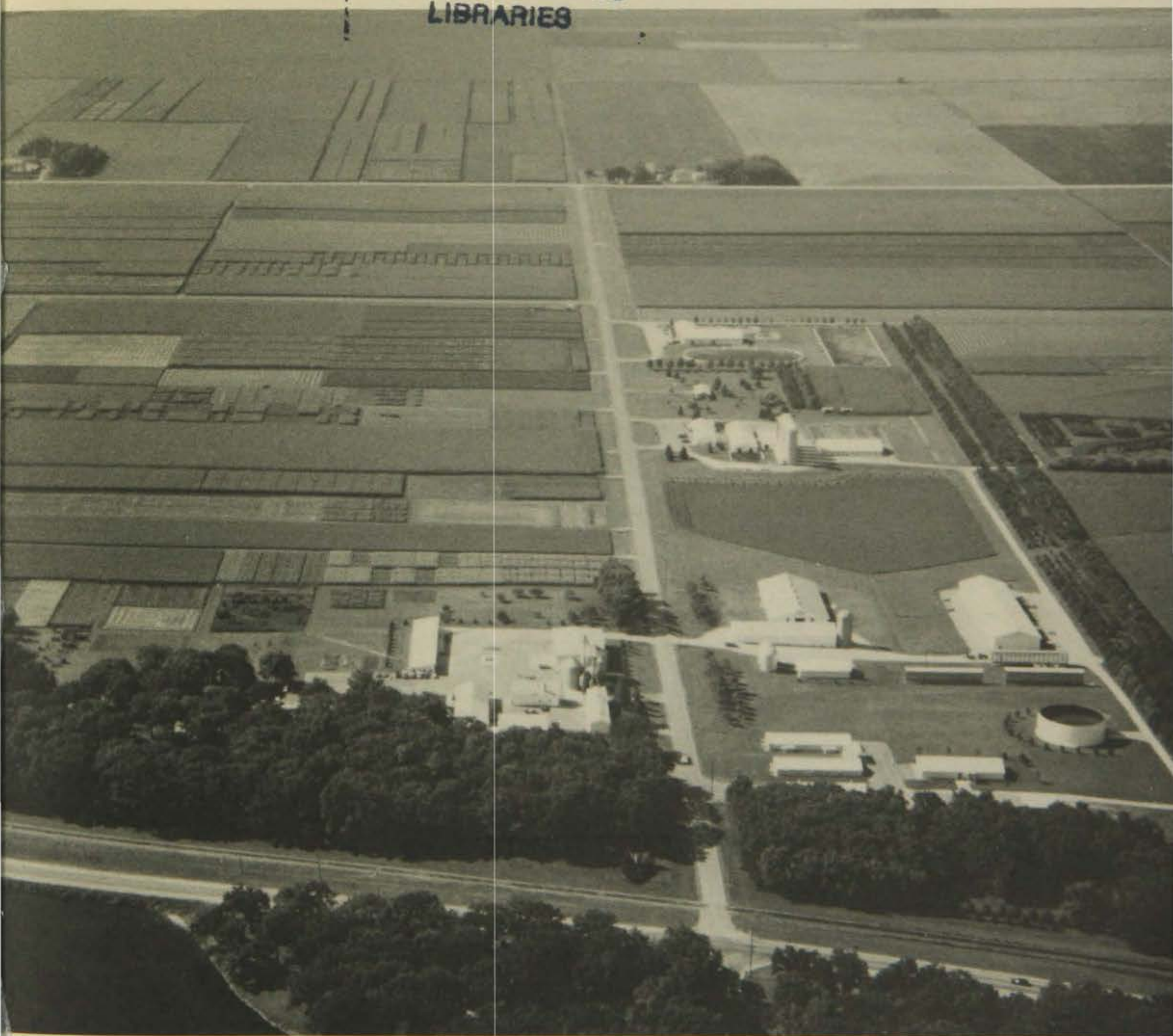
University of Minnesota

Southern Experiment Station
Waseca, Minnesota

Research Report 1990



1990 STAFF LISTING

Faculty

David D. Walgenbach - Superintendent
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:
  - Paul M. Haley - Non-Exempt Temp. & Casual Employee
  - Brian K. Kanne-Research Plot Technician
  - Kellie J. Roessler - Non-Exempt Temp. & Casual Employee
  - Gregg Rosenthal - Student Laborer

Animal Science

David M. Ziegler - Scientist
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:
  - Jeff Bennett - Student Laborer
  - Brian Oeltjenbruns - 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

James B. Hebel - Research Plot Coordinator
- Misc. Summer Help:
  - Michael A. Balak - Non-Exempt Temp. & Casual Employee
  - Lee Edberg - Non-Exempt Temp. & Casual Employee
  - Michael Kinniry - Non-Exempt Temp. & Casual Employee
  - Jason J. O'Brien - Non-Exempt Temp. & Casual Employee
  - Sue J. Schoenfeld - Laborer

Office

Arielle W. Balak - Senior Secretary
Steven A. Jaycox - Associate Administrator
Deanne J. Nelson - Senior Secretary
Dolores A. Stelter - Principal Secretary
Jeanette D. Williams - Executive Secretary

Soils

Brian W. Anderson - Assistant Scientist
Wayne W. Gottschalk - Research Plot Technician
- Misc. Summer Help:
  - Martha Byron - Non Exempt Temp. & Casual Employee
  - Brad Carlson - Non Exempt Temp. & Casual Employee
  - David Groh - Non Exempt Temp. & Casual Employee
  - Daryl Waltz - Non Exempt Temp. & Casual Employee

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

University of Minnesota
SOUTHERN EXPERIMENT STATION

RESEARCH REPORT, 1990

The Southern Experiment Station Annual Research Report for 1990 includes a complete listing of the research projects in progress. Detailed reports with summaries and conclusions are included for a selected number of projects. This work is a product of the University of Minnesota, Agricultural Experiment Station and also involves collaborative efforts with members of the Minnesota Extension Service 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
- Southwest Experiment Station
- West Central Experiment Station

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 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. We sincerely appreciate the Minnesota Soybean Research and Promotion Council, Minnesota Wheat Council, Midwest Food Processors Association (Minnesota Region), Southern Minnesota Vegetable Growers Association, Minnesota Fruit and Vegetable Growers Association, Minnesota Pork Producers Association, National Pork Producers Association, Minnesota Department of Agriculture, the Fats and Protein Research Foundation, USDA/ARS Dairy Forage Research Center, Tennessee Valley Authority, and the Center for Agricultural Impacts on Water Quality who 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 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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INTRODUCTION

The University of Minnesota, Southern Experiment Station is pleased to provide the results of a portion of our research activities on work conducted during 1990. This report summarizes only a fraction of the dedicated efforts from the scientists and staff as we strive to bring the latest and best information to your agricultural operation.

The organization of the University of Minnesota is as follows: Funding is provided by the Minnesota State Legislature with policy and direction under the Board of Regents; the President and central administrative officers are the executive body of the University. Dr. C. Eugene Allen is the Vice President for the Institute of Agriculture, Forestry and Home Economics, and also serves as Director of the Minnesota Agricultural Experiment Station. Dr. Richard L. Jones is Dean of the College of Agriculture and Associate Director of the Experiment Station. Reporting to him is the Associate Dean of Research and Assistant Director of the Experiment Station responsible for all branch stations. The Southern Experiment Station is administered by Dr. David D. Walgenbach, Superintendent, who in coalition with the research staff is supported by civil service and bargaining unit employees.

The Station and southern Minnesota agriculture is also served by an Advisory Committee comprised of agricultural leaders from the south-central and southeast areas of the state. They serve without salary or remuneration for their expenses. Committee members are highly valued for their advice and council by the staff of the Southern Experiment Station. Members in 1990 included:

William Arendt, Plainview
Leonard Binstock, Dodge Center
Julie Boyum, Hayfield
Norman E. Fredin, Albert Lea
Virgil Johnson, Caledonia
Garry E. Martin, Blue Earth
Paul Nesseth, Nerstrand
Charles Priebe, Waseca
David Rupprecht, Lewiston
F. W. Sanborn, Pine Island
M. Jan Schwantz, Plainview
Kent V. Thiesse, Mankato
Denny Trio, Mapleton
Charles Vollum, Albert Lea
Ben M. 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.

A COURSE FOR THE FUTURE

Agricultural research is, and will continue as, the mission of the Southern Experiment Station. Direction of research programs in this age of information requires a higher level of collaborative efforts between research administrators and agricultural leaders to establish short, intermediate and long-term goals. The focus on the individual farmer, producer and program informational needs requires attention as we continue in this ever-changing world of agriculture.

Crop and livestock production efficiency and the environment are the broad objectives, with renewed efforts to stabilize and increase livestock numbers in Minnesota as a major challenge. The willingness to take informed risks in research programs and the willingness to risk failure as we address agricultural research needs, requires close interchange on the management of resources and priority setting. We welcome your input on our activities and invite your participation in our field days and informational events as an integral part of the University of Minnesota.

Upcoming Special Events of the Southern Experiment Station

Crops and Soils Field Day	June 25, 1991
Corn and Soybean Field Day	September 12, 1991
Clergy Tour	September 13, 1991
Cattle Feeders & Dairy Beef Day	December 11, 1991
Swine Day	January 7, 1992
Winter Crops Day	January 23, 1992

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 1990. 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.

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.

David D. Walgenbach
Superintendent

Project Listings

1990 AGRONOMY PROJECT LIST

SOUTHERN EXPERIMENT STATION

William E. Lueschen, Agronomist

I. CORN

A. Corn Breeding - Steve Openshaw

This project has as its objectives the development and testing of germplasm with the goal of improving corn through plant breeding techniques. Included in this project was an elite hybrid trial where commercial hybrids are evaluated. Each year we also evaluated relative maturity of corn hybrids registered for sale in the state of Minnesota in cooperation with the Minnesota Department of Agriculture. Four graduate student thesis projects were part of the corn project for 1990. These projects involved evaluating test crosses derived from tissue culture work, evaluation of Poast tolerant corn lines, evaluation of germplasm derived from corn population using recurrent selection techniques and mass selection involving two populations of corn that were developed from two Iowa plant populations.

B. Corn Cultivation Study - Jeffrey Gunsolus and William Lueschen

The objective of this study was to evaluate the use of reduced amounts of herbicide in combination with rotary hoeing and cultivation for weed control in corn. In this study we compared a banded application of Lasso + Bladex to a broadcast application of these same herbicides. We also evaluated a broadcast application of Lasso at a reduced rate. Timely rotary hoeing and cultivation was evaluated to determine the role of these tools in obtaining acceptable weed control with reduced herbicide rates in corn.

C. Corn Population Study - Dale Hicks, William Lueschen, Harlan Ford and Bob Peterson

The objective of this study was to evaluate the effects of plant population on the performance of eight corn hybrids. One hybrid was an old hybrid developed back in the mid 1960's, another hybrid was a dwarf type hybrid that has recently been developed and the other hybrids represented modern corn genetics.

D. Corn Tolerance to Accent - William Lueschen, Gordon Harvey, Jim Kells, and Vince Fritz

The objective of this study was to evaluate the tolerance of corn to Accent herbicide and the interaction between Accent and Counter insecticide. Accent was applied at four rates and two stages of application to field corn and sweet corn. Counter was applied as an in-furrow treatment at two rates of application.

E. Advantage Seed Treatment and Herbicide Injury on Corn - William Lueschen, Jeffrey Gunsolus and Harlan Ford

The objective of this study was to evaluate the performance of Advantage seed safener for potential reduction of corn injury from Command, Pursuit, Scepter, and Treflan. Two field corn hybrids and one sweet corn hybrid were investigated. The effects of these treatments on early season crop injury, plant stand and yield parameters were determined at Waseca and Lamberton.

F. Effects of Advantage Seed Treatment on Seedling Vigor in Field Corn and Sweet Corn - William Lueschen, Vincent Fritz, Thomas Hoverstad, and Jim Hebel

The objective of this study was to evaluate the effects of Advantage seed treatment on the germinability and early seedling vigor of field and sweet corn. We also evaluated the effects of storage duration of seed treated with Advantage seed treatment on germinability and early seedling vigor of both types of corn. A standard cold germination test was conducted in germinators to evaluate performance of seed treated with various rates of Advantage seed treatment as well as an evaluation of the effects of Captan and Advantage seed treatment on seedling vigor on both germinator and field trials of field corn and sweet corn.

G. Herbicide Carryover in Corn - William Lueschen and Jeffrey Gunsolus

The objective of this study was to evaluate the potential carryover of Pursuit applied in 1989 for weed control in soybeans on corn performance in 1990. In 1989 Pursuit was applied as early preplant treatments at rates of 4 and 6 ounces of commercial product per acre. We evaluated the effects of these rates and times of application of Pursuit on early season corn injury and corn yield.

H. Long-Term Corn/Soybean Rotation Study - Kent Crookston

The objective of this study was to continue to evaluate the influence of continuous corn and corn/soybean rotations on the performance of each of these crops where the primary tillage system has been fall moldboard plowing. This study was established in 1982 when 16 treatments were installed which included planting 5 consecutive years of soybeans or 5 consecutive years of corn on a particular plot. The rotations were established so each year there are plots with 1-, 2-, 3-, 4-, or 5-year history of either corn or soybean. The major emphasis in this study in 1990 was to evaluate soybean cyst nematode populations that have developed since this study was initiated.

I. Lorsban T-Band Study - Ward Stienstra

The objective of this study was to evaluate the effects of Lorsban applied as a T-band at planting time on the seedling health of corn. The effects of this treatment on plant establishment, final plant population, grain yield and root health was examined.

J. Poast Tolerant Corn - Don Wyse and Peter Dotray

Corn resistant to Poast has been developed at the University of Minnesota through tissue culture techniques. The purpose of these studies was to investigate the field performance of Poast tolerant corn. Poast was sprayed over-the-top of the corn and injury ratings and weed control ratings were taken. These studies included different rates of application as well as different herbicides to determine the tolerance of this corn to other herbicide families.

K. Rotation/Monoculture Study - Kent Crookston

The objective of this study was to further evaluate the crop rotation effect to determine if it is more than just an interruption of the monoculture cropping that is responsible for crop rotation effects. This study consisted of continuous corn compared to: a corn/sorghum x sudan, corn/alfalfa, corn/fallow, and a corn/sunflower rotation. With these cropping systems studied in various combinations, we will be able to better explore the crop rotation effect and determine the potential cause of the advantage we normally see for rotating corn with other crops.

L. Water Quality and Tillage Study - Doug Buhler

The objective of this study was to continue to evaluate the effects of four different tillage systems on the movement of three herbicides within the soil profile. Soil and water samples were taken periodically throughout the season to determine movement of Lasso, Banvel, and atrazine. The four tillage systems that are involved in this study are: fall moldboard plowing, fall chisel plowing, ridge-till system, and a no-till system in continuous corn.

M. Wild Proso Millet Control in Corn - William Lueschen and Jeffrey Gunsolus and Thomas Hoverstad

The objective of this study was to evaluate the performance of various herbicides for control of wild proso millet in corn. Our major emphasis in this study in 1990 was to evaluate the effects of time and rate of application of Accent on control of wild proso millet. This study was located near Owatonna on the Jeff Bruessel farm.

N. Woolly Cupgrass Control in Corn - William Lueschen, Jeffrey Gunsolus, and Thomas Hoverstad

The objective of this study was to evaluate herbicide performance for control of woolly cupgrass in corn. The treatments in this study were identical to the treatments in the wild proso millet study. This study was located on the Tom Trnka farm near Faribault.

O. Cyanazine Dry vs Liquid Application - William Lueschen

The objective of this study was to evaluate the efficacy of cyanazine 90 WDG formulation applied as a dry material with a specialized applicator. This technique was compared to the 90 WDG formulation applied at 20 gpa with water as the carrier. Three rates of application were evaluated.

II. SOYBEANS

A. Hemp Dogbane and Tillage Study - Don Wyse and William Lueschen

The objective of this study was to evaluate the influence of tillage on the development and spread of hemp dogbane. We evaluated the effects of herbicide treatment in both corn and soybeans on the control of hemp dogbane. As part of this study we will monitor the residual effects of treatment in either corn or soybeans in the succeeding crop.

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

The purpose of this study was to evaluate herbicide treatments for weed control in a no-till soybean production system. Major emphasis in this study was an evaluation of the herbicide Pursuit which has shown promise as a early preplant and as a postemergence herbicide treatment. This study included treatments that were applied in the fall of 1989, treatments applied in early and late April 1990 and also treatments that were applied after planting.

C. Reduced Herbicide Rates Study - Bob Schmitt, William Lueschen, Jeffrey Gunsolus, and Thomas Hoverstad

The objective of this study was to evaluate the effects of time and rate of herbicide application and cultivation on weed control in soybeans. Three herbicides were investigated in this study: Poast, Basagran, and Blazer. We evaluated one-fourth label rates, one-half label rates, and full-label rates of each of these herbicides applied at three times of application; approximately 14, 21, and 28 days after planting. We evaluated cultivation following these herbicide treatments as a means of providing supplemental weed control.

D. Rotary Hoe Study - Bob Schmitt, William Lueschen, and Jeffrey Gunsolus

The purpose of this study was to evaluate the effects of low rates of herbicide application combined with rotary hoeing and cultivation on weed control in soybeans. We evaluated two row spacings in this study: 30-inch vs 10-inch. Only the 30-inch rows were cultivated.

E. Soybean Breeding - Jim Orf

The objective of this project is to improve soybean production through varietal development. Each year the Southern Experiment Station serves as one of the major test locations for material developed in this program. Small plot evaluations include new experimental lines, preliminary tests, Uniform Regional tests, and public and private variety testing. A disease nursery and the evaluation of early generation crosses were also included in this project. Soybean variety performance, row spacing and planting dates are also evaluated annually. Data collected from the soybean variety evaluations conducted at Waseca and other branch experiment stations, as well as on growers fields throughout Minnesota, are published each year in a publication entitled "Varietal Trials of Farm Crops". This data provides a basis for growers to select soybean varieties for use on their farm.

F. Soybean Cyst Nematode Studies - Jim Orf, Dave MacDonald, and William Lueschen

The purpose of this research work was to evaluate the influence of tillage and crop rotation on the spread of soybean cyst nematodes in a corn/soybean system. We also evaluated the performance of soybean varieties that have been developed with resistance to the cyst nematode.

G. Soybean Herbicide Screening Trial - 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 weed control in soybeans by evaluating a number of herbicides and additives. Similar studies were conducted each year at the Experiment Stations at Lamberton, Morris, and Rosemount, Minnesota. These studies provide the basis for herbicide recommendations for Minnesota soybean growers.

H. Soybean Seed Treatment - Ward Stienstra

The objective of this study was to evaluate the effects of several seed treatments on 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 seedling disease control in soybeans. Also included was an evaluation of seeding rate to determine if seeding rate could be increased to compensate for plants lost because of seedling disease.

I. Velvetleaf Eradication - William Lueschen

The objective of this study has been to determine the longevity of velvetleaf seed in the soil under different crop management systems. This study was initiated in 1974 and soil samples have been taken to determine the velvetleaf seed population in the soil since that time. Variables in this study range from continuous corn to continuous alfalfa and continuous oats to a continuous chemical fallow where no crop is produced and continuous cultivation fallow where no crop is produced. No velvetleaf plants have been permitted to produce seed in this study since it was initiated in 1974. Since 1974 certain treatments have resulted in about a 95% reduction in the velvetleaf seed population in the soil. However, certain other treatments, such as continuous alfalfa and continuous chemical fallow have resulted in only about a 50% reduction in the velvetleaf seed population in the soil.

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

The objective of this study was to evaluate herbicide treatments for control of wild proso millet in soybeans. Major emphasis in this study was on the evaluation of new postemergence grass compounds. We evaluated both rate and time of application and additives to enhance activities of postemergence herbicide treatments. This study was located on the Jeff Buressel farm just north of Owatonna, Minnesota.

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

The objective of this study was to evaluate herbicides for control of woolly cupgrass in soybeans. Our major emphasis was on postemergence grass herbicides that have been developed in recent years. In this study we evaluated the effects of time and rate of application and herbicide additives on woolly cupgrass control. This study is located on the Tom Trnka farm near Faribault, Minnesota.

III. SMALL GRAINS

A. Cereal Rust - Alan Roelfs and Thomas Hoverstad

The objective of this study was to determine the date of first occurrence of cereal rust on wheat, oats, barley, and rye. This project has been ongoing for many years to establish the average date of first appearance of rust and the amount of inoculum of this organism that arrives in southern Minnesota. This project was part of a regional rust survey on small grains.

B. Oat Breeding - Deon Stuthman and Thomas Hoverstad

Two studies were conducted under this project with the objective of improving oat by development of high yielding, disease resistant varieties. In these studies we evaluated maturity, lodging, disease resistance and yield of commercially available oat varieties as well as new experimental lines of oats. Similar studies were conducted at Lamberton, Morris, and other branch experiment stations in Minnesota to provide a basis for oat growers in Minnesota to select the best varieties for their area. Studies conducted in this trial are summarized each year in the publication entitled "Varietal Trials of Farm Crops".

C. Spring Wheat Variety Trial - Robert Busch and Thomas Hoverstad

This study was designed to evaluate the performance of hard red spring wheat varieties in southern Minnesota. Standard height and semi-dwarf varieties are evaluated each year in this study. Parameters investigated include plant height, lodging, maturity, yield, protein, and baking quality. Data from this study is published each year and is made available to growers in the publication entitled "Varietal Trials of Farm Crops".

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. Most of the entries in this trial are experimental lines. These plots are evaluated each year for winter hardiness, lodging resistance, height, and yield. This project allows breeders from several states to evaluate the performance of their new experimental lines in several locations throughout the U.S.

IV. FORAGES

A. Alfalfa Variety 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 and the other trial was established in the spring of 1988. These studies include varieties that were registered for sale as alfalfa varieties in Minnesota. The data collected from these trials will help growers select the best performing alfalfa varieties for their farms in southern Minnesota. Similar trials are conducted at Rosemount, Lamberton and Morris, Minnesota, as well as other experiment stations. These results are used to provide growers with information on alfalfa variety performance published each year in "Varietal Trials of Farm Crops".

B. No-Till Alfalfa Establishment Study - Roger Becker, Craig Sheaffer, and William Lueschen

The objective of this study initiated in 1989 was to compare alfalfa establishment into oats stubble after oat harvest by no-till and conventional tillage methods. These systems were compared with the normal establishment of alfalfa in the spring of the year. This trial was harvested on a 4-cut management system to determine the productivity of alfalfa the year following establishment with the various systems previously mentioned. A second study was established in 1990 to further evaluate alfalfa establishment techniques.

V. ENTOMOLOGY

A. Black Cutworm Pheromone Trap - Ken Ostlie

The objective of this project was to monitor the arrival of black cutworm moths in southern Minnesota. This was done as part of a joint project that we have in cooperation with Ken Ostlie and county extension personnel throughout Minnesota. Beginning in mid April the pheromone traps were placed in the field and checked daily to evaluate the number of cutworm moths that have arrived in our area. This data is used to predict the potential problems that may occur from cutworms.

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 provides information on the potential for insect pests in corn, soybeans, alfalfa and small grains. This project was in cooperation with the Minnesota Department of Agriculture.

1990 Dairy/Holstein-Beef Project Listing

Southern Experiment Station
Hugh Chester-Jones

I. Holstein-Beef

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

The objective of this study is to evaluate if there is an implant effect that may contribute to the stall-out period after 800 lbs for feedlot Holstein steers. A second objective is to evaluate the effect of using a new combination implant trenbelone acetate + synovex vs a single implant (synovex alone) on the performance of these Holstein steers during the final 100 days in the feedlot. A complete summary is included in this annual report.

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, J. C. Meiske, D. E. Otterby and D. M. Ziegler

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. A complete summary is included in this annual report.

C. Evaluation of feed flavors added to milk replacer and dry starter diets on performance of young male Holstein calves during the pre-weaning and immediate post-weaning periods - H. Chester-Jones, J. C. Meiske, P. Anderson, M. Wilson and D. M. Ziegler

This is the second phase of a study supported by Feed Flavors, Inc. The first phase evaluated the use of feed flavors and probiotics incorporated in the dry calf starter for 7 to 14 day old calves. The results from the first study were inconclusive, although the calves did not perform as typically found in other studies at the Station. Further work was indicated. The basis for this second phase will be confined to feed flavor use in both milk replacer and dry starter feed, the hypothesis being that feed flavors stimulate dry feed intake by young calves to promote optimum growth in the pre-weaning and post-weaning stages.

D. <u>Evaluation of the effect of number of Ralgro vs Synovex implants on performance and carcass quality of purchased Holstein-beef calves</u> - H. Chester-Jones, J. C. Meiske, P. T. Anderson, M. W. Wilson and D. M. Ziegler

Two groups of 48 males Holstein calves (3-13 d old) purchased directly from 19 dairy farms in SE Minnesota have been randomly assigned to one of 6 implant groups. All calves received an initial implant at 5-6 wks old. Calves have been assigned to receive either 1 Ralgro vs Synovex (initial implant only), 2 Ralgro vs Synovex (initial and 84 days later), and 3 Ralgro vs Synovex (initial, 84 and 168 days later). Performance and carcass characteristics are being monitored for each calf. Study is ongoing and data is not available for a complete report.

E. <u>Evaluation of the effect of number of Ralgro vs Steeroid implants on performance and carcass quality of home-raised Holstein-beef calves</u> - H. Chester-Jones, J. C. Meiske, P. T. Anderson, M. W. Wilson and D. M. Ziegler

Male calves born at the Southern Experiment Station are randomly assigned to one of 3 implant groups, the initial implant given at 6-7 wks old. Calves are assigned to receive either 2 (initial and 180 days later) or 3 (initial, 90 and 180 days later) implants of Ralgro vs 2 implants (initial and 180 days later) of Steeroid. Performance and carcass characteristics are being monitored for each calf. Study is ongoing and data is not available for a complete report.

F. <u>Evaluation of Barnsorb vs chopped newspaper as bedding materials for feedlot cattle pens at the Southern Experiment Station</u> - H. Chester-Jones and D. M. Ziegler

The object of this evaluation is to compare newspaper and the aspen by-product Barnsorb as bedding sources for feedlot pens based on criteria such as usage rate, absorbency potential and economic viability for livestock producers. A complete summary is included in this annual report.

II. Dairy

A. <u>Improving cattle through breeding with special emphasis on selection for: a) milk yield and b) lbs protein</u> - L. B. Hansen, C. W. Young, H. Chester-Jones and D. M. Ziegler

A detailed report on the breeding project emphasizing selection for milk yield appeared in the 1985 Southern Experiment Station Annual Report pp. 270-275. Data is still being collected for this phase of the original breeding project. In

II. Dairy (Continued)

addition a commitment was made in 1986 to build on the existing genetic base of the dairy herd and establish a third herd which emphasizes selection for milk protein. A detailed outline of this new project appeared in the 1986 Southern Experiment Station Annual Report pp. 218-219. An overview of the value of the initial breeding project summarized from 1969-1983 with the true control population vs the high milk yield selection line is given below. [This paper was presented by Les Hansen at the 1990 World Genetics Conference in Edinburgh, Scotland.]

B. 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 and urea estimates to be obtained. An initial summary is included in this annual report.

C. Body composition changes in 4 to 12 month old dairy heifers: correlation between indirect and direct techniques for body composition estimators - Bo Kyeun Lee, H. Chester-Jones, B. A. Crooker, K. D. Murphy, R. D. Appleman, D. E. Otterby and J. G. Linn

Objectives of this study are to compare deuterium oxide, urea and sodium thiosulphite dilution techniques to estimate body composition vs actual whole body composition of dairy heifers at 4, 8 and 12 months of age. The study is ongoing and data is not available for a complete report.

