12	12
Initial wt, kg[b]	332	331
Final wt, kg[b]	484	481
Days on feed	123	119
Daily gain, kg	1.24	1.26
Daily feed, kg DM		
Corn	6.57	6.27
Corn silage	1.92	1.85
Supplement	.35	.36
Total	8.84	8.47
Feed/100 kg gain, kg DM	713	673
Metabolizable energy Mcals/kg DM[c]	2.84	2.94
Estimated energetic efficiency[d]	26.1	27.1
Estimated tissue gain[e]		
% fat	53.5	53.8
% protein	10.6	11.0
Carcass data:		
Carcass wt, kg	282	280
Dressing %	58.4	58.1
Rib Eye Area, sq cm	25.0	24.4
Fat Depth, cm	.58	.58
KPH, %[f]	2.33	2.72
Marbling[g]	4.6	4.6
Quality Grade	Av/High Good	Av/High Good

[a] Chester-Jones et al. (unpublished).
[b] Weights taken after withholding feed and water 16 hours.
[c] Calculated by iterative procedures of Plegge (1986).
[d] Energy gained/ME intake, Crickenberger et al. (1978).
[e] Based on estimated given by Fox and Black (1984).
[f] Kidney, heart and pelvic fat as percentage of carcass weight
[g] Marbling scores: 4, slight; 5, small.

Table 7. Performance of Holstein steers fed in five housing systems

	Housing System				
Item	Open Lot	Manure scrape	Conventional	Cold slat	Warm slat
	Trial 1[a]				
No. of steers	20	27	38	32	42
Initial wt, kg	271	264	261	262	248
Final wt, kg	527	542	515	521	504
Daily gain, kg	1.29[c]	1.40[d]	1.28[c]	1.30[c]	1.29[c]
Daily feed, kg DM	8.77	8.84	8.51	8.52	8.42
Feed/100 kg gain, kg DM	680	631	665	655	653
	Trial 2[b]				
No. of steers	25	32	39	33	48
Initial wt, kg	185	187	179	181	184
Final wt, kg	503	498	479	488	490
Daily gain, kg	1.13	1.11	1.07	1.09	1.08
Daily feed, kg DM	7.18	7.02	6.87	6.90	6.74
Feed/100 kg gain, kg DM	635	632	642	633	624

[a] Trial 1, Smith et al. (1973). MN Cattle Feeders Report B-183.

[b] Trial 2, Smith et al. (1974). MN Cattle Feeders Report B-197.

[c,d] Means with unlike superscripts differ ($P < .05$).

Table 8. Estimated return to farm enterprise at various corn and forage prices for three diets fed to Holstein steers[a]

		Grain-Forage dry matter ratio		
Corn ($/bu)	Forage ($/ton as fed)	90:10	75:25	60:40
2.50	40	$51.47	$54.79	$43.79
2.50	60	47.49	44.34	25.44
2.50	80	43.51	33.88	7.09
3.00	40	21.24	28.92	21.91
3.00	60	17.26	18.47	3.56
3.00	80	13.29	8.02	-14.79
3.50	40	- 8.99	3.06	0.03
3.50	60	-12.96	- 7.39	-18.33
3.50	80	-16.94	-17.84	-36.68

[a] Adapted from Schaefer et al. (1986). Univ. WI Bull. #A3360.

Table 9. Estimated break-even price ($/cwt) to cover variable costs for Holsteins fed a 90% grain diet from 364-591 kg[a]

		Purchase price ($/cwt)				
		45.00	50.00	55.00	60.00	65.00
	2.00	46.81	50.13	53.45	56.77	60.09
Corn	2.50	49.58	52.90	56.22	59.54	62.86
price	3.00	52.34	55.67	58.99	62.31	65.63
($/bu)	3.50	55.11	58.43	61.76	65.08	68.40
	4.00	57.88	61.20	64.52	67.84	71.16

[a] Adapted from Schaefer et al. (1986). Univ. WI. Bull. #A3360.

Table 10. Estimated breakeven price ($/cwt) to cover variable costs for Holstein steers fed a 90% grain diet from 55-500 kg[a]

		Purchase price ($/cwt)				
		100.00	110.00	120.00	130.00	140.00
	2.00	43.42	44.71	46.01	47.31	48.61
Corn	2.50	46.81	48.11	49.41	50.71	52.01
price	3.00	50.21	51.51	52.81	54.11	55.41
($/bu)	3.50	53.61	54.90	56.20	57.50	58.80
	4.00	57.00	58.30	59.60	60.90	62.20

[a] Adapted from Schaefer et al. (1986). Univ. WI. Bull. #A3360.

SYSTEMIC FUNGICIDES FOR COMMON CORN RUST CONTROL

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SIGNIFICANCE:

Evaluation of various fungicides, both contact and systemic in nature, for common corn rust control, was conducted for the third year at the Southern Experiment Station. Systemic fungicides offer an advantage over contact fungicides because of their residual control between applications. Contact fungicides have to be applied more often and their rust control potential has paled by comparison to the systemic fungicides. In addition, the recent concern by the Environmental Protection Agency and the general public over the alleged carcinogenic properties of the EBDC fungicides has heightened efforts to ban the use on all crops in the near future. With the eventual expected loss of the EBDC materials, a tremendous void is created for the control of rust in sweet corn. If environmental conditions become favorable, and particularly early in the production season (late June), an epidemic is possible in varieties with little or moderate tolerance to the disease. Rust resistance continues to be an objective of many public and private breeding programs; however, the ability of the fungus to overcome levels of resistance in the plant is ever present, and for this reason future rust management practices are likely to include the use of tolerant varieties and judicial use of the newer systemic fungicides.

The objective of the study was to compare rust control potential of each fungicide and to determine if there were any adverse effects on yield.

MATERIALS AND METHODS:

Variety:	Jubilee
Planting Date:	June 29
Plant Population:	24,000/A
Herbicides:	Lasso (alachlor) and Bladex (cyanazine) at 2.5 and 2.0 lb. a.i./A preemergence.

The plot design was a randomized, complete block with four replications. Fungicide treatments were first applied when the average number of rust pustules/leaf was 4-5. Just prior to harvest, three leaves were sampled from each of five plants in each treatment to determine rust severity levels. Specific locations of the leaves evaluated were, counting basipetally, the flag, secondary, and opposite/above ear positions. All treatment plots were harvested when kernel moisture reached 72-74%.

RESULTS AND DISCUSSION:

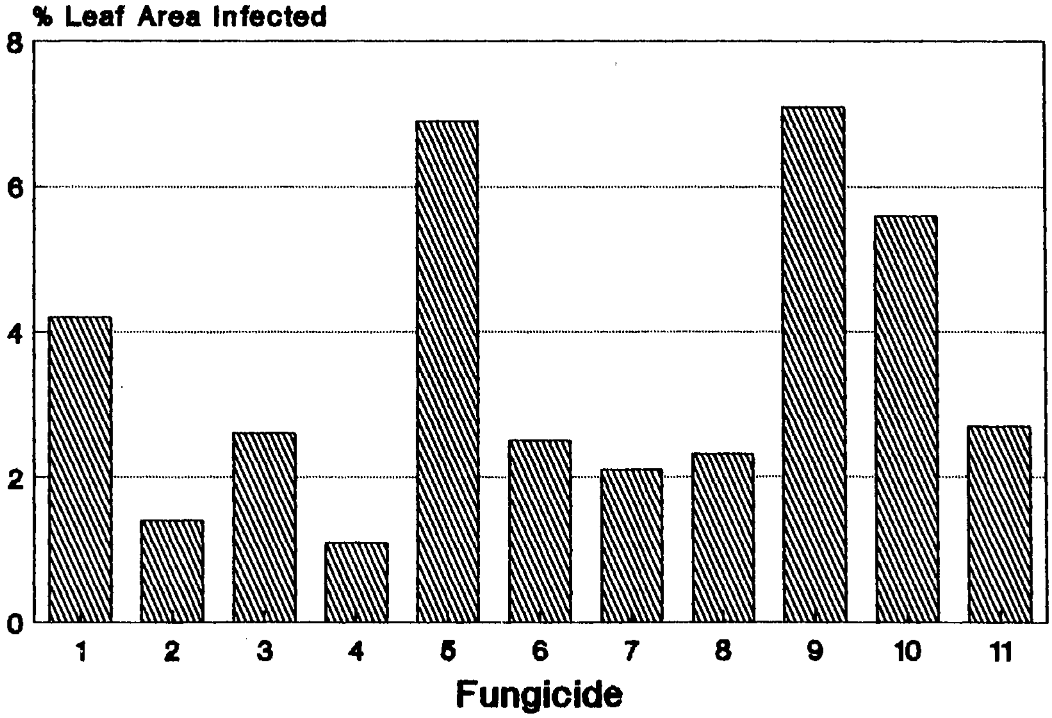
Maximum rust severity recorded was determined to be 8.5% of the total flag leaf area in the control plot. Tilt 3.6E at .11 lb. a.i./A (7 and 14 day application intervals) and Spotless 25WP provided significant rust control (1 and 2% leaf area infected, respectively). The standard Manzate treatment had an average 5% of the leaf area infected.

Sweet corn treated with Tilt 3.6E (.11 lb. a.i. every 14 days) yielded 13% more cut corn than the control. In addition, Tilt 3.6E (.055 and .11 lb. a.i. every 7 and 14 days, respectively) and Spotless 25WP treatments yielded 40% more useable ears for corn on the cob freezing when compared with the control. It is uncertain how much of this increase in yield from plants treated with either Tilt 3.6E or Spotless 25WP is wholly or in part attributable to a "growth regulator" effect, elicited by these fungicides, which has been observed before. It is projected by the manufacturer of Tilt 3.6E that a label will be obtained for use on rust in sweet corn for the 1992 production season.

RUST FUNGICIDE TRIAL
1989 UPDATE

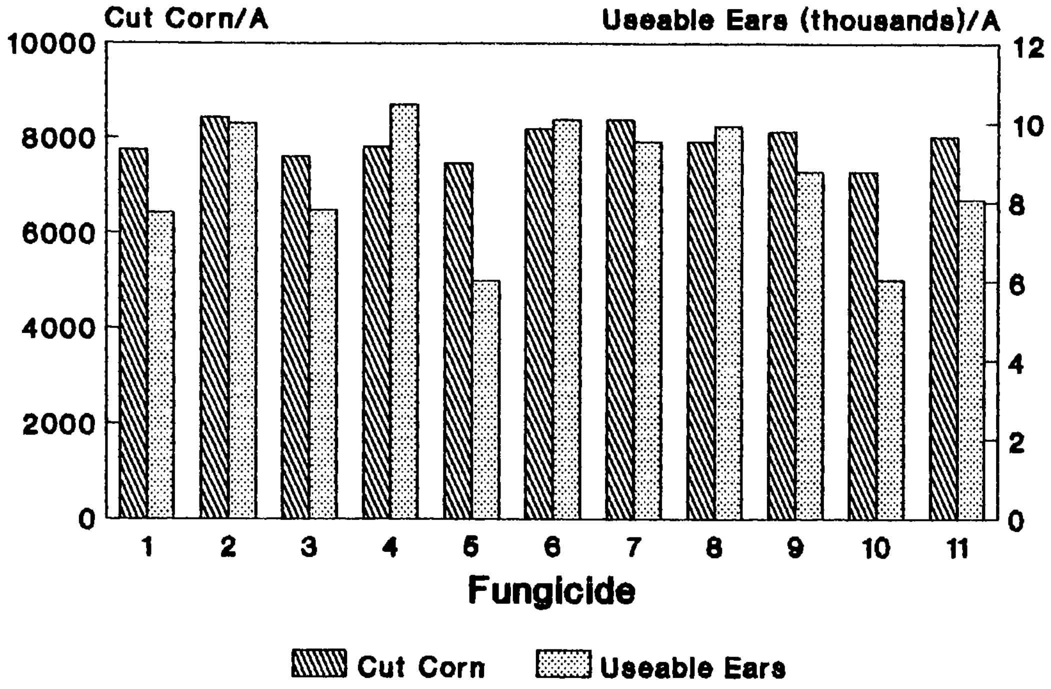
	FUNGICIDE	RATE (LB.AI./A)	APP. INTERVAL (DAYS)
1	RH-7592 2F	.06+1qt. COC/A	10
2	TILT 3.6E	.11	14
3	DITHANE F45	1.6+1pt.B-1956/100 gal.	7
4	TILT 3.6E	.055	7
5	BAYLETON 50WP	.25	10
6	SYSTHANE 60DF	.12+1pt.B-1956/100 gal.	10
7	TILT 3.6E	.11	7
8	SPOTLESS 25WP	.10+6oz.X-77/100 gal.	10
9	MANZATE 80WP	1.2	7
10	NONTREATED	--	--
11	BRAVO 6F	.52	7

DEGREE OF RUST CONTROL



Opp./Above Ear

YIELD SUMMARY



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Uniform Sweet Corn Seed Treatment Experiment - 1989: Preliminary Report (based on final stand counts)

Of the 37 plantings made in diverse locations, only 29 have been included in the analysis up to this point (Table 1). Site interacted strongly with treatment factors making simple analysis and interpretation impossible. A method was developed to assemble the sites into groups such that site would not interact with fungicide treatment within group. First, counts from the 30 fungicide treatments were considered variables describing the behavior of the site. Since these 30 variables were highly intercorrelated, the data set was subjected to principal components analysis to extract the information contained in the 30 variables into a smaller number of non-correlated variables (Table 1). The first principal component was an estimate of the location

Table 1. Sites included as of December 1989, group assigned and principal components.

Site	Mean % Stand	group	Principal Component Score			
			1	2	3	4
Fugisawa, Japan	74	1	4.08	-0.04	-0.30	-0.18
Belle Glade, FL	81	1	5.28	-0.12	-0.25	-0.19
Tifton, GA (early)	58	1	2.04	-0.02	-0.41	-0.21
Waseca, MN	66	1	3.05	0.26	-0.25	-0.14
Belle Glade, FL	77	2	4.75	0.27	0.05	0.03
Tifton, GA (late)	74	2	4.29	-0.12	0.02	-0.03
Nyssa, OR	61	2	2.62	-0.23	0.15	0.14
Farmington, MN	71	2	3.90	-0.15	0.13	-0.03
Davis, CA	72	2	3.98	-0.14	-0.08	0.08
Ontario, OR	78	2	4.82	0.09	0.09	0.07
Nampa, ID	69	2	3.65	-0.06	-0.03	0.23
Urbana, IL	71	2	3.81	0.10	-0.08	-0.11
Sun Prairie, WI	68	2	-3.71	0.11	0.01	-0.01
Buhl, ID	65	2	-2.90	-0.02	-0.05	0.19
Elizabethtown, PA	70	2	3.85	0.14	0.10	-0.07
Parma, ID (late)	66	2	3.30	-0.16	-0.02	0.20
LeSeur, MN (early)	62	2	-2.07	-0.18	0.03	-0.15
LeSeur, MN (late)	75	2	-1.12	0.09	0.01	-0.06
Sun Prairie, WI	67	3	3.46	-0.21	0.19	-0.41
Rochester, NY	40	3	-3.48	-0.41	0.02	-0.30
Fruita, CO	47	4	0.25	-0.45	-0.42	-0.10
Henderson, CO	50	5	0.71	-0.39	-0.48	0.48
Parma, ID (early)	69	5	3.81	-0.45	-0.19	0.27
Indio, CA	60	6	2.50	-0.58	0.29	0.06
Caldwell, ID	61	6	2.70	-0.62	0.02	0.06
Hollister, CA	57	7	1.64	0.42	0.33	0.09
Brighton, CO	28	8	-2.07	-1.26	0.32	-0.15
Rochester, NY	31	8	-3.84	-1.04	0.34	-0.15
rJohnston, IA	27	9	-2.29	-1.05	-0.14	0.20

main effect. Since the main effect could be specified in the subsequent analysis of variance, the first principal component was not used as a basis for separating the sites. Each site was plotted in the three-space comprised by the second through the fourth principal components (Fig. 1). Cluster analysis (centroid method) was used to form the sites into groups based on their distance apart in the three-space. Site identity and group are shown in table 1.

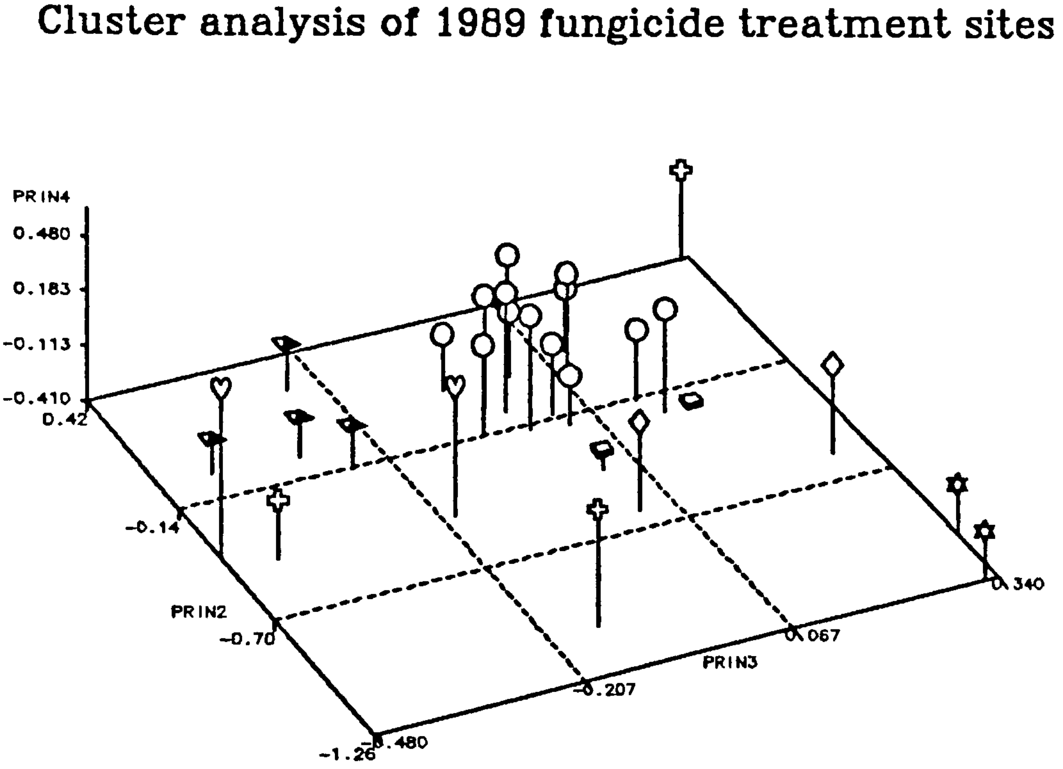

Fig. 1. Plot of sites in space comprised by principal components two through four. Symbol indicates group assigned by cluster analysis. ▶=group 1, ○=group 2, ◘=group 3, ♡ =group 5, ◇ =group 6, ✡=group 8, ✣ =groups 4,7,9 (single site groups).

Within group, site did not interact with treatment. Group was not correlated with geographic location. All results are presented as % improvement, that is proportional increase, not gain in % stand. Unless otherwise stated, the 5% confidence level was used.