D. Growth hormone and testicular development in bull calves as genetic markers for milk production - B. Crabo, P. Kishore, L. B. Hansen, H. Chester-Jones, J. Wheaton and D. M. 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. Project complete, data is not in final summary form.

E. Evaluation of the interrelationships between environment, calf management and health on performance, serum immunoglobulin G (IgG) and IGF-1 levels in male and female calves from divergent genetic lines from birth to 7 weeks of age - H. Chester-Jones, D. M. Ziegler, B. A. Crooker, L. B. Hansen and D. G. Johnson

This study will be conducted between November 24, 1990 and April 23, 1991. Calves will be randomly assigned to either inside calf crates, polydome calf hutches without outside pens or 4' x 8' hutches with a 4' x 6' outside pen (wooden or Fox Ag fiberglass hutches). Serum samples will be taken from all calves at 3 days old and analyzed for IgG to establish base level of colostral immunity. Samples of milk offered to calves to 35 days old will be analyzed for fat, lactose and somatic cells. Feed intake and body weight gain will be taken individually. Object is to clearly document typical management systems for raising calves using discard milk and calf starters in different housing environments. Also document relationship between calves' ability to combat environmental stress, and if differences exist, between sec and genetic divergence. Levels of IGF-1 will be used to build the comparative data base and integrate with the other physiology. Study is ongoing and data is not available for a complete report.

F. Physiological evaluation, techniques for identification and growth of free - martins from dairy herds - V. Cox, H. Momont, H. Chester-Jones and D. M. Ziegler

Objectives of this study are to a) clearly categorize the gross morphology of the reproductive tract of freemartin calves; b) to develop simple on farm procedures to identify freemartins on the farm and c) to monitor the growth and performance of freemartin calves vs normal dairy heifers and bull calves. The study is ongoing and data is not available for a complete report.

G. Evaluation of Bovine Placental Lactogen(BPL) levels in multiparous dairy cows from divergent genetic lines - B. A. Cooker, H. Chester-Jones, L. B. Hansen and D. M. Ziegler

Placenta lactogen is a hormone without a known function. Blood BPL has been shown to increase during lactation in dairy cattle. It has not been established if differences in plasma BPL content exist between low and high producing cows. An initial study is underway to collect serum samples from 6 cows each from the Station's Control and Select milk herds to monitor changes in BPL throughout lactation. Data is not available for a summary report.

1990 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 study is too preliminary to report.

B. Physiological Factors Affecting High Sugar *(sh_2)* 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 ratios, 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 study is too preliminary to report.

C. Vacuum Study Premoisturization Seed Treatment for Improved Sweet Corn Germination - Vincent Fritz and James Hebel

This is a 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, $Ca(NO_3)_2$, and $Mg(NO_3)_2$ at various temperatures were compared to a non-treated control. Germination, stand establishment, and seeding vigor measurements were compared between treatments. A detailed summary can be found with this report.

D. Seed Fungicide Evaluation Trial - Vincent Fritz and James Hebel

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. Data from this study is too preliminary to report.

E. Biological Control Seed Treatment Study - Nancy Callan (Montana State University) and Vincent Fritz

A cooperative study with Montana State University is being conducted to evaluate the effectiveness of a bacteria (*Pseudomonas* spp.) seed treatment in controlling preemergence damping off caused by *Pythium spp.* The disease controlling action of the bacteria is initiated through premoisturizing the seed before planting. This process is called 'biopriming'. The performance of the bioprimed seeds will be compared with seeds treated with metalaxyl (Apron), a common seed treatment used in the sweet corn seed industry for the control of *Pythium*. Data from this study is too preliminary to report.

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

The use of organic solvents (i.e. acetone, xylene, methanol) may improve fungicide seed treatment by actually infusing the fungicides 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. The study began in 1989. Data from this study is too preliminary to report.

G. Genetic Inheritance of 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. Huskability of sweet corn is a characteristic of tremendous importance to the processing industry. Commercial varieties and breeding lines of sweet corn which are easy or difficult to mechanically husk will be grown to harvest. Huskability will be evaluated by simulating a commercial husking operation and attempting to correlate various characteristics (flag leaves, tip exposure, kernel moisture content at harvest) to huskability. Data from this study is too preliminary to report.

H. Annual Weed Control - Leonard Hertz and Vincent Fritz

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

I. Bacillus Thuringiensis Application Study for the Control of European Corn Borer and Corn Earworm - David Bartels, William Hutchison, Vincent Fritz, and James Hebel

Two major production related insect pests, European corn borer and corn earworm, significantly affect sweet corn production in the Midwest. The objective of the study is to work towards the development of improved pest management through the use of environmentally sound strategies such as Bacillus thuringiensis (B.t.). Factors which are considered to be crucial are residual activity from B.t. (% kill/application interval), persistence on the sweet corn plant, and the impact of application on non-target insects. Data from this study is too preliminary to report.

II. PEAS

A. Root Rot (Aphanomyces) Screening Trial - 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. Data from this study is too preliminary to report.

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 tillage on soil moisture, bulk density, pea root development and Aphanomyces populations at various soil depths. The 1.25 acre site of the study is located in Otisco just south of Waseca. It was chosen because of the natural, high, and uniform Aphanomyces population. In addition, a more controlled experiment using containerized soil (microplots) was established in Waseca to study the behavior of the root rot fungal spores as affected by compaction, soil moisture content, and soil temperature. Data from this study is too preliminary to report.

C. Annual Weed Control - 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 summary can be found within this report.

III. ONIONS

A. Plant Population Study - Vincent Fritz and James Hebel

This study investigates 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 third year. A detailed summary can be found within this report.

B. Variety Trial - Vincent Fritz and James Hebel

The variety "Trapps" will not be available to growers in Hollandale (Southeast Minnesota) 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 21 are being evaluated. A detailed summary can be found within this report.

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 from this study is too preliminary to report.

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 study is too preliminary to report.

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 study is not reported.

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. Data from this study is too preliminary to report.

1990 SOIL SCIENCE PROJECTS

SOUTHERN EXPERIMENT STATION

Gyles W. Randall, Soil Scientist

A. FERTILIZATION PROJECTS

1. Nitrogen

a. Nitrogen Accumulation of Various Corn Hybrids as Affected by N and K Fertilization

Nitrogen uptake differences among corn hybrids are of current interest because of the potential effect on the management of sidedress-applied N. A study was started in 1987 to examine the effect of three rates of sidedress-applied N (with and without N-Serve) and potassium (K) fertilization on the time, rate and amount of N taken up by four corn hybrids (P3732, P3475, LH74xLH51, and A632xLH38). The K variable is included to evaluate its effect on the uptake of the ammonium (NH_4) form of N. Pioneer 3615 and LH74xLH82 have been substituted for P3732 and A632xLH38, respectively. This is the last year of this 4-yr project. Dr. Gary Malzer, Department of Soil Science, serves as the project leader.

b. Soybean Response to Residual Effects of Treatments Applied to Corn in 1989

Soybeans will be grown on the plots following the 1989 Hybrid x N x K study (see a. above) to determine whether residual effects from these treatments influence soybean yields. Dr. Gary Malzer, Department of Soil Science, also serves as leader of this project.

c. Development of a Nitrate Soil Test to Predict Sidedress N Needs

Results from recent studies conducted in Vermont, Pennsylvania, Wisconsin, Iowa and Kentucky indicate a high potential for the NO_3 test as a predictor of sidedress N needs by corn under humid climate conditions. Timing, depth of sampling, soil type, and previous crop are variables that may markedly influence the performance of this test. Studies to investigate the pre-sidedress NO_3 test are being conducted at the following southeastern Minnesota sites:

A. FERTILIZATION PROJECTS (Continued)

c. Development of a Nitrate Soil Test to Predict Sidedress N Needs (Continued)

County	Location
Waseca	SES, following soybeans
Waseca	SES, following corn
Waseca	SES, following alfalfa
Waseca	Schoenrock Farm*
Watonwan	Tilney Farm**
Olmsted	Lawler Farm
Goodhue	Overby Farm***

* Paul Miller, Consultant is a cooperator
** Tom Urevig, Manager is a cooperator
*** Dave Hjermstad, past president of Minn Plant Food & Chemical Assn, and Duane Grensteiner, Plant Sci, Res., Inc., are cooperators

Corn is being grown at all sites. Nitrogen treatments are being sidedressed at the V6 stage while soil samples to a 3-foot depth are being taken at the preplant, V2, V6, and post-harvest stages. Project leaders for this activity include Gary Malzer, George Rehm, Mike Schmitt (Dept. of Soil Science) and myself.

d. Nitrogen Credits from Manure and Alfalfa

Nitrogen credits from manure and alfalfa in the year after application are well known, but credits from both in the second year are not well known. In addition, there is very little known about the interaction between alfalfa residues and manure-N availability for corn. An investigation was initiated in 1990 to compare application rates of liquid dairy manure and fertilizer N for corn following alfalfa and continuous corn. Detailed soil and plant data will be gathered in both 1990 and 1991 to determine N credits from these various systems. Mr. John Lory, graduate student in Soil Science, will be conducting this work as part of his Ph.D dissertation under the guidance of Drs. Russelle and Randall.

2. P and K Fertilization Under High Levels of Accumulated P and K

This long-term study was initiated in 1974 in cooperation with the Tennessee Valley Authority and the branch stations at Lamberton and Morris. Gyles Randall serves as project leader. The objectives have been to determine: (1) the time required for depletion of soil P and K sources, (2) rates needed for maintenance, and (3) required frequency of application. Now that a large range of soil test values have been created, the objective beginning in 1986 is to measure the soil test drawdown rate when no additional P or K are applied.

A. FERTILIZATION PROJECTS (Continued)

3. Nutrient Availability from Manure for Alfalfa and Corn

A study was initated in 1989 to measure the N forms and quantities in the soil following manure application and to evaluate the uptake of nutrients from manure by alfalfa. Liquid dairy manure was broadcast and incorporated at rates of 3000, 6000 and 12000 gal/A prior to the seeding of alfalfa. Rates of 1500, 3000 and 6000 gal/A were topdressed after the 1st cutting in 1990. All manure treatments are compared to broadcast and incorporated fertilizer P and K treatments. Corn will be planted in 1991 to evaluate the residual effects of the manure treatments. Dr. Michael Schmitt serves as the project leader.

4. Bright Sun for Corn and Soybean Production

Bright Sun is a foliar plant food whose initial test data have been quite promising. The purpose of this study initiated in 1990 will be to determine the influence of multiple Bright Sun applications on: a) corn production and its interaction with N application rate and b) soybean production and its interaction with P and K application rate.

B. TILLAGE PROJECTS

1. Conservation Tillage for Corn and Soybeans

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 plant, and (5) till-plant without ridging. The last two treatments were planted with a Buffalo till planter. Treatment 5 was changed to a spring disking in 1983. All plots have been split to determine the effect of starter vs no starter fertilizer with reduced tillage. Long-term yields show about a 5 bu/A advantage for moldboard plowing over ridge planting and chiseling with no tillage yields being substantially lower. Yields have been increased about 6 bu/A with starter fertilizer applied to the ridge-plant, chisel and no tillage systems. Soybeans were planted in 1983 to begin long-term corn-soybean sequence. Corn will be planted in 1990. The starter fertilizer variable will be dropped. Detailed soil chemical and physical measurements will be taken again in 1990 to measure the effects of the 16 years of continuous tillage.

2. Residual Effects from P and K Placement in Two Tillage Systems

The purpose of this study is to evaluate the residual effects of various P and K placement methods on soybean yields. P and K were first applied in the fall of 1983 at rates of 0, x, 1.5x and 10x where x = 15+44+87 lb $N+P_2O_5+K_2O$/A. 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

B. TILLAGE PROJECTS (Continued)

2. Residual Effects from P and K Placement in Two Tillage Systems (Continued)

between the row. These fertilizer treatments were evaluated under chisel and ridge tillage systems from 1984 through 1987. The study is being continued at the low fertility site to measure the residual effect of the treatments. The project leader is Dr. George Rehm, Department of Soil Science.

3. Nitrogen Placement in a Ridge Tillage System

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. Dr. George Rehm, Department of Soil Science, serves as project leader in this continuing study.

4. Potassium Placement in a Ridge Tillage System

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/A. Dr. George Rehm, Department of Soil Science, serves as project leader in this continuing study.

C. ENVIRONMENTAL PROJECTS

1. Nitrogen Movement into Underground Drainage Systems as Influenced by Tillage

In the fall of 1981 two primary tillage treatments (moldboard plow and no tillage) were established in four replications. This design utilizes the eight tile plots from the original 12 plots with the most uniform drainage. Nitrogen (ammonium nitrate) is 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 are taken to determine the effect of tillage for continuous corn on N efficiency and movement. Over the 8-year period (1982-89) corn yields have averaged 11 bu/A better with moldboard plow tillage. However, a significant difference in NO_3-N lost via the tile lines has not been found between tillage systems.

C. ENVIRONMENTAL PROJECTS (Continued)

2. Nitrate Loss to Drainage Water as Affected by Crop Rotation and N Application

A study was established in the fall of 1986 to measure NO_3 losses to tile drainage as affected by both corn and soybeans in a crop rotation. Anhydrous ammonia is applied each year in mid-October and in mid-April with and without N-Serve to the no-tilled soybean ground which is planted to corn. N is also applied sidedress at the 8-lf stage. The area planted to corn in 1989 was fall chiseled and then planted to soybeans in 1990. Nitrate in the tile drainage will be measured under both corn and soybeans. In addition, N uptake, plant yields and NO_3 remaining in the soil will be determined for corn.

3. Pesticide Movement into Tile Drainage Water

Water samples are being periodically taken from the tile line studies and are being sent out for pesticide analyses. To date, small levels of atrazine (< 2 ppb) are being found where Lasso + atrazine have been applied annually since 1975. Lasso and Counter have not been found in the drainage water. In addition to Bladex and Amiben, two new herbicides (Pursuit and Accent) have been applied. Cooperators have been Dr. George Hallberg, Iowa Geological Survey, and Mr. Greg Buzicky, Minnesota Department of Agriculture, and now include Drs. Don Wyse and Doug Buhler (Department of Agronomy and Plant Genetics) and Dr. Bill Koskinen (Department of Soil Science).

4. Nutrient and Pesticide Movement in SE Minnesota

As part of a College of Agriculture effort involving the Departments of Soil Science, Agronomy, Agricultural Engineering, and Agricultural and Applied Economics, and the Southern Experiment Station, research activity has been initiated in southeastern Minnesota to determine the relationship of selected ag practices to the movement of NO_3 and pesticides to groundwater. Presently, three large field studies are in progress in Goodhue, Olmsted, and Winona Counties. The Olmsted County site is heavily monitored for both N and pesticide movement. Nitrogen is fall, spring and sidedress applied as AA and spring applied as manure. The other two sites concentrate on NO_3 movement from spring and sidedress AA treatments on both chisel and no-till systems for continuous corn. This project is in the fourth year and is being coordinated by the Center for Agricultural Impacts on Water Quality; Jim Anderson, Director.

C. ENVIRONMENTAL PROJECTS (Continued)

5. Nitrogen and Pesticide Loss in Tile Drainage as Affected by Cropping System

A study was started in 1988 at the Southwest Experiment Station at Lamberton to determine the effect of various cropping systems and agricultural chemical management on crop production, NO_3 and pesticide losses to tile water, and nitrate distribution in the soil profile. The cropping systems are: cont. corn, corn-soybean rotation, alfalfa, and CRP. Nitrogen rates are spring applied and are based on the soil profile NO_3 test in late April. Pesticides include Lasso, Bladex, Amiben, Pursuit and Accent. Project cooperators include Wally Nelson, Don Wyse, Doug Buhler, Bill Koskinen, Michael Russelle, Gary Malzer and Jim Anderson.

D. WEATHER

1. Climatological Data Measurements

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, 20" and 40", precipitation, wind movement and solar radiation. In addition, summer measurements include evaporation and water temperatures while winter measurements include snow depth and frost depth. An automatic recording system also 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.

2. Soil Moisture

The soil moisture status under continuous corn is being monitored again this year on a bimonthly basis. All data are sent to Dr. Baker as part of his soil water network.

1990 SWINE PROJECT LISTING

Southern Experiment Station

Mark E. Wilson

I. Exogenous injection of a vitamin B complex on subsequent growth and performance of pigs at weaning. M. Wilson, J. Pettigrew, J. Hawton and H. Chester-Jones.

Many times it is common practice to give stressed feedlot cattle an injection of B vitamins. However, there is not strong scientific support for use of this fairly common practice. There seems to be no literature on injectable B vitamins in swine on subsequent growth performance or reducing stress. If this is an effective way to improve performance and/or reduce stress, it will be a practical and economical management tool for the swine farmer. This study was designed to test if exogenous injections of B vitamins would decrease post-weaning depression and the stress of weaning pigs, thus improving performance of the nursery pig. A complete summary is included in this annual report.

II. Exogenous injections of vitamin B_{12} on subsequent growth and performance of nursery pigs. M. Wilson, J. Pettigrew, J. Hawton, J. Rust and H. Chester-Jones.

From a preliminary trial in 1989 there was an increase in rate of gain and feed intake with a single injection of vitamin B complex in the nursery pig. Because the greatest response occurs two weeks after weaning, this causes some curiosity as to the mechanism of this effect and which B vitamins are involved. The water soluble vitamins generally are not stored and are either utilized or excreted from the body fairly rapidly. The one B vitamin that does seem to show the greatest amount of storage capability is vitamin B_{12}. This vitamin is often administered by veterinarians to help stimulate appetite. It is the intent of this study to determine if vitamin B_{12} is responsible for the growth effect of the vitamin B complex. A complete summary is included in this annual report.

1990 Swine Project Listing

III. Effects of exogenous injections of vitamin B complex with growing and finishing swine on corn/soy-based diets. M. Wilson, L. Johnston, J. Pettigrew, J. Hawton and H. Chester-Jones.

This study was set up to test if the injections of the vitamin B complex had an additive effect on performance from those pigs injected in the nursery. Also, the design would allow the comparison of no injection versus being injected at the time the pig was moved from the nursery on growth performance. This would be particularly important for the swine producer that buys feeder pigs. Study is ongoing and data is not available for a complete report.

IV. The effects of injecting vitamin B complex at the time of weaning on post-weaning performance on complex starter diets. M. Wilson, J. Hawton, J. Pettigrew and H. Chester-Jones.

An increasing number of swine producers are using the complex starter diets that contain milk products to improve the performance of the early weaned pig. It is important to test if the injection of the vitamin B complex continues to give improved performance of growth when the complex starter diet already does this over a corn/soy diet.

V. Comparison of elevated levels of B vitamins in the feed to a single exogenous injection of vitamin B complex. M. Wilson, J. Pettigrew, L. Johnston, J. Hawton and J. Rust.

This trial is designed to determine if there is a significantly important role of the injection of the B vitamins or if the B vitamins can be increased in the feed to get the same growth response. The results from this trial should give us more clues as to the mechanism of action of the injected B vitamins. This will have an impact on designing a practical way for swine managers to improve growth performance after weaning. Project is in progress and is not available for a complete report.

VI. The use of lecithin as an emulsifier in diets for grower/finisher pigs. M. Overland, M. Tokach, S. Cornelius and M. Wilson.

Lecithin is a soybean by-product used in animal feed as an emulsifier. Lecithin was shown to increase the absorption of fat when added to chick and human diets. With low levels of lecithin (1.5%) added to swine diets, pigs responded similarly to those receiving a 4% fat diet suggesting that lecithin may be a possible fat source for pigs. This study was designed to look at the effect of 2% lecithin on fat digestibility when fed to grower/finisher pigs. Data has not been summarized and is not available for a complete report.

1990 Swine Project Listing

VII. Evaluation of cheese food as a substitute for dry skim milk in weanling pig diets. T. Lohrman, J. Pettigrew, M. Wilson and M. Tokach.

The addition of milk products to piglet corn/soy diet will commonly see improvement in gains (15-20%) and improvement in feed efficiency (13-18%). However, one limiting factor in the use of milk products, primarily dried skim milk, is the high cost. Some commercial companies are using a product called cheese food as a substitute for the dried skim milk. No scientific literature has documented the value of cheese food in weanling pig diets or as a substitute for dried skim milk. The objectives of this study are to examine the effectiveness of cheese food as a substitute for dried skim milk and what fraction of dried skim milk can be substituted in weanling pig diets and still maintain performance. A complete summary is included in this annual report.

VIII. Effects of milk products in starter diets on grow-finish performance. J. Fischer, M. Tokach, J. Pettigrew and M. Wilson.

The inclusion of milk products in starter diets has shown a large growth response in the first two weeks post-weaning. This response has been repeated many times, however, not only did the growth response occur during the starter phase when the experimental diets were fed, but also during the grow-finish phase when a standard corn/soy diet was fed. This study was designed to test if pigs fed a milk product starter diet will have an increased growth response and will maintain this advantage throughout the grow/finish phase of production. Also, the study will look at the dietary manipulations of the amount of milk product in the feed and yet will still retain the growth response with lower economic costs of the feed. A complete summary is included in this annual report.

IX. Determining nutrient levels for tomorrow's economy: a new approach. H. Chester-Jones, J. Pettigrew, V. Eidman, L. Jacobson, R. Moser, S. Cornelius and M. Wilson.

Data analysis for this study is incomplete. The objectives of the study are, a) to quantify the response in performance and carcass quality of growing and finishing pigs to diets continuing varying energy (fat) and lysine (soybean meal) levels of various environmental temperatures, and b) to use the response functions so produced to estimate economically optimal diets to be fed to growing-finishing pigs in various situations. A progress summary is included in this annual report.

Agronomy Research

Corn Population Study

W. E. Lueschen, D. R. Hicks and T. R. Hoverstad

The objective of this study was to evaluate the yield response of corn hybrids to population at and above optimum levels. Populations evaluated ranged from 23,000 to 43,000 plants per acre (ppa) in rows spaced 30-inches. The hybrids evaluated included an early maturing dwarf hybrid, Cargill 1077; a hybrid that represents older genetics from the early 1970's, Minhybrid 4201; and six hybrids adapted to southern Minnesota that represent newer genetics; Pioneer 3751, Asgrow RX578, DeKalb 535, Funks G4393, Northrup King N4545, and on open pedigree 100 day RM hybrid. These hybrids have been evaluated and determined to be among the highest yielding hybrids. Trials were conducted at Lamberton, Rosemount and Waseca with a similar trial using adapted hybrids at Morris.

Table 1 shows the yield of the eight hybrids at each location. At Rosemount a trial was conducted on irrigated and non-irrigated soil. The dwarf hybrid, Cargill 1077, was the lowest yielding hybrid in every trial with yields generally below 100 bu/A. The dwarf hybrid tended to respond favorably to higher populations, yielding highest at all locations at 38,000 ppa. The older hybrid, Minhybrid 4201, generally yielded highest at low populations. In all trials except the irrigated trial, 4201 yielded highest at 23,000 ppa with a dramatic decrease in yield at higher populations. In the irrigated trial 4201 yielded highest at 33,000 ppa. All six of the newer hybrids yielded higher than Minhybrid 4201 and responded to population in a similar manner. These hybrids yielded highest at 28-33,000 ppa and did not suffer a dramatic yield reduction at higher populations. An evaluation of the data shows that the older hybrid, Minhybrid 4201, had many plants that did not produce an ear at higher populations while with the newer hybrids nearly every plant produced an ear even at the highest populations.

From this research we can conclude that the newer generation corn hybrids not only yield higher than the older genetics but they do not suffer dramatic yield reductions when populations exceeded the optimum. The major difference in these hybrids is their ability to make more efficient use of the available water and nutrients allowing more plants per acre to produce grain where an older hybrid had many plants unable to produce an ear.

Table 1. Yield of 8 corn hybrids as affected by population at Lamberton, Rosemount and Waseca.

			Yield				
		Seeded		Rosemount			
Hybrid	RM	Population[1]	Lamberton	Irrigated	Non-irrigated	Waseca	Average
Cargill 1077	75	23,000	39	86	83	73	70
Cargill 1077	75	28,000	40	105	98	73	79
Cargill 1077	75	33,000	49	103	103	81	84
Cargill 1077	75	38,000	54	129	121	90	99
Cargill 1077	75	43,000	52	114	117	89	93
Open Pedigree	100	23,000	142	159	148	151	150
Open Pedigree	100	28,000	146	170	158	164	159
Open Pedigree	100	33,000	151	173	148	159	158
Open Pedigree	100	38,000	136	154	145	151	147
Open Pedigree	100	43,000	138	174	141	156	152
Pioneer 3751	100	23,000	134	169	143	157	151
Pioneer 3751	100	28,000	141	185	177	165	167
Pioneer 3751	100	33,000	131	184	162	147	156
Pioneer 3751	100	38,000	136	182	166	162	161
Pioneer 3751	100	43,000	132	179	161	144	154
Asgrow RX578	105	23,000	128	169	170	140	152
Asgrow RX578	105	28,000	127	184	172	150	158
Asgrow RX578	105	33,000	123	181	162	141	152
Asgrow RX578	105	38,000	125	179	167	138	152
Asgrow RX578	105	43,000	117	179	156	127	145
DeKalb 535	105	23,000	132	190	169	140	158
DeKalb 535	105	28,000	138	190	182	151	165
DeKalb 535	105	33,000	128	191	173	145	159
DeKalb 535	105	38,000	126	187	169	130	153
DeKalb 535	105	43,000	130	185	180	144	160
Funks G4393	105	23,000	144	178	160	137	155
Funks G4393	105	28,000	135	186	172	136	157
Funks G4393	105	33,000	131	181	177	153	161
Funks G4393	105	38,000	124	182	165	161	158
Funks G4393	105	43,000	118	193	167	146	156
Northrup King N4545	105	23,000	131	177	159	157	156
Northrup King N4545	105	28,000	128	183	178	158	162
Northrup King N4545	105	33,000	127	187	189	145	162
Northrup King N4545	105	38,000	123	181	180	145	157
Northrup King N4545	105	43,000	125	192	177	133	157
Minhybrid 4201	110	23,000	97	157	142	147	136
Minhybrid 4201	110	28,000	93	165	130	128	129
Minhybrid 4201	110	33,000	76	169	122	130	124
Minhybrid 4201	110	38,000	77	155	115	110	114
Minhybrid 4201	110	43,000	67	135	114	108	106

[1] Plots were overplanted and thinned to these densities

EFFECTS OF TIME AND RATE OF APPLICATION OF ACCENT HERBICIDE AND COUNTER INSECTICIDE ON INJURY TO FIELD CORN AND SWEET CORN

W.E. Lueschen, R.G. Harvey, J.J. Kells, V.A. Fritz and T.R. Hoverstad

Accent applied postemergence for weed control in corn has been reported to cause corn injury especially when Counter insecticide was applied at planting. The objective of these trials was to evaluate the effects of rate and time of Accent applied postemergence to corn and to evaluate the interaction between these Accent applications and two rates of in-furrow applications of Counter insecticide. This cooperative project was conducted at the Southern Experiment Station by W.E. Lueschen, V.A. Fritz and T.R. Hoverstad, at the University of Wisconsin by R.G. Harvey at Arlington and Hancock, WI and at the Michigan State University by J.J. Kells at East Lansing, MI.

Field Corn Response

Two major effects were observed in these trials. First, Accent caused little corn injury, even at high rates of application in field corn where no Counter was applied (Table 1). In-furrow Counter at both the 4 and 8 oz/1000 ft rates caused significant corn injury when Accent was applied. The greatest injury was observed with the 2 oz/A rate (twice the maximum labeled rate) of Accent. Secondly, corn injury was greatest when Accent was applied at the 4- to 5-leaf stage of corn. Corn yields were reduced where significant corn injury was observed.

Sweet Corn Response

Sweet corn (Jubilee) was much more sensitive to Accent applications than field corn where Counter was applied (Table 2). Only slight sweet corn injury and no yield reductions were observed where Accent was applied in the absence of Counter. Accent caused severe sweet corn injury when Counter was applied at either 4 or 8 oz/1000 ft, especially on a sandy soil in Wisconsin. Dramatic yield reductions occurred at the Wisconsin site where Counter was applied prior to Accent applications. Significant yield reductions occurred at Waseca only when the 2 oz/A rate of Accent was applied in combination with either the 4 or 8 oz/1000 ft rate of Counter.

A number of studies have confirmed that there is a strong interaction between organophosphate insecticides, especially Counter, and Accent. Therefore, Accent should not be used where Counter is applied because of potential injury. Accent is not currently labeled for sweet corn. These trials have demonstrated that sweet corn is highly susceptible to Accent injury where Counter is applied at planting.

Table 1. Effects of Accent rates and timing and Counter insecticide on field corn injury at these locations in 1990.

Counter[a]	Accent[b]	Corn Stage	Injury 14 DAT[c] MI	MN	WI	Corn Yield MI	MN	WI
(oz)	(oz/A)	(leaf No.)	----- (%) ------			----- (%) ------		
0	0	3	0	2	0	169	162	198
0	.75	3	11	6	0	168	164	200
0	1.0	3	8	11	1	167	163	198
0	2.0	3	9	3	1	154	150	213
0	0	4-5	0	3	0	162	160	208
0	0.75	4-5	5	5	1	174	155	193
0	1.0	4-5	12	4	2	165	157	182
0	2.0	4-5	8	3	3	165	146	212
4	0	3	0	0	0	161	160	200
4	0.75	3	15	4	5	169	162	192
4	1	3	19	1	13	160	165	185
4	2	3	35	9	24	155	154	172
4	0	4-5	0	2	0	172	158	191
4	0.75	4-5	8	13	34	170	151	178
4	1	4-5	22	17	38	164	150	179
4	2	4-5	26	16	61	147	144	161
8	0	3	0	3	0	182	148	209
8	0.75	3	30	5	15	168	165	177
8	1.0	3	29	9	22	161	138	180
8	2.0	3	45	4	30	146	150	180
8	0	4-5	0	7	0	179	165	204
8	0.75	4-5	23	24	40	152	142	176
8	1.0	4-5	38	13	58	156	154	184
8	2.0	4-5	51	27	68	147	132	175
LSD 0.05			10	9	9	14	17	26

[a]Rates = oz of product/1000 ft of row applied in-furrow
[b]Accent rate = oz active ingredient/A. Accent is a 75 DF.
[c]Visual corn injury 14 days after treatment with Accent.

Table 2. Effects of Accent rates and Counter insecticide on sweet corn injury at two locations in 1990.

Counter[a]	Accent	Injury 14 DAT MN	Injury 14 DAT WI	Unhusk Yield MN	Unhusk Yield WI
(oz)	oz/A	------ (%)-----		---- (T/A) ---	
0	0	9	0	9.3	7.2
0	0.75	9	4	9.7	8.0
0	1.0	9	9	9.4	7.9
0	2.0	8	32	9.5	7.1
4	0	15	0	9.5	7.9
4	0.75	28	98	9.0	1.0
4	1.0	25	97	9.2	1.6
4	2.0	40	98	7.6	0.4
8	0	8	1	9.7	8.2
8	0.75	26	99	9.4	0.6
8	1.0	30	96	9.0	0.8
8	2.0	53	99	7.4	0.2
LSD (0.05)		12	4	1.2	1.1

[a] Counter rate = oz product/1000 ft of row in-furrow.

EFFECTS OF NAPHTHALIC ANHYDRIDE SEED TREATMENT FOR SAFENING CORN FROM SOYBEAN HERBICIDE INJURY

W.E. Lueschen, J.H. Ford and T.R. Hoverstad

A study was conducted in 1989 and 1990 to evaluate the effects of 1,8-naphthalic anhydride (NA) as a seed treatment for corn to prevent corn injury from several soybean herbicides. Each herbicide evaluated was applied and incorporated twice with a field cultivator just prior to planting the corn. Two hybrids 'Pioneer 3737' and 'Cargill 3477' were evaluated at Waseca in 1989 and 1990. In 1990 Pioneer 3737 was evaluated at Lamberton. The NA (Advantage from FMC Corp.) seed treatment was applied at 0.5% w/w basis in all studies. In 1989 the Cargill hybrid was pretreated by the company. In all other cases the NA was applied as a dry seed treatment just prior to planting the corn. Planting was done on May 10, 1989 and April 23, 1990 at Waseca and on May 23, 1990 at Lamberton. Planting rate was 27,500 seeds/A at both locations.

In 1989 at Waseca NA seed treatment consistently reduced corn injury where either Command or Scepter was applied (Table 1). There was very little injury with either rate of Pursuit regardless of seed treatment. NA also prevented stand loss in corn where Command was applied. The other herbicides did not affect stand. NA seed treatment reduced yield losses where Command was applied with both corn hybrids. With NA seed treatment yields were equal to the atrazine control for both rates of Command. NA seed treatment also prevented yield loss where Scepter was applied. Pursuit had little effect on corn regardless of seed treatment.

In 1990 the results from Lamberton were very similar to those observed at Waseca in 1989 (Table 2). NA effectively reduced early season injury and stand loss. As was observed at Waseca in 1989, yield loss from Command was prevented by NA seed treatment. Where Treflan or Scepter was applied, NA seed treatment reduced corn injury. Although yield losses were reduced with NA seed treatment, yield with these herbicides and NA treated seed were still lower than those for the atrazine control.

In 1990 at Waseca results with NA were not consistent with those discussed above. NA seed treatment caused stunting and reduced yield with the atrazine control, especially with Pioneer 3737 (Table 2). Injury levels with Command in 1990 were much lower than those observed in 1989. NA seed treatment reduced injury and yield loss with Cargill 3477 where 1.25 lb/A of Command was applied. Similar results were observed with Scepter. NA seed treatment reduced corn yield of both hybrids were Treflan was applied at Waseca.

In studies to evaluate the effects of NA on seed germination and seedling vigor, NA consistently reduced germination of Cargill 3477 and reduced seedling vigor of both Pioneer 3737 and Cargill 3477.

Because of the inconsistent results obtained in these studies and similar studies conducted by other universities and private industry, FMC Corporation has decided not to promote Advantage seed treatment for general use. It will be available but should generally not be used unless there is significant risk of corn injury as a result of applying a residual soybean herbicide the previous year.

Table 1. Effects of NA seed treatment on corn injury, plant population and corn yield at Waseca in 1989.

Herbicide[a]	Rate	Hybrid[b]	NA	Injury[c] 6/9/89	Population 6/7/89	Yield
	(lb/A)			(%)	(1000's/A)	(bu/A)
Atrazine	1.5	P 3737	-	11	26.1	166
		P 3737	+	10	27.4	160
		C 3477	-	6	26.1	155
		C 3477	+	6	28.3	164
Command	0.63	P 3737	-	54	20.0	157
		P 3737	+	18	27.4	173
		C 3477	-	36	20.9	152
		C 3477	+	11	26.1	166
Command	1.25	P 3737	-	80	7.8	74
		P 3737	+	40	25.7	169
		C 3477	-	55	14.4	121
		C 3477	+	17	25.7	169
Pursuit	0.016	P 3737	-	6	27.0	170
		P 3737	+	4	27.9	172
		C 3477	-	11	25.3	166
		C 3477	+	8	26.6	149
Pursuit	0.031	P 3737	-	15	27.4	165
		P 3737	+	8	27.0	179
		C 3477	-	14	25.3	155
		C 3477	+	6	28.3	158
Scepter	0.031	P 3737	-	22	28.3	161
		P 3737	+	11	27.4	171
		C 3477	-	31	26.1	146
		C 3477	+	16	26.1	156

[a] Command was applied with 1.25 lb/A of atrazine
[b] Hybrid: P = Pioneer and C = Cargill.
[c] Injury on atrazine was the result of moisture stress due to very dry weather.

Table 2. Effects of NA seed treatment on corn injury, plant population and corn yield at Waseca and Lamberton in 1990.

Herbicide[a]	Rate	Hybrid[b]	NA	Injury[c] Lb	Injury[c] Wa	Population[d] Lb	Population[d] Wa	Yield Lb	Yield Wa
	(lb/A)			(%)		(1000's/A)		(bu/A)	
Atrazine	1.5	P 3737	-	4	3	24	26	144	156
		P 3737	+	4	13	25	25	147	141
		C 3477	-	--	14	--	26	--	155
		C 3477	+	--	11	--	23	--	151
Command	0.63	P 3737	-	31	21	22	24	130	146
		P 3737	+	7	12	25	22	143	130
		C 3477	-	--	10	--	25	--	143
		C 3477	+	--	18	--	21	--	122
Command	1.25	P 3737	-	64	18	13	25	85	139
		P 3737	+	27	14	24	24	139	149
		C 3477	-	--	45	--	19	--	114
		C 3477	+	--	12	--	25	--	146
Pursuit	0.016	P 3737	-	2	5	25	24	134	144
		P 3737	+	3	13	25	21	141	138
		C 3477	-	--	9	--	25	--	143
		C 3477	+	--	17	--	22	--	146
Pursuit	0.031	P 3737	-	9	15	24	23	135	149
		P 3737	+	3	12	25	23	136	145
		C 3477	-	--	19	--	26	--	142
		C 3477	+	--	13	--	23	--	153
Scepter	0.031	P 3737	-	30	15	24	26	103	130
		P 3737	+	12	19	25	23	129	133
		C 3477	-	--	32	--	26	--	129
		C 3477	+	--	0	--	26	--	146
Treflan	0.63	P 3737	-	68	5	14	25	81	156
		P 3737	+	45	15	20	21	124	135
		C 3477	-	--	26	--	25	--	149
		C 3477	+	--	18	--	24	--	137

[a] Command was applied with 1.25 lb/A of atrazine
[b] Hybrid: P = Pioneer and C = Cargill
[c] Injury: Rotating made on 6/13/90 at Lamberton and 6/14/90 at Waseca.
[d] Population: counts taken on 6/13/90 at Lamberton and 6/22/90 at Waseca.

CORN ROOT HEALTH/LORSBAN

W. C. Stienstra
Department of Plant Pathology

W. E. Lueschen
Southeastern Experiment Station

OBJECTIVE

To measure the level of root infection by Fusarium species and relate that to root health and hybrid yield when treated with the product Lorsban.

METHOD

Two corn hybrids were planted in paired plots with and without Lorsban 15G in a 7" T-band at 8 oz/1,000 row feet. Primary roots from select plants were harvested 56 & 125 days after planting for laboratory isolation of Fusarium fungi. The center two rows were machine harvested for yields. Leaf area was determined by measuring the length and width of the ear leaf.

RESULTS

No benefit was observed on roots as to colony counts, leaf area while yield was just significant. This completes a 3 year evaluation of Lorsban 15G and this soil insecticide is fungistatic, not fungicidal and may result in an additional benefit. The results are in general to lower Fusarium root colonization but are not consistent from year to year. Wet years like 1990 appear to prevent root infection reduction or may promote root infection. Lorsban, a soil insecticide should be used as that decision must be based on the benefits gained from insect treatment only. The results of 3 years of testing do not consistently result in reduced root infection by Fusarium or improved yields.

Lorsban T-Band Results at Waseca

Hybrid	Treatment	Plant Population 14 May	Plant Population 23 May	Root Health 21 June (56)	Root Health 29 August (125)	CM^2 Ear Leaf Area 29 August	H_2O	Yield 17 October
Pioneer 3377	T-Band	4.8	26.2	.594	.258	933.1	30.6	152.0
Pioneer 3377	Check	5.7	25.6	.516	.262	915.3	31.8	143.6
LH74 x LH82	T-Band	11.8	24.6	.632	.215	920.6	24.6	143.4
LH74 x LH82	Check	15.1	25.1	.639	.336	880.4	24.6	139.5
p-value		0.01	0.27	--	--	--	0.01	0.31
Average for Lorsban Treatment								
	T-Band	8.3	25.3	.613	.237	926.9	27.6	147.7
	Check	10.4	25.4	.578	.299	897.9	28.2	141.6
p-value		0.14	0.94	--	--	--	0.24	0.03
LSD at 0.05 (Duncan-Walker K-Ratio)		--	--	NS	NS	NS	--	5.4

Herbicides for Controlling Wild Proso Millet and Woolly Cupgrass in Corn and Soybeans

William E. Lueschen
University of Minnesota
Southern Experiment Station

Wild proso millet and woolly cupgrass have infested thousands of acres of corn and soybean in Minnesota. Wild proso millet was first observed in Minnesota in the 1930's. By the early 1970's it was recognized as a serious weed pest. By the early 1980's it was estimated that Minnesota and Wisconsin together had over 1.25 million acres infested with wild proso millet. Control of this species remains difficult and expensive in corn but several herbicides control wild proso millet easily and economically in soybeans.

Woolly cupgrass has spread to many areas in Minnesota since being identified in Dakota and Rice counties in the mid 1960's. This species is difficult to control in both corn and soybeans. Herbicides are only partially effective for controlling this species in corn. The situation for controlling woolly cupgrass in soybeans is somewhat brighter but it is certainly much more difficult to control than wild proso millet.

Since these two grass species are prolific seed producers and can spread rapidly once an infestation occurs, early detection and implementation of an integrated control program is necessary to keep both species from becoming a major weed problem. This discussion will focus on the activity of herbicides on these species. However, herbicides alone probably will not give adequate control of these species year-after-year because seeds germinate throughout the season. Chemical weed control must be integrated into an overall control strategy that includes crop rotation and cultivation.

Wild Proso Millet Control in Corn

Since 1988, Dr. Jeff Gunsolus and I have evaluated several herbicides for controlling wild proso millet in corn. Performance of herbicides has varied greatly from year-to-year since environmental conditions play a key role in herbicide activity. Eradicane or Eradicane Extra preplant incorporated gave nearly 70% control in 1988 but only 25% control in 1989, an extremely dry year (Table 1). A preemergence application of Lasso or Dual following preplant Eradicane Extra resulted in very good control in 1988 but poor control in 1989. Lasso has consistently given better performance than Dual on wild proso millet when applied at label rates. Following preplant Eradicane with postemergence Bladex, Bladex + vegetable oil, Bladex + Prowl or Bladex + Tandem gave excellent control in 1988 but only the Bladex plus Tandem in combination with Eradicane preplant gave acceptable wild proso millet control in 1989. The major limitation to Bladex combinations postemergence is the potential for crop injury that can be severe under cool environmental conditions.

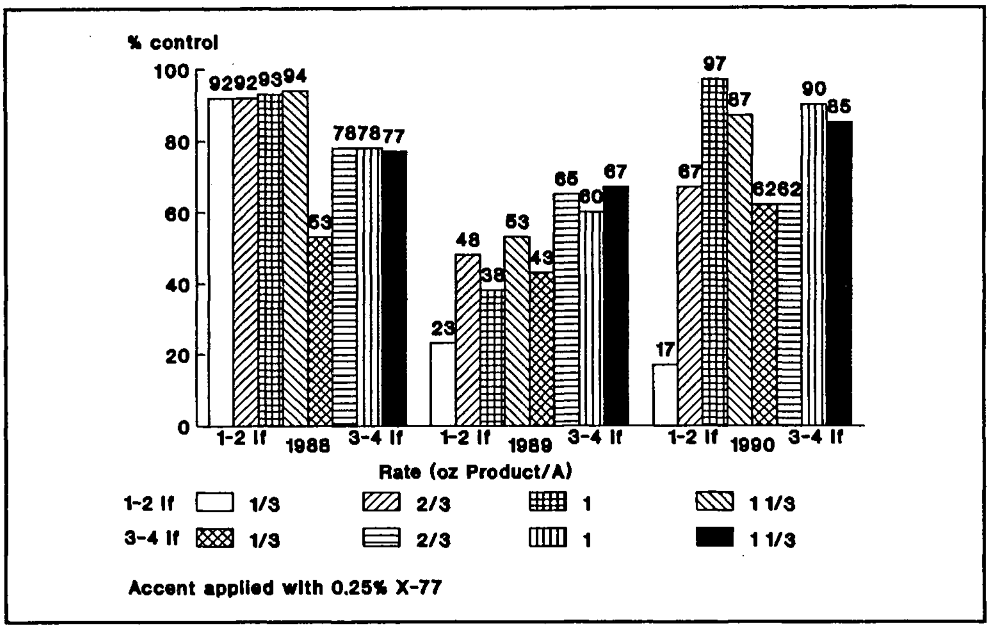
Table 1. Wild Proso Millet Control with Soil Applied Corn Herbicides

Herbicide	Rate	Wild Proso Millet 1988	1989
	(lb/A)	(% control)	
PPI 2X			
Eradicane	6	72	33
Eradicane Extra	6	70	23
PPI 2X / Pre			
Eradicane / Lasso	6 / 3	99	59
Eradicane / Dual	6 / 2.5	90	64
PPI 1 X / Pre			
Dual / Dual	2 / 2	63	57
PPI 1 X / Delayed Pre			
Lasso / Lasso	4 / 2	90	77
PPI 2X / Post			
Eradicane / Bladex	6 / 2	87	53
Eradicane / Bladex + Veg Oil	6 / 2 + 1.25%	85	42
Eradicane / Bladex + Prowl	6 / 2 + 1.5	85	63
Eradicane / Bladex + Tandem	6 / 2 + 0.75	93	85

For a number of years we have waited anxiously for a new postemergence corn herbicide to solve all of the grass woes in corn. Do we now have that product in Accent or Beacon? First lets deal with Beacon from CIBA-Geigy. After only one year of evaluation we were convinced that Beacon offered no hope for controlling either wild proso millet or woolly cupgrass (CIBA-Geigy told us this was the case but we wanted to prove it to ourselves).

Accent performance on wild proso millet has been a mixed bag (Figure 1). In 1988 and 1990 we had about 90% control of wild proso millet with Accent when applied at the 1- to 2-leaf stage. When the wild proso millet was under a lot of moisture stress in 1989, control with Accent was very poor regardless of rate of application. In 1988 Accent performed best when applied at the 1- to 2-leaf stage of wild proso millet. In 1990 stage of application was not an important factor. Rate of Accent application was not important in 1988 and 1989. The labeled rate of 0.67 oz of product was as effective as applying twice this amount of product. In 1990, the best performance with Accent occurred when either 1 or 1.33 oz/A of product was applied. The maximum label rate is 1.33 oz of product/A in any one season.

Figure 1. Effects of Time and Rate of Accent on Wild Proso Millet Control in Corn



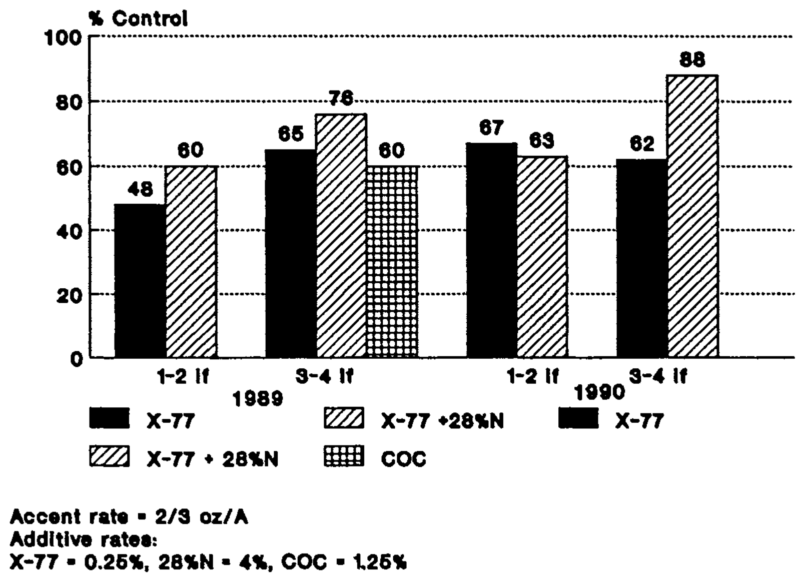
Split applications of Accent were evaluated in 1990 (Table 2). Applying split applications of 0.67 oz/A of Accent, applied at the 1- to 2- and the 3- to 5-leaf stage of wild proso millet, improved control by about 10 percentage points compared to single applications of 1.33 oz/A.

Table 2. Wild Proso Millet Control with Accent Split Applications in 1990

Herbicide	Rate oz Product/A	Wild Proso Millet (% control)
Single Application (1-2 lf)		
Accent + X-77	0.67 + 0.25%	67
Accent + X-77 + 28%	0.67 + 0.25% + 4%	63
Accent + X-77	1.33 + 0.25%	87
Split Application (1-2 lf / 3-5 lf)		
Accent + X-77 / Accent + X-77	0.67 + 0.25% / 0.67 + 0.25%	97
Accent + X-77 + 28%N / Accent + X-77 + 28%N	0.67 + 0.25% + 4% / 0.67 + 0.25% + 4%	96
Single Application (3-5 lf)		
Accent + X-77	0.67 + 0.25%	62
Accent + X-77 + 28%N	0.67 + 0.25% + 4%	88
Accent + X-77	1.33 + 0.25%	85

In 1989, under very dry conditions, the addition of 28%N to X-77 improved performance of Accent on wild proso millet at both stages of application (Figure 2). In 1990, 28%N resulted in enhanced wild proso millet control only when Accent was applied at the 3- to 4-leaf stage of wild proso millet.

Figure 2. Effects of Additive on Wild Proso Millet Control with Accent



Woolly Cupgrass Control in Corn

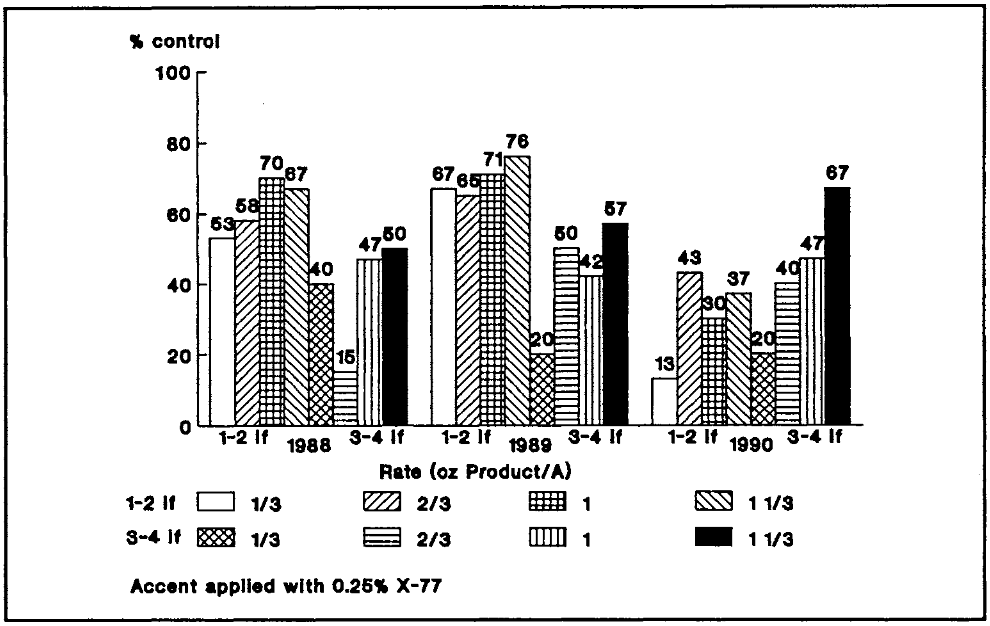
Woolly cupgrass control with soil applied corn herbicides was good to excellent in both 1988 and 1989 (Table 3). The only exception to this was in 1988 when neither Dual nor Lasso gave adequate control of woolly cupgrass. The most consistent control of woolly cupgrass was obtained by applying Eradicane preplant incorporated and following with either Dual or Lasso preemergence or Bladex, Bladex + vegetable oil, Bladex + Prowl or Bladex + Tandem postemergence. All of these treatments provided better than 90% control of woolly cupgrass both years.

Table 3. Woolly Cupgrass control with soil applied herbicides

Herbicide	Rate	Woolly Cupgrass 1988	1989
	(lb/A)	(% control)	
PPI 2X			
Eradicane	6	90	75
Eradicane Extra	6	82	83
PPI 2X / Pre			
Eradicane / Lasso	6 / 3	94	93
Eradicane / Dual	6 / 2.5	95	97
PPI 1 X / Pre			
Dual / Dual	2 / 2	55	89
PPI 1 X / Delayed Pre			
Lasso / Lasso	4 / 2	65	90
PPI 2X / Post			
Eradicane / Bladex	6 / 2	92	92
Eradicane / Bladex + Veg Oil	6 / 2 + 1.25%	92	97
Eradicane / Bladex + Prowl	6 / 2 + 1.5	91	92
Eradicane / Bladex + Tandem	6 / 2 + 0.75	94	96

Accent performance on woolly cupgrass has been disappointing. In three years of evaluating Accent plus X-77 on this species, our best control has been about 75% (Figure 3). This level of control is certainly not adequate to control this species and additional control measures need to be considered.

Figure 3. Effects of Time and Rate of Accent on Woolly Cupgrass Control in Corn



Fritz Breitenbach had a trial in 1990 in southeast Minnesota to evaluate postemergence herbicides for woolly cupgrass control (Table 4). In this trial 1 oz/A of Accent in combination with X-77 and 28%N gave 81% control of woolly cupgrass when applied as a single application and 88% control when applied as a split application. Bladex + Prowl postemergence gave 90% control.

Table 4. Woolly Cupgrass Control in Corn in Southeast Minnesota

Herbicide (date)	Rate*	Wocg size	Wocg	Corn Injury
			(% control)	(%)
Accent (6/6)	1 oz	2 lf	81	0
Accent (6/6)	0.5 oz			
" (6/15)	0.5 oz	2 lf	88	1
Bladex + X-77 (6/6)	2.2 lb + 1%	2 lf	79	15
Prowl + Bladex (5/29)	3 pt + 2.2 lb	1 lf	90	12

* Rate of Product. All Accent had 0.25% X-77 + 4% UAN

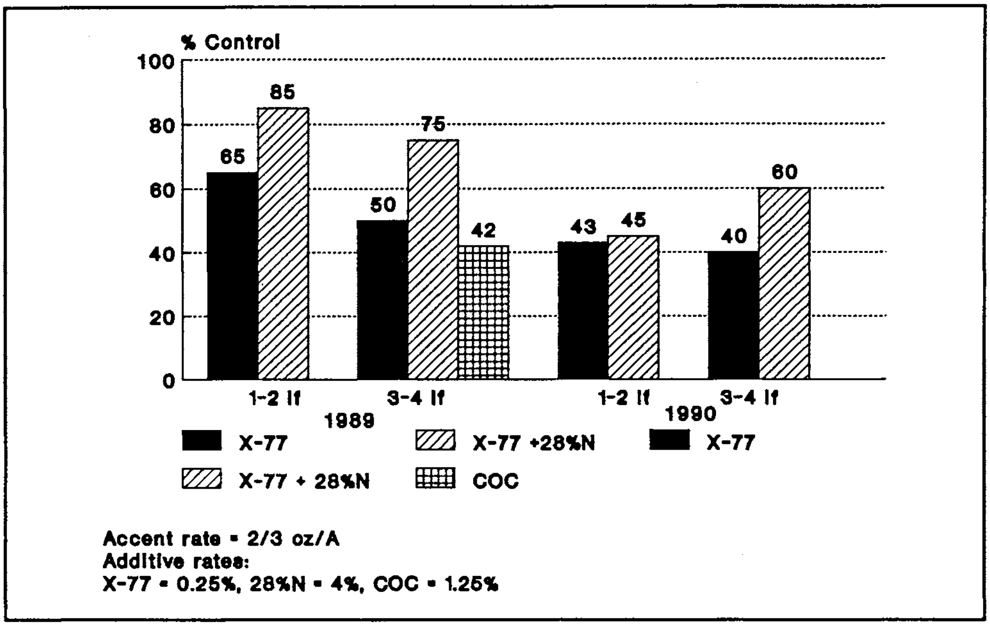
In 1990 split applications of Accent + X-77 + 28%N gave significantly better control of woolly cupgrass than a single application in our trial near Faribault (Table 5). With split applications of 0.67 oz/A of Accent applied at the 1- to 2-leaf stage with a second application about 10 days later, 88% woolly cupgrass control was obtained where 28%N was included as the additive. Without 28%N, the split application gave only 57% control compared to 37 and 67% control with a single application of 1.33 oz/A applied at either the 1- to 2- or 3- to 5-leaf stage, respectively.