Captan/Thiram (CT) was considered a single treatment factor in the core of this study. Treatment with CT was almost always better than treatment with either Benomyl (B), Imazalil (I) or Metalaxyl (M) alone, giving an improvement over the untreated control of from 10 to 430%. Addition of M to CT usually had either no effect or reduced the stand by 8 to 19%. However, at one site which comprised its own group, addition of M increased the stand by 37% over CT alone. Addition of B to CT increased final stand significantly in two groups consisting of a total of only three sites. When M was added to CTB, there was an improvement in stand ranging from 0-46%. The CTBM combination was significantly better than CT in five groups consisting of 20 sites, giving increases over CT ranging from 7 to 167%, and

Eliminating Captan from the mixture did not measurably reduce the final stand. Nusan or PCNB (P) as a basic protectant, instead of CT, reduced the stand from 0 to 65% compared to CTBM. Iprodione (R) instead of CT gave a reduction ranging from 0 to 15 %. However, R plus P was able to substitute for CT, and PRBM was not significantly different from CTBM. Using Thiabendazole instead of Benomyl in the CTBM combination gave a significant reduction in stand of 3% in one of the groups.

Imazalil (I) was not consistent. CTI was never significantly different from CTB. CTIM was significantly lower than CTBM in three groups representing 18 sites (3, 11, 42% reduction). None of the additives tested (Imazalil Lorsban, Vitavax, Nusan, Magnum, Iprodione, PCNB) increased final stand when added to CTBM. However, P decreased stand by 12% in one group (3 sites) and Vitavax decreased stand by 19% in another (2 sites).

In conclusion, three basic components appear to be necessary for optimum stand establishment: a wide spectrum protectant, a systemic similar to Benomyl in spectrum, and Metalaxyl. This conclusion is consistent with our more limited testing from previous years. None of the compounds added to CTBM further improved performance. TBM appeared to be a good minimal mixture, probably about as good as CTBM. The insecticides tested were not important in the sites studied, but didn't hurt. Combinations employing Imazalil instead of Benomyl, were inconsistent. Some evidence suggested that addition of other fungicides to CTBM could lead to inconsistent results.

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          Uniform Sweet Corn Seed Treatment Experiment - 1989
            Summary of final stand (%) by group (of sites)
                                                                page 1
   OBS     GROUP     TRT     _TYPE_     _FREQ_      STAND

     1       1        .         0         360      69.4778
     2       1        1         1          12      62.6667
     3       1        2         1          12      69.5000
     4       1        3         1          12      67.6667
     5       1        4         1          12      61.2500
     6       1        5         1          12      63.0833
     7       1        6         1          12      61.8333
     8       1        7         1          12      72.6667
     9       1        8         1          12      71.0833
    10       1        9         1          12      69.4167
    11       1       10         1          12      69.1667
    12       1       11         1          12      60.6667
    13       1       12         1          12      74.3333
    14       1       13         1          12      73.2500
    15       1       14         1          12      77.1667
    16       1       15         1          12      68.6667
    17       1       16         1          12      73.3333
    18       1       17         1          12      68.4167
    19       1       18         1          12      71.0000
    20       1       19         1          12      77.5000
    21       1       20         1          12      72.0000
    22       1       21         1          12      71.7500
    23       1       22         1          12      65.0833
    24       1       23         1          12      68.0833
    25       1       24         1          12      72.4167
    26       1       25         1          12      69.0000
    27       1       26         1          12      67.0833
    28       1       27         1          12      66.5000
    29       1       28         1          12      75.1667
    30       1       29         1          12      68.5000
    31       1       30         1          12      76.0833
    32       2        .         0        1680      71.6785
    33       2        1         1          56      59.2054
    34       2        2         1          56      70.8331
    35       2        3         1          56      66.9953
    36       2        4         1          56      64.7080
    37       2        5         1          56      66.3631
    38       2        6         1          56      69.5454
    39       2        7         1          56      71.5248
    40       2        8         1          56      71.9851
    41       2        9         1          56      71.0099
    42       2       10         1          56      68.4891
    43       2       11         1          56      68.7381
    44       2       12         1          56      75.7862
    45       2       13         1          56      73.1108
    46       2       14         1          56      73.2756
    47       2       15         1          56      72.5476
    48       2       16         1          56      76.1295
    49       2       17         1          56      75.3182
    50       2       18         1          56      74.8302
    51       2       19         1          56      76.6539
    52       2       20         1          56      75.8483
    53       2       21         1          56      75.7423
    54       2       22         1          56      75.0308
    55       2       23         1          56      73.8423
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Uniform Sweet Corn Seed Treatment Experiment - 1989

Summary of final stand (%) by group (of sites)

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                                                                  page 2
 OBS     GROUP      TRT     _TYPE_     _FREQ_      STAND

  56       2         24        1          56       74.6042
  57       2         25        1          56       71.6263
  58       2         26        1          56       68.8091
  59       2         27        1          56       73.2158
  60       2         28        1          56       73.2030
  61       2         29        1          56       67.3240
  62       2         30        1          56       74.0610
  63       3          .        0         240       57.3917
  64       3          1        1           8       41.6250
  65       3          2        1           8       50.3750
  66       3          3        1           8       38.0000
  67       3          4        1           8       53.8750
  68       3          5        1           8       42.2500
  69       3          6        1           8       56.6250
  70       3          7        1           8       64.1250
  71       3          8        1           8       55.6250
  72       3          9        1           8       64.1250
  73       3         10        1           8       45.2500
  74       3         11        1           8       52.8750
  75       3         12        1           8       64.2500
  76       3         13        1           8       49.1250
  77       3         14        1           8       62.6250
  78       3         15        1           8       55.8750
  79       3         16        1           8       63.7500
  80       3         17        1           8       64.3750
  81       3         18        1           8       66.1250
  82       3         19        1           8       71.7500
  83       3         20        1           8       51.8750
  84       3         21        1           8       59.5000
  85       3         22        1           8       64.7500
  86       3         23        1           8       62.3750
  87       3         24        1           8       66.6250
  88       3         25        1           8       56.2500
  89       3         26        1           8       53.6250
  90       3         27        1           8       61.7500
  91       3         28        1           8       62.0000
  92       3         29        1           8       60.7500
  93       3         30        1           8       59.6250
  94       4          .        0         120       47.9750
  95       4          1        1           4       35.0000
  96       4          2        1           4       39.0000
  97       4          3        1           4       48.7500
  98       4          4        1           4       30.7500
  99       4          5        1           4       42.0000
 100       4          6        1           4       39.5000
 101       4          7        1           4       54.5000
 102       4          8        1           4       43.5000
 103       4          9        1           4       48.5000
 104       4         10        1           4       48.0000
 105       4         11        1           4       44.0000
 106       4         12        1           4       62.2500
 107       4         13        1           4       50.5000
 108       4         14        1           4       56.7500
 109       4         15        1           4       46.5000
 110       4         16        1           4       61.0000
```

Uniform Sweet Corn Seed Treatment Experiment - 1989

Summary of final stand (%) by group (of sites)

```
                                                                  page 3
OBS     GROUP     TRT     _TYPE_     _FREQ_      STAND

111       4        17        1           4       55.7500
112       4        18        1           4       52.5000
113       4        19        1           4       54.0000
114       4        20        1           4       31.5000
115       4        21        1           4       48.7500
116       4        22        1           4       58.2500
117       4        23        1           4       50.7500
118       4        24        1           4       51.0000
119       4        25        1           4       50.7500
120       4        26        1           4       38.7500
121       4        27        1           4       50.0000
122       4        28        1           4       56.2500
123       4        29        1           4       34.5000
124       4        30        1           4       56.0000
125       5         .        0         240       61.4583
126       5         1        1           8       42.6250
127       5         2        1           8       60.7500
128       5         3        1           8       57.8750
129       5         4        1           8       46.1250
130       5         5        1           8       56.1250
131       5         6        1           8       49.1250
132       5         7        1           8       65.7500
133       5         8        1           8       60.2500
134       5         9        1           8       56.2500
135       5        10        1           8       56.7500
136       5        11        1           8       62.1250
137       5        12        1           8       65.6250
138       5        13        1           8       61.2500
139       5        14        1           8       70.1250
140       5        15        1           8       70.7500
141       5        16        1           8       71.2500
142       5        17        1           8       65.1250
143       5        18        1           8       64.0000
144       5        19        1           8       66.6250
145       5        20        1           8       71.1250
146       5        21        1           8       67.5000
147       5        22        1           8       67.2500
148       5        23        1           8       60.1250
149       5        24        1           8       57.6250
150       5        25        1           8       63.5000
151       5        26        1           8       57.8750
152       5        27        1           8       59.7500
153       5        28        1           8       67.6250
154       5        29        1           8       59.8750
155       5        30        1           8       63.0000
156       6         .        0         240       63.8667
157       6         1        1           8       40.6250
158       6         2        1           8       62.7500
159       6         3        1           8       53.1250
160       6         4        1           8       50.6250
161       6         5        1           8       54.1250
162       6         6        1           8       63.2500
163       6         7        1           8       67.7500
164       6         8        1           8       64.2500
165       6         9        1           8       65.5000
```

Uniform Sweet Corn Seed Treatment Experiment - 1989

Summary of final stand (%) by group (of sites)

```
                                                                page 4
OBS      GROUP      TRT      _TYPE_      _FREQ_      STAND

166        6         10        1            8       58.8750
167        6         11        1            8       54.1250
168        6         12        1            8       71.8750
169        6         13        1            8       63.8750
170        6         14        1            8       64.1250
171        6         15        1            8       61.6250
172        6         16        1            8       73.0000
173        6         17        1            8       71.1250
174        6         18        1            8       68.5000
175        6         19        1            8       67.0000
176        6         20        1            8       72.8750
177        6         21        1            8       68.0000
178        6         22        1            8       70.0000
179        6         23        1            8       65.3750
180        6         24        1            8       69.2500
181        6         25        1            8       69.6250
182        6         26        1            8       60.3750
183        6         27        1            8       67.8750
184        6         28        1            8       65.8750
185        6         29        1            8       59.5000
186        6         30        1            8       71.1250
187        7          .        0          120       57.1667
188        7          1        1            4       48.5000
189        7          2        1            4       58.0000
190        7          3        1            4       51.2500
191        7          4        1            4       60.5000
192        7          5        1            4       57.7500
193        7          6        1            4       58.0000
194        7          7        1            4       49.2500
195        7          8        1            4       63.0000
196        7          9        1            4       54.5000
197        7         10        1            4       58.5000
198        7         11        1            4       66.7500
199        7         12        1            4       60.5000
200        7         13        1            4       58.7500
201        7         14        1            4       51.0000
202        7         15        1            4       53.0000
203        7         16        1            4       63.0000
204        7         17        1            4       53.7500
205        7         18        1            4       54.2500
206        7         19        1            4       58.7500
207        7         20        1            4       63.2500
208        7         21        1            4       58.0000
209        7         22        1            4       54.5000
210        7         23        1            4       64.5000
211        7         24        1            4       62.2500
212        7         25        1            4       51.7500
213        7         26        1            4       55.2500
214        7         27        1            4       57.2500
215        7         28        1            4       64.2500
216        7         29        1            4       50.0000
217        7         30        1            4       55.0000
218        8          .        0          240       36.7208
219        8          1        1            8        7.3750
220        8          2        1            8       41.8750
```

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Uniform Sweet Corn Seed Treatment Experiment - 1989
   Summary of final stand (%) by group (of sites)
                                                                page 5
OBS      GROUP      TRT      _TYPE_      _FREQ_       STAND

221        8          3         1           8          9.6250
222        8          4         1           8         18.7500
223        8          5         1           8         11.6250
224        8          6         1           8         35.1250
225        8          7         1           8         30.5000
226        8          8         1           8         25.8750
227        8          9         1           8         37.6250
228        8         10         1           8         23.5000
229        8         11         1           8         17.2500
230        8         12         1           8         50.1250
231        8         13         1           8         38.6250
232        8         14         1           8         29.0000
233        8         15         1           8         46.6250
234        8         16         1           8         52.3750
235        8         17         1           8         57.7500
236        8         18         1           8         52.0000
237        8         19         1           8         48.0000
238        8         20         1           8         48.7500
239        8         21         1           8         44.7500
240        8         22         1           8         55.5000
241        8         23         1           8         48.2500
242        8         24         1           8         53.2500
243        8         25         1           8         34.1250
244        8         26         1           8         19.5000
245        8         27         1           8         31.8750
246        8         28         1           8         39.5000
247        8         29         1           8         45.0000
248        8         30         1           8         47.5000
249        9          .         0         120         30.9583
250        9          1         1           4         12.5000
251        9          2         1           4         16.7500
252        9          3         1           4         18.0000
253        9          4         1           4         14.7500
254        9          5         1           4         20.5000
255        9          6         1           4         23.0000
256        9          7         1           4         30.7500
257        9          8         1           4         33.0000
258        9          9         1           4         19.7500
259        9         10         1           4         25.7500
260        9         11         1           4         26.7500
261        9         12         1           4         44.7500
262        9         13         1           4         23.5000
263        9         14         1           4         35.0000
264        9         15         1           4         46.2500
265        9         16         1           4         45.5000
266        9         17         1           4         51.5000
267        9         18         1           4         40.7500
268        9         19         1           4         38.5000
269        9         20         1           4         44.2500
270        9         21         1           4         36.2500
271        9         22         1           4         43.2500
272        9         23         1           4         24.2500
273        9         24         1           4         38.5000
274        9         25         1           4         15.7500
275        9         26         1           4         22.7500
```

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         Uniform Sweet Corn Seed Treatment Experiment - 1989
            Summary of final stand (%) by group (of sites)
                                                                page 6
  OBS      GROUP      TRT      _TYPE_      _FREQ_      STAND