Table 5. Woolly Cupgrass Control with Accent Split Applications in 1990

Herbicide	Rate	Wild Proso Millet
	(oz Product/A)	(% control)
Single Application (1-2 lf)		
Accent + X-77	0.67 + 0.25%	43
Accent + X-77 + 28%	0.67 + 0.25% + 4%	45
Accent + X-77	1.33 + 0.25%	37
Split Application (1-2 lf / 3-5 lf)		
Accent + X-77 / Accent + X-77	0.67 + 0.25% / 0.67 + 0.25%	57
Accent + X-77 + 28%N / Accent + X-77 + 28%N	0.67 + 0.25% + 4% / 0.67 + 0.25% + 4%	88
Single Application (3-5 lf)		
Accent + X-77	0.67 + 0.25%	40
Accent + X-77 + 28%N	0.67 + 0.25% + 4%	60
Accent + X-77	1.33 + 0.25%	67

The addition of 28%N also improved control of woolly cupgrass with a single application of Accent in 1989 (Figure 4). Accent at 0.67 oz/A of product with X-77 applied at the 1- to 2-leaf stage gave only 65% woolly cupgrass control but the addition of 28%N increased control to 85%. Likewise, 28%N increased control of woolly cupgrass when applied at the 3- to 4-leaf stage. Crop oil concentrate did not enhance woolly cupgrass control when compared to X-77 as an additive with Accent in 1989. In 1990, 28%N enhanced control with Accent + X-77 only when applied at the 3- to 4-leaf stage, however, control was still only 60%.

Figure 4. Effects of Additive on Woolly Cupgrass Control with Accent



Wild Proso Millet Control in Soybeans

Soil applied soybean herbicides were evaluated for control of wild proso millet in 1988 and 1989 (Table 6). In 1988 Sonalan + Command preplant incorporated gave 93% wild proso millet control but this treatment gave only 40% control in 1989. Pursuit preplant incorporated gave 82% control in 88 and 64% control in 1989. The DNA herbicides (Treflan, Sonalan and Prowl) did not give adequate control of wild proso millet either year.

Table 6. Wild Proso Millet Control with Soil Applied Soybean Herbicides

Herbicide	Rate	Wild Proso Millet 1988	1989
	(lb/A)	(% control)	
PPI 2X			
Command	1	60	17
Sonalan	1.13	55	30
Sonalan + Command	1.13 + 0.75	93	40
Pursuit	0.063	82	64
Prowl	1.5	53	43
Prowl + Command	1.5 + 0.75	73	48
Treflan	1	63	27
Treflan + Command	1 + 0.75	77	33

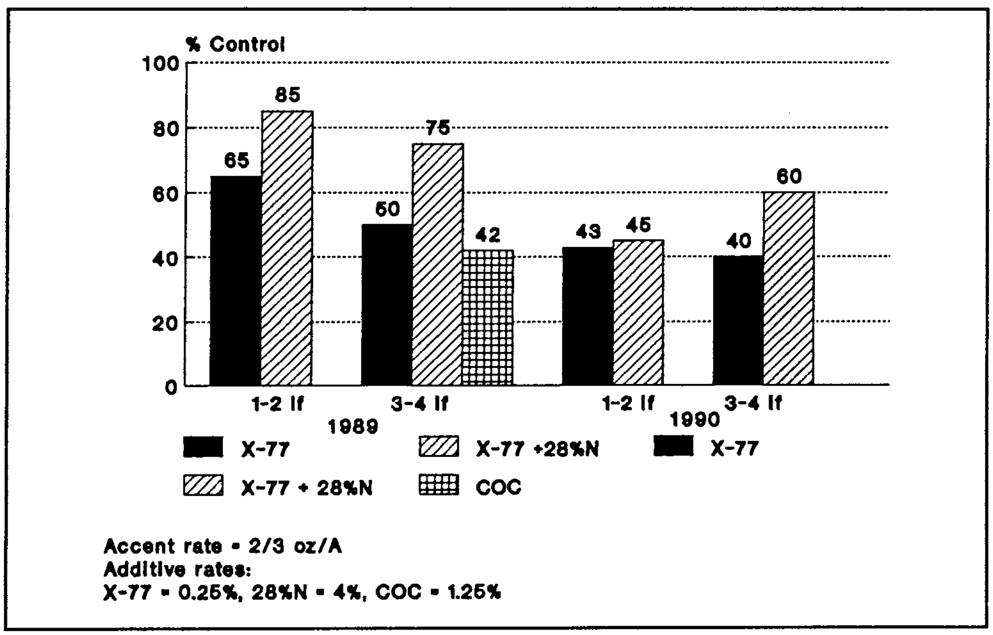
Lasso applied preemergence at 3 lb/A following Treflan at 1 lb/A preplant incorporated improved wild proso millet control more than Dual applied at 2.5 lb/A following Treflan preplant (Table 7). However, postemergence Fusilade 2000, Pursuit or Poast gave better control following Treflan preplant than either Lasso or Dual preemergence

Table 7. Wild Proso Millet Control with Soil Applied Soybean Herbicides

Herbicide	Rate	Wild Proso Millet 1988	1989
	(lb/A)	(% control)	
PPI 2X			
Treflan / Lasso	1 / 3	85	55
Treflan / Dual	1 / 2.5	75	48
PPI 2X / Post			
Treflan /	1 /	98	78
Fusilade 2000 + COC	0.09 + 1.25%		
Treflan /	1 /	88	81
Pursuit + Surf + 28%N	0.063 + 0.25% + 1.25%		
Treflan /	1 /	99	89
Poast + Dash	0.1 + 1.25%		

A number of postemergence soybean herbicides have excellent activity on wild proso millet at low rates of application (Figure 5). Assure, Fusilade 2000 and Poast have good to excellent activity with Fusilade 2000 being slightly weaker on this species than the other two products. Performance of Assure and Poast dropped dramatically in 1989 when hot, dry conditions prevailed. While Pursuit postemergence does not have as good of activity as the other products described above, it has reasonable activity on this species but would not be the herbicide of choice if wild proso millet was the primary target species. Select, a product from Valent that is not registered yet, has shown excellent activity on wild proso millet all three years of our study.

Figure 5. Wild Proso Millet Control with Postemergence Soybean Herbicides



Split applications of Poast were evaluated in 1989 and compared to Poast applications made at either the 1- to 4- or the 5- to 6-leaf stage of wild proso millet (Table 8). Split applications gave control similar to a single application. This is not surprising since Poast has a high level of activity on wild proso millet. The main objective of a split application would be to control late flushes of the weed. Since conditions were very dry in 1989, we did not get reinfestation in the single application treatments.

Table 8. Wild Proso Millet Control with Split Applications in 1989

Herbicide	Rate	Wild Proso Millet
	oz Product/A	(% control)
Post 1-4 lf		
Poast + Dash + 28%	0.1 + 1.25% + 5%	86
Post 1-4 lf / Post 5-6 lf		
Poast + Dash + 28%	0.05 + 1.25% + 5% /	88
Poast + Dash + 28%	0.05 + 1.25% + 5%	
Poast + Dash + 28%	0.1 + 1.25% + 5% /	97
Poast + Dash + 28%	0.1 + 1.25% + 5%	
Post 5-6 lf		
Poast + Dash + 28%	0.1 + 1.25% + 5%	91

In 1990 we evaluated split applications of Assure, Fusilade 2000 and Poast Plus (Table 9). Our results again indicated that split applications were not necessary for excellent control. In fact, the split application of 0.05 lb/A of Poast Plus resulted in only 68% control of wild proso millet compared over 90% control for single applications.

Table 9. Wild Proso Millet Control with Split Applications in 1989

Herbicide	Rate	Wild Proso Millet
	oz Product/A	(% control)
Post 3-5 lf		
Assure II + COC + 28%N	0.03 + 1.25% + 5%	93
Fusilade 2000 + COC + 28%N	0.09 + 1.25% + 5%	85
Poast Plus + 28%N	0.1 + 5%	93
Post 3-5 lf / Post 4-6 lf		
Assure II + COC + 28%N /	0.015 + 1.25% + 5%	93
Assure II + COC + 28%N	0.015 + 1.25% + 5%	
Fusilade 2000 + COC + 28%N /	0.045 + 1.25% + 5% /	87
Fusilade 2000 + COC + 28%N	0.045 + 1.25% + 5%	
Poast Plus + 28%N	0.05 + 2.5%	68
Poast Plus + 28%N	0.05 + 2.5%	
Post 4-6 lf		
Assure II + COC + 28%N	0.03 + 1.25% + 5%	91
Fusilade 2000 + COC + 28%N	0.09 + 1.25% + 5%	81
Poast Plus + Dash + 28%N	0.1 + 0.625% + 5%	96

The addition of 28%N as a herbicide additive has enhanced wild proso millet control for most postemergence herbicides during this three year study. The results with 28%N have not been consistent over years, however, based on our results 28%N should be used where the labels allow its use. There has been no case where 28%N reduced postemergence herbicide performance and several cases where enhanced wild proso millet control was substantial where 28%N was included as an additive.

Woolly Cupgrass Control in Soybeans

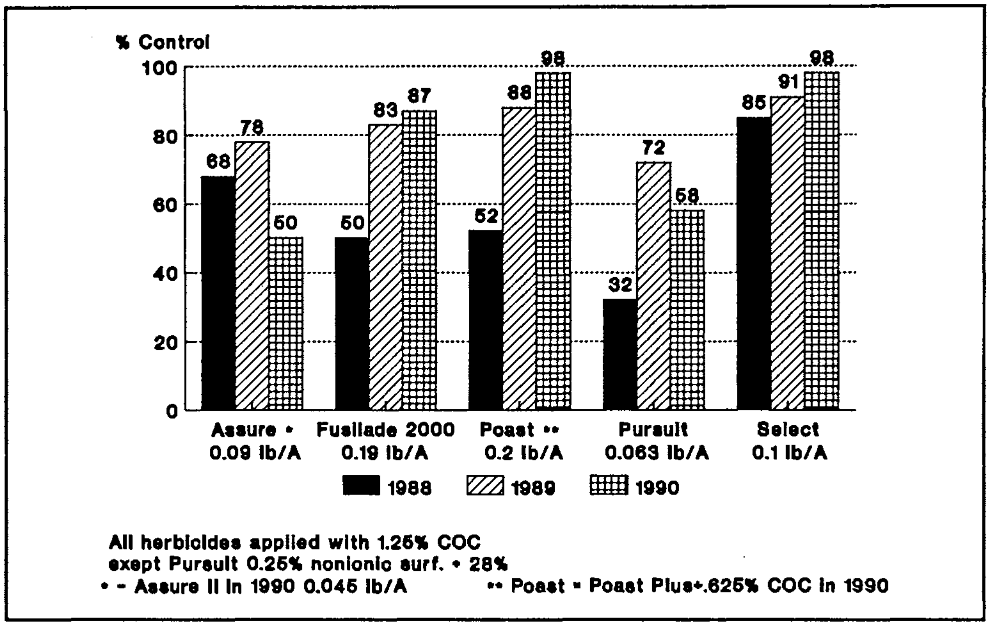
Soil applied soybean herbicides were evaluated in 1988 and 1989 for control of woolly cupgrass. Over the two years Treflan and Sonalan applied preplant incorporated gave better control of woolly cupgrass than Prowl (Table 10). However, control with these DNA herbicides were generally not good enough to serve as stand-alone treatments. Neither Command nor Pursuit were very effective on woolly cupgrass.

Table 10. Woolly Cupgrass Control with Soil Applied Soybean Herbicides

		Wild Proso Millet	
Herbicide	Rate	1988	1989
	(lb/A)	(% control)	
PPI 2X			
Command	1	27	75
Sonalan	1.13	77	89
Sonalan + Command	1.13 + 0.75	70	85
Pursuit	0.063	35	68
Prowl	1.5	55	78
Prowl + Command	1.5 + 0.75	53	85
Treflan	1	72	81
Treflan + Command	1 + 0.75	58	78

Activity of postemergence soybean grass herbicides on woolly cupgrass is much lower than we observed on wild proso millet. The rates of application of these herbicides for woolly cupgrass control were increased by 30 to 100% compared to the rates used for wild proso millet. Differences between postemergence herbicides were much greater with woolly cupgrass than with wild proso millet. In 1988, when we had a very dense population of woolly cupgrass and a lot of drought stress at the time of application, activity of Assure, Fusilade 2000, Poast and Pursuit was very poor (Figure 6). In 1988, only Select gave adequate control of woolly cupgrass postemergence. Performance of Assure and Pursuit was also poor in 1989 and 1990. Fusilade 2000 gave between 82 and 88% control and Poast gave 88 to 98% control of woolly cupgrass in 1989 and 1990, respectively. Select gave the most consistent control of woolly cupgrass all three years.

Figure 6. Woolly Cupgrass Control with Postemergence Soybean Herbicides



In 1989, a split application of Poast did not provide any better control of woolly cupgrass than single applications. Also, Poast applied at the 3- to 5-leaf stage of woolly cupgrass gave control equal to the same treatments applied at the 2- to 4-leaf stage (Table 11).

Table 11. Woolly Cupgrass Control with Split Applications in 1989

Herbicide	Rate oz Product/A	Wild Proso Millet (% control)
Post 2-4 lf		
Poast + Dash + 28%	0.2 + 1.25% + 5%	92
Post 2-4 lf / Post 3-5 lf		
Poast + Dash + 28%	0.1 + 1.25% + 5% /	94
Poast + Dash + 28%	0.1 + 1.25% + 5%	
Poast + Dash + 28%	0.15 + 1.25% + 5% /	96
Poast + Dash + 28%	0.15 + 1.25% + 5%	
Post 3-5 lf		
Poast + Dash + 28%	0.2 + 1.25% + 5%	89

In 1990, a split application of Fusilade 2000 or Poast Plus controlled woolly cupgrass as well as a single application made when the woolly cupgrass was in the 3- to 5-leaf stage. Control with both of these herbicides was reduced if application was delayed about 10 days when the woolly cupgrass was in the 4- to 6-leaf stage. A split application of Assure II resulted in reduced control of woolly cupgrass (Table 12).

Table 12. Woolly Cupgrass Control with Split Applications in 1990

Herbicide	Rate	Wild Proso Millet
	oz Product/A	(% control)
Post 3-5 lf		
Assure II + COC + 28%N	0.045 + 1.25% + 5%	62
Fusilade 2000 + COC + 28%N	0.19 + 1.25% + 5%	83
Poast Plus + 28%N	0.2 + 5%	98
Post 3-5 lf / Post 4-6 lf		
Assure II + COC + 28%N /	0.022 + 1.25% + 5% /	48
Assure II + COC + 28%N	0.022 + 1.25% + 5%	
Fusilade 2000 + COC + 28%N /	0.1 + 1.25% + 5% /	85
Fusilade 2000 + COC + 28%N	0.1 + 1.25% + 5%	
Poast Plus + 28%N	0.1 + 2.5%	95
Poast Plus + 28%N	0.1 + 2.5%	
Post 4-6 lf		
Assure II + COC + 28%N	0.045 + 1.25% + 5%	60
Fusilade 2000 + COC + 28%N	0.19 + 1.25% + 5%	65
Poast Plus + Dash + 28%N	0.2 + 0.625% + 5%	83

The addition of 28%N as an additive generally did not enhance performance of postemergence herbicides for control of woolly cupgrass. With Poast we observed enhanced control with 28%N in 1988 and 1989 but not in 1990.

Summary

Since wild proso millet and woolly cupgrass are difficult to control in corn, an integrated control program will be essential to obtain consistent control of these species. Eradicane applied preplant incorporated should serve as a foundation treatment for both species in corn. If good performance is obtained with Eradicane, supplemental cultivations may be adequate to give good season long control. However, in many situations Eradicane will need to be supplemented with other herbicide treatments, especially where wild proso millet or woolly cupgrass have been allowed to build to high levels. Lasso preemergence following Eradicane preplant has helped control both species. However, this combination is quite expensive and the Lasso should be banded to help reduce cost. Performance of Dual has not been as good as Lasso. Either Accent or a combination of Bladex + Prowl postemergence following a preplant application of Eradicane has resulted in more consistent control of wild proso millet than Eradicane alone. However, it is not wise to count on these postemergence treatments alone since variable weather conditions influence control and make postemergence herbicides risky for controlling wild proso millet and woolly cupgrass. Continuous use of Eradicane is not recommended since rapid degradation of this product may occur with continuous use. Therefore, crop rotation will be beneficial for long-term control.

In soybeans a foundation treatment of a DNA herbicide (Treflan, Sonalan or Prowl) preplant incorporated provides initial control or suppression of wild proso millet and woolly cupgrass. Following this foundation treatment with postemergence Assure, Fusilade 2000 or Poast will normally provide excellent control of wild proso millet at low rates of application. Following a DNA with a postemergence application of Poast has given the most consistent control of woolly cupgrass. Performance of Assure on woolly cupgrass has not been as good as either Poast or Fusilade 2000. If Select becomes registered for use on soybeans, it will offer an excellent postemergence control alternative since it has been consistently effective on both species.

Crop rotation and cultivation should play a major role in control of wild proso millet or woolly cupgrass. Controlling these species in corn is very expensive and control can be variable from year-to-year. Including soybeans in the rotation where these weeds are a problem will improve the chances of getting good control. Where alfalfa is a alternative crop, it will help reduce the soil seed reservoir since over the three to five year life of an alfalfa stand, part of the seed will dissipate from the soil. Small grains will effectively compete with wild proso millet and woolly cupgrass because of early planting. However, after small grain harvest, these weed species will need to be controlled to prevent seed production.

NO-TILL SOYBEAN WEED CONTROL

W.E. Lueschen and T.R. Hoverstad

The production of soybeans in conservation tillage and no-till systems has increased in the recent past. Consistent weed control has been a major limiting factor with no-till soybeans. The primary objective of this research was to evaluate the time and rate of application of Pursuit and herbicide programs involving Pursuit on weed control in no-till soybeans.

This research has been conducted each year since 1987. These trials were conducted on a Webster clay loam soil with 6 to 7% organic matter and high soil fertility levels. The previous crop each year was no-till corn. Soybeans were planted with a no-till planter with residue cutting coulters ahead of double disk openers with planting units spaced 10-inches apart. In 1989 a no-till grain drill (JD 750) with row a spacing of 7.5-inches was used instead of the 10-inch row no-till planter.

Results from this study in 1987 and 1988 are presented in Table 1. In 1987 and 1988 Pursuit was evaluated as an early preplant (EPP) treatment applied 3 to 4 weeks prior to planting, and before any weeds had emerged, and as a preemergence treatment. Preemergence treatments were applied the same day as planting May 16, 1987 and May 12, 1988. Pursuit performed best both years when applied as a split application where 0.03 lb AI/A (2 oz/A) was applied EPP followed by an additional 0.03 lb/A (2 oz/A) preemergence. A single early preplant application of 0.06 lb/A (4 oz/A) or 0.09 lb/A (6 oz/A) performed well in 1988 but failed to control common ragweed in 1987 (data not shown). Pursuit applied alone at 0.06 lb/A (4 oz/A) or with X-77 at 0.25% or X-77 plus 28%N at 0.25 + 2.5% as a preemergence herbicide with no additional burndown did not provide acceptable weed control either year and resulted in poor soybean yields. Using a Roundup burndown treatment followed by Pursuit or Pursuit plus Amiben preemergence failed in both years primarily because of inadequate performance of the burndown treatments.

In 1989 and 1990 the main focus of this research was on early preplant applications of Pursuit. Table 2 shows the results from 1989 and 1990. A fall applied treatment was evaluated along with two spring early preplant treatments. The fall treatments were applied in mid- to late October following corn harvest. The two early preplant treatments were: 1) 4 weeks before planting (EPP I) or 2) two weeks before planting (EPP II). No weeds had emerged at the time of the spring early preplant treatments. Burndown treatments were applied one to three days before planting when weeds were one half inch tall. Preemergence treatments were applied on the same day as planting May 10, 1989 and May 18, 1990. In 1989 and 1990 a postemergence treatment was applied when the soybeans were in the first trifoliolate leaf stage and weeds were 1 to 4 inches tall. The fall applied treatments failed to provide acceptable weed control and soybean yields except in 1990 at a rate that is twice the normal use rate for spring applied Pursuit. Splitting a fall applied treatment with a spring early preplant treatment was better than a single fall application but did not perform as well as spring early preplant treatments. EPP II treatments consistently provided better weed control and high soybean yields than EPP I treatments in both years. Pursuit Plus did not perform significantly better than Pursuit as an early preplant treatment. A split application of Pursuit with 0.03 lb/A (2 oz/A) EPP and 0.03 lb/A (2 oz/A) preemergence performed very well especially when Sencor/Lexone at 0.38 lb AI/A (0.5 lb 75DF) was added to each treatment. This Pursuit plus Sencor/Lexone tank mixture performed better than a Dual plus Sencor/Lexone tank mixture applied in the same manner. Pursuit early preplant at 0.03 lb/A (2 oz/A) provided a weed-free seedbed and subsequent postemergence weed control with Poast and Basagran plus Blazer plus oil concentrate provided acceptable weed control. This treatment was better than Roundup burndown followed by Dual plus Sencor/Lexone preemergence, especially in dry years or when burndown treatments did not perform well.

From this research we have concluded that no-till soybeans have the capability to yield very well where weed control is adequate. Our best results have been with early preplant Pursuit plus Sencor Lexone tank mixes followed by an additional preemergence application of Pursuit plus Sencor/Lexone. Postemergence weed control is a viable option for no-till soybeans if an effective early preplant or burndown treatment is also used.

Table 1. Effects of herbicide treatment on weed control and yield of no-till soybean in 1987-88 at Waseca, MN.

		1987					1988				
Herbicide	Rate[a]	Gift	Colq	Rrpw	Vele	Yield	Gift	Colq	Rrpw	Vele	Yield
	(lb/A)	-- (% control) --				(bu/A)	-- (% control) --				(bu/A)
EPP (Apr 22,1987 ; Apr 14,1988)											
Pursuit	0.06	73	10	78	93	0	80	88	100	93	30
Pursuit	0.09	82	56	93	94	14	63	93	97	94	32
EPP / Pre (Apr 22,1987 / May 16,1987 ; Apr 14,1988 / May 14,1988)											
Pursuit / Pursuit	0.05 / 0.04	89	58	100	97	23	89	95	95	96	28
Pre (May 16,1987 ; May 14,1988)											
Pursuit	0.06	78	20	83	87	3	71	48	82	24	9
Pursuit + X-77	0.06 + 0.25%	60	43	98	90	8	68	17	50	32	6
Pursuit + X-77 + 28%N	0.06 + 0.25% + 2.5%	82	43	100	75	8	71	58	48	37	10
Burndown (Roundup 0.381b/A + X-77 0,5% + AMS 3.4 lb/A) / pre (May 16,1987 ; May 14,1988)											
Pursuit	0.06	47	85	95	72	15	48	43	52	10	12
Pursuit + Amiben	0.06 + 2	63	82	98	50	23	37	30	57	33	10
Weedy Check	-	0	0	0	0	2	0	0	0	0	6
Weed-free Check	-	100	100	100	100	36	100	100	100	100	30

[a] Rate = ln active ingredient/A. For Pursuit lb/A converted to oz of product/A as follows: 0.04 lb/A = 2.7 oz/A, 0.05 lb/A = 3.3 oz/A, 0.06 lb/A = 4 oz/A, 0.09 lb/A = 6 oz/A.
Amiben 2 lb/A = 2.67 lb/A of 75DS.

Table 2. Effects of herbicide treatment on weed control and yield of no-till soybean in 1989-90 at Waseca, MN.

Herbicide [a]	Rate [b]	1989 Gift	1989 Colq	1989 Rrpw	1989 Vele	1989 Yield	1990 Gift	1990 Colq	1990 Rrpw	1990 Vele	1990 Yield
	(lb/A)	-- (% control			)---	bu/A)	--- (% control			)---	(bu/A)
Fall Applied (Oct 10,1988 ; Oct 31,1990)											
Pursuit	0.06	41	65	75	72	15	44	65	100	100	23
Pursuit	0.09	40	50	50	50	18	66	91	100	100	36
Pursuit	0.12	71	68	68	74	20	84	100	100	100	53
Fall Applied / EPP II (Oct 10,1988 / Apr 24,1989 ; Oct 31,1989 / Apr 26,1990)											
Pursuit / Pursuit	0.03 / 0.03	82	100	100	99	27	64	95	100	100	21
Pursuit / Pursuit	0.05 / 0.04	98	100	95	100	36	73	98	100	100	51
Pursuit + Command /	0.03 + 0.75 /	95	95	100	95	28	79	91	100	100	41
Pursuit	0.03										
EPP I (Apr 13,1989 ; Apr 12,1990)											
Pursuit	0.06	70	80	100	90	34	59	86	100	100	24
Pursuit	0.09	93	93	100	95	33	24	61	100	100	15
Pursuit Plus	0.94	72	73	75	73	36	75	82	100	100	36
EPP II (Apr 24,1989 ; Apr 26,1990)											
Pursuit	0.06	76	100	100	92	27	70	90	100	100	33
Pursuit	0.09	100	100	100	100	32	77	88	100	100	47
Pursuit Plus	0.94	96	92	100	99	42	69	92	100	100	39
EPP I / Pre (Apr 13,1989 / May 10,1989 ; Apr 12,1990 / May 18,1990)											
Pursuit / Pursuit	0.03 / 0.03	69	95	100	82	33	79	100	100	100	36
Pursuit / Pursuit	0.05 / 0.04	71	68	75	90	28	69	88	100	100	32
Pursuit + metribuzin /	0.03 + 0.38	91	100	100	90	41	79	100	100	100	44
Pursuit + metribuzin	0.03 + 0.38										
Dual + metribuzin /	2 + 0.38	22	35	50	16	18	85	100	98	100	47
Dual + metribuzin	1 + 0.38										
EPP II / Pre (Apr 24,1989 / May 10,1989 ; Apr 26,1990 / May 18,1990)											
Pursuit / Pursuit	0.03 / 0.03	88	82	100	85	36	81	100	100	100	45
Pursuit / Pursuit	0.05 / 0.04	99	100	100	100	34	88	100	100	100	48
Pursuit + metribuzin /	0.03 + 0.38	96	100	100	100	48	85	100	100	100	44
Pursuit + metribuzin	0.03 + 0.38										
Dual + metribuzin /	2 + 0.38										
Dual + metribuzin	1 + 0.38	38	45	50	39	26	62	100	100	100	30
EPP II / post (Apr 24,1989 / June 8,1989 ; Apr 26,1990 / June 14,1990)											
Pursuit /	0.03 /	98	95	100	100	26	95	94	100	100	54
Basagran + Poast +	0.5 + 0.15										
Dash + 28%N	1.25% + 5%										
Burndown / preemergence (May 9,1989 / May 10,1989 ; May 18,1990 / May 18,1990)											
Roundup + X-77 + AMS /	0.38 + 0.5% + 3.4	30	32	62	31	12	85	96	100	100	49
Dual + metribuzin	3 + 0.5										
Weedy Check	-	0	0	0	0	3	0	0	0	0	5
Weed-Free	-	100	100	100	100	42	100	100	100	100	54

[a] metrubuzin = Sencor/Lexone, Pursuit Plus = Prowl + Pursuit.