  276        9         27         1           4        22.75
  277        9         28         1           4        33.50
  278        9         29         1           4        38.25
  279        9         30         1           4        42.00
```

High Sugar (sh_2) Variety Trial - Rochester

Dennis Schrock and Vincent Fritz
Minnesota Extension Service, Rochester, Minnesota
Southern Experiment Station, University of Minnesota

1989 Sweet Corn Variety Trials

Fifteen cultivars of supersweet (sh_2) sweet corn were planted on May 25, 1989 in a randomized complete block design with three replications. Spacing was equivalent to 24,000 plants/A in 38" rows. Fertilization consisted of 100#/A N impregnated on Bladex and Eradicane and worked in 4" deep.

Although all seed was treated with a fungicide, the cultivars which were treated only in the field, rather than by the seed distributor, had extremely poor germination. Thus, only 11 cultivars were harvested for yield and quality data.

Four rows 25' in length were planted for each cultivar in each of three replicates. Only the middle 20' of the middle two rows were harvested for yield data.

When looking at total yield as measured by weight of ears with husks removed, 'Sweetie 76' and 'Landmark' had significantly greater yields than other cultivars (Table 1). 'Pinnacle,' 'Zenith', 'Illini Xtra Sweet', 'Yankee Belle', and 'Sweet Season' were a group of second highest yielders.

Table 1 Average total husked weight per plot for sh2 sweet corn cultivars.

Cultivar	Weight [1]	
CNS 700	14.0 lbs	a
Sweetie 70	16.3	ab
Sweet Desire	17.8	b
Upmost	29.0	b
Pinnacle	22.7	c
Zenith	23.3	c
Illini Xtra Sweet	23.7	c
Yankee Belle	23.8	c
Sweet Season	24	c
Landmark	28.3	c
Sweetie 76	29.3	d

[1] Means with the same letter designation are not significantly different at $p=.05$ according to Duncan's Multiple Range Test Weights are means of three replicates.

However, when percent useable ears are factored into the harvest, a slightly different array results (Table 2). In this case, 'Sweetie 76' still shows a tendency for highest useable yield, but it is not significantly different from 'Zenith', 'Pinnacle', 'Landmark', and 'Sweet Season'. 'Crisp 'N Sweet 700', 'Upmost', 'Sweetie 70', and 'Sweet Desire' had the lowest yields in both methods of measurement.

Table 2 Average useable weight per plot for sh_2 sweet corn cultivars.

Cultivar	Useable Weight [1]	
CNS 700	5.6 lbs.	a
Upmost	9.8	ab
Sweetie 70	12.6	bc
Sweet Desire	16.0	bcd
Illini Xtra Sweet	18.9	cde
Yankee Belle	20.0	de
Zenith	20.6	def
Pinnacle	20.8	def
Landmark	21.5	def
Sweet Season	23.8	ef
Sweetie 76	27.4	f

[1] Useable weight was determined by multiplying husked weight by percent useable ears for each plot. Figures are means for three replicates. Means with the same letter designation are not significantly different at $p=.05$ according to Duncan's Multiple Range Test.

Specific comments about the various cultivars were as follows:

CNS 700

Some lodging; rust, no smut.
Husks don't cover ear to tip.

Illini Xtrasweet

End of ears exposed.
Some rust, no smut.

Landmark

Lodging, light rust, no smut.
Very large kernels.

Pinnacle

Little rust, no smut, recovered from lodging.
Very big ears.

Sweet Desire

Some smut, some rust, badly lodged.
Ears well filled.

Sweetie 70

Much rust, some smut, little lodging.
Ends of ears open.

Sweetie 76

No rust, no smut, badly lodged.

Sweet Season

No smut, no rust, no lodging.
Ears well filled.

UpMost

A great deal of smut, no lodging.

Yankee Belle

No rust, occasional smut, little lodging.
Some small ears.

Zenith

No rust, some lodging, but good recovery.
Some ears not well-filled, small.

PRELIMINARY STUDIES ON CAUSES OF POOR HUSKABILITY IN SWEET CORN

Vince Fritz and Dave Davis

Department of Horticultural Science

Introduction

Reports of poor huskability surface periodically in the Industry. Causes probably can be related to 1) certain varieties or 2) to a high stress year, such as 1988, when ear/husk relationships are more likely to be abnormal, particularly if ears are not well filled. However, our impression is that beyond these two reasons there also are other reasons for poor huskability. Whatever the causes, poor huskability can result in reduced yield recovery and in a decrease in general efficiency and quality of pack. Some widely used hybrids, such as Jubilee, are marginal in ease of huskability. Many other hybrids are discarded in the testing stage because they are poor huskers.

Our objective was to find out why some varieties are poor huskers and why other varieties which generally are good huskers, on occasion cause difficulty in husking. Results from this work may assist the industry in the following ways:

1. Processors may be better able to choose one variety over another for production. They also may be able to make certain management changes, such as in plant population, timing of harvest, etc.

2. Plant personnel may be able to modify post-harvest raw product handling practices to reduce the problem.

3. Sweet corn breeders may be able to better identify and eliminate poor huskers before sending them to the processing industry.

Materials and Methods

A non-butting husking table available at the Southern Experiment Station, Waseca, MN, was used. There have been two phases to the experimental work thus far. One was based on experimental plots under controlled conditions. The other was based on Jubilee samples drawn from the post-harvest holding slab at the Birds Eye plant in Waseca. In the first phase, 2 easy-husking, 2 intermediate-husking, and 2 difficult-to-husk hybrids used by the Industry were studied.

Phase 1: The following hybrids were used:

Poor Huskers	Intermediate Huskers	Easy Huskers
Jubilee	Commander	Exp. 62312
Shield Crest	Exp. 20-35	Exp. 20-216

The above 6 hybrids were grown in blocks in an non-irrigated replicated (4 reps) field trial planted on May 22 at Waseca, using six 30-inch rows 60 feet long as the experimental plot and a population of 22,000 plants per acre. Our goal was to harvest at 2 maturities (moistures)--about 78-80% and 73-75%. In each case, about 100 ears were harvested from each plot and run through the husker.

After dry husking, the ears were evaluated for degree of husk removed. The Husk Removal Classes into which these ears were classified are as follows:

1) unhusked
2) tip exposed due to the husking process
3) half husked
4) entirely husked

Hence, the ratings were subjective and thus based on judgement. But they were repeatable and not very confusing.

Phase 2: In Phase 2, Jubilee ears at about 72% moisture and with good tip cover were taken from the Birds Eye holding slab. These were divided into the following categories when we selected them from the pile:

1) long flags; no tip exposure
2) long flags; tip exposed
3) small (1 to 1 1/2 inch long) flags; no tip exposure
4) intermediate (2 to 3 1/2 inch long) flags; no tip exposure

Results

Phase 1. Harvest at the desired kernel moisture level was difficult due to the workload at the time from other experiments. Harvest of all 6 entries was made at a high moisture level, generally 76 to 80%. Of the 6, four were harvested also at a low moisture level, generally 69 to 74%.

Although the data have not been analyzed critically, the results do seem to correlate well with the known ease of huskability of the 6 hybrids. Differences in kernel moisture level within a hybrid did not seem to change huskability very much.

Averaged across replications and moisture levels, the huskability of the 6 was as follows:

Hybrid	% of Ears in Each Husk Removal Class 1	2	3	4	Total # of Ears	Ear Type
Jubilee	8.3	3.6	13.3	74.8	1103	large ears; short tip cover
Shield Crest	16.0	3.9	7.6	72.5	1100	
Commander	1.5	2.3	7.8	88.5	400	large ears; intermediate tip cover
Exp. 20-35	1.9	0.8	16.8	80.5	723	intermediate between Commander & Exp. 20316
Exp. 62312	0.3	0.8	2.8	96.3	400	fairly large ear; long tip cover
Exp. 20-216	1.4	0.8	12.8	85.1	800	small ear; long tip cover

To summarize, Jubilee and Shield Crest, the 2 poor huskers did not husk as well, with 74.8 and 72.5 of the ears fully husked, respectively. Differences among the other 4 were less clear, although Experimental Hybrid 62312 husked exceedingly well (96.3% in category #4).

These data tend to document that the hybrids do differ, but do not tell us why. Our work in 1990 will be directed more toward the reasons why these hybrids differ in huskability. The 6 hybrids were chosen for ear type and size differences but these differences did not provide recognizable clues to husking performance.

Phase 2. Huskability data on the Jubilee ears collected from the Birds Eye holding slab are as follows:

Ear Type	% of Ears in Each Husk Removal Class 1	2	3	4	Total # of Ears
Long flags, no tip exposed	20.6	0.9	12.4	66.1	218
Long flags; tip exposed	11.1	4.8	14.3	69.8	63
Small flag leaves	13.9	1.4	2.8	81.9	72
Intermediate flag leaves	12.4	2.2	10.9	74.5	137

The preliminary results from Phase 2 indicate to us that, based on this small sample, the different types of Jubilee ears pulled from the storage pile did not differ greatly in huskability. There was a tendency for ears with small flag leaves to husk better than those with larger (longer) flag leaves. We might have expected the opposite!

Regardless of ear type, Jubilee husked about the same in this experiment as it did in Phase 1, where we used a large sample (1103 ears). The differences among the 4 types of Jubilee ears used in Phase 2 could be due to random chance variation.

We will continue to work on the huskability problem in 1990.

Annual Grass and Broadleaf Weed Control in Sweet Corn

Leonard B. Hertz and V. Fritz
Southern Experiment Station
Waseca, MN - 1989

A study was conducted to evaluate several combinations of herbicides for weed control in sweet corn. 'Jubilee' sweet corn was planted May 17, 1989, in a clay loam soil, pH 6.4 and organic matter 6.5%, at the Southern Experiment Station, Waseca, MN. The plots were 10 by 30 ft with four rows spaced 30 inches apart and arranged in a randomized complete block with four replications. All herbicide applications were made with a CO_2 pressured bicycle sprayer equipped with 8002 nozzles, with the exception of the directed sprays, which were applied with a hand held CO_2 sprayer equipped with a three drop nozzle (11002) boom with 30 inch spacings. Weed control and crop injury were rated on July 24. Weed populations were low and consisted of giant foxtail (67%), common ragweed (23%), redroot pigweed (4%), velvetleaf (3%), cocklebur (2%) and common lambsquarters (1%). Application dates, sprayer settings, environmental conditions, and plant size are listed below:

Date	May 17	June 9	June 22	June 28
Treatment	PRE	EPO	LPO	PDIR
Sprayer				
gpa	20	20	20	15
psi	40	40	40	28
Wind (mph)	10-15	5-10	5	0-5
Air temperature (F)	60	64	75	79
Sky	clear	cloudy	cloudy	clear
Sweet corn				
leaf no.	--	2-3	4-5	6
Giant foxtail				
leaf no.	--	--	--	7
height (inch)	--	1-2	4-6	<15
infestation	--	--	--	$2/ft^2$
Broadleaves				
height (inch)	--	0.5-1	4-6	8-13
infestation	—	--	--	$<1/ft^2$

Weed control, corn injury and yield are summarized in the accompanying table. All herbicides provided excellent control of broadleaf weeds. Combinations of Laddok plus Lasso; Curtail plus Lasso; Buctril and Aatrex plus Lasso gave poor control of foxtail spp. Mixtures of Tandem plus Aatrex or Bladex have excellent overall weed control. Post-directed sprays of Gramoxone and Roundup gave poor control of velvetleaf and slight injury to the sweet corn. (Dept. of Horticulture, Univ. of MN, St. Paul).

Table. Weed control in sweet corn. (Hertz and Fritz)

Treatment	Rate	Time of appl.[y]	Weed control					Corn inj[w]	Yield husk
			Colq[x]	Rrpw	Vele	Gift	Oval		
	(lb/A)		- - - - - - - - - - - - - -	%	- - - - - - - - - - - -				(T/A)
Lasso +	2.0	PRE	95	100	100	60	60	0	4.3
Curtail	0.28	LPO							
Lasso +	2.0	PRE	100	100	100	43	43	0	3.7
Curtail	0.56	LPO							
Lasso +	2.0	PRE	100	100	100	60	60	0	4.2
Curtail	0.84	LPO							
Lasso +	2.0	PRE	100	100	100	60	60	0	4.4
Laddok + 28%N[z]	1.04	LPO							
Lasso +	2.0	PRE	100	100	100	60	60	0	4.4
Laddok + Dash[z]	1.04	LPO							
Lasso +	2.0	PRE	100	100	100	60	60	0	4.4
Laddok + COC[z]	1.04	LPO							
Lasso +	2.0	PRE	100	100	100	60	60	0	4.4
Laddok + 28%N	1.45	LPO							
Lasso +	2.0	PRE	100	100	100	60	60	0	4.4
Laddok + Dash	1.45	LPO							
Lasso +	2.0	PRE	100	100	100	60	60	0	4.4
Laddok+Dash+28%N	1.45	LPO							
Lasso +	2.0	PRE	100	100	100	43	43	0	4.6
Buctril + Aatrex	0.25+0.5	PRE							
Tandem +	0.5	EPO	100	100	98	90	90	0	4.8
Aatrex + COC	2.0	EPO							
Tandem +	0.75	EPO	100	100	100	88	88	0	4.6
Aatrex + COC	1.5	EPO							
Tandem +	0.75	EPO	100	100	100	95	95	0	5.1
Aatrex + COC	2.0	EPO							
Tandem +	0.75	EPO	100	100	100	93	93	0	4.4
Bladex	2.0	EPO							
Tandem +	0.75	EPO	100	100	100	95	93	0	3.6
Bladex + Aatrex	1.0+1.0	EPO							
Gramoxone + Aatrex + X-77[z]	0.28	PDIR	100	100	75	68	65	0	4.7
Gramoxone + Aatrex + X-77	0.37	PDIR	88	88	63	80	78	1	4.5
Gramoxone + Aatrex + X-77	0.46	PDIR	100	100	63	85	85	1	4.6
Gramoxone + X-77	0.28+0.25	PDIR	100	100	75	85	85	1	4.3
Gramoxone + X-77	0.28+0.5	PDIR	100	100	63	88	83	2	4.7
Gramoxone + X-77	0.28+1.0	PDIR	100	100	100	83	83	2	4.5
Roundup	0.18	PDIR	50	10	38	88	83	0	4.4
Roundup	0.36	PDIR	75	75	88	88	85	4	3.1
Roundup + COC	0.18	PDIR	63	100	88	78	78	0	4.6
Prowl +	1.5	EPO	100	100	100	88	88	0	4.2
Bladex + Aatrex	1.5+1.5	EPO							
Prowl + Bladex	1.5+2.0	EPO	100	100	100	80	80	0	4.1
Hand weeded	--	--	100	100	100	100	100	0	5.3
Unweeded check	--	--	0	0	0	0	0	0	3.9
LSD (.05)			20	10	28	27	27		0.5

[z] Additives: COC = crop oil concentrate, 1 qt/A; Dash = crop oil concentrate (BASF), 1 qt/A; 28%N = aqueous nitrogen solution with urea and ammonium nitrate, 4 qt/A; X-77 = non-ionic surfactant, 1 qt/A.

[y] Application: PRE = preemergence; EPO = early postemergence; LPO = late postemergence; DIR = postemergence, directed.

[x] Colq = common lambsquarters; Rrpw = redroot pigweed; Vele = velevetleaf; Gift = giant foxtail; Oval = overall weed control.

[w] Inj. = injury: 0 = none; 10 = dead.

EVALUATION OF PEA CULTIVARS AND BREEDING MATERIAL

Dave Davis, Vince Fritz, Frank Pfleger

University of Minnesota, Southern Experiment Station
Waseca, 1989

The attached tables summarize the results from the 1989 evaluations in the pea root rot nursery. Entries were planted on May 15 into moist soil at the rate of 100 seeds per 20-foot plot row. After emergence and stand establishment, the plots were sprinkle irrigated heavily and frequently to encourage infection and disease development. Irrigation was terminated beginning about one week prebloom. The degree of subsequent drought stress was dependent at least in part on the amount of root disease.

Data were taken on % stand, date of 50% bloom, estimated prime harvest date for canning/freezing and root rot score. In addition, a dry seed yield (grams) was obtained from the harvest of a 10-foot center length on the 4-row replicated plots.

Root rot evaluation was obtained by scoring the plants for foliar symptoms on both July 7 and July 13. Dr. John Kraft, Plant Pathologist, USDA, Prosser, WA, assisted in the root rot scoring. A 1 to 5 scoring system was used, where 0 = no damage; 1 = 1-25% damage (1-25% dead or showing symptoms); 2 = 26-50% damage; 3 = 51-75% damage; 4 = 76-100% damage; 5 = all dead.

In September, seeds of 12 of the best entries were planted in the greenhouse and some 400 crosses were made among these entries. This established a new (and higher) base population in the breeding program. Choice of entries for these hybridizations was based also on plant type (normal foliage; semi-leafless), earliness, pod type (normal, snap pod, snow pod), parentage, and the results of previous disease evaluation here and /or in other states. Some of the entries chosen were resistant to diseases other than common root rot, such as fusarium wilt, powdery mildew, and pea seedborne mosaic. Thus, the use of the chosen entries as parents gives us an opportunity to recombine different useful genes for disease resistance and useful plant and pod traits.

Seeds from these crosses were harvested in December and planted in the greenhouse in January. Harvest of seed from these hybrid plants in April will provide F_2 seed (the segregating generation) for planting back into the root rot nursery next May. Selection from the nursery next July will be based primarily on individual plants.

Pea Root Rot Evaluations
University of Minnesota, Southern Experiment Station
Waseca, 1989

Four-Row Replicated Entries

Three Reps

89MF	Variety or Line Seed Source	Stand			50% Bloom	Harvest Date	Dry Seed Yield (g)			Root Rot Score					
										7/7			7/13		
		A	B	C			A	B	C	A	B	C	A	B	C
1	CS 9727-10	62	82	83	6/25	7/11	420	486	1254	2+	3+	1+	1+	3	3
2	CS 9811-7	88	91	86	6/25	7/11	666	928	1068	3+	2+	1+	4	2	2+
3	CS 9711-7-1	87	88	69	6/24	7/11	376	530	558	4	3+	3+	4+	3+	4
4	CS 9747-2	85	86	55	6/25	7/13	304	346	234	4	3+	4	4+	4	3
5	CS Argona	83	79	83	6/25	7/10	640	618	1046	2+	2+	1+	3+	2+	1+
6	CS 517-4	83	90	70	6/26	7/15	206	428	144	4	3+	4	4+	4	4+
7	CS 8440	86	78	86	6/26	7/14	130	464	690	4+	3+	3	4+	3	3+
8	CS 9798-3	82	81	66	6/27	7/12	834	208	240	2	4	4	1+	3+	4
9	CS 9823-12	89	88	81	6/26	7/10	988	382	968	1+	4	1+	1+	4	1+
10	CS 77224	84	83	90	6/29	7/13	596	720	976	3+	2+	2	3	3	2
11	CS 11154Bc4F$_2$	85	79	81	6/30	7/11	738	302	712	2+	3+	2+	3+	4+	3+
12	CS 7705-32	87	87	86	6/28	7/10	684	160	224	2+	5	4	3+	5	5
13	CS 9000	88	87	87	6/30	7/11	596	182	442	3	4+	3+	3	4+	4+
14	CS 10053-9	86	85	76	7/3	7/16	352	954	400	1+	1+	3	3	2	2+
15	CS 512-2	79	81	85	7/1	7/15	556	492	594	3	3+	2	3+	4+	3
16	Alaska M 163	80	85	80	6/19	7/5	94	486	492	2	4+	3+			
17	Early Sweet 41	90	88	83	6/19	7/5	164	432	644	2+	2	2+			