[b] rates = lb active ingredient/A to convert to product/A:

		Pursuit:
Command	0.75 lb/A = 0.75 qt/A	0.03 lb/A = 2 oz/A
metrubuzin	0.38 lb/A = 0.5 lb 75DF/A	0.04 lb/A = 2.7 oz/A
Pursuit Plus	0.94 lb/A = 2.5 pt/A	0.05 lb/A = 3.3 oz/A
Dual	2 lb/A = 1 pt/A	0.06 lb/A = 4 oz/A
Poast	0.15 lb/A = 0.8 pt/A	0.09 lb/A = 6 oz/A
Basagran	0.5 lb/A = 0.5 qt/A	0.12 lb/A = 8 oz/A

REDUCED HERBICIDE RATES AND CULTIVATION FOR WEED CONTROL IN SOYBEANS

W.E. Lueschen, R.M. Schmitt, J.L. Gunsolus and T.R. Hoverstad

Studies have been conducted since 1988 to evaluate the effects of postemergence herbicide rates, application timing and cultivation on weed control in soybeans. Our objective has been to evaluate rates of application of Poast and Basagran plus Blazer when applications were made approximately 13 and 14, 20 and 21, and 27 and 28 days after planting (DAP). Herbicide rates were approximately equivalent to one-fourth, one-half and full-label rates. Actual rates were: Poast 0.05 lb/A (0.25 pt/A), 0.1 lb/A (0.5 pt/A) and 0.2 lb/A (1 pt/A) and rates of Basagran + Blazer were 0.25 + 0.06 lb/A (0.5 + 0.25 pt/A), 0.5 + 0.13 lb/A (1 + 0.5 pt/A) and 1 + 0.25 lb/A (2 + 1 pt/A). We also evaluated three cultivation regimes: no cultivation, one cultivation 14 days after herbicide application or two cultivation, one 7 days after herbicide application with a repeat cultivation 7 days later. In 1989 and 1990 all cultivated plots were cultivated an additional time to control late emerging weeds. In all cases the Poast was applied one day prior to applying the Basagran plus Blazer tank mixture. This was done to prevent antagonism that would have interfered with the results. Oil concentrate was added to both herbicide treatments at the rate of 1 qt/A with a total spray volume of 20 gpa.

The soybean variety was 'Hardin' planted in 30-inch rows at a seeding rate of 150,000 seeds/A. Planting dates ranged from mid-May to early June.

Giant foxtail was the dominate weed species all three years. Redroot pigweed, common lambsquarters and velvetleaf populations were light to moderate but were adequate to evaluate. Yield responses were primary related to control of giant foxtail. Cultivation was essential to obtain good weed control, especially with the reduced herbicide rates (Table 1). Without cultivation poor giant foxtail control was observed in September with Poast applied 13 DAP. This was the result of germination of giant foxtail after the herbicide was applied. With cultivation Poast applied at 0.05 lb/A (0.25 pt/A) gave nearly 80% giant foxtail control. An additional cultivation did not influence giant foxtail control very much. With the 0.1 lb/A (0.5 pt/A) rate of Poast excellent control of giant foxtail was obtained when this treatment was cultivated. With both the lowest rate of Poast and the intermediate rate, the best application timing was 13 or 20 DAP. Application made 27 DAP consistently resulted in reduced giant foxtail control.

Response of broadleaf weeds to rate and time of Basagran + Blazer application were similar to those discussed above for giant foxtail control with Poast. Early application and cultivation were necessary for good control of broadleaf weeds. The biggest response to rate of application was observed with velvetleaf.

Based on the results of these studies that were conducted under two dry environments (1988 and 1989) and one wet environment (1990), reduced rates of postemergence herbicides have excellent potential when combined with cultivation. Poast applied at 0.1 lb/A (0.5 pt/A) gave excellent control of giant foxtail when applied from 13 to 20 DAP. Likewise, Basagran + Blazer at 0.5 + 0.12 lb/A (1 pt + 0.5 pt/A) gave good to excellent control of broadleaf weeds especially when applied 14 DAP. Cultivation was essential with these reduced rates to prevent yield losses.

Several factors need to be considered by those considering below-label rates of herbicides. The grower must be willing to assume the responsibility if poor weed control results from below-label treatments. A high level of management is necessary to make reduce rates work. Fields need to be monitored carefully to determine the weed stage and growing conditions. It is best to apply postemergence treatments between 14 and 21 days following planting. Later applications may not perform satisfactorily. The grower must adjust his weed control program to climatic conditions. If drought stress symptoms result from dry conditions, or if difficult to control weed species are present, herbicide rates should probably not be reduced below label recommendations since poor control may result.

Reduce rates of herbicide can increase profitability by reducing herbicide costs where high yield levels are maintained. Reduced herbicides rates also benefit the environment since fewer pesticides are used and the risk of contaminating ground and surface waters is reduced.

Table 1. Effects of herbicide rate, application timing and cultivation on weed control and soybean yield at Waseca, 1988-90.

Herbicide	Rate	Timing	Cultivation	Gift	Colq	Rrpw	Vele	Yield
	(lb/A)	DAP		-- (% control	September) --			(bu/A)
Poast + COC /	0.05 + 1.25%	13	0	39	74	79	74	17
Basagran + Blazer + COC	0.25 + 0.06 + 1.25%	14						
Poast + COC /	0.05 + 1.25%	20	0	58	65	57	60	21
Basagran + Blazer + COC	0.25 + 0.06 + 1.25%	21						
Poast + COC /	0.05 + 1.25%	27	0	44	66	67	54	18
Basagran + Blazer + COC	0.25 + 0.06 + 1.25%	28						
Poast + COC /	0.1 + 1.25%	13	0	58	72	70	76	22
Basagran + Blazer + COC	0.5 + 0.12 + 1.25%	14						
Poast + COC /	0.1 + 1.25%	20	0	84	71	79	80	32
Basagran + Blazer + COC	0.5 + 0.12 + 1.25%	21						
Poast + COC /	0.1 + 1.25%	27	0	61	77	78	79	26
Basagran + Blazer + COC	0.5 + 0.12 + 1.25%	28						
Poast + COC /	0.2 + 1.25%	13	0	75	75	76	83	32
Basagran + Blazer + COC	0.1 + 0.25 + 1.25%	14						
Poast + COC /	0.2 + 1.25%	20	0	93	68	82	81	32
Basagran + Blazer + COC	0.1 + 0.25 + 1.25%	21						
Poast + COC /	0.2 + 1.25%	27	0	72	70	72	77	28
Basagran + Blazer + COC	0.1 + 0.25 + 1.25%	28						
Poast + COC /	0.05 + 1.25%	13	1	79	83	84	77	34
Basagran + Blazer + COC	0.25 + 0.06 + 1.25%	14						
Poast + COC /	0.05 + 1.25%	20	1	80	79	78	71	30
Basagran + Blazer + COC	0.25 + 0.06 + 1.25%	21						
Poast + COC /	0.05 + 1.25%	27	1	70	80	77	82	24
Basagran + Blazer + COC	0.25 + 0.06 + 1.25%	28						
Poast + COC /	0.1 + 1.25%	13	1	86	92	88	87	38
Basagran + Blazer + COC	0.5 + 0.12 + 1.25%	14						
Poast + COC /	0.1 + 1.25%	20	1	87	78	82	76	36
Basagran + Blazer + COC	0.5 + 0.12 + 1.25%	21						
Poast + COC /	0.1 + 1.25%	27	1	79	82	80	80	30
Basagran + Blazer + COC	0.5 + 0.12 + 1.25%	28						
Poast + COC /	0.2 + 1.25%	13	1	90	86	88	95	40
Basagran + Blazer + COC	0.1 + 0.25 + 1.25%	14						
Poast + COC /	0.2 + 1.25%	20	1	95	78	82	88	37
Basagran + Blazer + COC	0.1 + 0.25 + 1.25%	21						
Poast + COC /	0.2 + 1.25%	27	1	82	78	79	89	30
Basagran + Blazer + COC	0.1 + 0.25 + 1.25%	28						
Poast + COC /	0.05 + 1.25%	13	2	83	89	92	92	36
Basagran + Blazer + COC	0.25 + 0.06 + 1.25%	14						
Poast + COC /	0.05 + 1.25%	20	2	75	79	76	69	30
Basagran + Blazer + COC	0.25 + 0.06 + 1.25%	21						
Poast + COC /	0.05 + 1.25%	27	2	74	85	80	78	27
Basagran + Blazer + COC	0.25 + 0.06 + 1.25%	28						
Poast + COC /	0.1 + 1.25%	13	2	86	90	90	93	37
Basagran + Blazer + COC	0.5 + 0.12 + 1.25%	14						
Poast + COC /	0.1 + 1.25%	20	2	87	80	78	84	35
Basagran + Blazer + COC	0.5 + 0.12 + 1.25%	21						
Poast + COC /	0.1 + 1.25%	27	2	78	80	78	75	29
Basagran + Blazer + COC	0.5 + 0.12 + 1.25%	28						
Poast + COC /	0.2 + 1.25%	13	2	90	89	91	95	38
Basagran + Blazer + COC	0.1 + 0.25 + 1.25%	14						
Poast + COC /	0.2 + 1.25%	20	2	94	88	88	92	39
Basagran + Blazer + COC	0.1 + 0.25 + 1.25%	21						
Poast + COC /	0.2 + 1.25%	27	2	81	81	82	86	32
Basagran + Blazer + COC	0.1 + 0.25 + 1.25%	28						

EFFECTS OF REDUCED HERBICIDE RATES, ROTARY HOEING, CULTIVATION AND ROW SPACING ON WEED CONTROL IN SOYBEANS AT WASECA, MN - 1990

R.M. Schmitt, W.E. Lueschen and J.L. Gunsolus

Reduced rates of herbicides can mean a more profitable crop for producers and a reduction of pesticides introduced into the environment. Reducing rates of postemergence soybean herbicides has been researched at the Southern Experiment Station each year since 1988 with favorable results. Cultivation has been important for successful weed control with reduced herbicide rates. A study was conducted in 1990 to evaluate the effects of rotary hoeing on weed control in soybeans with reduced herbicide rates. There were three objectives to this research: to investigate (1) reduced rates of soil applied and postemergence herbicides, (2) rotary hoeing and cultivation and (3) row spacing effects on weed control in soybeans.

Two row spacings and three rotary hoe treatments were the main plots and herbicide treatments were the subplots. 'Hardin' soybeans were planted on May 30, 1990 at a seeding rate 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 June 6, 1990 when the soybeans were in the crook stage and one-half an inch below the soil surface. Weeds had begun to germinate but had not yet emerged. The second rotary hoeing was done on June 8, 1990 with the soybeans in the crook stage and beginning to emerge. Weeds had not yet emerged. The 30-inch row spacings were cultivated on July 2 and July 11. Post emergence applications were timed toward 2-inch foxtail.

Rotary hoeing delayed weed emergence. Treatments receiving no rotary hoeing or a single rotary hoeing on June 6 were sprayed with either Poast or Pursuit on June 18. On June 20 Basagran + Blazer was applied to plots previously sprayed with Poast. On June 21 treatments that were rotary hoed on June 6 + June 8 were sprayed with either Poast or Pursuit. Two hours later, plots that were sprayed with Poast were sprayed with Basagran + Blazer.

Giant foxtail was the predominant weed species at this location. Pursuit gave over 80% giant foxtail control when applied PPI and over 95% control when applied postemergence at both rates. Cultivation did not increase giant foxtail control in the 30-inch row spacing. Treflan gave 80% giant foxtail control when cultivated and 75% control in the 10-inch row treatments. Lasso averaged 80% control in both 30-inch and 10-inch row spacings. A postemergence application of Poast followed by Basagran + Blazer gave 85% giant foxtail control and cultivation was necessary to control late emerging weeds.

Broadleaf weed infestations were light and Pursuit applied either preplant or postemergence provided nearly complete control of all broadleaf weeds regardless of cultivation or rotary hoe treatment. Similar results were observed with Poast followed by Basagran + Blazer. Treflan provided good control of common lambsquarters. Redroot pigweed control with Treflan was poor in 10-inch rows but Treflan provided good control of redroot pigweed in cultivated 30-inch rows. Lasso preemergence generally provided lower levels of control of broadleaf weeds than Treflan preplant incorporated. Rotary hoeing had no effect on weed control due to wet soil conditions at time of rotary hoeing.

Table 1. Effects of reduced herbicide rate, rotary hoeing, cultivation and row spacing on weed control in soybeans at Waseca, MN in 1990 (Schmitt, Lueschen and Gunsolus).

				Weed control								
				Giant Foxtail		Common Lambsquarters		Redroot Pigweed		Velvetleaf		
Treatment	Rot[1] Hoe	Approx. Cost[2]	Soy Inj	7/13	9/13	7/13	9/13	7/13	9/13	7/13	9/13	Yield
		$/A	%									bu/A
Treflan 0.75 lb/A Preplant incorporated												
10-inch rows	0	6.56	0	69	46	93	92	79	82	47	80	31
	1	8.94	0	76	58	84	91	57	71	25	68	32
	2	11.32	0	76	51	80	90	72	77	51	89	36
30-inch rows	0	14.60	0	79	70	96	100	93	90	56	54	30
	1	16.98	0	80	83	85	100	89	100	63	75	32
	2	19.36	0	80	81	97	100	89	93	66	90	34
Pursuit 0.03 lb/A Preplant incorporated												
10-inch rows	0	9.93	0	82	71	100	100	100	100	91	100	48
	1	12.31	0	79	60	95	100	98	100	95	91	49
	2	14.69	0	78	74	100	100	100	100	94	100	52
30-inch rows	0	17.97	0	87	91	100	100	100	100	96	100	41
	1	20.35	0	85	88	98	100	98	100	92	100	38
	2	22.73	0	84	96	98	100	98	100	93	100	45
Pursuit 0.06 lb/A Preplant incorporated												
10-inch rows	0	18.55	0	86	91	100	100	100	100	95	100	61
	1	20.93	0	85	84	93	100	100	100	96	100	50
	2	23.31	0	82	85	97	100	97	100	96	100	64
30-inch rows	0	26.59	0	97	100	100	100	100	100	100	100	36
	1	28.97	0	92	98	100	100	100	100	100	100	38
	2	31.35	0	90	97	100	100	100	100	96	100	43
Lasso 2.5 lb/A Preemergence												
10-inch rows	0	16.09	0	77	57	62	53	64	72	30	100	34
	1	18.47	0	84	76	78	82	78	68	57	66	52
	2	20.85	0	82	69	76	100	66	83	36	72	46
30-inch rows	0	24.13	0	84	80	70	77	88	92	55	73	35
	1	26.51	0	84	83	74	77	91	82	72	82	32
	2	28.89	0	95	96	96	100	96	100	88	90	33
Poast + COC 0.05 lb/A + 1.25% / Basagran + Blazer + COC 0.25 + 0.06 lb/A + 1.25% Post.												
10-inch rows	0	13.70	4	85	79	89	95	91	100	88	100	47
	1	16.08	3	84	69	94	100	91	100	92	100	45
	2	18.46	5	78	45	92	100	90	93	84	83	41
30-inch rows	0	21.74	1	96	91	98	100	100	100	96	100	38
	1	24.12	2	92	96	95	90	96	100	98	91	39
	2	26.50	1	88	77	98	100	100	100	96	100	37

continued

Table 1 cont.

Treatment	Rot[1] Hoe	Approx. Cost[2]	Soy Inj	Giant Foxtail 7/13	Giant Foxtail 9/13	Common Lambsquarters 7/13	Common Lambsquarters 9/13	Redroot Pigweed 7/13	Redroot Pigweed 9/13	Velvetleaf 7/13	Velvetleaf 9/13	Yield
		$/A	%									bu/A
Pursuit + 28%N + surfactant 0.03 lb/A + 1.25% + 0.25% Postemergence												
10-inch rows	0	10.93	1	97	95	98	100	98	100	94	100	62
	1	13.31	8	96	100	98	95	100	100	97	100	65
	2	15.69	8	95	97	93	94	97	100	93	91	75
30-inch rows	0	18.97	2	100	100	100	100	100	100	96	100	42
	1	21.35	6	97	99	98	100	100	100	97	100	37
	2	23.73	5	97	99	100	100	100	100	97	100	40
Pursuit + 28%N + surfactant 0.06 lb/A + 1.25% + 0.25% Postemergence												
10-inch rows	0	19.55	1	100	100	100	100	100	100	98	100	67
	1	21.86	8	98	100	100	100	100	100	99	100	75
	2	24.24	8	97	100	98	100	100	100	94	100	69
30-inch rows	0	27.59	2	100	100	100	99	99	98	98	100	35
	1	29.97	6	100	100	100	100	100	100	99	100	48
	2	32.35	5	100	100	100	100	100	100	98	100	43
Weedy Checks												
10-inch rows	0	0.00	0	10	0	30	100	30	85	13	82	19
	1	2.38	0	12	0	17	100	17	80	18	80	10
	2	4.76	0	35	0	30	100	30	83	30	93	16
30-inch rows	0	8.04	0	49	45	55	80	53	77	48	58	20
	1	10.42	0	53	59	65	100	63	79	63	100	25
	2	12.80	0	68	61	67	93	68	80	70	93	28
LSD (0.05) Row spacing			1	3	4	3	3	5	4	4	5	3
Rotary hoe			1	3	4	4	4	6	5	5	6	4
Herbicide			1	4	6	7	5	6	6	6	8	5

[1]Rot hoe = Rotary hoeing: 0 = none; 1 = 6 days after planting; 2 = 6 + 8 days after planting.

[2]Includes approximate herbicide costs and cost of rotary hoeing and cultivation only.

EFFECT OF BIOLOGICAL SEED TREATMENTS ON PHYTOPHTHORA ROOT ROT

W. C. Stienstra
Department of Plant Pathology

W. E. Lueschen
Southeastern Experiment Station

OBJECTIVE

To evaluate biological seed treatments and chemical products for Phytophthora Root Rot (PRR) damage control as measured by stand and yield.

PROCEDURES

Seed of Corsoy 79, BSR101 and II-54-254 were treated, counted, packaged and planted May 24, in a randomized complete block, 4 rows 30", 4 replicates with plot size of 10 x 12 ft. Seven seed per foot was the seeding rate for all treatments. Seed treatments were applied with lab batch seed treater at recommended rates. A 5 foot section of row selected early was used for stand counts. The Webster clay loam soil with high organic matter, adequate P & K levels is well drained and tiled. Rain fell weekly and some flooding was observed.

RESULTS

Disease was very low and few plants were observed with PRR. Seed treatments or additional seed resulted in no increase in yield while some stand differences were observed. Final populations did not appear to effect yield. This is the 3rd year of this testing and seed treatments are not recommended if good seed quality is planted into well prepared seed beds. Seed treatment is recommended when germination of seed lots is poor less than 85% or if genetic resistance to specific disease is poor and you can reasonably expect the disease to occur.

EFFECTS OF SEED TREATMENT ON SOYBEANS WASECA - 1990

TREATMENT	VARIETY II-54-254 POPULATION 1000'S/A				BSR101 POPULATION 1000'S/A				CORSOY 79 POPULATION 1000'S/A			
	6/6	6/20	FINAL	YIELD BUS/A	6/6	6/20	FINAL	YIELD BUS/A	6/6	6/20	FINAL	YIELD BUS/A
7 seed/ft	112.8	138.1	127.6	57.3	98.4	125.4	114.1	72.5	91.9	113.3	99.3	65.8
10 seed/ft	142.8	169.0	156.4	61.1	115.0	137.2	122.0	67.8	136.8	163.8	143.8	65.5
Ridomil 5G 3 oz/100 rf	72.8	101.5	93.6	58.1	107.2	128.9	125.4	56.2	101.5	121.5	115.0	67.6
Apron .75 oz/100#	74.9	110.6	101.1	53.8	93.6	116.7	107.2	69.2	85.4	116.3	105.4	63.9
Biological Peat Powder	65.8	98.9	74.0	52.4	78.8	101.9	100.2	69.6	81.9	103.2	98.4	62.4
Biological Clay Powder	73.1	101.9	95.8	52.6	92.8	126.8	120.2	63.9	95.0	111.5	101.5	60.8
Biological Clay Granule	87.6	112.4	92.8	53.1	108.9	132.4	118.5	67.7	89.3	108.4	107.2	63.1
Biological Clay Granule & Apron	99.3	119.8	112.4	53.5	92.3	111.9	111.5	65.9	86.7	112.4	104.1	65.7
Average	91.2	119.0	106.7	55.2	98.4	122.7	114.9	66.6	96.1	118.8	109.3	64.4

Dairy/Holstein-Beef Research

HOLSTEIN-BEEF

Performance and Carcass Characteristics of Holstein Steers in the Feedlot With or Without Finaplix vs Synovex Implants During the Last 100 Days

H. Chester-Jones and D. M. Ziegler, Southern Experiment Station, Waseca
J. C. Meiske and B. T. Larson, Department of Animal Science, St. Paul
T. M. Peters, Nutritional Consultant, Esmond, IL

Summary

Two groups of 36 feedlot Holstein steers (av wt 758 lbs) were used in two studies to evaluate the effect of a final implant on steer performance during the last 100 days in the feedlot, and on subsequent carcass quality. Comparison of using Synovex vs Synovex in combination with Finaplix as final implants were also evaluated. All steers had received a third implant of Ralgro 108 days prior to initiation of these studies. There were no performance differences ($P > .05$) due to type of implant used. Steers that did not receive a final implant gained 18% slower ($P < .05$) and utilized their feed 11% less efficiently ($P < .05$) than implanted steers. Average daily gains, daily DM intakes and DM/100 lb gain were 17.68, 2.66, 665; 18.75, 3.14, 597; 19.03, 3.14 and 606 lb for steers receiving no implant, Synovex and Finaplix + Synovex combination implants, respectively. Non-implanted steers had a higher ($P < .05$) marbling score and quality carcass grade than those implanted with Synovex. Steers implanted with Finaplix + Synovex had similar ($P > .05$) carcass quality to the other cattle groups.

Objectives

The objectives of these studies were: a) to evaluate the effect of a final implant on performance of feedlot Holsteins and subsequent carcass quality, and b) evaluate the effect of using Synovex alone vs combination of Synovex (progesterone and estradiol) and Finaplix (trenbelone acetate) as final implants.

Experimental Procedure

Seventy-two Holstein steers (av wt 758 lb) housed in a conventional pole barn feedlot were assigned to four replicate pens (6 steers/pen) of three treatments. Treatments consisted of no implant, Synovex (S) implant alone or in combination with Finaplix (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 at 77-day intervals 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 (50% CP, 225 mg monensin/hd) 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.

Conclusion

Performance data is summarized in Table 1. The study demonstrated positive performance advantages from implanting cattle during the last 100 days in the feedlot. The implications of differences in carcass quality suggest that the use of implants as management tools can be refined to allow producers to meet their preferred market niche and still maintain optimal economic return.

An overall additive effect on steer performance for the combination F + S implant vs S alone was not demonstrated. However, within weight ranges an additive effect was apparent. Between 800 and 900 lbs, non-implanted steers gained 5.1 and 13.9% slower than those receiving S and F + S implants, respectively. Between 900 and 1000 lbs steers implanted with F + S and S gained 26.9 and 21.3% faster, respectively, compared to non-implanted steers. There was no evidence of a "stall-out" period in steer performance from 900 lbs regardless of whether an implant treatment was imposed.

Table 1. Effect of final implant on performance and carcass characteristics of Holstein steers during final 100 days in the feedlot

	Implant treatment[a]			
Item	No Implant	Synovex-S	Finaplix + Synovex-S	SE
No. steers	24	24	24	
Initial wt, lb[b]	768	756	749	5.1
Final wt, lb[bc]	1116	1114	1107	11.2
Days on feed	131[d]	114[e]	114[e]	3.5
Daily DM intake, lb	17.68	18.75	19.03	.51
Daily gain, lb	2.66[d]	3.14[e]	3.14[e]	.10
Feed/100 lb gain, lb DM	665[d]	597[e]	606[e]	14
Feed cost/100 lb gain, $[f]	31.20	27.40	28.00	
Carcass characteristics:				
Carcass wt, lb	669	668	664	6.8
Dressing percentage	59.7	60.3	59.9	.3
REA, sq. in.	9.6	10.2	10.1	.2
Fat depth, in.	.24	.27	.23	.01
KPH, %	2.4	2.5	2.5	.1
Marbling score[g]	5.2[d]	4.7[e]	4.9[de]	.1
Av. Quality Grade	Choice-	Select+	Select+	

[a] All cattle received a third implant 108 days prior to the study.
[b] Obtained after withholding feed and water 16 h.
[c] Adjusted to a common dressing percentage of 60.0.
[de] Row means with different superscripts differ ($P < .05$).
[f] Based on corn @ $80/ton; supplement @ $240/ton; corn silage @ $25/ton.
[g] Slight = 4.0; small = 5.0

HOLSTEIN-BEEF

Effect of Feed Flavors and Probiotics on Performance of Young Male Holstein Calves During the Pre-Weaning and Immediate Post-Weaning Periods

H. Chester-Jones and D. M. Ziegler, Southern Experiment Station, Waseca
J. C. Meiske, D. Otterby and P. T. Anderson, Department of Animal Science, St. Paul
S. Moreland, Feed Flavors, Inc., Wheeling, IL

Summary

Two groups of 48 purchased male Holstein calves (av 7 days old) were used for two consecutive studies to evaluate the incorporation of feed flavors and probiotics into the dietary regimen during the pre-weaning and immediate post-weaning periods. In experiment 1 individually fed calves offered feed flavored starter diets with or without probiotics performed similarly ($P > .05$) over a 57-day study to those fed a control diet with or without probiotics. Average DM intake, daily gains and feed/gain across all calf groups were 2.60, 1.10 and 238 lb, respectively. Daily gains by calves during the first 28 days in group pens averaged 1.98 and 1.88 lb for those fed diets with or without probiotics, respectively. In experiment 2 calves fed flavored milk replacer pre-weaning with or without flavored starter diets pre- and post-weaning performed similarly ($P > .05$) to those calves fed liquid and dry diets without added flavor for a 47-day study. Average DM intake, daily gain and feed/gain among all calves were 1.89, .85 and 224 lb, respectively. Initial feedlot performance was similar ($P > .05$) among calf groups. Incorporation of feed flavors and probiotics into dietary regimens for young male Holstein calves did not appear beneficial.

Objectives

The objectives of this study were to: a) compare the effect of probiotics and feed flavors on performance of young purchased male Holstein calves during the pre- and post-weaning periods when individually fed, and b) to monitor performance of calves during initial group feeding in the feedlot.

Experimental Procedures

Two groups of 48 male Holstein calves, av 7-days old, were purchased from nineteen dairy farms in S.E. Minnesota and used for two consecutive studies over a 10-month period at the Southern Experiment Station. Calves were directly picked up from individual pens or hutches at each farm and transported to the Station calf facility. Prior to pickup all calves received an oral vaccine for rota-corona virus.