89MF	Variety or Line Seed Source	Stand			50% Bloom	Harvest Date	Dry Seed Yield (g)			Root Rot Score					
										7/7			7/13		
		A	B	C			A	B	C	A	B	C	A	B	C
18	Canners 8221 EP	83	78	56	6/28	7/12	590	752	252	3	1+	3	3+	2+	3
19	Columbia	92	76	81	6/25	7/11	822	822	1048	1+	3	1	2	2	1+
20	Sunfire	87	88	89	6/28	7/11	1204	756	1108	1+	2+	2	1+	3	2+
21	Bounty	78	81	77	6/26	7/11	866	408	930	2	3	2	2+	3+	3
22	Nomad	90	93	84	7/1	7/13	1100	818	530	2	2	3	1+	2+	4
23	Span	90	87	80	6/21	7/9	834	558	864	2+	3	1+			
24	88MF 1231	56	42	58	7/1	7/14				2	2	2	2	3	
25	88MF 1231	55	61	61	6/30	7/14				1+	4	1+	2	4	
26	88MF 1231	70	65	58	7/1	7/14				1+	1+	2+	2+	2	
93	1150 E.S.	90	83	93	6/21	7/7	832	800	794	2+	1+	1+			
94	Sultan	87	87	92	6/29	7/12	838	650	782	2+	2+	2	3	3+	3
95	Payload	90	91	92	6/20	7/6	556	532	960	1+	2+	3			

Single-Row Non-replicated Entries

27	PI 166159	74			7/11					4			5		
28	MN 108	72			7/5					1			1+		
29	79-2022	87			6/30					1+			1+		
30	88-149	86			6/30					2			2+		
31	88-186	90			6/30					2+			3		
32	88-270	75			6/29					2			2+		
33	88-323	76			6/29					1+			2+		
34	88-325	86			6/24					1			1		

89MF	Variety or Line Seed Source	Stand			50% Bloom	Harvest Date	Dry Seed Yield (g)			Root Rot Score					
										7/7			7/13		
		A	B	C			A	B	C	A	B	C	A	B	C
35	88-381	77			7/5					2+			4		
36	88-385	81			7/1					2+			2+		
37	88-408	67			6/30					3			4		
38	88-425	93			6/25					1+			3		
39	88-427	83			6/29					2+			3		
40	88-438	92			6/30					1+			2+		
41	88-466	92			7/1					1			2		
42	88-479	83			6/29					3			3		
43	88-552	81			6/30					2+			3		
44	88-570	84			6/30					3			3		
45	88-589	88			6/29					2			2+		
46	88-604	87			6/29					1+			1+		
47	88-606	81			7/1					1			1+		
48	88-607	86			7/3					2			2+		
49	88-612	95			6/28					2			3+		
50	88-616	94			6/30					3			4		
51	88-659	92			7/1					2+			3+		
52	88-660	74			6/30					2			3		
53	88-668	86			6/27					1			1+		
54	88-767	90			6/29					3+			4		
55	88-780	94			7/2					3			4		
56	88-763	83			6/29					2			3		

89MF	Variety or Line Seed Source	Stand			50% Bloom	Harvest Date	Dry Seed Yield (g)			Root Rot Score					
		A	B	C			A	B	C	7/7			7/13		
										A	B	C	A	B	C
57	88-781	88			7/6					1			1+		
58	88-790	90			6/28					1+			2+		
59	88-793	85			6/27					1+			2		
60	88-799	88			6/28					3			3		
61	88-830	82			6/28					2+			2+		
62	88-1058	78			7/1					2+			3		
63	88-1073	87			7/1					1			1+		
64	88-1074	95			7/5					1			1+		
65	88-1135	91			6/28					2+			2+		
Single-Row Replicated Entries															
Three Reps															
66	GG 512	92	82	86	6/27					2+	2	1+	2+	1+	
67	GG 613	94	83	89	6/28					2	2	1+			
68	SN 5	82	88	80	7/1					4	3	3	4	3+	3
69	Vantage	84	79	82	6/27					1+	1+	2+	2	2	3
70	Mini	89	83	84	6/27					3	3	2	4	3+	3+
71	88-27	85	91	86	6/29					2+	2+	1+	3+	3	3+
72	88-63	93	93	92	6/27					2	2	2	3	4	2+
73	88-125	97	90	93	6/29					1	2+	2	1+	3	2
74	88-462	83	68	84	7/1					1+	2+	3	2+	4+	
75	88-522	82	85	94	6/29					2+	3+	1+	2+	4+	2+

							Dry Seed			Root Rot Score					
	Variety or Line	Stand			50%	Harvest	Yield (g)			7/7			7/13		
89MF	Seed Source	A	B	C	Bloom	Date	A	B	C	A	B	C	A	B	C
76	88-620	91	87	91	6/26					3+	3+	4	3+	4	4+
77	88-621	87	89	86	6/25					3+	3	3	3+	3+	4+
78	88-628	89	83	81	7/1					1	3	2	1+	3	4
79	88-750	87	82	90	7/1					1+	3	3+	2	4	4
80	88-781	87	75	87	7/6					1	1	2	1+	3+	1+
81	88-782	76	73	76	7/5					2	2	3	3	3	4
82	88-829	86	84	89	6/30					3	2	3+	3+	3	3+
83	88-841	86	87	81	6/30					2+	2+	2+	3+	3	4
84	88-846	62	75	56	6/30					2+	2+	3	2+	4	3+
85	88-848	83	81	91	6/27					2	3	2	3+	3+	
86	88-890	63	61	62	6/30					3+	3	3	3+	3+	4
87	88-892	80	85	82	6/29					3+	2+	2	4	3	2+
88	88-920	96	92	91	6/29					3	1+	2	4	3	3
89	88-965	82	90	72	6/28					2	3+	2+	2	4+	3
90	88-982	86	60	78	6/30					1+	1	1	1	1	1
91	88-985	81	84	85	7/1					1+	1	1+	1+	1+	2
92	88-1046	84	88	90	6/30					2+	2+	2	3	2	4
Two Reps															
96	88-1059	82	81		6/30					1+	3		2	3	
97	88-1062	85	95		7/2					1+	2			2	
98	88-1077	83	86		6/29					2+	2+		2+	3	

89MF	Variety or Line Seed Source	Stand			50% Bloom	Harvest Date	Dry Seed Yield (g)			Root Rot Score					
										7/7			7/13		
		A	B	C			A	B	C	A	B	C	A	B	C
99	88-1078	90	88		6/29					1+	1+		3	3	
100	88-1138	79	78		6/30					4	4		4+	4+	

planted 5/15; 20' plot length; 100 seeds/20'; Command herbicide; harvest date is estimated date of prime maturity for canning/freezing.

root rot scale: 0 = no damage; 1 = 1.25% damage (1-25% plants dead or showing symptoms); 2 = 26-50% damage; 3 = 51-75% damage; 4 = 76-100% damage; 5 = all dead.

Selective Weed Control in Canning Peas

Leonard B. Hertz and V. Fritz
Southern Experiment Station
Waseca, MN - 1989

This study was conducted to evaluate several combinations of herbicides for weed control in canning peas. 'Canners 9901' pea seed was planted May 16, 1989 into a clay loam soil, pH 6.4 and 6.5% organic matter at the Southern Experiment Station, Waseca, MN. The plots were 7 by 30 ft, arranged in a randomized complete block, each with four replications. All herbicides were applied with a bicycle mounted CO_2 pressure sprayer. A visual rating of weed control was made on June 20. Weed populations were light and consisted of giant foxtail (72%), redroot pigweed (15%), common lambsquarters (7%) and velvetleaf (6%). Application dates, sprayer settings, environmental conditions, and plant sizes are listed below:

Date	May 16	June 6
Treatment	PPI	EPO
Sprayer		
gpa	20	20
psi	40	40
Air temperature (F)	58	62
Wind (mph)	5	7
Sky	cloudy	clear
Pea		
size (nodes)	--	2-4
Weeds		
height (inches)	--	0.5-2
infestation		
broadleaves	--	$2/ft^2$
giant foxtail	--	$6/ft^2$

Results of this study are summarized in the accompanying table. Several herbicides performed well, including Command, Pursuit, and Basagran. Basagran plus 28%N or Dash produced slight crop injury. There were no differences in weed control or pea injury when Command was deep or shallow incorporated. (Dept. of Horticulture, Univ. of MN, St. Paul).

Table. Weed control, crop injury, and yield of peas (Hertz and Fritz).

Treatment	Rate	Time of appl.[y]	Weed control Gift[x]	Colq	Vele	Oval	Pea Inj.[w]	Yield
	(lb/A)		-----	(%)	-----			(T/A)
Command	0.5	PPIS	94	95	99	92	0	1.6
Command	0.5	PPID	92	94	100	92	0	1.8
Command	1.0	PPIS	95	97	100	95	0	1.9
Command	1.0	PPID	98	97	100	97	0	1.6
Command + Treflan	0.5+0.5	PPI	99	99	100	98	0	1.5
Command + Treflan	1.0+0.5	PPI	99	99	100	98	0	1.4
Pursuit	0.063	PPI	97	100	100	97	0	1.6
Pursuit	0.094	PPI	96	100	100	96	0	1.6
Pursuit	0.063	PPI	97	100	100	97	0	1.6
+ Treflan	0.5	PPI						
Pursuit	0.063	PPI	97	100	100	97	0	1.7
+ Prowl	0.75	PPI						
Pursuit	0.063	PPI	94	100	100	94	0	1.8
+ Command	0.5	PPI						
Cinch	1.5	PPI	97	100	100	97	0	1.4
+ Treflan	0.5	PPI						
Treflan	0.75	PPI	96	99	99	97	0	1.6
Treflan	0.5	PPI	94	100	99	94	0	1.7
+Basagran+28%N[z]	0.5	EPO						
Treflan	0.5	PPI	97	100	100	97	1	1.4
+Basagran+COC[z]	0.5	EPO						
Treflan	0.5	PPI	97	100	100	97	0	1.5
+Basagran+Dash[z]	0.5	EPO						
Basagran	0.5	EPO	97	100	100	97	1	1.5
+ FMC46360+COC	0.05	EPO						
Basagran	0.5	EPO	94	97	100	94	2	1.6
+ FMC46360+COC	0.075	EPO						
Hand weeded	--	--	100	100	100	100	0	1.7
Unweeded check	--	--	0	0	0	0	0	1.8
LSD(0.05)			15	3	1	15		0.3

[z] Additives: 28%N = aqueous nitrogen solution with urea and ammonium nitrate, 1 gal/A; COC = crop oil concentrate, 1 qt/A; Dash = crop oil concentrate (BASF), 1 qt/A.

[y] Time of application: PPIS = shallow incorporation; PPID = deep incorporation; EPO = early postemergence.

[x] Gift = giant foxtail; Colq = common lambsquarters; Vele = velvetleaf; Oval = Overall weed control.

[w] Inj. = Injury: 0 = none; 10 = peas dead.

Onion Plant Population Study

Vincent Fritz and James Hebel
Southern Experiment Station
Waseca, Minnesota

SIGNIFICANCE:

Plant populations which ensure maximum potential profitability is one of the many management tools used by several crop producers. Populations directly affect individual plant growth rate due to competition for water and nutrients. Bulb size of yellow storage onions are impacted by plant population. A study was initiated in 1988 to establish relationships between yield and plant population on the peat soils of southeast Minnesota.

MATERIALS AND METHODS:

Seed of the variety "Trapps", were double broadcast planted in dual rows (2.5" wide) on April 24 on raised beds (35" wide). The necessary fertilizer and pesticide applications for maximum growth were applied prior to planting and throughout the growing season.

The experimental design was a randomized, complete block with four replications. Individual plots were comprised of 8 raised beds, 25 feet long. Just prior to harvest (August 31), stand counts were taken on 20 feet of row in each plot. At harvest, onions were collected from ten feet of the inner two beds for yield determination.

RESULTS AND DISCUSSION:

None of the plant populations had a significant effect on U.S. No. 1 yield. However, as plant population progressively increased, boiler size onion production increased. A very significant increase in boiler production occurred when populations were increased from 237,046 to 291,174 plants/A. After two years of study, the conclusion can be made that increased plant population, at least within the populations tested, does not lead to increased production of U.S. No. 1 onions. However, the higher populations significantly increase boiler size onions.

1989 ONION POPULATION COMPARISON
Cooperator: Greg Steginga, Hollandale, MN

Seeding Rate (seeds/ft)	Stand/A	Yield/A (cwt) US#1	Yield/A (cwt) Boilers
8 - 9	191,005	456	30 b
11 - 12	237,046	486	53 b
14 - 15	291,174	471	91 a
Significant (95%) Difference	*	n.s.	*

Variety:Trapps Planted: 4/24 Harvested: 8/31

** Double broadcasted rows on raised beds using a Nibex 500 Seeder

ONION VARIETY TRIAL

Vincent Fritz and James Hebel
University of Minnesota
Southern Experiment Station
Waseca, MN

SIGNIFICANCE

A variety trial was conducted in southeast Minnesota on peat soil to determine which onion hybrids had the greatest production potential for the 1990 production season. Traditionally, the variety 'Trapps' is produced in the production region due to its consistent performance and economical value since it is an open pollinated variety. However, 'Trapps' will not be available in 1990 due to a seed crop failure which established a need to determine which varieties would be comparable or superior to 'Trapps' with the same maturity.

MATERIALS AND METHODS

Seeds of 20 varieties were planted on May 3 in double broadcasted rows on 2 raised beds (35" wide) 40 feet long. Traditional production practices were followed. The experimental design was a randomized complete block with 4 replications. Relative maturity was determined on August 30. The entire trial was harvested on September 5.

Adjacent to the variety trial, a non-replicated observation trial was planted at the same time. Twenty-two varieties were represented. Each variety was double row broadcasted on 1 raised bed (35" wide) 90 feet long. The observation trial was also harvested on September 5.

RESULTS AND DISCUSSION

A number of varieties were similar or earlier than 'Trapps' maturity. In addition, several varieties out yielded 'Trapps'. Higher yields from hybrids is one of the principal reasons for producing hybrids over open-pollinated varieties; however, the seed costs are greater for hybrid onion seed.

In the observation (non-replicated) trial, several experimental varieties had good production potential. Those that were most promising will be included in the replicated variety trial in 1990.

ONION VARIETY/OBSERVATION TRIAL
RELATIVE MATURITY AS OF 8/30/89

	Variety	% Tops Down
Variety Trial	Norstar	60
	Eskimo	60
	Northern Oak	40
	Trapp Downing	50
	Flame	50
	Fortress	30
	XPH 3246	60
	Spartan Banner 80	0
	Garrison	10
	Paragon	90
	Krummery Banner	10
	Hustler	85
	Copra	70
	Sassy Brassy	50
	Early Pak	70
	Cuprum	25
	Capable	70
	Superior	0
	Sweet Sandwich	45
	Krummery Downing	0
Observation Trial	ACX 870600	0
	Kodiac	0
	XPH 3311	90
	XPH 3243	100
	XPH 3380	80
	Simcoe	90
	HXP 2611	90
	PS 1483	50
	Marathon	0
	HXP 2612	60
	Keepsweet	0
	HXP 2613	10
	Advancer	90
	N.Y. Early	50
	HMX 2612	20
	Super Apollo	90
	HXP 2614	10
	Progress	95
	HXP 2621	75

1989 ONION VARIETY TRIAL

Cooperator: Larry Reynen, Hollandale, MN

Variety (Source)	Yield/A (cwt) US#1	Yield/A (cwt) Boilers
Norstar (Takii)	371	37
Eskimo (Takii)	274	48
Northern Oak (Stokes)	302	20
Trapp Downing	345	62
Flame (Asgrow)	395	33
Fortress (Asgrow)	398	25
3246 (Asgrow)	340	40
Spartan Banner (H.Moran)	310	29
Garrison	249	57
Paragon (Sunseeds)	331	61
Krummery	306	42
Hustler (H.Moran)	372	27
Copra (Seedway)	338	33
Sassy Brassy (F.Morse)	302	29
Early Pak (Crookham)	344	59
Cuprum (Sunseeds)	372	38
Capable (Sunseeds)	420	24
Superior (Ab & Cobb)	309	25
Swt Sandwich (H.Moran)	332	21
Krummery Downing	417	33

Planted: 5/3 Harvested: 9/5

1989 ONION VARIETY OBSERVATION

Cooperator: Larry Reynen, Hollandale, MN

	Yield/A (cwt)	
Variety	US#1	Boilers
Kodiac	273	19
Simcoe	273	53
Marathon	265	40
Keepsweet II	314	53
Advancer	222	44
New York Early	567	58
Super Apollo	353	39
Progress	445	24
ACX 87066	131	32
XPH 3243	347	64
XPH 3311	200	59
XPH 3380	190	39
HXP 2611	367	44
PS 1483	285	58
HXP 2612	219	40
HXP 2613	287	43
HMX 2612	395	32
HXP 2614	466	26
HXP 2621	394	63

Planted: 5/3 Harvested: 9/5

** Double broadcasted rows on raised beds using a Nibex 500 seeder

Onion Weed Control

Vincent Fritz and Larry Binning
University of Minnesota, Southern Experiment Station, Waseca, MN
and
University of Wisconsin, Department of Horticulture, Madison, WI

SIGNIFICANCE:

As the number of pesticide options constantly decrease for "minor acreage crops", increased pressure is placed on the producer to maintain productivity and competitiveness in the marketplace. This problem is compounded for those who produce crops on high organic matter soils (muck, peat). The recent loss of chlorpropham (Furloe) has left onion producers with no preemergent weed control available. Early weed control is extremely important to a crop like onions because the young seedlings are not competitive.

The objective of the weed control trial was to evaluate a number of preemergence weed control herbicides not currently labeled for use in onions, in combination with the common postemergence practices. Data collected will be used to support any section 18 label exemptions for any herbicide that has good weed control potential with no injury to the crop.

MATERIALS AND METHODS:

The trial was established on a muck soil near Maple Island, Minnesota. A total of 30 treatments were evaluted for weed control potential. The plot design was a randomized, complete block with 4 replications. Preemergence treatments were applied on May 8, followed by postemergence treatments on June 6 when the onion seedlings were in the 2 expanded, true leaf stage. Weed control readings were recorded prior to and after the postemergence applications.

RESULTS AND DISCUSSION:

The herbicides, Ramrod and Prowl, both showed good weed control activity. Dual also had good activity, however, stunting was recorded in one of the plots (#4). Buctril applications showed some pigtailing of the leaves, however, there did not appear to be any long term effects. The use of Basagran caused severe injury, and often crop kill. This response may be due to the time of application. Later application, when the seedlings have three or more true leaves, may cause less injury due to greater wax development on the leaves as they mature.

ONION WEED CONTROL - 1989

Treatment	lb a.i./A	Timing	% Injury	Comments	% Control					
					Pigweed		Penn. Smartweed		Foxtail	Common Purslane
					6/6	6/28	6/6	6/28	6/6	6/28
1 Prowl 4.0 L	1.0	Pre			10	72	0	78	0	90
Prowl 4.0 L	1.0	PO 2 1f								
Fusilade 2000 1.0 L	.156	PO 2 1f								
COC	1 qt.	PO 2 1f								
2 Prowl 4.0 L	2.0	Pre			10	96	0	84	0	100
Prowl 4.0 L	2.0	PO 2 1f								
Fusilade 2000 1.0 L	.156	PO 2 1f								
COC	1 qt.	PO 2 1f								
3 Prowl 4.0 L	3.0	Pre			60	92	100	100	75	100
Prowl 4.0 L	3.0	PO 2 1f								
Fusilade 2000 1.0 L	.156	PO 2 1f								
COC	1 qt.	PO 2 1f								
4 Dual 8.0 L	2.0	Pre	10	Stunting	70	66	95	85	85	85
Fusilade 2000	1.0	PO 2 1f								
COC	1 qt.									
5 Prowl 4.0 L	1.0	Pre			70	85	95	100	85	85
Buctril 2.0 L	.125	PO 2 1f								
Fusilade 2000 1.0 L	.156	PO 2 1f								
COC	1 qt.	PO 2 1f								
6 Prowl 4.0 L	2.0	Pre			70	94	100	98	65	88
Buctril	.125	PO 2 1f								
Fusilade 2000 1.0 L	.156	PO 2 1f								
COC	1 qt.									
7 Ramrod 4.0 L	3.0	Pre			65	81	90	78	90	98
Ramrod 4.0 L	3.0	PO 2 1f								
Fusilade 2000 1.0 L	.156	PO 2 1f								
COC										

ONION WEED CONTROL - 1989

Treatment		lb a.i./A	Timing	% Injury	Comments	% Control					
						Pigweed		Penn. Smartweed		Foxtail	Common Purslane
						6/6	6/28	6/6	6/28	6/6	6/28
8	Ramrod	6.0	Pre			45	89	25	85	50	96
	Ramrod	6.0	PO 2 lf								
	Fusilade	.156	PO 2 lf								
	COC										
9	Ramrod	3.0	Pre	33	Stunting	60	93	90	100	70	100
	Basagran 4.0 L	.75	PO 2 lf								
	Fusilade	.156	PO 2 lf								
	COC										
10	Ramrod	3.0	Pre	80	Kill	65	95	95	100	95	100
	Basagran	1.0	PO 2 lf								
	Fusilade	.156	PO 2 lf								
	COC										
11	Ramrod	3.0	Pre	81	Kill	55	97	95	100	90	99
	Basagran	.75	PO 2 lf								
	Buctril 2.0 L	.25	PO 2 lf								
	Fusilade	.156	PO 2 lf								
	COC										
12	Ramrod	3.0	Pre	46	Kill	80	93	100	98	99	100
	Basagran	.50	PO 2 lf								
	Fusilade	.156	PO 2 lf								
	COC		PO 2 lf								
	Basagran	.50	PO								
13	Ramrod	3.0	Pre	55	Kill	95	91	99	100	100	100
	Basagran	.75	PO 2 lf								
	Fusilade	.156	PO 2 lf								
	COC										
	Basagran	.75	PO								
	COC		PO								
14	Ramrod	3.0	Pre	75	Kill	90	94	99	100	85	100
	Basagran	1.0	PO 2 lf								
	Fusilade	.156	PO 2 lf								
	COC		PO 2 lf								

ONION WEED CONTROL - 1989