Experiment 1. In experiment 1 all calves were pre-assigned to one of four dietary treatment groups of 12 calves each. Diets were: a) control starter diet, b) control starter + probiotics (C+P), c) starter with added dry feed flavor (Calf-ADE) and d) Calf-ADE starter + probiotics (Calf-ADE + P). At pickup, calves assigned to the C+P and Calf-ADE + P groups received a 10 g oral dose of probiotics (lactobacillus acidophilus, lactobacillus plantarum, lactobacillus casei and streptococcus faecium). The composition of the dry feed flavor included monosodium glutamate, disodium quanylate, sodium saccharin, ethyl alcohol, glycerol, propylene glycol, calcium silicate and dextrose. Both Calf-ADE and probiotics were provided by Feed Flavors, Inc. Upon arrival at the Southern Experiment Station all calves were weighed and placed in preassigned individual crates. Calves were conditioned to their new environment as per usual Station program whereby they receive 2 feedings of glucose water and electrolytes, are administered a nasal modified live vaccine for infectious bovine rhinotracheitis and parainfluenza, intramuscular injections of vitamins A, D, E, B-Complex, iron and four 5cc doses of penicillin. From the third feeding all calves received milk replacer in twice daily feedings of 2 quarts each. Maximum dry milk replacer daily was limited to 1 lb. Fresh water was provided in buckets to all calves daily. Water supply was monitored to prevent excessive intake. Dry starter diets were offered to all calves during the second day after arrival at the Station. The control starter diet was based on cracked corn, oats, alfalfa meal, SBM and dry molasses. Soybean hulls replaced molasses in Calf-ADE diets. All diets supplied 2000 IU vitamin A and 200 IU vitamin D/lb beef. Calves were full fed their respective diets and individual intakes recorded. During the first 10 days of the study amprolium was incorporated into the milk replacer solution daily to prevent coccidiosis.

Calves were weaned at 4-5 wk old. Those calves assigned to probiotic diets received a second 10 g oral probiotic gel dose at weaning. Calves were individually fed their respective diets for an average of 32 days post weaning. Between 1 and 2 weeks post weaning calves were castrated, dehorned and implanted. At the end of the individual feeding period calves were transferred to a conventional pole barn feedlot in group pens (seven steers/pen) assigned by weight and probiotics vs non-probiotic groups. Calves on the probiotic treatment received a further oral dose of 10 g probiotic gel within 24 hours after being transferred to the feedlot. All calves were group fed the control starter diet (Table 1) for 28 days. Calves were weighed on two consecutive days prior to feeding upon arrival at the Station, at weaning, when moved to the feedlot, and after being fed 28 days in the feedlot. Throughout the study feed refusals were taken as frequently as necessary to allow for uncontaminated feed to be available for the calves. Criteria for evaluation of probiotics and feed flavor was based on feed intake, daily gain and feed/gain ratio.

Experiment 2. The second phase of the study evaluated the use of feed flavors incorporated in both the milk replacer and dry starter diet. Probiotics were not used in the second phase of the study. In this second experiment 48 purchased male Holstein calves were randomly assigned to the following three dietary treatments in groups of 16 calves each; a) control group fed milk replacer and dry calf starter without feed flavor, b) calves fed dry calf starter and milk replacer with feed flavor added and, c) calves fed milk replacer with feed flavor added and dry calf starter without feed flavor to weaning. After weaning calves assigned to groups b and c were fed the same starter diet with added feed flavor. The control diet was based on rolled corn fed at a 1:1 ratio with a 21% protein supplement to supply a total dietary crude protein content of 16.7%, .73% Ca and .53% P on a dry matter basis. Decoquinate was incorporated into the pellet to control coccidiosis at level to provide 56.8 mg decoquinate per 250 lbs body weight daily. Feed flavor (provided by Feed Flavors, Inc.) was added at the rate of 3 lb/ton and incorporated into a second pellet with wheat middlings which replaced dry molasses in the control diet. The pelleted supplement was based on SBM, alfalfa meal, oats, and molasses. Wheat middlings replaced molasses in the feed flavored pellet. All diets provided 2000 IU vitamin A, 200 IU vitamin D and 34 IU vitamin E/lb diet. Feed flavor was added at 1 lb/ton to the rolled corn and fed to those calves assigned to the flavored starter diet groups. Soybean oil was added to the rolled corn to supply 1.65% in the total diet to reduced the dustiness of the feed.

Upon arrival at the Southern Experiment Station, all calves were weighed and placed in previously assigned individual crates. The calf health conditioning program and other procedures were similar to those described for experiment 1. In addition, within 72 hours after arrival at the Station, a 7 ml jugular blood sample was taken from all calves. Serum from these samples was analyzed for immunoglobulin G levels to describe the colostral immunity each calf had attained from their respective dairy farms.

Calves were weaned at approximately 28 days of age. After weaning calves were full fed their respective starter diets for 27 days in the individual crates then transferred to group feedlot pens of eight calves each. Calves remained on their assigned starter diets for the first 21 days in the feedlot after which time all calves were fed the same starter diet based on 50% cracked corn, 30% oats, 13% soybean meal, 1% limestone, 1% dicalcium phosphate, 1% trace mineralized salt and 2% vitamin pre-mix. Calf weights taken initially, at weaning, when moved to the feedlot and after 21 days in the feedlot were an average of weights taken on two consecutive days prior to feeding. Throughout the study feed refusals were taken as frequently as necessary to allow for non-contaminated feed to be available for the calves. Criteria for evaluation was based on calf performance.

<u>Conclusion</u>

Only 29% of the 48 calves purchased for experiment 2 had optimum IgG levels of >2000 mg/dl. Sixteen calves had IgG levels <800 mg/dl which is considered a failure in colostral antibody transfer. The implications for the calves with suboptimal colostral immunity are their lower ability to combat environmental stress compared to those calves with optimal colostral immunity. This factor may have contributed to the poor performance of some calves.

Performance data are summarized in Tables 1 and 2. Under the conditions of the two experiments discussed, the incorporation of feed flavors and probiotics into dietary regimens for young growing male Holstein calves during the pre-weaning and immediate post-weaning periods did not appear beneficial. More precise information is needed on the relationship between colostral immunity, environment, nutritional regimen and age of young male Holstein calves during the pre-weaning and immediate post-weaning periods. The studies conducted did emphasize the variability of performance of purchased Holstein calves regardless of dietary conditions imposed.

Table 1. Performance of male Holstein calves fed diets with/without feed flavors and/or probiotics during the pre-weaning and immediate post-weaning periods - - Experiment 1.

Item	Starter diets fed[a]				
	Control	C+P	Calf-ADE	Calf-ADE +P	SE
No. calves[b]	12	11	11	12	
Initial age, days	9	8	8	7	
Initial wt, lb[c]	96	92	92	95	3.0
	---------- Pre-weaning, av 25 days ------------				
Weaning (W), wt, lb[c]	107	102	100	102	4.0
Daily feed intake (DFI), lb DM					
Milk replacer	.85	.83	.83	.82	.04
Calf starter	.72	.80	.51	.46	.12
Total DFI to W, lb DM	1.57^{de}	1.63^{d}	1.34^{de}	1.28^{e}	.13
Daily gain (ADG), lb	.46	.42	.33	.27	.11
	--------- Post-weaning, av 32 days ------------				
Final wt, lb[c]	161	153	153	156	7.0
DFI, lb DM	3.73	3.40	3.43	3.42	.29
ADG, lb	1.69	1.551.71	1.74	.12	
Feed/100 gain (F/G), lb DM	221	219	201	197	9.0
	----- Overall performance, av 57 days -----				
DFI, lb DM	2.79	2.66	2.54	2.46	.22
ADG, lb	1.14	1.09	1.09	1.07	.11
F/G, lb DM	245	244	233	230	9.0

[a] C+P = control starter diet + probiotics; Calf-ADE = starter diet with feed flavor; Calf-ADE + P = Feed flavored starter diet + probiotics.

[b] Two calves died during pre-weaning period.

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

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

Table 2. Performance of male Holstein calves fed diets with and without feed flavors during the pre-weaning and immediate post-weaning periods - Experiment 2.

Item	Dietary group[a] A	B	C	SE
No calves[b]	16	15	14	
Initial age, days	7	6	6	
Serum IgG, mg/dl[c]	1648	1529	1281	246
Initial wt, lb[d]	99	95	96	2.9
	------ Pre-weaning, av 21 days -------			
Weaning (W), wt, lb[d]	105	99	101	3.4
Daily feed intake (DFI), lb DM				
Milk replacer	.97	.96	.95	.02
Calf starter	.48	.35	.39	.09
Total DFI to W, lb DM	1.45	1.31	1.34	.10
Daily gain (ADG), lb	.29	.19	.24	.10
	----- Post-weaning, av 26 days ------			
Final wt, lb[d]	142	132	136	6.0
DFI, lb DM	3.01	2.69	2.88	.26
ADG, lb	1.42	1.27	1.35	.26
Feed/100 lb gain (F/G), lb DM	212	213	2.4	
	- Overall performance, av 47 days -			
DFI, lb DM	2.03	1.73	1.92	.19
ADG, lb	0.92	.79	.85	.10
F/G, lb DM	226	219	226	.18

[a] A = No feed flavor added, B = flavored starter but none in milk replacer; C = flavored starter and milk replacer.

[b] Three calves died during the pre-weaning period.

[c] Serum immunoglobulin G levels, 3 days after arrival at the Station.

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

HOLSTEIN-BEEF

Evaluation of Hydrolyzed Feathermeal and Urea as Main Nitrogen Sources in Pelleted Protein Supplements Fed in High Energy Diets to Growing Holstein Steers

H. Chester-Jones and D. M. Ziegler, Southern Experiment Station, Waseca
J. C. Meiske and B. T. Larson, Department of Animal Science, St. Paul

Summary

Two groups of 36 Holstein steers (av wt 460 lb) were used to evaluate the use of urea, feathermeal or a combination of urea and feathermeal incorporated into pelleted protein supplements as main N sources in high energy growing diets. Supplemental N source did not affect ($P > .05$) steer performance. Average daily gain, daily DM intake, and DM/100 lb gain were 3.20, 15.85, 495; 3.35, 16.14, 482; 3.28, 15.93 and 486 lb for steers fed the urea, feathermeal and combined supplements, respectively. Steers fed feathermeal tended to show higher average daily gains throughout the study. Ruminal fluid pH, ammonia-N and VFA concentrations were similar ($P > .05$) for steers fed the three different protein supplements. Growing diet did not affect ($P > .05$) performance or carcass composition when all steers were fed a common finishing diet. There were interactions ($P < .05$) between groups of steers in the finishing phase for some performance parameters.

Objectives

The objectives of this study were: a) to compare urea and hydrolyzed feathermeal as nitrogen sources incorporated in pelleted protein supplements in high energy growing diets fed to Holstein steers from 460 lb to heavy feeder weight of over 800 lb, and b) to evaluate the effects of these growing diets on final carcass composition after steers had been fed a common finishing diet to market weight.

Experimental Procedure

Two groups of 36 Holstein steers (av wt 460 lb) that had been fed whole or rolled corn with a pelleted plant protein supplement from weaning were used for two consecutive studies. All steers had been purchased as 7-14 day old calves from dairy farms in SE Minnesota, one group in September another the following April. In each study steers were randomly assigned to two replicate pens (six steers/pen) each of three diets. Diets consisted of a full feed of corn (whole used on the first study and rolled for the second study), corn silage fed at 12% of the diet DM and a pelleted protein supplement fed at 3 lb/steer, daily. The supplement contained either urea (U), feathermeal (FM) or a combination of urea and feathermeal (UFM), each to supply 50% of supplemental nitrogen (N). Pelleted supplements average 25% CP, 6.4% ADF, and 77.9% TDN. Ingredient and chemical composition of the supplements are shown in Table 1. Steers were full fed their respective treatment diets once daily. Feeds were weighed individually and mixed in the feed bunk. Daily feed intakes were recorded on a group pen basis and feed refusals recorded weekly. Initial and final weights were an average weight taken on two consecutive days prior to feeding. Steers were fed their respective growing diets for 125 days. On day 120 in each study ruminal fluid samples were taken from each steer at 3 hours post feedings and analyzed for pH, then frozen for subsequent ammonia-N and individual volatile fatty acid (VFA) concentrations. At the termination of the growing phase steers were slowly introduced to a common finishing diet of rolled corn, corn silage fed at 12% of the diet DM and urea protein supplement (50% CP; 225 mg rumensin/d) fed at 1 lb/head daily. Steers were full fed the finishing diet until mean pen weights averaged approximately 1150 lb when a final terminal shrunk weight was taken after withholding feed and water for 16 hours. Steers were then marketed and individual carcass data collected. Steers were vaccinated for IBR, PI_3, BVD and seven strains of clostridia prior to the study. Steers were implanted with Ralgro every 77 days after weaning.

Conclusion

Performance data for the growing phase is shown in Table 2 and influence of growing diet supplemental N source on performance and carcass composition of steers when fed the same finishing diet is summarized in Table 3. The study indicated that feathermeal is an effective N supplement for growing Holstein steers from 460 lb. Economics will dictate if the price differential between FM and U permits increased usage of the former by producers. A combination pellet of UFM may be useful in reducing feed costs of gain based on the results of the present study. Sources of N-supplement used in the growing phase did not affect carcass composition of the finished cattle. The study exemplified the environmental effects on performance of feedlot cattle and suggests careful buying and selling decisions are needed to meet individual market preferences by producers to maintain optimum economic return.

Table 1. Composition of pelleted supplements fed in growing diets.[a]

	Supplement, main nitrogen source[b]		
Ingredient	U	FM	UFM
	lb/ton		
Ground corn	1534.8	1232.4	1383.4
Urea	126.8	-	61.7
Feathermeal	-	431.7	215.6
Dicalcium phosphate	77.6	73.2	75.6
Limestone	173.4	175.3	176.3
Trace mineralized salt	50	50	50
Calcium sulfate (gypsum)	11.8	11.8	11.8
Betonite	20	20	20
Vitamin A (30,000 IU/g)[c]	1.2	1.2	1.2
Vitamin D (720,000 IU/lb)[c]	2.2	2.2	2.2
Vitamin E (500 IU/G)[c]	.2	.2	.2
Rumensin 60 (200 mg monensin/steer, daily)	2	2	2

[a] Fed at 3 lb per head daily.

[b] Nitrogen source; U = Urea; FM = Feathermeal and UFM = 50% protein each supplied by urea and feathermeal.

[c] To supply 25,000 IU vitamin A, 2400 IU vitamin D and 15 IU vitamin E per steer daily.

Table 2. Performance of steers fed growing diets with different nitrogen (N) sources in pelleted protein supplements.

Item	N source[a] U	FM	UFM	SE[b]
No. steers	24	24	24	
Initial wt, lb [c]	460	460	460	3.4
Final wt, lb[c]	864	879	870	6.1
Days on feed[c]	125	125	125	
Daily gain, lb	3.20	3.35	3.28	.05
Daily feed, lb DM	15.85	16.14	15.93	.27
Feed/100 lb gain, lb DM	495	482	486	7.3

[a] U = urea; FM = feathermeal; UFM = 50% supplemental N supplied each by urea combined with feathermeal.

[b] Standard error.

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

[d] Based on corn @$86/ton; corn silage @ $25/ton; U supplement @ $16.7/ton; FM supplement @ $183/ton; UFM supplement @ $174/ton.

Table 3. Influence of growing diet supplemental N source on performance and carcass composition of steers fed the same finishing diets.

Item	Growing diet N source[a]			
	U	FM	UFM	SE
No. steers	24	24	24	
Age from birth to market, days	389	382	390	5.4
Initial wt, lb[b]	864	879	870	6.1
Final wt, lb[c]	1077	1078	1070	4.6
Days on feed	89	84	89	4.5
Daily gain, lb [d]	2.45	2.40	2.27	.11
Daily feed, lb DM[e]	18.38	18.55	17.90	.32
Feed/100 lb gain[f], lb DM	764	797	799	26.6
Carcass composition:				
Carcass wt, lb	649	640	641	5.6
Dressing %	60.3	59.4	59.8	.4
Back fat, in.	.27	.28	.27	.01
Rib-eye area, sq. in.	9.7	9.6	9.9	.2
KPH, %	3.1	3.1	3.1	.1
Marbling[g]	5.2	5.1	5.1	.2
Quality grade	Choice -	Choice -	Choice -	

[a] U = urea; FM = feathermeal; UFM = 50% supplemental N supplied each by urea in combination with feathermeal.
[b] Av of two consecutive weights taken prior to feeding.
[c] Obtained after withholding feed and water 16 hours.
[d] Daily gain in spring steers > fall steers ($P<.05$; 2.72 vs 2.02).
[e] Daily feed in spring steers > fall steers ($P<.05$; 18.93 vs 17.63).
[f] Feed/gain in spring steers < fall steers ($P<.05$; 698 vs 875).
[g] Slight = 4.0; small = 5.0; modest = 6.0.

HOLSTEIN-BEEF AND DAIRY

Observations on the Use of Recycled Newspaper in the Dairy and Dairy-Beef Facilities at the Southern Experiment Station

Hugh Chester-Jones, David Ziegler and Rene Greenwald

Background

The use of recycled newspaper for animal bedding is not a new concept; however, the resurgence of an emphasis on recycling has allowed for a number of communities and large municipalities to establish recycling centers that in many cases include provision for processing and baling recycled newspaper. This has presented livestock producers with an alternative bedding source that if used correctly, can offer an economic alternative to more traditional bedding sources. Ideally, a well managed bedding material should provide a clean comfortable environment for the animal allowing for absorption of extraneous material and minimizing potential contamination and growth of harmful environmental organisms.

University of Minnesota Lab Study

A laboratory study conducted in the University of Minnesota Animal Science Department in 1985 compared bacterial growth in fine hardwood chips, recycled manure, chopped newspaper, softwood sawdust and chopped straw when incubated at 99°F. Bacterial species monitored included environmental organisms E. coli, klebsiella pneumonia and streptococcus uberis. Rapid growth of bacteria was seen in recycled manure and chopped straw, some growth in hardwood chips, limited growth in softwood sawdust, and very limited growth in chopped newspaper. The study indicated the potential of chopped newspaper in controlling buildup of environmental bacteria but this needed to be substantiated under more practical farm conditions.

Research at the Southern Experiment Station Dairy Facility

A 34-week study was conducted (completed in 1988) with 72 gestating cows and heifers assigned to one of two pens (10 free stalls/pen) bedded with either chopped straw or newspaper to evaluate the effect of bedding source on prevalence of environmental bacterial growth and subsequent udder contamination. Chopped newspaper was purchased in 60 lb bales from ABC Recycling Center in Rochester. A portable bale chopper was used to further process the paper to average particle sizes of 1/2 to 1-1/2 inches, and allow the paper to be distributed evenly into the stalls. The straw was chopped through a conventional forage harvester. Bedding material was added to each free stall 3 times each week and random samples taken for subsequent bacterial analysis.

The study showed that, under practical conditions, the average growth of environmental pathogens which may cause clinical mastitis were similar between newspaper and straw. The study confirmed that newspaper was as acceptable as straw for use in free stalls for gestating cows. The study did support observations by other producers that newspaper can be a problem to keep in the stalls under windy conditions. The source of paper used for the study did not cause any problems with agitation or pumping the liquid manure pits. Large chunks of cardboard should be removed before processing. Removal of slick paper is also advisable for dairy cow bedding.

Current use of newspaper bedding at the Southern Experiment Station Dairy Facility

Recycled newspaper is now routinely used in the 84-free stall cow barn with slatted floors at the Southern Experiment Station. Newspaper is purchase from Rice County Recycling Center in Faribault in processed 55-60 lb bales for 50 cents/bale. Bales are stored under cover. The portable bale chopper is used to increase the uniformity of the bedding and distribute the paper evenly in each stall.

Observations

An adjustment period was needed to establish a routine for paper usage. Initially too much paper was applied to each stall and the cows tended to waste bedding by dragging material out onto the slats. Another initial observation indicated that paper tended to mat down in the free stalls and became difficult to manage unless new material was frequently added. Eventually, a routine of bedding three times weekly was established using up to 250 lbs paper (4-5 bales) for each 21-free stall lot per week (1.7 lbs per stall daily). At this bedding rate the cows appeared to be dry and comfortable. In comparison to the chopped straw previously used in these free stalls, cows appeared cleaner with paper bedding. Contaminated paper bedding scraped or dragged onto the slats worked through the slatted floor to the manure pit more easily than previously found with chopped straw. The amount of paper used was reduced to approximately 200 lb weekly per 21 stalls as at the higher rate of 250 lb agitation of the liquid manure pit prior to cleaning was more difficult than previously experienced with straw (used at a weekly rate of 175 lbs per 21 stalls). Reprocessing the paper bales through the bale chopper increased the dustiness of the material and a disposable face mask should be worn if a similar system is contemplated. A management system should be adapted to individual circumstances. Although more absorbent than other sources, the amount of paper used may not necessarily be reduced.

Observations of use of recycled newspaper in calf hutches

Traditionally corn cobs as a base plus chopped straw is used in calf hutches at the Southern Experiment Station. Replacing the straw with processed newspaper worked well initially until the amount of paper built up in each hutch during the pre-weaning period. Paper had a tendency to become matted and absorbance efficiency was reduced. Close attention to management is necessary when using paper as bedding for calf hutches.

Current use of newspaper bedding at the Southern Experiment Station Dairy-Beef Facility

The source of paper used in the manure-pack dairy-beef feedlot operation at the Southern Experiment Station is large, coarsely chopped (av 3"-8" squares) bales weighing 1200-1300 lbs purchased from a Mankato Recycling Center. The bales are delivered in 19-ton loads at a cost of $15/ton, unloaded with a front-end loader tractor and stored under cover in a closed pole barn. The paper can easily be separated into manageable leaves when needed. Corn cobs have been the bedding material of choice prior to using newspaper. Twice a year the pens are cleaned and manure applied to a designated area with a conventional manure spreader. The paper works well for feedlot cattle if well managed and with an initial corn cob base applied directly after the pens are cleaned.

Observations of paper vs aspen product (barnsorb) as a bedding source for feedlot pens

Four groups of 6 Holstein steers (av wt 544 lb) were randomly assigned to 4 feedlot pens (15' x 30'). Two pens each were assigned to be bedded with paper or barnsorb (finely processed, 1/4 to 1/2" shavings supplied by American Excelsior Company, Minneapolis). After pens had been cleaned, one of two pens in each treatment was bedded with a corn cob base before adding the paper or barnsorb. All materials were weighed prior to adding to the pens. Subsequent addition of bedding was at the discretion of the dairy-beef technical staff to ensure that the same standard of steer comfort and cleanliness was applied to all four pens. Observations were made over a 3-month period. Both materials were quite acceptable as bedding materials. Within each bedding type the initial addition of a corn cob base reduced the overall use of the paper and barnsorb by 22.4 and 22.9%, respectively. Pens bedded with paper tended to require more frequent addition of fresh material to maintain the same standard of cleanliness. Paper without a corn cob base was more difficult to manage under these conditions. The average daily pen usage over the 3-month period was 78.6, 64.2, 51.6 and 42 lbs for pens bedded with paper alone, paper + corn cob base, barnsorb alone and barnsorb + corn-cob base, respectively. When all pens were cleaned, both bedding materials had decomposed efficiently and did not cause manure handling problems.

Conclusion

Observations on use of recycled newspaper for use in free stalls, calf hutches or feedlot pens have been presented. Newspaper is an acceptable bedding material but requires good management for optimum use. The availability of a consistent product and economic comparisons to other materials will be the basis for the use of paper on the dairy farm.

NET VALUE OF GENETIC IMPROVEMENT: CURRENT STOCKS VS CONTROLS

L. B. Hansen, C. W. Young, and H. Chester-Jones
University of Minnesota, St. Paul 55108, USA

SUMMARY

A designed selection experiment with a true control population has been conducted for over 25 years. Holstein cows in the selection line have been mated to AI bulls with highest transmitting abilities for milk yield and no other traits have been considered. Genetic trend from 1969 to 1983 was estimated to be 126 kg milk per year, and environmental trend was 18 kg milk per year. Correlated responses were decreased percentages of fat and protein, greater health costs especially for mastitis, and improved conformation. Undesirable correlated responses to selection for milk yield were more than compensated by additional income over feed cost from milk sales. True control populations usually have not been included in designed selection experiments of dairy cattle.

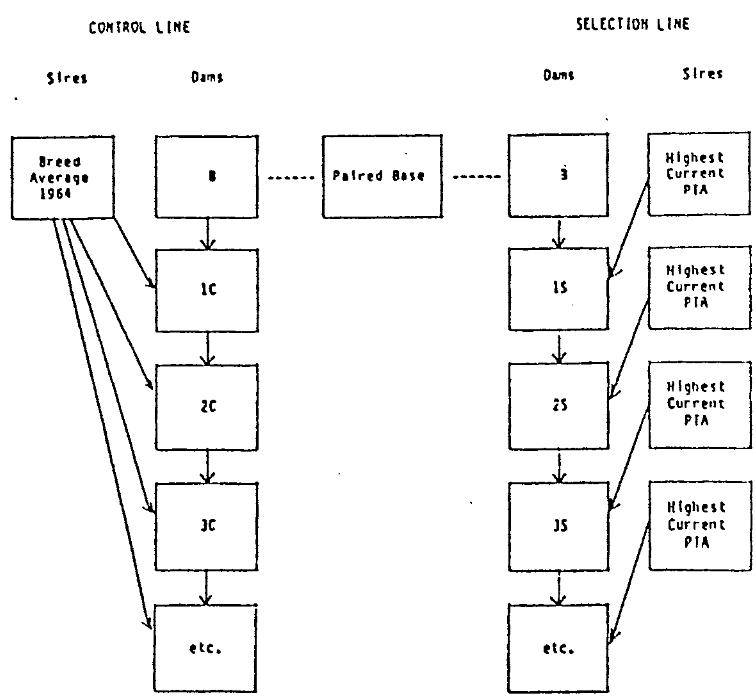
INTRODUCTION

Genetic improvement of dairy cattle for milk yield was not realized in North America until the early 1960's. During the past 25 years, however, tremendous genetic improvement has been made. A timely selection experiment implemented in 1964 at the Southern Experiment Station (Waseca), University of Minnesota, measures direct and correlated responses to single-trait selection for milk yield. A true control population was included in the design.

MATERIALS AND METHODS

Figure 1 has the generational mating scheme designed to monitor changes accompanying genetic selection. In 1964, 66 heifers and young cows were paired by pedigree (mostly sire). One member of each pair was randomly chosen for the control line, and the other member of the pair became part of the selection line. Thus, genetic groups were formed to serve as base-generation females. Details of experimental design were fully explained by Hansen et al. (1979).

Figure 1. Generational Mating Scheme



Twenty AI bulls that were reliably breed average for transmitting milk yield in 1964 were randomly selected from all available AI bulls. The 20 bulls have been used four/year in a 5-year rotation since 1964 as mates for the control line. Semen from the control bulls apparently was unaffected by 25 years of storage in liquid nitrogen. A cross-section of the USA Holstein population in 1964 was represented by the 20 control bulls. When necessary, cows were randomly culled from the line. The four highest bulls for predicted transmitting ability (PTA) of milk have been selected each summer from the US Department of Agriculture (USDA) genetic evaluations to be mates for cows in the selection line. A minimum reliability of 60% has been required for bulls to be considered, and bulls have been used for only one year. No other traits have been considered. Mating has been completely random within genetic lines, except close inbreeding (F>6.25%) has not been permitted. The two lines have been housed and managed together and alike.

RESULTS

Table 1 has phenotypic 12-month production averages for the lines in January 1990. The difference in milk is the direct response to selection for milk, and other differences are correlated responses. Undoubtedly, substantial direct gain resulted from selection for milk. Correlated responses for fat and protein have been decreased percentages but increased volumes of these components. Value of milk produced (+$837) and income over feed cost (+$599) also indicate dramatic change. Ratios (change to control yield) provide the relative changes from selection for milk over 25 years commencing in 1964: +50% milk (kg), +46% fat (kg), +36% protein (kg), +47% value of product, and +57% income over feed cost. Interestingly, relative change was greater for income over feed cost than for milk. This likely results from similar average maintenance requirements for cows in the two lines.

Table 1. 12-month Production Averages for January 1990

Line	Cows	Milk	Fat		Protein		Value of product	Income over feed cost
	(n)	(kg)	(%)	kg)	(%)	(kg)	($)	($)
Selection	61	9193	3.58	329	3.01	277	2616	1647
Control	33	6150	3.65	225	3.30	203	1779	1048
Phenotypic difference		+3043	-.07	+104	-.29	+74	+837	+599

Boettcher *et al.* (1990) used the animal model program of Misztal *et al.* (1987) to examine 518 records of first-lactation milk and fat yield (305-2X-ME) for 1967 to 1988. All pedigrees were traced to birth dates of approximately 1942, and then a single male and single female were assigned as phantom ancestors. For results in Table 2, sires were grouped genetically; control sires were members of one group whereas 70 selection sires were grouped by registration number into four groups of 19 or 20 sires. EBV's were deviated from controls in Table 2. Results were compared to the PTA's from USDA genetic evaluations for July 1989, which also used an animal model but considered records of relatives not in the study. The two methods of obtaining estimated breeding values (EBV's) with an animal model gave similar results.

Differences of mean EBV for selection groups 1 and 4 from the USDA animal model (1845 kg milk) was divided by difference of mean birth year of cows (14.7

yr) to estimate genetic trend from 1969 to 1983 of 126 kg/yr. Difference of phenotypic change and genetic trend provided an estimated environmental trend of 18 kg/yr.

Table 2. Means of EBV from Animal Models for Yield Traits

Line or group	Within study (July 1989) Milk (kg)	Fat (kg)	USDA (July 1989) Milk (kg)	Fat (kg)
Control	0	0	0	0
Selection 1	+1115	+28	+ 470	+15
Selection 2	+1429	+34	+ 938	+25
Selection 3	+1817	+47	+1674	+39
Selection 4	+2059	+53	+2315	+58

Hansen et al. (1979) reported greater health costs for cows in the selection versus control lines. Most differences for lines was because of mammary treatment. Lines did not differ for reproduction costs. Although health costs were greater, extra income over feed cost more than compensated for these costs. Petersen et al. (1985) investigated the udder dimensions of the selection and control. Distances between teats were measured both before and after milking. Increased udder capacity to accomodate greater yield of selection cows apparently came from longer and wider (but not deeper) udders. Milking time and flow rates were examined by Petersen et al. (1986a), and differences of lines were not great enough in first lactation to be of consequence except for milking time. Because selection cows produced more milk, it was not surprising that they took longer to milk than controls. When adjustment was made for the amount of milk produced, milking times did not differ. Multiparous selection cows exceeded controls for milk flow rates. Wautlet et al. (1990) found no differences between the lines for severity of udder, incidence of retained placenta, or dystocia.

Two studies, Petersen et al. (1986b) and Boettcher et al. (1990) looked at classification scores for physical conformation of the two lines. Boettcher et al. (1990) examined linear classification scores recorded on a 50-point scale from 1983 to 1989. Animal model EBV were compared for cows in the two lines and are in Table 3. Conformation improved with selection for milk yield.

Table 3. Difference of EBV from Animal Model for Conformation Traits

Trait	Selection-Control	Trait	Selection-Control
Stature	+2.5 (taller)	Foot angle	+0.2 (steeper)
Strength	+0.5 (stronger)	Fore udder	+0.3 (snugger)
Body depth	+1.7 (deeper)	Rear udder height	+1.7 (higher).
Angularity	+3.4 (sharper)	Rear udder width	+1.8 (wider)
Rump angle	+0.1 (more slope)	Udder support	+1.3 (more cleft)
Rump width	+0.8 (wider)	Udder depth	+0.7 (shallower)
Rear legs	-0.7 (straighter)	Teat placement	+0.1 (closer)

DISCUSSION

Selection for milk yield has dramatically changed Holsteins in North America, and the influence of North American Holsteins is rapidly spreading throughout the world. In many areas, local dairy stocks have essentially been replaced with genetic material from North America. The 1964 control line at the Southern Experiment Station (Waseca), University of Minnesota, is a genetic control that is ideally suited for monitoring direct and correlated responses to selection for yield. This true genetic control may be unique among designed dairy cattle experiments worldwide. Why is this case? Control population often are maintained for laboratory animals, hogs, and poultry, but not dairy cattle. Perhaps, control populations of dairy cattle should be given more consideration in the future when selection experiments are designed.

It should be mentioned at this point that selection for milk yield in this study is not the result of single-trait selection in the strictest sense. Potential AI sires in North America must pass severe selection standards for nonyield traits, mostly conformational, in addition to yield traits before they are progeny-tested. Some dairy producers believe that use of bulls with highest PTA's for yield will slowly deteriorate the conformation of cows in their herds. Conformation is regarded to be important by many producers because of suspected relationships with functionality and survival. Often diminished strength and capacity are predicted by these producers. Results from this designed experiment should help to alleviate most of these concerns. Selection for nonyield traits by AI may minimize the need for dairy producers to consider traits other than yield when choosing progeny-tested bulls to use in their herds.

The two lines have been subjected to recombinant bovine somatotropin (bST) and responses will be reported in 1990. Also, young bulls from the selection and control lines are being compared for testicular development, sperm motility and production, endocrine secretion, and growth rate. Furthermore, semen is being collected from three random sons of each of the original 20 control bulls to perpetuate the control line. Also, an increase in facility size has permitted the selection line to double in size from 30 to 60 cows. A random half of the selection cows have been mated since November 1, 1986 to AI bulls highest for PTA protein (kg) instead of PTA milk. This leaves intact the 1964 design of single-trait selection for milk versus a control population. Plans are to continue this selection study for the foreseeable future.

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DAIRY

Relationships of Feed Utilization to Growth Patterns and Body Compositional Changes in Dairy Heifers from Divergent Genetic Lines

K. D. Murphy, R. D. Appleman, D. E. Otterby, J. G. Linn, B. A. Crooker, and L. B. Hansen, Department of Animal Science, St. Paul
H. Chester-Jones and D. M. Ziegler, Southern Experiment Station, Waseca

Objectives

The objectives of this study are to a) establish a data base 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 composiion estimates to be obtained.

A preliminary summary is given below which will be presented at the 1991 ADAS annual meetings at Utah State University in August.

Holstein heifers (48) from genetic lines (control, C: select, S) in the same herd were used to determine effects of selection for milk yield on dry matter intake and composition of growth. Milk yield of C and S cows differed by 8000 lb/305d lactation in 1990. Nutrient content of diet met 1989 NRC requirements for 1.7 lb gain/d during 4-5, 6-11, and 12-14 months of age (MOA). Individual feed intake (DMI, daily); body weight (BW, biweekly); body condition score (BCS, 1-5) and wither height (WH, monthly) were measured. Indirect body composition was measured at 4, 8, and 12 months of age. Empty body protein was 47.7, 42.5, 82.5, 90.9, 102.7, 119 lb for C and S at 4, 8, and 12 MOA, respectively. Dry matter intake (DMI) and average daily gain (ADG) were 9.0, 1.74; 14.7, 1.85; 15.4 and 1.50 lbs for heifers from the control herd at 4-5, 6-11 and 12-14 MOA, respectively. The heifers from the selection herd had DMI and ADG of 9.7, 1.87; 16.7, 1.98; 18.3 and 1.41 lbs at 4-5, 6-11 and 12-14 MOA, respectively.

The average BW (lb) and DMI/BW% for the control heifers were 325, 2.78; 545, 2.71; 783 and 1.98 at 4-5, 6-11 and 12-14 MOA, respectively. Similar data for the select heifers were 353, 2.71; 590, 2.84; 846 and 2.18 at 4-5, 6-11, and 12-14 MOA, respectively. Wither height of control vs select heifers were 38 vs 39.3; 44.1 vs 45.6; and 47.8 vs 49.8 ins at 4-5 mths, 6-11 mths and 12-14 mths of age, respectively. Consistent differences ($P < .06$) were shown between control and select heifers at all ages for DMI, BW and wither height. Average daily gain differed only in heifers from 6-11 mths of age.

Conclusion

This preliminary summary indicates that heifers selected for milk yield had greater propensity for higher dry matter intake, growth and were different in body composition, compared to heifers with low-milk production potential. Complete summary including first lactation milk production will be included in next year's Annual Report.

Horticultural Research

VACUUM PREMOISTURIZATION SEED TREATMENT FOR IMPROVED SWEET CORN GERMINATION

Vincent Fritz and James Hebel
University of Minnesota
Southern Experiment Station
Waseca, MN

SIGNIFICANCE

Recent interest in the production of *super* sweet corn has presented new challenges to both fresh market producers and processors. Poor germination and seedling vigor in the *super* sweets have prevented the widespread acceptance and production of the newer type of sweet corn. Specifically, factors which have been identified as contributors to poor seed quality include but are not limited to a cracked seed coat, low food reserves, and high sugar levels within the seed. The high sugar level in conjunction with the cracked seed coat create a non-uniform and non-regulated rate of water uptake during initial moisturization which disrupts normal germination processes. This results in leaching of nutrients from the seed and provides a food source for soil borne fungal pathogens that attack and kill the seed or developing seedling, particularly in cold, spring soils. Efforts to minimize the problem of poor germination and seedling vigor through the use of preplanting treatments has been studied at the Southern Experiment Station. The treatments were designed to "control" the uniformity and rate of water uptake during initial moisturization and decrease the amount of nutrient leaching from the seed.

MATERIALS AND METHODS

Seeds of the *super* sweet corn variety 'How Sweet It Is' that had not been treated with fungicide, were premoisturized using dilute salt solutions of $Mg(NO_3)_2$, $Ca(NO_3)_2$, or deionized water. Four replications of 100 seeds each were premoisturized with each solution in the presence and absence of a vacuum. The vacuum treatment consisted of seeds being submerged in a solution within a vacuum vessel for 10 minutes under full vacuum. This procedure was then followed by a 10 minute treatment of 5 psi pressure while seeds were still submerged. This treatment was compared to a standard 20 minute soak and dry non-treated control. All premoisturization was conducted at 25°C. After premoisturization, the seed were double rinsed with deionized water and allowed to air dry for 4 hours. Seeds were rolled up in moistened germination paper (rag dolls) and placed in a germination chamber for 4 days at 10°C and was then transferred to another chamber set at 25°C for 4 more days. After the second 4 day incubation period, the rag dolls were evaluated for germination and seedling vigor by recording root and shoot dry weight.

RESULTS AND DISCUSSION

When averaged across all soaking solutions, the vacuum effect of the treatment reduced germination by 10%. The use of $Ca(NO_3)_2$ resulted in the highest germination however there was not any discernable trend relating to seedling vigor between the salt solutions in the laboratory.

Seeds of 'How Sweet It Is' exposed to the identical premoisturization treatments were treated with captan, thiram, and vitavax and planted in the field in Grand Rapids, MN on June 1. Rate of emergence and yield were recorded.

Results again indicated that the vacuum treatment had deleterious effects on seedling vigor (fig. 1). Whether in the presence or absence of a vacuum, $Ca(NO_3)_2$ treated seed had the best emergence rate when compared to $Mg(NO_3)_2$ and deionized water. Although differences in seedling emergence were observed, yield (dozen/A, useable ears) was not affected by any of the treatments.

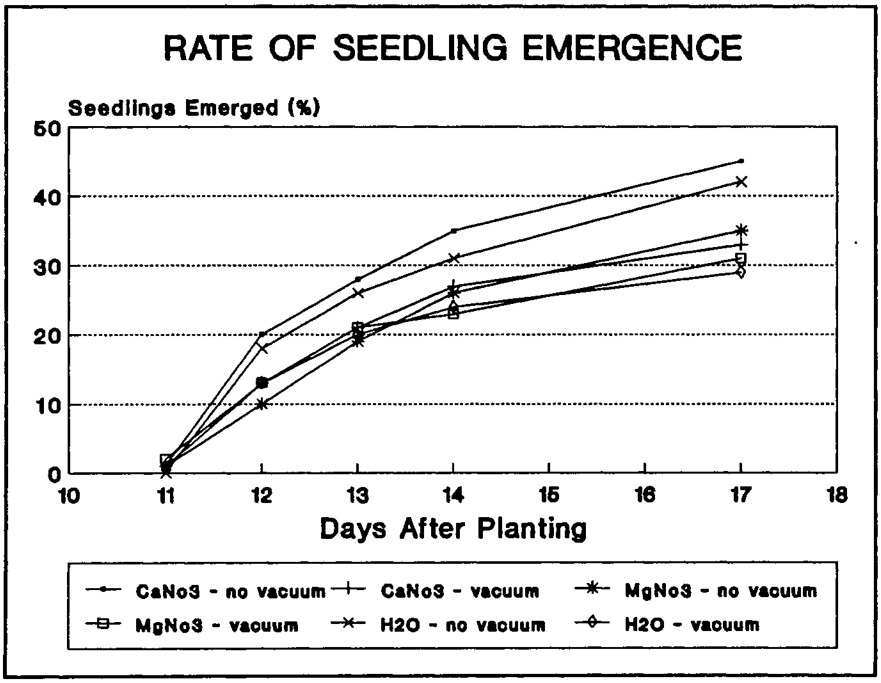

Fig. 1. Seedling emergence of 'How Sweet It Is' seed premoisturized with dilute salt solutions and in the presence and absence of a vacuum.

SUMMARY

The use of vacuum premoisturization needs further study so as to effectively modify the severity of the treatment. Calcium nitrate appears to have some beneficial affect on germination and seedling vigor, however a range of salt concentrations need to be evaluated to maximize this effect. In addition, other salts and temperatures during premoisturization will be conducted to further evaluate the potential for improved germination.

Herbicide combinations for annual weed control in sweet corn. Hertz, Leonard B. and V. Fritz. This study was conducted to evaluate several herbicide combinations for weed control in sweet corn. 'Jubilee' sweet corn was planted May 30, 1990 in a clay loam soil, pH 6.4 and 6.5% organic matter at the Southern Experiment Station, Waseca, MN. The plots were 10 by 30 ft. with four rows spaced 30 inches 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. Weed control and crop injury were rated on June 28 (PPI and PRE) and July 12 (PO). Weed populations consisted of giant foxtail (79%), common lambsquarters (16%), and redroot pigweed (5%). Application dates, sprayer settings, environmental conditions, and plant size are listed below:

Date	May 30	May 30	June 22
Treatment	PPI	PRE	PO
Sprayer			
gpa	20	20	20
psi	40	40	40
Wind (mph)	10	10	3-4
Air temperature (F)	68	68	72
Sweet corn			
leaf no.	--	--	4-5
Giant foxtail			
leaf no.	--	--	3-4
height (inch)	--	--	4-6
infestation	--	--	$34/ft^2$
Common lambsquarters			
leaf no.	--	--	1-2
height (inch)	--	--	2-4
infestation	--	--	$7/ft^2$
Redroot piweed			
leaf no.	--	--	1-2
height (inch)	--	--	2-4
infestation	--	--	$2/ft^2$

Weed control and corn injury are summarized in the accompanying table. All herbicide combinations gave excellent control of the grass and broadleaf weed complex. The addition of the seed additive appears to reduce overall weed control when compared to clomazone alone. Clomazone caused corn injury. Affected plants had chlorotic foliage and a reduced stand of corn after emergence. Corn plots where seed was treated with the seed safener, naphthalic anhydride, had increased plant stands when compared to non-treated corn (Dept. of Horticulture, Univ. of MN., St. Paul).

Table. Annual weed control in sweet corn (Hertz and Fritz).

Treatment	Rate	Method of appl.	Weed control: Gift	Colq	Rrpw	Oval[y]	Corn inj.	Corn stand loss
	(lb/A)		- - - - - - - - - (%)			- - - - - - - - -	(%)	(%)
Command	0.75	PPI	95	93	80	72	40	90
Command + safener[z]	0.75	PPI	85	93	88	65	40	28
Command	1.0	PPI	98	98	85	83	38	90
Command + safener	1.0	PPI	95	95	83	73	45	68
Command	0.5	PPI	93	98	100	90	40	18
+ atrazine + safener	1.5	PPI						
Lasso	2.5	PRE	95	93	100	90	0	0
Lasso	1.5	PRE	90	98	100	88	0	0
+ Bladex	1.0	PRE						
Lasso	2.0	PRE	100	100	100	100	0	0
+ Bladex	1.5	PRE						
Lasso	2.5	PRE	100	100	100	100	0	0
+ Bladex	2.0	PRE						
Lasso	2.5	PRE	100	100	100	100	0	0
+ Bladex	2.0	PRE						
+ Prowl	1.5	PRE						
Lasso	2.5	PRE	100	100	100	100	0	0
+ atrazine	1.5	PRE						
Prowl	1.5	PRE	93	100	100	93	0	0
+ Bladex	2.0	PRE						
Lasso	2.0	PRE	85	95	100	80	0	0
+ Stinger	0.12	PO						
Lasso	2.0	PRE	90	95	100	88	0	0
+ Stinger	0.18	PO						
Lasso	2.0	PRE	85	95	100	80	0	0
+ Stinger	0.24	PO						
Banvel	0.48	PO	0	100	98	33	0	0
Weeded	--	--	100	100	100	100	0	0
Untreated	--	--	0	0	0	0	0	0

[z]Seed treatment: treated with FMC Corp. F-80, naphthalic anhydride seed treatment at a rate of 0.5%w/w.
[y]Oval = overall weed control.

Annual weed control in canning peas. Hertz, Leonard B. and V. Fritz. This study was conducted to evaluate several combinations of herbicides for weed control in canning peas. 'Canners 9901' pea seed was planted May 29, 1990, into a clay loam soil, pH 6.5 and 6.3% 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. Visual ratings of weed control were made on June 28 and July 12. Weed populations were light and consisted of giant foxtail (43%), common lambsquarters (32%), redroot pigweed (17%), velvetleaf (6%), and common ragweed (2%). Application dates, sprayer settings, environmental conditions, and plant size are listed below:

Date	May 29	May 30	June 25
Treatment	PPI	PRE	EPO
Sprayer			
gpa	20	20	20
psi	30	30	30
Air temperature (F)	67	60	85
Wind (mph)	10-15	10	5
RH (%)	75	53	65
Pea			
size (nodes)	--	--	1-2
Giant foxtail			
height (inches)	--	--	1-2
infestation	--	--	$2/ft^2$
Broadleaves			
height (inches)	--	--	1-2
infestation	--	--	$2/ft^2$

Results of this study are summarized in the accompanying table. Several herbicides gave excellent control of the weed population, including clomazone, imazethapyr, bentazon, and sethoxydim. Increasing rates of clomazone gave increased pea injury. The addition of naphthalid anhydride seed safener, significantly decreased pea injury without affecting weed control or pea growth (Dept. of Horticulture, Univ. of MN, St. Paul).

Table. Annual weed control in canning peas (Hertz and Fritz).

Treatment	Rate	Method of appl.	Weed control Gift	Colq	Rrpw	Vele	Oval[x]	Pea injury
	(lb/A)		(%)					(%)
Command	0.5	PPI	100	98	100	98	93	8
Command	0.75	PPI	100	100	100	100	100	28
Command	1.0	PPI	100	100	100	100	100	33
Command + safener[z]	0.75	PPI	100	100	100	100	100	8
Command + safener	1.0	PPI	100	100	98	100	100	3
Treflan	0.75	PPI	100	100	100	98	95	0
Dual	3.0	PRE	98	98	100	95	90	0
Pursuit	0.047	PRE	100	100	100	100	100	0
Pursuit	0.063	PRE	100	100	100	100	100	0
Pursuit	0.094	PRE	100	100	100	100	100	0
Pursuit	0.063	PRE	100	100	100	98	98	0
+ Lasso	2.0	PRE						
Lasso	2.0	PRE	100	100	100	100	100	0
Pursuit + COC[y]	0.063	EPO	95	100	100	93	90	0
Pursuit + UAN[y]	0.063	EPO	95	100	100	98	93	0
Pursuit+COC	0.063	EPO	100	98	100	100	98	0
+ Poast	0.18	EPO						
Basagran + COC	0.75	EPO	100	100	98	100	98	0
+ Poast	0.18	EPO						
Pursuit	0.031	EPO	85	95	100	100	80	0
Pursuit	0.047	PPI	98	100	100	100	98	0
Pursuit	0.031	EPO	100	100	100	90	90	10
+ Treflan	0.5	PPI						
Weeded	--	--	100	100	100	100	100	0
Untreated	--	--	0	0	0	0	0	0
$LSD_{(0.05)}$			4	15	2	6	8	11

[z]Seed treatment: Treated with FMC Corp. F-80, naphthalid anhydride seed treatment at 0.5 % w/w.
[y]Adjuvants: COC=crop oil concentrate, 1qt/A.; UAN = 28% aqueous nitrogen solution with urea and ammonium nitrate, 1 gal/A.
[x]Oval = overall weed control.

PLANT POPULATION AND VARIETY TRIAL RESULTS IN ONIONS

Vincent Fritz and James Hebel
University of Minnesota
Southern Experiment Station
Waseca, MN

SIGNIFICANCE

The recent development of several new onion varieties by commercial seed companies has created an opportunity for Minnesota producers to evaluate the comparative performance of the varieties they currently use through yield and quality studies. Traditionally, the variety 'Trapps', has been used in southern Minnesota, primarily due to the economy of seed cost; a benefit commonly associated with an open-pollinated variety. The dark skin color of 'Trapps' has also been a desirable characteristic. A comprehensive trial was conducted on 20 varieties to determine if yield and quality could be improved through the use of these newer varieties.

In addition, maximum production efficiency can be affected by plant populations. Efforts were made over the past three years to evaluate deviations from current production practices for any improvement of production efficiency.

MATERIALS AND METHODS

Variety Trial

Seeds of 20 varieties were planted on a muck soil in southeast Minnesota (Hollandale) on 35" raised beds in a double row, broadcasted arrangement. All varieties were seeded at a rate of 11-12 seeds/ft. using a Nibex 500 planter. Traditional production practices were followed. All plots were hand harvested, graded, and stored under conventional conditions.

Population Trial

Seeds of the variety 'Trapps' were planted at various seeding rates on a muck soil in Hollandale Minnesota on 35" raised beds in a double row, broadcasted arrangement. Seeding rates were 8-9, 11-12, and 14-15 seeds/foot. Traditional production practices were followed. All treatments were replicated four times. Plots were hand harvested, graded, and stored under conventional conditions.

RESULTS AND DISCUSSION

Variety Trial

In 1990, six varieties produced a **significantly** higher U.S.#1 yield than 'Trapps'. Those varieties were 'Progress', 'Keepsweet II', 'Hustler', 'XPH 3246', 'HXP 2614', and 'Krummery Downing'. When conducting cost comparisons of these varieties with 'Trapps', it is important to include factors such as percent germination, no. of seed/pound, and associated costs for pelleting. In addition, more specific yield comparisons should be conducted if the market has specific size requirements.

Population Trial

Final plant stand was increased as seeding rate increased, however it did not result in a significant increase in U.S.#1 yield. Seeding rate was directly related to boiler (<2" dia.) production.

ONION VARIETY TRIAL
A TWO YEAR SUMMARY

VARIETY	RELATIVE MATURITY (%TOPS DOWN) 1989 Aug. 30	1990 Aug. 28
Paragon	90	98
Sweet Sandwich	45	75
Progress	95	98
Guardian	60	85
Marathon	0	70
Keepsweet II	0	60
Hustler	85	99
XPH 3246	60	98
Citadel	--	95
Benchmark	90	30
Magna Sweet	--	85
HXP 2614	10	25
Rip van Winkel	--	93
North Star	--	98
Krummery Downing	0	10
J K Special	--	0
HMX 0625	--	35
Flame	50	85
Trapps	50	80
Early Downing Globe	--	25

Hollandale, MN
Larry Reynen - Cooperator
Planted: May 3 (1989), April 19 (1990)

ONION VARIETY TRIAL

A TWO YEAR SUMMARY

VARIETY	YIELD (CWT/A) U.S.#1 1989	1990	BOILERS 1989	1990
Paragon	331	448	61	26
Sweet Sandwich	332	477	21	6
Progress	(445)*	500	(24)	20
Guardian	(219)	411	(40)	12
Marathon	(394)	493	(63)	21
Keepsweet II	(314)	600	(53)	32
Hustler	372	546	27	35
XPH 3246	340	575	40	20
Citadel	--	404	--	7
Benchmark	(200)	414	(59)	4
Magna Sweet	--	417	--	99
HXP 2614	(466)	578	(26)	10
Rip van Winkel	--	490	--	40
North Star	--	456	--	53
Krummery Downing	417	501	33	29
J K Special	--	153	--	6
HMX 0625	--	452	--	32
Flame	395	427	33	20
Trapps	345	408	62	30
Early Downing Globe	--	401	--	33
LSD (.05)	84	88	21	18

*Yield estimate based on a non-replicated harvest and not used in statistical comparisons.

Hollandale, MN
Larry Reynen - Cooperator
Planted: May 3 (1989), April 19 (1990)
Harvested: September 5 (1989), September 6 (1990)
Seeded at 11-12 seeds/foot in double broadcasted rows using a Nibex 500 planter

ONION POPULATION TRIAL

A THREE YEAR SUMMARY

SEEDS/FT.	FINAL STAND/A	U.S.#1 (CWT/A)	BOILERS (CWT/A)
8-9	116,843	420	9
	191,005	**456**	**30**
	169,524	*340*	*5*
11-12	147,702	485	15
	237,046	**486**	**53**
	202,009	*342*	*10*
14-15	172,713	443	25
	291,174	**471**	**91**
	252,792	*400*	*13*
LSD (.O5)	23,879	N.S.	9
	45,746	**N.S.**	**N.S.**
	28,623	*N.S.*	*5*

1990 - planted April 18; harvested September 1
1989 - planted April 24; harvested September 6
1988 - planted April 18; harvested September 1

Hollandale, MN
Greg Stegenga - Cooperator
Seeded on 35" raised beds in double broadcasted rows using a Nibex 500 planter

Soil Science Research

SOUTHERN EXPERIMENT STATION

WASECA, MINNESOTA

WEATHER DATA - 1990

Month	Period	Precipitation 1990	Precipitation Normal[1]	Avg. Air Temp. 1990	Avg. Air Temp. Normal[1]	Growing Degree Days 1990	Growing Degree Days Normal[1]
		------ inches -----		------- ° F ------			
January	1-31	0.26	0.84	25.9	10.0		
February	1-28	1.03	0.99	22.6	16.4		
March	1-31	4.02	1.99	35.5	27.6		
April	1-30	2.80	2.64	45.9	44.7		
May	1-10	1.88		53.8		87.5	
	11-20	2.54		52.1		58.0	
	21-31	.89		60.1		119.0	
	Total	5.31	3.76	55.4	57.7	264.5	334
June	1-10	1.37		62.2		133.5	
	11-20	4.32		73.3		231.0	
	21-30	.99		72.9		220.5	
	Total	6.68	4.48	69.5	67.1	585.0	518
July	1-10	2.23		74.5		235.0	
	11-20	2.21		69.2		190.5	
	21-31	1.70		69.8		218.0	
	Total	6.14	4.02	71.1	71.2	643.5	641
August	1-10	0.91		66.9		170.0	
	11-20	4.60		71.1		209.0	
	21-31	0.94		72.6		246.0	
	Total	6.45	3.99	70.3	68.8	625.0	579
September	1-30	1.50	3.36	64.6	59.8	476.5	311
October	1-31	1.36	2.08	47.7	48.9		38
November	1-30	0.53	1.43	37.5	32.5		
December	1-31	1.63	1.02	15.1	18.0		
Year	Jan-Dec	37.71	30.60	46.9	43.6	2594.5[2]	2421
Growing Season	May-Sep	26.08	19.61	66.2	64.9	2594.5	2383

[1] 30-year normal from 1951 – 1980.
[2] 50 to 86 ° F base, May 1 until first fall frost.