					% Control					
					Pigweed		Penn. Smartweed		Foxtail	Common Purslane
Treatment	lb a.i./A	Timing	% Injury	Comments	6/6	6/28	6/6	6/28	6/6	6/28
15 Ramrod	3.0	Pre	45	Kill/pigtail	95	90	99	100	90	100
Basagran	.50	PO 2 lf								
Fusilade	.156	PO 2 lf								
COC		PO 2 lf								
16 Ramrod	3.0	Pre			90	61	95	90	95	100
46360 0.63	.05	PO 2 lf								
COC		PO 2 lf								
17 Ramrod	3.0	Pre			90	65	90	85	99	100
46360 0.63	.075	PO 2 lf								
COC		PO 2 lf								
18 Ramrod	3.0	Pre			85	63	85	88	75	95
Option 16C	.10	PO 2 lf								
COC		PO 2 lf								
19 Ramrod	3.0	Pre			95	76	90	75	75	93
Poast 1.5 L	.19	PO 2 lf								
DASH	2 pts	PO 2 lf								
20 Ramrod	3.0	Pre	80	Pigtail	90	95	85	95	25	93
Buctril	.125	PO 2 lf								
Fusilade	.156	PO 2 lf								
COC		PO 2 lf								
21 Ramrod	3.0	Pre	90	Pigtail	90	96	99	96	50	93
Buctril	.25	PO 2 lf								
Fusilade	.156	PO 2 lf								
COC		PO 2 lf								
22 Goal 1.6 L	.20	Pre	85	Pigtail	95	97	100	100	20	100
Goal 1.6	.20	PO 2 lf								
Fusilade	.188	PO 2 lf								
COC		PO 2 lf								

ONION WEED CONTROL - 1989

					% Control					
					Pigweed		Penn. Smartweed		Foxtail	Common Purslane
Treatment	lb a.i./A	Timing	% Injury	Comments	6/6	6/28	6/6	6/28	6/6	6/28
23 Ramrod	3.0	Pre	70	Pigtail	85	94	100	98	50	90
Buctril	.25	PO 2 lf								
Fusilade	.188	PO 2 lf								
COC		PO 2 lf								
24 Ramrod	3.0	Pre			90	61	90	85	50	90
Fusilade	.188	PO 2 lf								
COC										
25 Dual	4.0	Pre			95	71	100	81	70	96
Fusilade	.188	PO 2 lf								
COC		PO 2 lf								
26 Prowl	1.0	Pre			90	97	100	98	30	100
Goal	.20	PO 2 lf								
Fusilade	.156	PO 2 lf								
COC	1 qt.	PO 2 lf								
27 Prowl	2.0	Pre			95	94	100	97	50	100
Goal	.12	PO 2 lf								
Fusilade	.156	PO 2 lf								
COC	1 qt.	PO 2 lf								
28 Prowl	2.0	Pre			95	95	75	95	50	100
Goal	.12	PO 2 lf								
Fusilade	.188	PO 2 lf								
COC	1 qt.	PO 2 lf								
29 Hand Weed					100	100	100	100	100	100
30 Weedy Check					0	0	0	0	0	0

SOUTHERN EXPERIMENT STATION
WASECA, MINNESOTA

WEATHER DATA - 1989

Month	Period	Precipitation 1989	Precipitation Normal[1]	Avg. Air Temp. 1989	Avg. Air Temp. Normal[1]	Growing Degree Days 1989	Growing Degree Days Normal[1]
		---- inches ----		------ °F -----			
January	1-31	0.55	0.84	21.1	10.0		
February	1-28	0.80	0.99	9.1	16.4		
March	1-31	2.70	1.99	25.9	27.6		
April	1-30	3.21	2.64	44.7	44.7		
May	1-10	0.70		45.4		34.5	
	11-20	0.46		64.4		153.0	
	21-31	0.40		61.8		147.5	
	Total	1.56	3.76	57.4	57.7	335.0	334
June	1-10	0.10		62.4		136.0	
	11-20	0.33		64.3		151.0	
	20-30	1.78		72.8		219.0	
	Total	2.21	4.48	66.5	67.1	506.0	518
July	1-10	0.56		78.8		262.5	
	11-20	2.73		71.1		207.0	
	21-31	0.65		73.9		261.0	
	Total	3.94	4.02	74.6	71.2	730.5	641
August	1-10	0.05		70.8		205.0	
	11-20	0.46		69.4		193.0	
	21-31	1.92		71.2		230.5	
	Total	2.43	3.99	70.5	68.8	628.5	579
September	1-30	2.35	3.36	59.7	59.8	312.5	311
October	1-31	0.20	2.08	50.1	48.9		38
November	1-30	1.64	1.43	26.8	32.5		
December	1-31	0.35	1.02	8.8	18.0		
Year	Jan-Dec	21.94	30.60	43.0	43.6	2512.5[2]	2421
Growing Season	May-Sep	12.49	19.61	65.8	64.9	2512.5	2383

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[1] 30-year normal from 1951 - 1980.

[2] 50 to 86°F base, May 1 until first fall frost.

Notes:
1) Highest temperature on July 10 and August 5 -- 97°.
2) Highest 24-hour precipitation on August 28 -- 1.26".
3) Highest 2-day precipitation on June 25 & 26 -- 1.73".
4) Last spring frost -- May 7.
5) First fall frost -- September 23.
6) Driest year since 1976 and 6th driest year in 75 years of records.

11/17/89

1989 Soil Moisture
0-5' Profile, Webster Clay Loam
Continuous Corn
Southern Experiment Station, Waseca, MN 56093

Depth	4/17	5/2	5/15	6/1	6/16	7/3	7/17	8/1	8/16	8/30	9/19	10/2	10/17	11/2
Inches	inches available water in zone													
0-6[1]	.86	.95	.61	.67	.69	.46	.44	.24	.09	.55	.53	.43	.46	.43
6-12	.63	.79	.43	.42	.32	.51	-.02	.02	-.11	.11	.29	.27	.21	.28
12-18	.82	.82	.73	.80	.70	.75	.33	.30	.15	.33	.46	.43	.26	.42
18-24	.70	.66	.74	.66	.68	.75	.37	.35	.03	-.01	.05	.26	.04	.09
24-36	1.55	2.03	1.77	1.56	1.57	1.61	1.19	1.05	.59	.38	.32	.50	.70	.45
36-48	1.84	2.16	2.24	2.29	2.07	2.29	2.47	1.85	1.50	1.51	1.17	1.06	1.49	1.47
48-60	1.25	1.57	1.51	1.74	1.49	1.86	1.41	1.52	1.46	.92	.85	.80	1.22	1.09
Total available water in 0-5' profile (inches)	7.65	8.98	8.02	8.12	7.54	8.23	6.19	5.32	3.71	3.80	3.66	3.76	4.37	4.24
% of Capacity[2]	69	81	73	74	68	74	56	48	34	34	33	34	40	38

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[1] All values obtained by gravimetric sampling using Waseca D_b and WP constants.

[2] Assuming 11.05" field moist capacity.

NITROGEN LOSS TO TILE LINES AS AFFECTED BY TILLAGE[1]

Waseca, 1989

G. W. Randall and B. W. Anderson[2]

ABSTRACT: No tillage (NT) is thought to increase infiltration and, therefore, should increase the amount of water percolating through the soil compared to conventional tillage. This long-term study is being conducted to determine if greater amounts of NO_3-N and pesticides are being lost to tile drainage water with NT compared to moldboard plow (MP) tillage. Rainfall during 1989 was 8.7" below normal and tile flow was limited. Although NO_3 concentrations were similar for the two tillage systems, higher discharge volume with NT (1.64 vs 0.92 acre-inches) resulted in slightly higher NO_3-N losses to the drainage water with the NT system. Corn yields, N uptake, and N removal in the grain were all significantly higher for MP compared to NT. Substantially higher amounts of NO_3 remained in the 8-foot soil profile in October with the MP system compared to NT.

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 1988. The stalks were chopped in October, 1988 and moldboard plots plowed.

On May 11, 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 12 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. Furadan was applied at 1 lb (ai)/A to control rootworms. Weeds were controlled with a preemergence application of Lasso (3½ lb/A) and Bladex (3 lb/A) applied May 18. Weed and insect control were excellent. Percent surface residue was measured on April 11 and averaged 8 and 94% for the MP and NT systems, respectively.

The leaf opposite and below the ear was taken from 10 randomly selected plants per plot at silking (MP = July 24 and NT = July 31) and was analyzed for N. Silage and grain yields were taken at physiological maturity by hand harvesting 40' and 80' of row, respectively, from each plot.

Tile lines flowed intermittently from April 28 to June 3. When tile lines were flowing, flow rates were measured daily and samples taken on a daily basis for the first week and then on a M-W-F basis thereafter 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 31, 1989.

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[1] Funding provided by the North Central Regional Research Committee (NC-98) and the Southern Experiment Station.

[2] Professor and Asst. Scientist, Southern Experiment Station, Univ. of Minnesota.

RESULTS

Yields, N uptake by the whole plant (silage), and N removal in the grain were all significantly higher for the moldboard plow (MP) system compared to no tillage (NT) (Table 1). This was the fourth year of eight where MP yields were significantly higher. Neither leaf N nor grain N concentration was affected by tillage, however.

Table 1. Influence of tillage system on corn production and N utilization at Waseca in 1989.

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	26.2	3.06	7.39	151.8	153.2	1.39	100.8
No Tillage	28.9	2.94	6.33	137.0	128.0	1.41	85.3
Signif. Level (%):1/	99	76	99	95	99	42	99
CV (%) :	2.6	4.0	3.0	4.7	2.6	2.9	4.0

1/ Probability level of significance.

Precipitation during the growing season was 8.7" below normal. Thus, tile flow was confined from late-April into early June. Although tile flow for 1989 was very low, discharge in the NT system was 78% higher than for MP (Table 2). Nitrate-N concentrations were not different between the two tillage systems. Consequently, NO_3-N losses to the drainage water were slightly higher for NT. These losses were very small, however, and represent only a small portion of the fertilizer N added to these plots.

Table 2. Influence of tillage system on tile flow, NO_3-N concentration and NO_3-N loss in 1989.

Tillage system	Tile flow	Nitrate-N	
		Concentration1/	Loss
	acre inches	mg/L	lb N/A
Moldboard Plow	.92	13.6	2.71
No Tillage	1.64	12.8	4.75

1/ Flow-weighted

Residual NO_3-N in the soil profile at the end of the 1989 growing season showed about 102 lb/A more N remaining with the MP system (Table 3). The largest differences between the two tillage systems occurred in the top 1' where substantially more NO_3 accumulated with MP. These results are similar to 1987 and 1988.

Table 3. Influence of tillage systems on residual NO_3-N in the soil profile in Oct., 1989.

Profile depth	Tillage System	
	Mb. Plow	No Tillage
feet	-------- NO_3-N (lb/A)	---------
0-1	93.7	29.6
1-2	30.5	19.8
2-3	41.5	25.3
3-4	21.1	13.3
4-5	16.3	11.8
5-6	12.0	13.6
6-7	11.8	11.6
7-8	12.6	12.2
Total (lb NO_3-N/A 0-8')	239.5	137.2

EIGHT-YEAR SUMMARY

The cumulative totals for the 8-year period (1982-1989) are shown in Table 4. Corn yields over this period have averaged 11 bu/A better with moldboard plow tillage. Approximately 12% 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 (50% vs 45% for MP vs NT, respectively). Even though total water flow and NO_3-N lost through the tile lines was about 9% higher with no tillage, this small difference is considered to be insignificant when considering tile flow variability among the eight plots over this 8-year period.

Table 4. Cumulative effects of the two tillage systems over the 8-year period.

Parameter	Tillage System	
	Mb. plow	No tillage
Fert. N applied (lb/A)	1440	1440
Corn grain removed (bu/A)	1085	997
N removed in grain (lb/A)	724	644
N removed in grain as a percent of applied N (%)	50	45
Tile flow (acre inches)	61.3	66.8
Nitrate-N lost in tile (lb/A)	149.1	162.6
N lost via tile lines as a percent of applied N (%)	10	11

NITRATE LOSSES TO TILE DRAINAGE AS AFFECTED BY NITROGEN FERTILIZATION OF CORN IN A CORN-SOYBEAN ROTATION[1/]

Waseca, 1989

Gyles W. Randall, Gary L. Malzer and Brian W. Anderson[2/]

ABSTRACT: A study to determine the influence of time of N application and N-Serve on the uptake of N by corn and the loss of NO_3 to tile drainage was continued in 1989. Results from this third year showed significant yield improvement over the control with all N treatments, but no significant differences among the four primary application time/method treatments. The majority of N uptake occurred prior to silking for all treatments. Tile lines flowed sporadically in early May and averaged less than 0.1 acre-inch discharge. Even though NO_3-N concentrations averaged over 30 mg/L, NO_3-N losses were very low. Over winter "loss" of NO_3 from the 0-8' soil profile averaged 25% in the fallow plots and 45 to 55% in the corn plots regardless of N treatment. Because of dry soil conditions these "losses" suggest immobilization rather than leaching or denitrification as the cause for this change. Residual NO_3 remaining in the soil profile after harvest was quite low except for very high levels with the fallow treatment.

Nitrogen (N) losses to tile drainage water have been directly linked to N additions, crop grown, and soil organic matter level. Research has been conducted on NO_3 losses to tile water in Minnesota since 1972. This research has focused primarily on the effects of rates and timing of fertilizer N application and tillage in a continuous corn system. The purpose of this study is to determine the influence of time of N application and the use of a nitrification inhibitor on NO_3 movement and accumulation in the soil, NO_3 losses via tile drainage, and yield and N uptake by corn grown in a rotation with soybeans.

EXPERIMENTAL PROCEDURES

Thirty-six individual tile line plots were installed on a poorly drained Webster clay loam at the Southern Experiment Station in 1976. Each 20 x 30' plot is completely surrounded by plastic sheeting to a depth of 6' to prevent lateral flow and contains a tile line (4' deep) 5 feet from one end. All tiles drain to collection pits where flow rates can be measured and water samples collected for analyses. After completing a research project in 1983 using this tile facility, the plots were cropped to corn with a blanket N rate in 1984 and 1985 to establish uniformity.

Beginning in 1986 corn was planted on one-half of the experimental site while soybeans were planted on the other half. Thirty two plots (16 with corn and 16 with soybeans) with the most uniform drainage were selected from the 36 for the primary study. The experimental design consists of a 4 x 4 Latin square where the rows and columns were based on the previous (1977-83) tile flow rates from each plot. The four basic N treatments (see Table 1) are applied to the corn phase each year with the residual effects measured in the soybean phase. Three additional N treatments were replicated four times around the edge of the core 16-tile-plot area and were planted to corn. These three treatments were analyzed along with the other four as a completely randomized design.

Anhydrous ammonia was applied at a rate of 135 lb/A for all N treatments while N-Serve was applied at 0.5 lb/A. Fall treatments were applied on October 19. Average soil temperature at the 4" depth on that date was 47°F with an average of 42°F over the following 10-day period. Spring preplant treatments were applied on May 12. The sidedress portion (60%) of the split treatments was applied at the V-7 stage on June 28.

No primary or secondary tillage was done on the soybean area that was planted to corn in 1989. The corn area, however, was fall chiseled and spring disked once prior to planting soybeans. Surface residue accumulation estimated by the line-transect method on April 11 showed an average of 29 and 65% for the areas that were planted to corn and soybeans, respectively, in 1988. Because of high soil P and K tests, no broadcast nor starter fertilizer was used.

[1/] Partial funding provided by Dow Chemical U.S.A. and Minnesota Agric. Exp. Stn.

[2/] Professor, So. Exp. Stn.; Assoc. Prof. Dept. of Soil Science; Assistant Scientist, So. Exp. Stn., Waseca.

Corn (Pioneer 3737) was planted at 30,800 plants/acre on May 16 with a JD Max-Emerge planter equipped with waffle coulters. A corn rootworm insecticide was not used. Weeds were chemically controlled with a preemergence application of Lasso (3.5 lb/A) plus Bladex (3 lb/A).

Soybeans (Hardin) were planted in 30" rows at 9 beans per foot of row on May 23. Weeds were chemically controlled with a preemergence application of Lasso (3½ lb/A) plus Amiben (3 lb/A). Pursuit (imazethapyr) was applied on June 28 at 0.06 lb/A plus 0.25% v/v X-77 to plots 18, 20, 21, 22, 24, 27, 28 & 30 to determine if it could be found in tile drainage water.

Two plots within each of the corn and soybean areas were not planted and were fallowed all summer. These four fallow plot areas were located on those tile plots that showed greatest water flow variability (1977-83). The purposes of these plots were to simply check the NO_3-N concentrations in the tile water in a fallow system and to utilize all 36 of the tiled plots, even though these four historically showed the highest flow variability.

Stand counts were taken at the V-5 stage and plots were thinned to a uniform population. Eight randomly selected plants were removed from the center rows at silk initiation (July 27) and were chopped, dried, weighed and ground for total dry matter accumulation and analyzed for total N concentration. Stover and grain samples were taken at physiological maturity by hand harvesting 30' of row for stover yields and 60' of row for grain yields and moisture. Chemical analyses of whole plant, stover and grain samples were performed by the Research Analytical Laboratory, University of Minnesota.

Tile line flow rates were determined daily and were recorded when flow exceeded 10 ml/minute (0.01"/day). Samples were collected for NO_3-N analysis on an every-other-day basis. Periodic samples were collected for alachlor (Lasso) and cyanazine (Bladex) analyses.

Soil samples for NO_3-N analysis were taken in 1-foot increments to a depth of 8 feet from the fallow plots and selected corn and soybean plots on April 24. The same technique was used to sample all fallow and corn plots and selected soybean plots after harvest on October 31.

RESULTS AND DISCUSSION

Rainfall

Weather conditions during the 1989 growing season were slightly warmer than normal but were extremely dry. Fortunately, very timely rainfall in late June, mid-July, and late August resulted in very good corn and soybean yields. Precipitation for the year was 8.66" below normal with a deficit of 7.12" for the growing season. Departure from normal was greatest in the dry months of May, June, August, and October. Runoff did not occur in 1989 as the highest 24-hour and 48-hour rainfalls totalled only 1.26" (August 28) and 1.73" (June 25 and 26), respectively. These very dry conditions along with high ET resulted in low available soil moisture levels throughout much of the year. Available soil water in the 5-foot profile under corn dropped to a low of 3.7" on September 19 (33% of a full profile). Low fall precipitation limited recharge of the soil profile to only 4.2" (38% of full) on November 2 -- much below the normal of 8.8".

Plant

Whole plant N concentration at the silking stage was greatly increased over the check by all of the N treatments with little difference among the six N treatments (Table 1). Dry matter accumulation at this stage was unaffected by time/method of N treatment. Stover N concentration at physiological maturity (PM) was increased consistently over the check by all N treatments. Stover yield at PM was higher than the control for all of the N treatments except the fall application without N-Serve. Stover N concentration was increased over the control by all N treatments. Neither stover N concentration nor stover yield were affected by the four primary time/method treatments. Final population was not significantly different among the N treatments.

Table 1. Influence of time of N application and N-Serve on whole plant N, stover yield, and final population of corn following soybeans.

N application		Whole Plant Silk Stage		Stover		
Time	N-Serve	N	DM	N	Yield	Final Population
		%	g/plt	%	TDM/A	ppA x 10^{-3}
Primary trts						
Fall (Oct.)	No	1.51	102	.34	2.01	28.5
Fall (Oct.)	Yes	1.62	108	.38	2.12	28.4
Spr. (April)	No	1.69	113	.41	2.19	28.5
Split[1/]	No	1.62	108	.41	2.12	28.5
Additional trts						
Check	-	1.05	80	.25	1.79	28.5
Spr. (April)	Yes	1.69	112	.42	2.62	28.5
Split[1/]	Yes	1.71	103	.39	2.13	28.5
		Statistical Analysis				
Latin square (Primary Trts)						
Signif. Level (%):		66	83	84	56	55
CV (%) :		7.7	5.8	11.	6.8	0.5
Completely randomized (7 trts)						
Signif. Level (%):		99	99	99	99	55
BLSD (.05) :		.21	12	.05	.33	-
CV (%) :		9.4	8.2	9.4	10.	0.4

[1/] 40% preplant + 60% sidedress.

Grain and silage yields were increased significantly over the check (0 lb N/A) by all of the N treatments (Table 2). Although a 20 bu/A range appeared among the four primary time/method treatments, this difference was not statistically significant at the P = 90% level. Grain moisture at harvest was significantly higher for the check compared to the N treatments with no difference among the four primary time/method N treatments. Grain N concentration and N removal in the grain were increased over the 0-lb N check by all of the N treatments but was not different among the four primary treatments. Total N uptake was increased almost two-fold over the 0-lb N check by all of the N treatments. In addition, the spring preplant and split treatments significantly improved total N uptake over the fall application without N-Serve.

Total N removal in the grain ranged from 86.2 to 104.9 lb/A for the six N treatments (Table 2). Based on these removal amounts, N efficiency (N removed by a treatment - N removed in the check ÷ 135 lb N/A) ranged from 29 to 41% for the four primary treatments up to a maximum of 42% with the spring preplant application with N-Serve. Nitrogen efficiency based on the total plant uptake ranged from 32 to 48% for the four primary treatments up to a high of 52% with the spring preplant application with N-Serve. These efficiency values are considerably better than in 1988.

Total N uptake by the plants prior to silking (Fodder N yield at silking) divided by total N uptake at PM shows that from 93 to 99% of the N was accumulated by the plants prior to silking (Table 3). The lowest amounts of pre-silk N accumulation were generally found with the fall application without N-Serve. NEW N in the grain (assumed to be taken up by the plant after silking and translocated to the grain) ranged from 1 to 7%. Under the 1989 conditions there was no affect of time/method of N application on post-silk (NEW N) N uptake into the grain.

Table 2. Corn grain and silage production as influenced by time of N application and N-Serve.

N application		Grain					Total N
Time	N-Serve	Yield	H_2O	N	N removal	Silage	uptake
		bu/A	%	%	lb/A	TDM/A	lb/A
Primary trts							
Fall (Oct.)	No	132.6	13.0	1.38	86.2	5.52	99.7
Fall (Oct.)	Yes	143.1	12.8	1.41	95.4	5.90	111.7
Spr. (April)	No	152.6	12.7	1.44	103.5	6.23	121.5
Split[1/]	No	146.0	13.0	1.42	98.1	6.00	115.4
Additional trts							
Check	-	97.8	14.2	1.03	47.6	4.36	56.6
Spr. (April)	Yes	162.0	13.2	1.37	104.9	6.91	126.7
Split[1/]	Yes	146.4	13.1	1.42	97.9	6.01	114.5
		Statistical Analysis					
Latin square (Primary trts)							
Signif. Level (%):		75	87	67	91	79	97
BLSD (.05) :		-	-	-	-	-	13.4
CV (%) :		8.6	1.4	3.1	8.2	7.0	6.6
Completely randomized (7 trts)							
Signif. Level (%):		99	99	99	99	99	99
BLSD (.05) :		23.0	0.8	0.06	12.2	0.80	12.9
CV (%) :		11.	3.7	3.5	9.9	9.6	9.0

[1/] 40% preplant + 60% sidedress.

Table 3. Influence of time of N application and N-Serve on time of N uptake.

N application		Fodder N Yield at[1/]		Grain N Yield at PM			
Time	N-Serve	Silk	PM	Total	OLD[2/]	NEW[3/]	NEW[3/]
		lb N/A					%
Primary trts							
Fall (Oct)	No	96.5	13.5	86.2	83.0	3.2	3
Fall (Oct)	Yes	109.1	16.4	95.4	92.7	2.6	3
Spr (April)	No	119.8	18.0	103.5	101.8	1.7	1
Split[4/]	No	110.1	17.3	98.1	92.6	5.4	5
Additional trts							
Check	-	53.8	9.0	47.6	44.8	2.8	6
Spr (April)	Yes	118.3	21.8	104.9	96.4	8.4	7
Split[4/]	Yes	110.6	16.6	97.9	94.0	3.9	4
		Statistical Analysis					
Latin square (Primary trts)							
Signif. Level (%):		87	95	91	73	3	3
BLSD (.05) :		-	3.4	-	-	-	-
CV (%) :		10.	11.	8.2	13.	356.	380.
Completely randomized (7 trts)							
Signif. Level (%):		99	99	99	99	1	1
BLSD (.05) :		16.8	3.1	12.2	18.1	-	-
CV (%) :		12.	14.	9.9	15.	307.	407.

[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 and/or translocated from the roots after silking.

[4/] 40% preplant + 60% sidedress.

Water

Because precipitation for April through May totaled only 4.77" (74% of the normal 6.40"), water flow occurred in only 4 of 36 tile lines, and then only for an 8-day period in early May. Drainage volumes were extremely low and averaged less than 0.1 acre-inch. Flow weighted NO$_3$-N concentrations from the 8 water samples obtained from treatment 2 (Fall N + N-Serve) averaged 41 mg/L while the 12 samples from the split N treatment (No. 4) averaged 30 mg/L. Two tile water samples from the fallow plots averaged 63 mg/L. Nitrate-N losses averaged less than 0.3 lb/A due to the low flow rates.

Soil

Nitrate-N remaining in the 0-8' soil profile in mid-April was very high in the fallow plots (346 lb/A) compared to those where either soybeans or corn were grown in 1988 (Table 4). Soybeans that had not received fall-applied N averaged 112 lb/A with 84 lb/A remaining in the top 5'. Moderately low amounts of residual NO$_3$-N remained in the 0-8' profile when corn receiving no N fertilizer was the previous crop (104 lb/A). Residual NO$_3$-N remaining from the 1988 crop was increased by about 50 lb/A with the previous fall and spring preplant applications and by over 100 lb/A with the split application. These data reinforce data from other previous studies which generally have shown higher levels of residual NO$_3$ associated with split and sidedress N applications. Distribution of NO$_3$ within the profile was consistently very high to 8' with the fallow system compared to high levels only in the top two feet following soybeans and unfertilized corn. Corn receiving N showed increased levels of NO$_3$ down to the 6' depth.

Table 4. Nitrate-N in the soil profile in April, 1989 as influenced by previous crop and N treatment for corn in 1988.

Profile depth	1988 Crop					
			Corn[1/]			
	Fallow	Soybean	0 lb N	Fall	Preplant	Split
feet	lb/A[2/]					
0-1	68.4	35.2	28.8	33.5	35.7	42.5
1-2	67.1	19.4	19.3	23.7	27.4	56.9
2-3	56.8	10.6	5.9	22.5	26.2	33.6
3-4	43.9	9.5	7.0	24.0	14.9	22.1
4-5	36.4	9.6	10.7	16.9	16.3	21.2
5-6	34.8	8.2	12.4	13.0	15.5	15.8
6-7	21.8	10.3	11.2	10.3	13.0	14.1
7-8	16.8	9.5	8.6	9.2	9.6	11.0
Total in						
0-5' profile	272.6	84.3	71.7	120.6	120.5	176.3
0-8' profile	346.0	112.3	103.9	153.1	158.6	217.2

[1/] These fall, spring preplant and split treatments all received N-Serve.
[2/] Average of 4 replications

A comparison of the residual NO$_3$ amounts found in April, 1989 (Table 4) with those amounts found in the same plots in October, 1988, shows the spring NO$_3$ levels to be approximately 25% lower for the fallow plots and 45 to 55% lower for the corn plots regardless of N fertilization time/method. Considering the relatively dry conditions throughout soil profile during this 6-month period, it is doubtful that this change was due to leaching or denitrification, but more than likely was due to immobilization.

Residual NO$_3$-N remaining in the 0-8' profile after the 1989 season shows an entirely different picture than in 1988 except on the continuous fallow plots where very high accumulations were found in both years (Table 6). Very low amounts of NO$_3$ were found in October, 1989 compared to October, 1988 regardless of the N treatment. This was probably due to greater NO$_3$ uptake as well as more favorable conditions for immobilization in 1989. Differences among the N treatments were not substantial; however, consistently higher levels were found with the spring and split-applied N-Serve treatments.

Table 5. Residual NO_3-N remaining in the 0-8' soil profile after harvest as influenced by time of N application and N-Serve.

			Application Time					
			N-Serve			No N-Serve		
Profile depth	Fallow	Check	Fall	Preplant	Split	Fall	Preplant	Split
ft.	lbs NO_3-N/A[1]							
0-1	111.9	22.9	39.4	54.4	33.2	37.4	36.5	27.5
1-2	64.0	4.3	11.3	12.0	14.2	16.5	10.5	7.6
2-3	62.3	3.2	7.3	8.0	7.7	6.1	8.3	7.4
3-4	56.1	3.1	5.9	8.3	6.3	5.8	6.8	8.1
4-5	50.0	3.9	6.1	7.7	7.4	6.4	8.7	7.4
5-6	38.7	5.8	6.8	8.1	7.6	7.8	7.6	8.1
6-7	30.8	6.5	7.4	7.6	6.3	8.7	6.7	7.2
7-8	23.2	6.8	6.4	5.9	6.6	8.3	6.2	7.2
Total in								
0-5' profile	344	37	70	90	69	72	71	58
0-8' profile	437	56	91	112	89	97	91	80

[1] Avg. of 4 replications

CONCLUSIONS

The warm and drier than normal conditions with some timely rainfall resulted in good corn yields and N efficiency but almost no tile water drainage (less than 0.1 acre-inch). Nitrate-N concentrations in the very few samples averaged 41 and 30 mg/L from the fall treatment + N-Serve and split treatment, respectively. Water from the fallow plots averaged 63 mg NO_3-N/L. Surprisingly little residual NO_3-N remained in the soil profile after harvest except in the fallow plots where 437 lb/A was found in the 0-8' profile.

RESIDUAL SOIL NITRATE IN SECOND YEAR CORN FOLLOWING ALFALFA AS INFLUENCED BY TILLAGE AND CORN HYBRID[1]

G. W. Randall and B. W. Anderson[2]

Experiments were conducted at two locations in 1989 to determine the influence of tillage, N rate and corn hybrid on residual NO_3 for second year corn following alfalfa. Spring residual NO_3 levels were very high in Waseca Co. due to the drought in 1988 and in the moldboard plowed plots that received fertilizer N in Winona Co. On average residual NO_3 increased by 8% and decreased by 26% from October 1988 to April 1989 in Waseca and Winona Counties, respectively. Samples taken from the top foot indicate a slight increase in NO_3-N concentration between preplant sampling and the V2 and V6 stages. Highest levels of residual soil NO_3 occurred at both sites where N had been applied to the MP plots. Residual N was lowest with no tillage in Winona Co. Significantly less residual NO_3 remained with DK547 compared to P3732. These data indicate that soil NO_3-N levels are greatly affected by tillage, N rate, and hybrid even for second year corn following alfalfa. Management systems can be employed that reduce carryover of NO_3 and thus minimize the potential for NO_3 leaching.

Recent evidence has shown that residual soil nitrate (NO_3) in the upper part of the root zone may be helpful in more accurately predicting fertilizer N needs of corn. The purpose of this study was to determine: (1) the amount of residual NO_3-N remaining in the spring after 1st year corn following alfalfa, (2) the effect of tillage on soil NO_3-N at the preplant, V2 and V6 growth stages, and (3) the effect of tillage, corn hybrid, and fertilizer N rate on residual NO_3-N following second year corn after alfalfa.

EXPERIMENTAL PROCEDURES

Studies were initiated into growing alfalfa stands at the Rosemount Agricultural Experiment Station, Southern Experiment Station at Waseca, and on the Gary Luehmann farm in Winona Co. in April, 1988. The primary soil type at each location was Port Byron sil, Nicollet cl, and Seaton sil, respectively. A randomized, complete-block experiment in a split-plot arrangement with four replications was used. Main plots consisted of two primary tillage variables (moldboard plow vs no tillage) while subplots consisted of six genetically dissimilar 105-day RM corn hybrids.

Following harvest and soil sampling in October, 1988, all moldboard plots were plowed at the Waseca and Winona Co. sites. Soil samples were taken in 1-foot increments to a depth of 5' from the 0 and 100-lb plots (1989 N rate) of the P3732 hybrid on both tillage systems in late-April, 1989 prior to planting. Additional samples were taken from the 0-lb N rate plots of this hybrid at the V2 stage (Winona Co.) and V6 stage at both sites. After harvest, soil samples were again taken from both tillage systems in 1-foot increments to a depth of 5' from the P3732 and DK547 plots receiving the 0 and 100-lb N rates. All soil samples were forced-air, oven-dried at 120°F, crushed to pass a 2 mm sieve, and analyzed for NO_3-N.

The corn hybrids planted in 1988 were repeated again on the same plots in 1989. The N rate was raised from 60 lb/A in 1988 to 100 lb/A in 1989 on those plots receiving N.

RESULTS AND DISCUSSION

Spring sampling

Samples taken prior to planting and N fertilization indicate substantial carryover of residual NO_3-N at both locations (Table 1). Residual NO_3 levels were very high for all previous N rate/tillage systems in Waseca Co. because of the extremely low corn yields in 1988 due to drought. In Winona Co., residual NO_3 was highest for the MP system especially those plots that received 60 lb N/A in 1988. Residual NO_3 in the top 5' increased by 8% between October 1988 and April 1989 in Waseca Co. probably due to additional nitrification and very dry conditions that minimized any NO_3 losses. In Winona Co. where significant fall rain occurred after sampling, residual NO_3 decreased by 26% during this 6-month period.

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[1] Funding provided by the Minnesota Agric. Exp. Stn. and the So. Exp. Stn. at Waseca.

[2] Professor and Assistant Scientist, So. Exp. Stn., Waseca.

Fall sampling

Samples were taken from the 0-1' and 1-2' depths at the preplant, V2 and V6 growth stages to determine if the NO_3 concentrations would change greatly during this period due to nitrification or loss of N. Information of this type may be helpful as agronomists evaluate the pre-sidedress soil nitrate test. Results shown in Table 2 show a slight increase in NO_3-N concentration in the top foot for both tillage systems at Waseca over this 8-week period. In Winona Co., soil NO_3-N increased in the top foot from preplant (late April) to V2 (early June) but did not change over the next four weeks (V6 stage). Soil NO_3-N changes in the 1-2' layer were small and inconsistent.

Waseca

Soil NO_3 amounts in October 1989 are given in Tables 3 and 5. Main effects showed significantly higher residual NO_3-N with the 100-lb N rate and with P3732 compared to DK547 but no effect of tillage. The significant tillage x N rate interaction indicates a greater effect of N with the MP system compared to NT. Larger differences between the amount of residual NO_3 after P3732 compared to DK547 with the MP system resulted in the significant tillage x hybrid interaction. Proportionately more NO_3 remained after the P3732 hybrid especially when fertilizer N was not applied. When N was applied there was less relative difference between hybrids. These results may have been unduly affected by the poor crop at this site in 1988.

Winona Co.

Fall total profile NO_3-N values shown in Table 4 show a substantial and highly significant effect of tillage, N rate, and hybrid on residual NO_3 (Table 5). The highly significant tillage x N rate interaction shows very low residual soil NO_3 except when 100 lb N/A was applied to the MP system. This high level of residual NO_3 reflects carryover of the fertilizer N which was not needed by the corn because of adequate N being supplied by mineralization of the N in the moldboard plowed alfalfa system. Almost 2X as much residual NO_3 was found after P3732 compared to DK547. This may have been due to slightly higher yields with DK547.

Table 1. Soil nitrate-N in April, 1989 following 1 year of corn after alfalfa.

Profile depth	Tillage: N rate:	Waseca				Winona Co.			
		Moldboard		No till		Moldboard		No till	
		0	100	0	100	0	100	0	100
feet		lb NO_3-N/A							
0 - 1		37.8	69.4	39.3	45.5	49.3	112.2	41.1	70.1
1 - 2		72.3	104.7	57.6	117.2	43.7	83.1	27.9	63.8
2 - 3		51.9	55.0	46.9	57.6	21.4	30.0	14.4	23.6
3 - 4		17.3	32.1	26.2	23.8	11.4	12.5	9.5	11.0
4 - 5		6.7	13.1	12.7	10.0	6.5	9.8	7.1	10.9
Total in 5-foot profile									
April, 1989		186	274	183	254	132	248	100	117
Oct., 1988		170	235	184	236	178	302	136	182

Table 2. Soil NO_3-N concentration at the preplant, V2 and V6 stages as influenced by tillage.

Soil depth	Moldboard			No tillage		
	Preplant	V2	V6	Preplant	V2	V6
feet	NO_3-N, ppm					
			Waseca Co.			
0 - 1	9.5	-	12.3	9.8	-	13.6
1 - 2	18.1	-	13.8	14.4	-	14.2
			Winona Co.			
0 - 1	17.5	21.8	21.4	10.3	12.9	12.9
1 - 2	16.0	14.2	15.6	7.0	7.9	7.5

Table 3. Residual soil nitrate-N after harvest in October, 1989 at Waseca as influenced by tillage, hybrid, and N rate.

	Moldboard				No-tillage			
Profile	P3732		DK547		P3732		DK547	
depth lb N/A:	0	100	0	100	0	100	0	100
feet	lb NO_3-N/A							
0 - 1	19.6	101.5	16.4	56.3	22.9	53.9	17.5	50.1
1 - 2	8.4	41.6	6.3	28.3	6.9	27.4	6.2	38.3
2 - 3	13.4	29.5	5.3	23.2	11.7	31.3	8.5	28.0
3 - 4	10.4	16.1	6.6	13.4	13.9	16.3	10.3	13.2
4 - 5	6.3	8.5	6.6	9.0	9.5	8.3	8.2	6.9
Total in 0-5' profile	58	197	41	130	65	137	51	136

Table 4. Residual soil nitrate-N after harvest in October, 1989 in Winona Co. as influenced by tillage, hybrid, and N rate.

	Moldboard				No-tillage			
Profile	P3732		DK547		P3732		DK547	
depth lb N/A:	0	100	0	100	0	100	0	100
feet	lb NO_3-N/A							
0 - 1	33.0	142.5	17.0	89.1	19.3	59.9	18.8	17.9
1 - 2	17.5	86.5	3.3	34.7	3.4	23.7	4.0	5.7
2 - 3	11.9	34.1	3.3	17.1	5.2	13.0	2.6	6.7
3 - 4	10.5	12.4	7.8	7.7	7.3	8.9	4.5	5.6
4 - 5	5.2	7.2	4.7	7.5	6.7	6.5	4.9	5.6
Total in 0-5' profile	78	283	36	156	42	112	35	42

Table 5. Means for main effects and interactions for total residual soil nitrate-N (0-5') after harvest at Waseca and Winona Co. in October, 1989.

Treatment		Location	
		Waseca	Winona Co.
		-------- lb NO_3-N/A -------	
Tillage			
Moldboard		107	138
No-tillage		97	57
P > F		0.23	0.01
N Rate (lb/A)			
0		54	47
100		150	148
P > F		0.01	0.01
Hybrid			
P3732		114	128
DK547		89	66
P > F		0.01	0.01
Tillage X N Rate Interaction			
Moldboard	0	50	56
	100	164	219
No-tillage	0	58	38
	100	137	77
P > F		0.01	0.01
Tillage X Hybrid Interaction			
Moldboard	P3732	128	180
	DK547	86	96
No-tillage	P3732	101	77
	DK547	94	38
P > F		0.01	0.16
N Rate X Hybrid Interaction			
0	P3732	62	60
	DK547	46	34
100	P3732	167	197
	DK547	133	99
P > F		0.04	0.03
Tillage X N Rate X Hybrid Interaction			
P > F		0.01	0.72
CV (%):		11.4	45.

IMPACT OF NITROGEN AND TILLAGE MANAGEMENT PRACTICES ON CORN YIELD AND POTENTIAL GROUNDWATER CONTAMINATION IN SOUTHEASTERN MINNESOTA[1]

Center for Agricultural Impacts on Water Quality
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ABSTRACT: Studies are being conducted on the silt loam soils of southeastern Minnesota to evaluate specific N and tillage practices for their role in providing profitability (BENEFIT) while minimizing NO_3 occurrences in the water below the root zone (RISK). In general, continuous corn yields were optimized at N rates from 100 to 150 lb N/A except when alfalfa and manure were in the system (1983-85), where 50 lb N/A optimized yields. Corn yields were not improved with split or sidedress N applications. Tillage did not appear to effect either corn yield or NO_3-N concentrations in the soil water. Yields from the residual manure treatments (manure applied in 1987 and 1988) were equal to yields from the 150-lb fertilizer N rate. However, NO_3-N concentrations in the water at 5′ still remained very high (38 to 79 mg/L). When profitability was highest, NO_3-N concentrations at 5′ averaged about 15 mg/L. In an effort to more clearly define BMP's for these soils, additional years will be needed to more closely ascertain benefit vs risk relationships of these various N and tillage practices.

Current agricultural production systems are being linked closely to the occurrence of agricultural chemicals in the groundwater. This concern is especially prevalent in southeastern Minnesota where agriculture is quite intensive and the soils are rather shallow over a fractured limestone and sandstone bedrock geology (karst). The purposes of these studies are to: (1) determine the cause and effect relationship of specific N and tillage management practices on corn production and NO_3 and pesticide accumulation/movement through the soil and (2) identify best management practices that minimize groundwater contamination while maintaining economic profitability.

EXPERIMENTAL PROCEDURES

Three sites were continued for the 1989 studies. The primary site with the most intensive investigation is being conducted in Olmsted Co. on the Lawler Farm. The other sites are in Goodhue Co. on the Foss Farm and in Winona Co. on the Kalmes Farm.

Olmsted County - Lawler Farm

In April of 1986 a 6.5 acre site of Port Byron soil was identified on the Richard Lawler and Sons Farm approximately 6 miles east of Rochester. A very comprehensive field history for the last 7 years was provided. Corn was grown in 1986. No herbicides and no nitrogen (N) fertilizer were applied to the corn which was cultivated three times.

Nitrogen Study

A randomized, complete-block with 4 replications was established in the fall of 1986 and was continued in 1989. Ten N treatments including both anhydrous ammonia and manure were established for a total of 40 plots (Table 1). Each plot was 30′ wide and 65′ long. The fall N treatments were applied on November 3, 1988. Spring N fertilizer treatments were applied on May 3 and again on June 29, 1989. Liquid hog manure was not applied in 1989. All plots except the no-till treatment were disked on May 8.

Corn (Pioneer 3737) was planted on May 15 at 30,200 plants/A. Lasso (3 lb/A) and atrazine (2.5 lb/A) were applied preemergence. Force was applied in the furrow at a rate of 8 oz/1000′ of row to control rootworms. All chisel plow plots were cultivated on June 22.

Whole plants were harvested from selected rows at silking, were weighed, dried, ground and analyzed for total N to determine pre-silk N uptake. Stover and grain yields were taken from 20′ and 80′ of row, respectively, at physiological maturity (Oct. 4). All samples were weighed, dried, ground and analyzed for total N.

Soil samples were obtained from each plot on April 18 and Nov. 6 by taking two 2-inch cores in 1-foot increments to the bedrock and then compositing the cores from each increment. The samples were forced-air, oven-dried at 120° F, ground and analyzed for inorganic N (NH_4-N and NO_3-N).

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1) Funding provided by the Legislative Commission on Minnesota Resources, Center for Agricultural Impacts on Water Quality, and the Minnesota Agricultural Experiment Station.

Suction lysimeters installed in 1987 at the 5 and 7.5-foot depths in each plot were used to extract soil water from these depths to measure NO_3 concentrations in the soil water. Samples were collected on May 12, June 7, July 26, and September 12.

Pesticide Study

An area adjacent to the N study was established in the fall of 1986 to accommodate a study to evaluate the movement of Lasso, atrazine, Banvel, and Counter through the soil profile as influenced by four tillage systems. The four tillage treatments (moldboard plow, chisel plow, ridge tillage, and no tillage) were initiated in November, 1986. Nitrogen was applied on May 3 at a rate of 180 lb N/A as anhydrous ammonia. All other planting operations were the same as in the N study. The herbicides were applied using specialized plot equipment. Potassium bromide was broadcast-applied to a 15-foot section of each plot. The Br serves as a tracer to which pesticide movement can be compared. The corn was cultivated two times. The ridge plots were ridged in mid-June.

Each plot was intensively soil sampled throughout the season to monitor herbicide movement. Stainless steel suction lysimeters installed at 5′ and 7.5′ depths were used to extract soil water. Grain and stover yields were taken at physiological maturity (PM).

Goodhue County - Foss Farm

In May of 1986 an area of 5.1 acres of Port Byron soil was identified on the Selmer Foss and Sons (James Foss) farm in Goodhue County. A good field history was provided for the past 6 years. Corn was grown in 1986 and received a minimal amount of N (75 lb N/A) because it was in continuous corn. Weeds were controlled with 4 lb atrazine/A. Due to wet conditions no primary tillage was performed in the fall of 1986.

A randomized, complete-block design with 4 replications was established at this site in April, 1987 and was continued in 1989. Sixteen N treatments all consisting of anhydrous ammonia applied to chiseled and no-till plots were established. Each of the 64 plots measures 30′ wide and 65′ long. Chisel plowing was done with a John Deere Mulch Tiller on October 31, 1988. Anhydrous ammonia was applied preplant on May 9. All chisel plots were disked on May 12.

Corn (Pioneer 3772) was planted at 30,200 plants/A on May 16. Lasso (4 lb/A) and Bladex (2.5 lb/A) was applied preemergence. Force was applied (8 oz/1000 ft) to control corn rootworms. The chisel plowed plots were cultivated to remove weeds and volunteer corn. Sidedress applications of N as anhydrous ammonia were applied at the 6-leaf stage (June 21) and 8 to 9-leaf stage (June 29).

Plant sampling procedures at silking and at PM were essentially the same as at the Olmsted Co. site except that grain yields were determined by combine harvesting two rows per plot. Soil sampling to the 8-foot depth on May 3 and November 10 was accomplished using the same procedures as in Olmsted Co. Suction lysimeters installed in six treatments (24 plots) to a 5′ depth in 1987 were sampled on May 3, June 21, July 20, and Sept. 11 to determine the NO_3 and pesticide concentrations in the extracted soil water.

Winona County - Kalmes Farm

A 3.0 acre contour strip of Seaton soil was identified in early April, 1987. This farm is owned by Eugene Kalmes and son, Robert Kalmes. A field history was provided for the last 4 years. Corn was grown in 1986 and received 70 lb N/A and 2 lb atrazine/A. Alfalfa was grown in 1983-85 and received 6 T manure/A in the fall of 1985.

A randomized, complete-block design with 4 replications was established at this site in mid-April, 1987 and was continued in 1989. Twelve N treatments were established for a total of 48 plots. Each plot measures 20′ wide by 65′ long.

Fall chiseling was conducted on October 31, 1988. The preplant anhydrous ammonia treatments were applied on May 4. A field cultivator was used as secondary tillage just prior to planting.

Corn (Pioneer 3772) was planted at 30,200 plants/A on May 15. Lasso (3 lb/A) and Bladex (2.5 lb/A) were applied preemergence. Force (8 oz/1000′) was used to control corn rootworms. The chisel plowed plots were cultivated to remove weeds. Sidedress applications of N as anhydrous ammonia were applied at the 6-leaf stage (June 20) and the 8 to 9-leaf stage (June 29).

Plant and soil sampling procedures were identical to those used in Olmsted Co. Stainless steel and PVC suction lysimeters installed in 1987 at the 5′ depth in six treatments (24 plots) were sampled on May 16, June 15, Aug. 3, and Sept. 12 to determine NO_3 and pesticide concentrations in the extracted soil water.

RESULTS AND DISCUSSION

Olmsted Co.

Corn grain yields in 1989 were increased significantly by both the fertilizer and previous manure N treatments (Table 1). The addition of 75 lb N/A increased yield by 86 bu/A resulting in very high fertilizer N efficiency. The 150-lb N rate applied preplant (PP) gave the optimum yield among the fertilizer treatments. Yields with the two hog manure treatments were not significantly different than the 150-lb N/A PP treatments. Corn yields with the fall and split 150-lb treatments were not significantly different from the 150-lb PP treatment. There was no significant yield difference between the chisel and no tillage systems. Average 3-year yields showed greatest economic return to the 150-lb PP application with no advantage to higher rates, fall application, or split treatments.

Table 1. Effect of N treatments on the 1989 corn yields and NO_3-N concentrations in the water at 5' in Olmsted Co.

Treatment				Grain Yield		Nitrate-N[3] Conc. in Water	
No.	Tillage	N rate	Time/Method	1989	1987-89	5'	7.5'
		lb N/A		---- bu/A ----		--- mg/L ---	
1	Chisel	0	------	69.0	86.1	1	3
2	Chisel	75	Spr., preplant	155.2	159.1	7	7
3	Chisel	150	Spr., preplant	181.4	178.4	15	7
4	Chisel	225	Spr., preplant	174.6	170.7	28	9
5	Chisel	150	Fall, post tillage	183.1	177.6	17	-
6	Chisel	150+NI[1]	Fall, post tillage	180.8	176.3	15	-
7	Chisel	150- Split	50% Spr., preplant 50% SD, 8-leaf	174.0	173.2	-	-
8	No tillage	150	Spr., preplant	178.8	177.4	-	-
9	Chisel	315[2]	Spr., disked in	186.6	185.2	38	13
10	Chisel	490[2]	Spr., disked in	181.2	183.9	79	6
	Significance level (%)		:	99			
	BLSD (.05)		:	13.1			
	CV (%)		:	6.0			

1) N-Serve
2) Liquid swine manure was applied annually at an average rate of 6050 and 9200 gal/A, respectively, in 1987 and 1988. No manure was applied in 1989. Total N rates were 315 and 490 lb N/A or approximately 175 and 265 lb "available" N/A.
3) September 12, 1989

Nitrate-N concentrations in the soil water extracted from the 5-foot depth were correlated linearly with the spring-N rate (Table 1). Concentrations below 10 mg/L were found only with the 0 and 75-lb N rates, but economical return was also considerably less with the treatments. Contrary to 1988, fall applications of N, regardless of the inclusion of N-Serve, showed similar NO_3-N concentrations as the spring preplant applications. There appeared to be no difference between tillage systems. Highest NO_3-N concentrations occurred with realistic application rates of liquid hog manure. Nitrate leaching from the treatments had not reached the 7.5-foot depth at the end of three growing seasons probably because of the dry conditions in both 1988 and 1989. It should be cautioned that these 5-foot NO_3-N concentrations may not represent the concentrations entering the aquifer because of dilution; however, they do provide an indication as to the environmental sensitivity of the treatments.

Corn yields in the pesticide study were greatly influenced by tillage (Table 2). The yields with the MP system were significantly higher than those from either the ridge till (RT) or NT systems with yields from CP being intermediate. A slight weed infestation in the RT and NT systems may have competed for soil water in this dry year, thus reducing corn yields.

Table 2. Effect of tillage treatments on the 1989 corn yields in Olmsted Co.

Tillage	Grain Yield 1989	Grain Yield 1987-89 Avg.
	---------- bu/A	--------
Moldboard plow	180.1	174.0
Chisel plow	169.1	170.1
Ridge till	156.5	160.7
No tillage	158.8	157.4
Significance level (%):	98	
BLSD (.05) :	15.7	
CV (%) :	5.5	

Goodhue Co.

Grain yields were increased significantly over the control (both chisel and no tillage) by all of the N treatments (Table 3). Yields were optimized with the 100-lb spring PP treatment. The highest yield, although not statistically speaking, was obtained with the 150-lb PP treatment. There was no significant difference between the two tillage systems except when no N was applied. Under these conditions yields were better with the CP system. None of the split and sidedress treatments enhanced yields over the spring PP anhydrous applications. Benefits were not obtained by including N-Serve with the anhydrous ammonia.

Three-year average grain yields also show: (1) optimum N rate to be 100 lb/A, (2) no improvement in yield with either split or sidedress N application, and (3) no difference between the two tillage systems except at the 0-lb N rate where there was a slight advantage for chisel plowing.

Nitrate-N concentrations in the soil water extracted from the 5-foot depth on Sept. 11 varied considerably and did not relate closely to N treatment (Table 3). This was probably due to the dry conditions and the incomplete number of samples obtained.

Table 3. Corn yield and NO_3-N concentration in the soil water at 5' as affected by N treatments in Goodhue Co. in 1989.

Treatment No.	Tillage[1]	N rate	Time/Method	Grain Yield 1989	Grain Yield 1987-89	Nitrate-N[3] Conc. in Water at 5'
		lb N/A		---- bu/A	----	mg/L
1	Chisel	0	---------	55.2	87.1	11
2	Chisel	50	Spr., preplant (PP)	111.9	129.8	-
3	Chisel	100	Spr., preplant (PP)	139.2	146.3	11*
4	Chisel	150	Spr., preplant (PP)	146.4	148.4	33
5	Chisel	200	Spr., preplant (PP)	137.9	148.6	-
6	No tillage	0	---------	38.2	73.8	-
7	No tillage	100	Spr., preplant (PP)	128.8	142.9	8
8	No tillage	150	Spr., preplant (PP)	139.4	148.3	16
9	No tillage	200	Spr., preplant (PP)	126.6	144.5	-
10	Chisel	50+50	Spr. PP + SD 9-lf	135.6	142.3	-
11	Chisel	50+100	Spr. PP + SD 9-lf	142.2	147.0	-
12	Chisel	100+50	Spr. PP + SD 9-lf	142.8	148.7	-
13	Chisel	100	SD 6-lf	138.5	141.8	-
14	Chisel	150	SD 6-lf	136.7	147.0	32
15	Chisel	150+NI[2]	Spr. PP	138.1	152.1	-
16	Chisel	150+NI	SD 6-lf	144.0	148.0	-
	Significance level (%) :			99		
	BLSD (.05) :			11.8		
	CV (%) :			7.4		

1) Chiseling was done in Oct., 1988.
2) NI = N-Serve
3) Sept. 11, 1989
* Average of only 2 samples

Winona Co.

Corn grain yields were improved over the 0-lb control by about 45 bu/A with all of the N treatments (Table 4). Yields were optimized by the 50-lb N rate applied preplant. Higher rates of N and split or sidedress applications showed no additional yield advantage. No difference was observed between the two tillage systems.

Three-year average yields show: (1) no difference between the two tillage systems, (2) no advantage for the split and sidedress applications, and (3) a very slight but inconsistent response to fertilizer N at this site which was in alfalfa from 1983-85. Nitrate-N concentrations in the soil water at 5′ after three years of experimentation still are at 19 mg/L where no N has been used. Concentrations ranged between 39 and 73 mg NO_3-N/L for the treatments that received fertilizer N, with a positive relationship to N rate. These high values must be a result of the previous alfalfa crop which received manure in 1985 and the very dry conditions in 1988 that limited yields and N uptake by the crop severely.

Table 4. Effect of N treatments on the corn grain yield and NO_3-N concentrations in the soil water at 5′ and 7.5′ in Winona County in 1989.

Treatment				Grain Yield		Nitrate-N[2] Conc. in Water	
No.	Tillage[1]	N rate	Time/Method	1989	1987-89	5′	7.5′
		lb N/A		---- bu/A ----		--- mg/L ---	
1	Chisel	0	------	131.9	129.9	19[*]	-
2	Chisel	50	Spr., preplant	175.1	146.2	-	-
3	Chisel	100	Spr., preplant	174.6	148.3	44	21[*]
4	Chisel	150	Spr., preplant	173.4	149.7	44	-
5	Chisel	200	Spr., preplant	175.2	154.8	73	42
6	No tillage	0	------	137.0	131.7	-	-
7	No tillage	100	Spr., preplant	174.6	148.2	39[*]	-
8	No tillage	150	Spr., preplant	171.7	141.8	-	34
9	No tillage	200	Spr., preplant	167.6	146.2	62	36
10	Chisel	50+50	Spr. PP + SD 9-lf	170.7	149.2	-	-
11	Chisel	50+100	Spr. PP + SD 9-lf	177.3	152.0	-	23
12	Chisel	150	SD 6-lf	162.0	142.4	61[*]	-
	Significance level (%) :			99			
	BLSD (.05) :			12.4			
	CV (%) :			5.5			

1) Chiseling was done in October, 1988.
2) Sept. 12, 1989
* - Average of two samples

SUMMARY

The following summarizes the yield results from the third year of these studies:

1) N rates for continuous corn were optimized at 150 lb/A at one site, 100 lb/A at another, and at 50 N lb/A at the site with an alfalfa and manure history (1983-85).
2) No apparent yield advantages were found with split or sidedress applications of N at any of the three sites.
3) There was no yield difference between the no tillage and chisel tillage systems at any of the three sites except when no N was applied.
4) Previous crop and manure history apparently still impacts corn yield and N management at the Winona Co. site.
5) The role of alfalfa and manure contributions to available N for succeeding corn crops needs to be carefully examined and understood before improved N management is a reality on these soils.
6) Nitrate-N concentrations in the soil water at 5′ (below the root zone) provide a good basis upon which to compare the environmental risks associated with various N management systems.
7) Highest NO_3-N concentrations in the soil water obtained by suction lysimeter were associated with the 1987 and 1988 manure treatments. Concentrations also related very closely to the rate of fertilizer N applied.

ACKNOWLEDGEMENT

This interdisciplinary investigation would not have been possible without the fine cooperation and dedication of the farmer-cooperators and the participation of the Soil Conservation Service and the Minnesota Extension Service. Sincere appreciation is also extended to the Minnesota Valley Testing Lab who graciously conducted the manure analysis in previous years.

DECLINE RATES OF SOIL TEST P AND K IN A CORN-SOYBEAN ROTATION[1]

1989

G. W. Randall and S. D. Evans[2]

ABSTRACT: Decline rates of soil test P and K are being measured following 12 years of various application rates of P and K at two locations. Soil test P declined by about 15% at Waseca and 20% at Morris. Soil test K did not change at Waseca but increased about 20% at Morris. Corn yields were increased 10 to 16% over the long-term control plots at the two sites when soil test Bray P_1 was greater than 30 lb/A. Highest yields occurred at both locations when both P and K were applied to these high testing soils. There appeared to be little effect of soil test K on corn yield at Waseca.

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 have not received additional P since 1984 while treatments 6 and 7 at Waseca have not received 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.

Table 1. Experimental procedures for corn on the high P and K rate study at the two branch stations in 1989.

	Location	
Variable	Morris	Waseca
Planting date	5/10	5/15
Row spacing	30"	30"
Planting rate (plants/A)	32,000	30,000
Variety	Dekalb 461	Pioneer 3732
Herbicide	3# Lasso + 2.2# Bladex/A(Bdct)	3.5# Lasso + 3# Bladex/A(Bdct)
Harvest date	10/3	10/12
Soil type	Aastad clay loam	Webster clay loam

The P and K materials (0-46-0 and 0-0-60) were broadcast on the soil surface and incorporated by chisel plowing the corn residue in the fall of 1988. Specific experimental procedures used for corn 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.

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[1] Funding provided by the TVA-National Fertilizer Development Center.

[2] Soil scientists and professors at the Southern Experiment Station (Waseca) and West Central Experiment Station (Morris), respectively.

Results and Discussion

Total phosphate (P_2O_5) and potash (K_2O) applied over the 12-year period ranged from 0 to 1200 lb/A (Tables 2 and 3). These application rates plus the 1985-86 rates resulted in highly significant differences in soil test P at both locations and in soil test K at Waseca. At Waseca soil test P ranged from 12 to 110 lb/A (Table 2). Soil test P declined slightly compared to 1988, but soil test K did not. Corn yields were increased significantly by P but plateaued at soil P levels higher than 45 lb/A.

At Morris, Bray P_1 ranged from 13 to 70 lb/A while Olsen's $NaHCO_3$ test ranged from 8 to 44 lb P/A (Table 3). Soil test P values declined about 20% at Morris, while soil K values increased about 20%. Grain yields were increased and grain moisture was decreased significantly by the P treatments.

Table 2. Soil test values, grain moisture, and grain yield as influenced by 16 years' application of P and K at Waseca.

	P and K Treatments						
	Total		Soil Test[2]			Corn	
No.	1973-84	1985-88[1]	pH	P	K	Moisture	Yield
	---- lb P_2O_5 + K_2O/A ----			--- lb/A ---		%	bu/A
2	0 + 1200	0 + 100	6.8	12	306	20.1	140.0
3	600 + 1200	0 + 100	6.4	43	304	19.6	163.3
4	1200 + 1200	0 + 100	6.6	72	290	19.3	167.1
5	600 + 1200	100 + 100	6.6	74	295	19.1	178.4
6	1200 + 0	100 + 0	6.7	110	245	19.2	172.7
7	1200 + 600	100 + 0	6.6	100	231	18.8	166.4
	Signif. Level (%):		44	99	99	93	99
	BLSD (.05) :		-	11	46	-	12.5
	CV (%) :		3.6	9.8	8.7	2.4	4.2

1. Treatments applied each fall. P was discontinued for treatments 6 & 7 in 1988.
2. Samples were taken in October before 1989 treatments were applied.

Table 3. Soil test values, grain moisture, and grain yield as influenced by 16 years' application of P and K at Morris.

	P and K Treatments							
	Total		Soil Test[2]				Corn	
No.	1973-84	1985-88[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	7.7	13	8	533	21.8	135.1
3	600 + 1200	0 + 100	7.7	32	21	454	20.8	151.1
4	1200 + 1200	0 + 100	7.8	52	34	473	20.8	149.7
5	600 + 1200	100 + 100	7.6	70	44	446	20.4	173.7
	Signif. Level (%):		95	99	99	99	99	99
	BLSD (.05) :		0.1	22	13	53	0.7	17.7
	CV (%) :		1.0	33.	31.	6.5	2.1	7.0

1. Treatments applied each fall.
2. Samples were taken in October before 1989 treatments were applied.

CONCLUSIONS

Long term (12-yr) additions to these two soils created a wide range in soil test P levels. Corn yields were optimized over the no P treatments at soil test P levels of 40 lb/A at Waseca. Yields were not affected by K at Waseca. At Morris, corn yields were significantly improved with the higher soil test P levels. It is interesting to note that the highest yield at each site was produced with the 100 + 100 treatment even though soil tests were already high. Soil test P declined by about 15% at Waseca and 20% at Morris. Soil test K was not changed at Waseca but increased by about 20% at Morris. Additional years will be needed to more accurately determine the decline rates.

CONSERVATION TILLAGE FOR CORN AND SOYBEAN PRODUCTION[1/]

Waseca, 1989

G. W. Randall and J. B. Swan[2/]

ABSTRACT: This was the 15th year of a study to evaluate five primary tillage systems for corn and soybean production on a Nicollet-Webster soil complex. Because of extremely high weed pressure with the NT system in previous years, all weed growth was eliminated by an aggressive herbicide program in 1989. Surface residue amounts ranged from 8% with MP tillage to 99% with NT. Soybean yields were unaffected by tillage systems under these conditions.

With increasing emphasis on controlling erosion and minimizing energy requirements (time, labor, and fuel), tillage practices have changed markedly over the last decade. Many 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.

EXPERIMENTAL PROCEDURES

To evaluate some of these conservation tillage 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 (NT), fall moldboard plow (MP), fall chisel plow (CP), ridge-plant (RP) 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 (SD) (20" disk blade) treatment (Table 1). Because of increased pressure of the grass weeds in the NT 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.

Ridges for the RP treatment in 1989 were built in June, 1988. After the 1988 corn harvest stalks were chopped and the MP and CP treatments were performed. On May 30 the MP and CP treatments were field cultivated once with the chiseled plots receiving a prior disking. The SD treatment was disked twice. Ridges for 1990 corn were prepared on July 24.

Soybeans (Hardin) were planted in 30" rows at a rate of 160,000 plants/A on May 31. All treatments except RP were planted with a John Deere 7300 planter equipped with bubble coulters. B&H ridge cleaners were attached to a JD 7100 planter for the RP treatment. No starter fertilizer was used. Broadcast P and K were not applied for the 1989 soybean 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. Because of extraordinarily high weed pressures associated with the NT treatments over the last 8 years, and the increasing weed pressure with the CP and SD systems, weed control methods to "eradicate" weeds were employed in 1989. Roundup (2 qts/A) was applied to all NT plots on June 2. Lasso (3.5 qts/A) + Amiben (3 lb/A) were applied broadcast to all plots on June 2. All plots except NT were cultivated with a Hiniker 5000 cultivator on June 30. Poast (0.35 lb/A) was applied broadcast with 1 qt of crop oil concentrate/A to all plots on July 4. This same rate of Poast + oil was applied to the NT, CP, and SD treatments on July 24 and again to the NT plots on August 8. As a result of this chemical arsenal plus cultivation, weed control was perfect.

Surface residue coverage was measured by the line-transect method on April 11 prior to spring tillage. Yields were taken by combine harvesting the center two rows from each plot.

RESULTS

Surface residue amounts prior to planting were highly related to tillage system with the following ranking NT > SD > RP > CP > MP (Table 1).

[1/] Funding provided by the Southern Experiment Station, Waseca.

[2/] Professors, Southern Experiment Station and Department of Soil Science, respectively.

Table 1. Influence of tillage methods for soybeans after corn on surface residue before spring tillage at Waseca in 1989.

Treatment	Surface Residue Coverage
	%
No tillage	99
Fall plow	8
Fall chisel	36
Ridge plant	55
Spring disk (2x)	84
Significance Level (%):	99
BLSD (.05) :	10
CV (%) :	13.

Seed yield and moisture were not affected by the tillage systems in 1989 (Table 2). This was in sharp contrast to previous years where yields with NT were severely depressed. However, even though surface residue accumulations were very high, soybean yields were not affected when weeds were completely removed from the system.

Table 2. Influence of tillage method on soybean production at Waseca in 1989.

	Seed	
Tillage	Moisture	Yield
	%	bu/A
No tillage	10.1	39.2
Fall plow	10.1	41.5
Fall chisel	10.0	41.1
Ridge plant	10.2	40.4
Spring disk (2x)	10.0	41.3
Significance Level (%)[1/]:	45	80
CV (%) :	1.2	3.4

[1/] Probability level of significant difference between means.

SUMMARY - 1989

This was the fourth crop of soybeans grown following corn in this long-term study with continuous corn from 1975 through 1982 and soybeans in 1983, 1985, and 1987. Surface residues prior to planting were greater than 50% with the NT, RP, and SD tillage. Weeds were completely eliminated from the plots with an aggressive chemical and cultivation program. As a result, soybean yields and moisture content at harvest were not affected by tillage.

FOURTEEN-YEAR YIELD SUMMARY (Not including 1989)

Grain yields from the five tillage systems where starter fertilizer was used from 1975-1982 are shown in Table 3. 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 3). Corn yields in this sequence have not been different among the MP, CP, RP and SD systems when starter fertilizer has been used. Without starter fertilizer, yields from the CP, RP and SD systems have averaged about 9% less than from the MP system. 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 3. 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 & 87	1984, 86 & 88
		bu/A			
No tillage	Yes	129.2	140.6	34.5	111.5
"	No		136.0	34.3	98.8
Fall plow	Yes	154.5	170.9	51.0	145.6
"	No		170.8	50.2	141.2
Fall chisel	Yes	144.4	161.8	47.7	136.0
"	No		155.5	45.5	124.5
Ridge plant	Yes	149.2	161.5	46.9	137.5
"	No		156.4	47.2	129.4
Till plant (flat) 1/	Yes	144.9	154.8	46.8	139.7
"	No		157.4	47.1	132.1

1/ This treatment was converted to a spring disk (2x) beginning with the 1983 crop.

TILLAGE SYSTEMS FOR CORN AND SOYBEAN CROP SEQUENCES

Waseca, 1989

G. W. Randall, B. W. Anderson and R. R. Allmaras[1/]

ABSTRACT: A study was started in 1986 to determine the effect of tillage on corn and soybean production when grown in rotation compared to a continuous monoculture. Yield results in 1989 were quite variable due to moisture stress and the presence of soybean cyst nematode. Corn yields were not influenced by tillage. On the other hand, soybean yields were 9 and 24% higher with MP and CP tillage compared to NT. Corn and soybeans in rotation yielded 14 and 42% higher, respectively, than did the continuous monoculture systems. Tillage x crop sequence interactions were not significant for either crop.

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, 1988 after stalk chopping all corn plots. Spring secondary tillage consisted of disking the CP plots and field cultivating the MP and CP plots on May 11.

Nitrogen was broadcast applied as ammonium nitrate prior to secondary tillage to all 1989 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 12 at a rate of 29,700 ppA with a John Deere Max-Emerge II 4-row planter equipped with bubble coulters. Furadan (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 3 qts Bladex/A applied preemergence on May 23. Row cultivation was performed on June 21 in the MP and CP corn plots.

Soybeans (Hardin) were planted in 30" rows with the aforementioned planter at a rate of 9 beans/foot on May 24. Weeds were controlled with a preemergence application of Lasso (3½ qts/A) + Amiben (6 qts/A) on May 31. The MP and CP soybean plots were cultivated on June 21.

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 below normal and quite variable due to the dry conditions throughout most of the growing season (Table 1). When averaged over crop sequence, there was not a significant difference

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[1/] Soil scientist and assistant scientist, Southern Experiment Station and Professor, Department of Soil Science.

at the P = 90% level in yield among the tillage systems. Crop sequence significantly influenced corn yield. Corn following soybeans yielded 14% higher than continuous corn. There was no tillage x crop sequence interaction. Grain moisture was significantly higher with NT compared to the MP and CP systems but was not influenced by cropping sequence (Table 1).

Table 1. Corn grain yield and moisture content as affected by tillage and crop sequence.

Tillage	Crop Sequence	Grain Yield	Grain Moisture
		bu/A	%
MP	C-C	119.1	14.0
"	C-Sb	142.8	14.0
CP	C-C	129.2	14.2
"	C-Sb	145.1	13.9
NT	C-C	120.0	15.5
"	C-Sb	130.6	14.8
FACTORIAL COMPARISONS			
Tillage			
MP		131.0	14.0
CP		137.2	14.0
NT		125.3	15.1
Signif. Level (%):[1/]		75	99
BLSD (.05) :			0.8
Crop Sequence			
C-C		122.8	14.6
C-Sb		139.5	14.2
Signif. Level (%):[1/]		94	91
Tillage x Sequence Interaction			
Signif. Level (%):[1/]		21	60
CV (%) :		14.	3.4

[1/] Probability level of significance.

Soybean yields were also highly variable (Table 2). Highly significant yield differences occurred among the three tillage systems. When averaged over crop sequence, yields with the MP and CP systems were 9 and 24% higher than with the NT system. A severe infestation of soybean cyst nematode became evident in 1989. This was especially true on some of the MP plots that were in continuous soybeans. Consequently, yields for the MP system were lower than expected. The lower yields with no tillage resulted primarily from poor broadleaf weed control in some plots. Lambsquarter and red root pigweed pressures have continued to increase over the years with continuous NT. Continuous soybeans yielded 30% lower than the Sb-C sequence. A significant tillage x crop sequence interaction was not found. Seed moisture at harvest was not influenced by tillage or crop sequence.

FOUR-YEAR SUMMARY

Corn yields from this completely weed-free site were 8 to 12 bu/A higher for NT compared to either MP or CP regardless of crop sequence (Table 3). Corn yields following soybeans averaged 14% higher than continuous corn for the MP system and 9% higher for the CP and NT systems. Soybean yields were not affected by tillage system. Soybeans following corn yielded 15, 22, and 25% higher than continuous corn for the MP, CP and NT systems, respectively.

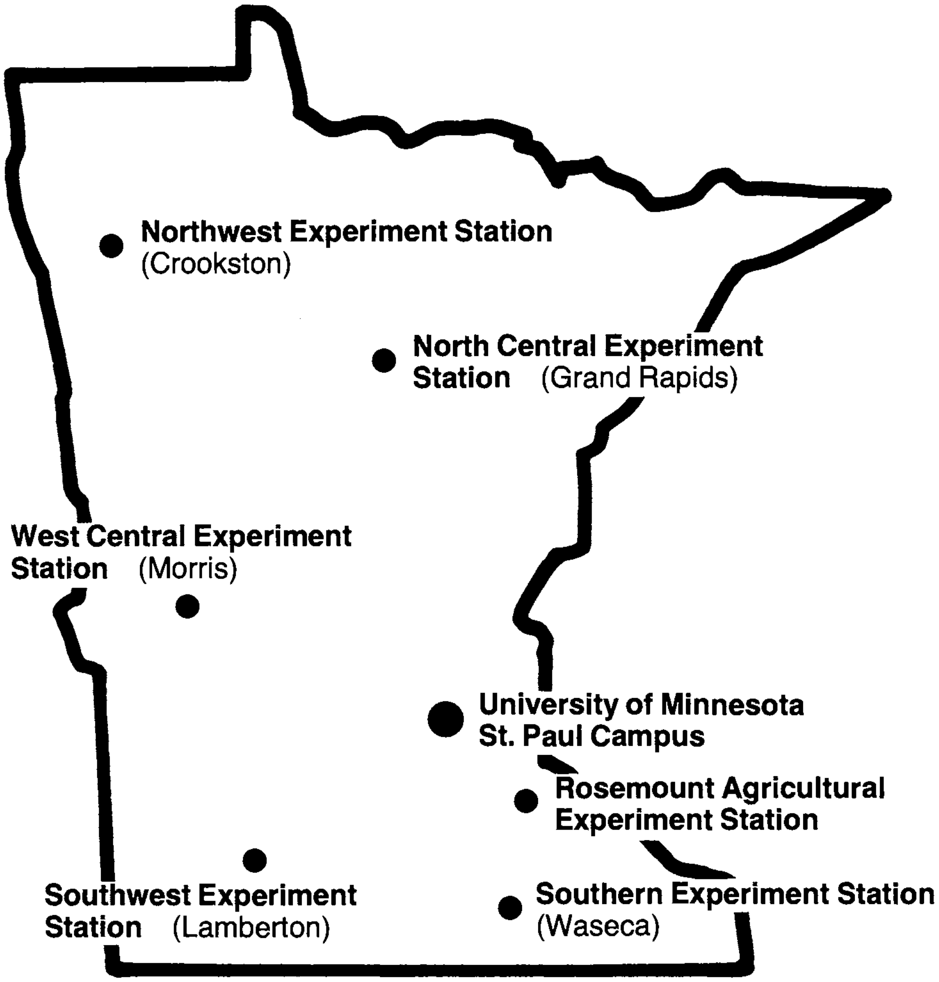
Table 2. Soybean seed yield and moisture content as affected by tillage and crop sequence.

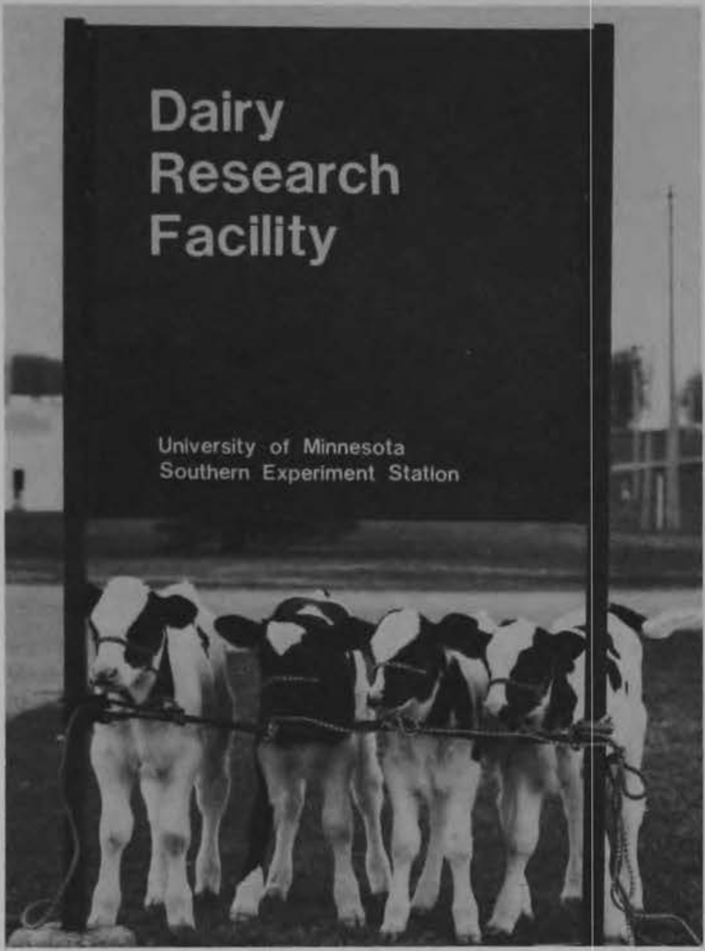
Tillage	Crop Sequence	Yield	Moisture
		bu/A	%
MP	Sb-Sb	31.7	8.3
"	Sb-C	43.1	8.4
CP	Sb-Sb	36.8	8.4
"	Sb-C	48.2	8.4
NT	Sb-Sb	25.8	8.4
"	Sb-C	42.8	8.4
FACTORIAL COMPARISONS			
Tillage			
MP		37.4	8.3
CP		42.5	8.4
NT		34.3	8.4
Signif. Level (%):		99	78
Crop Sequence			
Sb-Sb		31.4	8.4
Sb-C		44.7	8.4
Signif. Level (%):		99	79
BLSD (.05) :		3.2	-
Tillage x Sequence Interaction			
Signif. Level (%):		50	14
CV (%) :		14.	1.1

Table 3. Four-year corn and soybean yield averages as influenced by tillage and crop sequence.

Tillage	Crop Sequence	Yield	
		Corn	Soybean
		bu/A	
MP	Cont. Corn	128.0	-
"	Corn-Soybean	145.6	47.4
"	Cont. Soybean	-	41.1
CP	Cont. Corn	131.7	-
"	Corn-Soybean	143.2	50.1
"	Cont. Soybean	-	41.1
NT	Cont. Corn	140.6	-
"	Corn-Soybean	153.8	49.4
"	Cont. Soybean	-	39.5

Minnesota Agricultural Experiment Station Locations





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