Notes:
1) Highest temperature on July 4 - - - 102 °.
2) Only 8 days of ≥90 ° F.
3) Highest 24-hour precipitation on August 20 - - - 4.02".
4) Last spring frost - - - May 2.
5) First fall frost - - - October 1.

1990 Soil Moisture
0-5′ Profile, Webster Clay Loam
Continuous Corn
Southern Experiment Station, Waseca, MN 56093

Depth	4/13	5/3	5/18	6/1	6/15	7/2	7/16	7/31	8/16	8/31	9/14	10/1	10/16	11/1
	inches available water in zone													
0-6[1/]	.66	.80	.97	1.29	1.08	.82	.79	.88	.54	1.06	.74	.72	1.03	.95
6-12	.45	.66	.71	1.13	.90	.74	.57	.70	.29	.68	.67	.46	.70	.66
12-18	.65	.75	1.17	.92	.83	.83	.78	.60	.41	.72	.68	.59	.73	.86
18-24	.56	.81	.92	.70	.71	.63	.59	.47	.35	.59	.64	.55	.54	.75
24-36	1.28	1.89	1.51	1.78	1.90	1.53	1.49	1.29	1.12	1.66	1.86	1.59	1.74	1.65
36-48	2.25	2.13	2.01	2.78	2.92	2.41	2.17	2.01	2.36	2.50	2.71	2.85	2.37	2.55
48-60	1.36	1.61	1.33	2.33	2.68	1.71	1.90	1.52	2.32	2.31	2.11	2.51	2.17	1.96
Total available water in 0-5′ profile (inches)	7.21	8.65	8.63	10.93	11.02	8.65	8.29	7.47	7.40	9.52	9.41	9.27	9.29	9.38
% of Capacity[2/]	65	78	78	99	100	78	75	68	67	86	85	84	84	85

[1/] All values obtained by gravimetric sampling using Waseca D_b and WP constants.

[2/] Assuming 11.05" field moist capacity.

Available soil moisture in the five-foot profile was plentiful throughout 1990. Above average rainfall from May through August resulted in a full soil moisture profile in June and no lower than 67% of a full profile at the height of evapotranspiration demand (July and August). Soil moisture conditions going in to 1991 are very favorable with an 85% full profile.

N CREDITS FOR MANURE AND ALFALFA

J. A. Lory, G. W. Randall and M. P. Russelle[1]

ABSTRACT: Applications of fertilizer-N to corn can be reduced the first year following a manure application or when the corn crop follows alfalfa in rotation. The objective of this study is to determine first and second year N credits for these two sources of organic-N. In this first year there was no yield response of corn following alfalfa to applications of fertilizer-N or manure at Rosemount and Waseca, MN. Continuous corn yield at the highest fertilizer-N rate was equivalent to the yield of first year corn in rotation with alfalfa. Manure-N availability was predicted based on 25% of the organic-N in the manure being available in the first year after application. The manure N credit for continuous corn closely matched the predicted manure-N availability at Rosemount, whereas the manure N credit at Waseca was 55% of that predicted.

Many dairy farmers apply manure to alfalfa in the spring before they plow down an old stand. This practice is not recommended because it causes an oversupply of N, but the prevalence of the practice requires that we investigate the fate of the excess N. The first objective of this study is to assess the impact of manure on the alfalfa N-credit. Portions of the manure and alfalfa N will not be available to a corn crop until the second and third year after incorporation. Consequently, this study will determine N credits for first and second year corn grown after: (i) previous alfalfa, (ii) spring-applied dairy manure on previous corn, and (iii) spring-applied dairy manure on previous alfalfa. The second objective is to compare the impact of over-application of fertilizer-N and manure-N on soil inorganic-N levels in both continuous corn and alfalfa-corn rotations.

Materials and Methods

Experimental plots were located on a Webster clay loam at the Southern Experiment Station, Waseca, MN and on a Port Byron silt loam at Agronomy Hill, Rosemount Experiment Station, Rosemount, MN.

Plot history

The plots were established in spring of 1988 in a randomized, split-block design with 4 replicates at Waseca and 3 replicates at Rosemount. At both Waseca and Rosemount, portions of established stands of alfalfa were moldboard plowed to establish the corn portion of a alfalfa-corn rotation. The alfalfa was maintained in other blocks. Blazer alfalfa had been seeded in April, 1984 at Waseca and Pioneer 532 alfalfa had been seeded in fall 1985 after oats at Rosemount. Alfalfa was managed for hay production on a 3-cut system, and corn was managed for grain production. Corn plots were chisel plowed at Waseca in fall 1988 and 1989 and plots were chisel plowed in spring 1989 at Rosemount. Fertility levels of P and K, and pH were maintained at or above Minnesota soil test recommendations. At Waseca 0 and 100 lb N/A were applied in spring 1988 and 1989, respectively; at Rosemount, 0 and 30 lb N/A were applied in spring 1988 and 1989, respectively.

Procedures

In spring 1990, before planting corn on all plots, 8 treatments were applied randomly to each previous crop block. Treatments in previous corn were 0 N (control); 60, 100, 140 and 180 lb N/A as urea; and 3000, 7000 and 11,000 gal dairy manure per acre. First year corn following alfalfa treatments were: 0 N (control); 30, 60, 100, and 140 lb N/A as urea; and 3000, 5000, and 7000 gal/A dairy manure per acre. Liquid dairy manure was obtained from the Southern Experiment Station dairy and the Richard Fox farm near Rosemount, MN. These manure sources provided about 18 lb available N/1000 gal at Waseca, and 11 lb available N/1000 gal at Rosemount, based on 25% of the organic N being available the first year. Manure was surface-applied on April 26 at Waseca and April 23 at Rosemount. All plot areas were moldboard plowed, incorporating the manure within 45 min. of application. Urea was surface-applied preplant and disk incorporated.

At Waseca Pioneer 3751 was planted May 29 at 28,400 seeds/A and the stand was thinned to 26,300 plants/A on July 9. To control corn rootworms, Force insecticide (8.7 lb/A actual rate) was applied over the row at planting. Weeds were controlled with a preemergence application of Lasso (3.5 lb/A) and Bladex (3 lb/A). At Rosemount Pioneer 3751 was planted on May 3 at 26,000 seeds/A. To control corn rootworm, Counter (10 lb/A actual rate) was applied over the row at planting. Lasso and Bladex (2 lb/A each) were applied preemergence to control weeds. Atrazine (2 lb/A) was applied May 15 to reduce quackgrass growth.

Plots were harvested October 2 at Waseca and September 29 at Rosemount. Grain and stover dry matter samples were harvested from 40 and 20 ft. of row, respectively. Plant samples were dried at 60°C and ground in preparation for total-N analysis.

Soil samples were taken from each main plot (previous crop) in the spring before applying treatments, and from all treatments in the fall after corn harvest. At Waseca, two 2" dia. cores were taken per plot to a minimum depth of 4 ft and maximum depth of 8 ft, divided into 1 ft increments and combined by depth. At Rosemount, three 2" dia. cores were taken per plot to a depth of 8 ft, divided into 1 ft increments and combined by depth. The 2" cores were not taken within 10 ft of other sampling points. At Rosemount 1" dia. soil cores to a depth of 3 ft were also taken from selected plots on June 21. All soil samples were dried at 40°C, ground to pass through a 2-mm screen, and analyzed for NO_3 and NH_4.

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[1] Research Assistant, Univ. of Minnesota, St. Paul; Professor, Southern Experiment Station, Waseca; Soil Scientist, USDA/ARS Dairy Forage Research Center, St. Paul.

Results and Discussion

First year corn grain and silage yields following alfalfa did not respond to applications of fertilizer-N or dairy manure at Rosemount and Waseca (Tables 1 and 2). Application of manure or urea significantly increased N uptake of corn following alfalfa at both sites. Continuous corn dry matter yield and N-uptake responded to both manure and fertilizer-N applications.

Dairy manure N credits for continuous corn, based on continuous corn grain yield response to fertilizer-N, are presented in Table 3. Continuous corn may have responded to higher rates of manure at both sites. Manure N was 55% less available than predicted at Waseca. The manure at Rosemount had a relatively low N content.

These results emphasize that first-year corn following alfalfa typically does not respond to N applications in the southeast region of Minnesota.

Table 1. Effect of previous crop, dairy manure, and urea-N on corn yield and N uptake at Rosemount, MN in 1990.

Previous crop	N source	Rate	Grain Yield	Grain N uptake	Silage Yield	Silage N uptake
			bu/A	lb/A	T DM/A	lb/A
Alfalfa	Urea	0 lb/A	214	141	9.49	190
		30	211	150	9.49	206
		60	223	155	9.70	213
		100	218	164	9.70	230
		140	223	167	9.75	234
	Manure	3000 gal/A	210	147	9.31	200
		5000	221	163	9.80	226
		7000	216	153	9.50	216
P>F			0.5	0.04	0.6	0.01
CV(%)			4.3	5.9	3.4	5.3
Corn	Urea	0 lb/A	172	99	7.32	131
		60	190	116	8.32	151
		100	203	138	9.18	187
		140	209	153	9.44	206
		180	218	162	9.80	221
	Manure	3000 gal/A	186	112	8.28	149
		7000	194	127	8.82	169
		11000	197	133	8.66	172
P>F			0.01	0.01	0.01	0.01
CV (%)			3.4	4.9	2.8	6.4

Table 2. Effect of previous crop, dairy manure, and urea-N on corn yield and N uptake at Waseca, MN in 1990.

Previous crop	N source	Rate	Grain Yield	Grain N uptake	Silage Yield	Silage N uptake
			bu/A	lb/A	T DM/A	lb/A
Alfalfa	Urea	0 lb/A	154	102	6.84	129
		30	177	124	7.77	156
		60	172	118	7.94	155
		100	159	113	7.12	149
		140	159	115	7.24	150
	Manure	3000 gal/A	170	117	7.45	148
		5000	174	120	7.69	157
		7000	177	117	8.00	152
P>F			0.07	0.12	0.07	0.16
CV(%)			7.2	8.0	13.1	10.5
Corn	Urea	0 lb/A	136	78	5.71	98
		60	146	89	6.50	116
		100	145	92	6.43	120
		140	146	95	6.50	121
		180	167	112	7.19	141
	Manure	3000 gal/A	132	79	5.61	98
		7000	145	93	6.22	121
		11000	150	98	6.59	132
P>F			0.01	0.05	0.01	0.01
CV (%)			7.2	7.5	7.3	7.7

Table 3. Estimated N availability and N credits for dairy manure applied to continuous corn at Rosemount and Waseca, MN.

Location	Manure rate	Estimated N-availability[1]	N-credit[2]
Waseca	3000	55	0
	7000	130	75
	11000	203	110
Rosemount	3000	32	47
	7000	74	78
	11000	116	90

[1] Estimated N availability is based on 25% of the organic N being available the year of application

[2] N credit was determined by comparing continuous corn grain yield after application of manure with fertilizer-N response of continuous corn

SUPPLEMENTAL APPLICATION OF N TO CORN AFTER HEAVY SPRING RAINFALL[1]

1990

G. W. Randall and B. W. Anderson[2]

ABSTRACT: This was a one-year study conducted because of the high amounts of rainfall that occurred during May and June. The purpose was to determine if a supplemental, sidedress application of N was beneficial to continuous corn where various N rates had already been preplant-applied. Highest grain and silage yields, grain N concentration, N removal and recovery in the grain, and profit were obtained with the 150-lb rate of preplant-applied N. Sidedress application of 50 lb N/A enhanced yields, N concentrations, and profit when the preplant N rates were insufficient (0 and 75 lb/A) but not at the 150-lb rate on this somewhat poorly drained soil. This is not to say that sidedress N applications did not enhance yields and profitability under soil conditions where N losses due to either leaching or denitrification were more severe.

Split and sidedress applications of N are often recommended to maximize N efficiency under high-loss conditions such as irrigated, coarse-textured, sandy soils. These applications are also often suggested on medium and fine-textured soils even though most Minnesota research does not support these "advantages". Because of very high rainfall amounts in May and June in 1990 (11.99 inches, 3.75" above normal), a study was conducted to determine if a sidedress application of 50 lb N/A as anhydrous ammonia (AA) would be beneficial to continuous corn where preplant applications of AA had been preplant-applied.

Experimental Procedures

A factorial design consisting of three preplant N rates (0, 75 and 150 lb N/A) and two sidedress N rates (0 and 50 lb/A) was replicated four times on a Nicollet clay loam (Aquic Hapludoll). The previous crop was corn which had been moldboard plowed in October, 1989. Anhydrous ammonia was preplant applied on May 4 just prior to field cultivation. Corn (Pioneer 3737) was planted on May 8 at 28,420 plants/acre. Lasso (3.5 lb/A) plus Bladex (3.0 lb/A) was applied preemergence on May 11. All plots were cultivated once in mid June. Weed control was excellent.

Supplemental N was applied at 50 lb/A as AA to one half of the plots when corn was in the V7-V8 stage (July 2). Earleaf samples were taken on July 30. Silage yields were taken by hand-harvesting 15' of row on Sept. 27. Grain yield and moisture were obtained on October 4 by combine harvesting the center two rows of each 4-row plot.

Results and Discussion

Main factor analyses showed that leaf N concentration was increased significantly (P=99% level) by both the preplant N rate and the sidedress N treatment (Table 1). However, the preplant x sidedress interaction was highly significant, which indicates that the sidedress N treatment increased leaf N concentration only at the two lower preplant N rates. Sufficient N was available with the 150-lb preplant rate so that sidedressing an additional 50 lb did not increase leaf N. It is noteworthy that leaf N responded this quickly to sidedress N applications made only 28 days before sampling.

Grain yield was increased by both the preplant N treatments and the sidedress treatment (Table 1). The highly significant interaction between preplant and sidedress treatments, however, indicates that yields were only increased by the sidedress treatment when insufficient amounts of N (0 and 75 lb/A) had been preplant applied. Adding an additional 50 lb N/A to the 150-lb preplant AA treatment did not increase yield on this somewhat poorly drained soil even under these high soil moisture conditions. Perhaps a yield increase would have been obtained if: 1) the N had been fall-applied or applied earlier in the spring, 2) a source of N had been used that was more susceptible to N loss under these moist conditions, or 3) the soil would have been very well drained (to promote leaching) or very poorly drained where more denitrification would have been expected.

Grain moisture at harvest was reduced by both the preplant and supplemental N additions. Grain N concentration was increased significantly by the preplant rates but not by the supplemental N.

Fodder N yield was increased by the sidedress N treatment applied to the 0-lb preplant treatment but not to the 75 and 150-lb preplant treatments (Table 1). On the other hand, fodder N concentration was reduced by the sidedress application of N to the 0 and 75-lb preplant N rates. This was probably due to greater translocation of N from the stalk to the grain in these treatments where the combined total rate of N was limiting. Similar to grain yield, silage yields were not increased with the supplemental N addition when the preplant N rate was sufficient (150 lb N/A).

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[1] Funding supported by the Southern Experiment Station.

[2] Professor and Assistant Scientist at the Southern Experiment Station.

Table 1. Grain yield, silage yield, and N concentrations in the plant as affected by N rate and time of application at Waseca in 1990.

N rate/time	Earleaf N	Grain H_2O	Grain Yield	Grain N	Fodder Yield	Fodder N	Silage Yield
lb/A	%	%	bu/A	%	T DM/A	%	T DM/A
0 PP + 0 SD	1.88	26.7	94.4	1.18	2.07	0.40	5.14
0 PP + 50 SD	2.70	23.9	115.4	1.19	2.46	0.36	6.29
75 PP + 0 SD	2.60	22.5	136.0	1.23	2.93	0.50	7.13
75 PP + 50 SD	2.82	20.5	153.9	1.33	2.67	0.42	7.29
150 PP + 0 SD	2.86	21.2	162.6	1.40	3.16	0.50	8.23
150 PP + 50 SD	2.90	21.1	161.0	1.40	3.08	0.55	7.90
Preplant N rate (lb/A)							
0	2.29	25.3	104.9	1.18	2.27	0.38	5.71
75	2.71	21.5	145.0	1.28	2.81	0.46	7.21
150	2.88	21.1	161.8	1.40	3.12	0.52	8.06
Signif. Level (%):	99	99	99	99	99	99	99
BLSD (.05) :	0.08	1.1	6.5	0.05	0.18	0.05	0.38
Sidedress N rate (lb/A)							
0	2.45	23.4	131.0	1.27	2.72	0.46	6.83
50	2.81	21.8	143.4	1.31	2.75	0.44	7.16
Signif. Level (%):	99	99	99	89	27	73	94
PP rate x SD rate Interaction							
Signif. Level (%):	99	93	99	86	99	96	99
CV (%) :	3.3	4.8	4.9	4.0	6.6	10	5.6

Table 2. N removal in the grain, total N uptake, apparent N recovery, and production economics as influenced by N rate and time of application.

N rate/time	N removal in grain	Total N uptake	N recovery in[1] grain	N recovery in[1] silage	Cost of[2] treatment	Return to[3] fertilizer	Return to[3] fertilizer
lb/A	lb/A	lb/A	%	%	$/A	$/A	$/lb of N
0 PP + 0 SD	52.7	69.2	–	–	0	-	-
0 PP + 50 SD	65.0	82.9	25	27	10.50	36.75	0.74
75 PP + 0 SD	79.3	108.6	35	52	9.00	84.60	1.13
75 PP + 50 SD	97.0	119.5	35	40	13.50	120.38	0.96
150 PP + 0 SD	108.0	139.5	37	47	18.00	135.45	0.90
150 PP + 50 SD	106.9	140.5	27	36	22.50	127.35	0.64
Preplant N rate (lb/A)							
0	58.9	76.0					
75	88.2	114.1					
150	107.4	140.0					
Signif. Level (%):	99	99					
BLSD (.05) :	6.1	6.3					
Sidedress N rate (lb/A)							
0	80.0	105.8					
50	89.6	114.3					
Signif. Level (%):	99	99					
PP x SD rate interaction							
Signif. Level (%):	98	84					
CV (%) :	7.4	5.9					

1 (N removed in grain or taken up in silage - N removed or taken up by the check treatment) : N application rate

2 Based on N = 12¢/lb and $4.50 for SD application

3 Based on corn at $2.25/bu.

Nitrogen removal in the grain and total N uptake (silage) were both increased significantly by the preplant and sidedress treatments (Table 2). However, N removal in the grain was not increased when the supplemental N was applied to the 150-lb N treatment. Nitrogen recovery as a percent of the N applied was highest for the 150-lb preplant N treatment. Sidedress application of N did not enhance N recovery either in the grain or in the total above-ground plant (silage).

Economic return was highest with the 150-lb preplant N rate (Table 2). Sidedress application of 50-lb N increased economic return when the preplant N rates were insufficient (0 & 75 lb/A) but not when the 150-lb preplant rate was applied. Highest return per pound of fertilizer N applied was at the 75-lb preplant rate.

DECLINE RATES OF SOIL TEST P AND K IN A CORN-SOYBEAN ROTATION[1]

1990

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 13% at Waseca. Soil test K also decreased from 15 to 30% at Waseca. Even though soil test differences occurred among the treatments at Morris, the high variability made interpretation very difficult. Soybean yields were increased about 13% over the long-term control plots at the two sites when soil test Bray P_1 was greater than 30 lb/A. Reducing soil test K from about 250 lb/A to 175 lb/A resulted in a 7 to 8 bu/A soybean yield reduction 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 soybeans on the high P and K rate study at the two branch stations in 1990.

Variable	Location: Morris	Location: Waseca
Planting date	5/21	6/1
Row spacing	30"	30"
Planting rate (plants/A)	9-10 seeds/ft	10-11 seeds/ft
Variety	Evans	Hardin
Herbicide	3# Lasso/A (Bdct)	3.5# Lasso + 3# Amiben/A (Bdct)
Harvest date	9/24	10/11
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 1989. 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.

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 1985-89 rates resulted in highly significant differences in soil test P and soil test K at Waseca. At Waseca soil test P ranged from 10 to 99 lb/A (Table 2). Soil test P declined about 13% compared to 1989. Soil test K declined by about 15% since 1989 where the 100-lb rate was applied but by over 25% where no K was applied. Soybean yields were increased significantly by P but plateaued at soil P levels higher than 30 lb/A. Yields were also decreased significantly on those plots that did not receive K and had soil test K values of 170 to 175 lb/A.

[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.

At Morris, Bray P_1 ranged from 13 to 35 lb/A while Olsen's $NaHCO_3$ test ranged from 12 to 29 lb P/A (Table 3). Due to extremely high variability, these differences were not statistically significant at the P = 90% level. Considering this variability, both soil test P and K declined at this site in 1990.

Table 2. Soil test values, seed moisture, and seed yield as influenced by 17 years' application of P and K at Waseca.

	P and K Treatments		Soil Test[2]			Soybean	
	Total						
No.	1973-84	1985-89[1]	pH	P	K	Moisture	Yield
	------ lb P_2O_5 + K_2O/A ------			--- lb/A ---		%	bu/A
2	0 + 1200	0 + 100	6.7	10	278	12.5	42.6
3	600 + 1200	0 + 100	6.6	30	239	12.8	55.5
4	1200 + 1200	0 + 100	6.8	67	251	12.7	53.6
5	600 + 1200	100 + 100	6.7	71	254	12.8	54.5
6	1200 + 0	100 + 0	6.8	99	171	12.1	47.5
7	1200 + 600	100 + 0	6.7	91	175	12.1	47.0
	Signif. Level (%):		32	99	99	91	99
	BLSD (.05) :		-	15	48	-	5.9
	CV (%) :		2.7	15.0	12.	2.7	6.4

[1] Treatments applied each fall. P was discontinued for treatments 6 & 7 in 1988.
[2] Samples were taken in October before 1990 treatments were applied.

Table 3. Soil test values, seed moisture, and seed yield as influenced by 17 years' application of P and K at Morris.

	P and K Treatments		Soil Test[2]				Soybean	
	Total							
No.	1973-84	1985-89[1]	pH	P_1	P_{oL}	K	Moisture	Yield
	------ lb P_2O_5 + K_2O/A ------			------- lb/A -------			%	bu/A
2	0 + 1200	0 + 100	7.9	13	12	424	13.2	26.2
3	600 + 1200	0 + 100	7.9	30	27	344	13.0	30.6
4	1200 + 1200	0 + 100	7.9	35	29	366	13.3	35.4
5	600 + 1200	100 + 100	7.9	27	24	388	13.3	34.1
	Signif. Level (%):		13	50	50	60	98	95
	BLSD (.05) :		-	-	-	-	0.2	7.4
	CV (%) :		0.8	78.	71.	17.	1.0	13.

[1] Treatments applied each fall.
[2] Samples were taken in October before 1990 treatments were applied.

CONCLUSIONS

Long term (12-yr) additions to these two soils created a wide range in soil test P levels. Soybean yields were optimized over the no P treatments at soil test P levels of 30 lb/A at Waseca. Yields were reduced when soil test K dropped to <175 lb/A at Waseca. At Morris, soybean yields were significantly improved with the higher soil test P levels. Soil test P declined by about 13% at Waseca. Soil test K was reduced by 15% when K was added and by over 25% when no K was added at Waseca. Additional years will be needed to more accurately determine the decline rates.

CORN AND SOYBEAN PRODUCTION AS INFLUENCED BY BRIGHT SUN[1]

1990

G. W. Randall and B. W. Anderson[2]

ABSTRACT: This one-year study was conducted to determine if foliar applications of Bright Sun, a foliar plant food, would enhance corn or soybean production. Factorial studies with Bright Sun and N applied to corn and Bright Sun and P & K applied to soybeans were conducted on Nicollet and Webster soils at Waseca. Corn production was improved by N application but unaffected by Bright Sun. Soybean production was not improved by either the application of P & K or by Bright Sun. Based on this test, Bright Sun is not recommended for corn or soybeans at this time.

Foliar application of nutrients to corn and soybeans has shown very limited success in numerous trials throughout the Corn Belt. The purpose of this study was to evaluate the efficacy of Bright Sun, a molasses containing foliar plant food, on corn and soybean production in south-central Minnesota.

Experimental Procedures - CORN

A factorial design consisting of three preplant N rates (0, 75 and 150 lb N/A) and two Bright Sun treatments (none and a complete foliar program) was replicated four times on a Nicollet clay loam (Aquic Hapludoll). This previous crop was corn that had been moldboard plowed in October, 1989. Anhydrous ammonia was preplant-applied on May 4 just prior to field cultivation. Corn (Pioneer 3737) was planted on May 8 at 28,420 plants/A. Lasso (3.5 lb/A) plus Bladex (3.0 lb/A) was applied preemergence on May 11. All plots were cultivated once in mid-June. Weed control was excellent. Each plot was 10' wide (4-30" rows) x 55' long.

Bright Sun was applied three times at a rate of 3 gal/A each time using 40+ psi and a total application volume of 18 gal/A. Water was the carrier. The first application was made with a bicycle sprayer on June 21 when the corn was in the V5 stage (12" tall). The second application was made with a Spirit motorized sprayer on July 13 (VII stage with 0-lb N rate and V12-13 with 75- and 150-lb N rates). A Hy-Boy sprayer was used on July 31 to make the third application (R1 to R2 stage). All applications were made before 9:30 AM or after 5:00 PM without using a surfactant.

Plant population was determined by counting the total number of plants in the two center rows each 55' long. Plant height after tasseling was taken on August 9 by measuring to the top of the tassel on 10 random plants/plot. Silage yields were taken by hand-harvesting 15' of row on September 27. Grain yield and moisture were obtained on October 6 by combine harvesting the center two rows of each 4-row plot with a JD 3300 plot combine. Ear length was determined from a random sample of 10 ears per plot. Kernel weight was determined by weighing 100 kernels that had been oven-dried to remove water.

Grain N concentration was determined by the University's Research Analytical Laboratory using a total Kjeldahl N procedure. Fodder samples taken at physiological maturity were ground and submitted to the University's NIRS Forage Research Laboratory for crude protein, ADF, NDF, and elemental analyses.

Experimental Procedures - SOYBEANS

A factorial design consisting of three preplant phosphate (P) and potash (K) applications (0, 25 lb P_2O_5/A + 40 lb K_2O/A, and 50 lb P_2O_5 + 80 lb K_2O/A) and two Bright Sun treatments (none and a complete foliar program) was replicated four times. The experimental site was a Nicollet clay loam (Aquic Hapludoll) - Webster clay loam (Typic Haplaquoll) complex that was tile drained. The previous crop was corn that had been moldboard plowed in October, 1989. The P and K treatments were broadcast applied on June 6 and immediately incorporated with a field cultivator. Soil tests for the area prior to fertilization averaged: pH = 6.4, Bray P_1 = 21 ppm (VH), and exchangeable K = 156 ppm (VH).

Hardin soybeans were planted in 30-inch rows at a rate of 10 beans/foot of row on June 6. Each plot was 10' wide (4 - 30" rows) x 55' long. Lasso (3.5 lb/A) and Amiben (2.5 lb/A) were applied on June 7. All plots were cultivated on July 16. Weed control was perfect. Pictures were taken on July 13 and 31.

Bright Sun was applied four times at a rate of 3 gal/A each time using the same procedures as for corn. The first and second applications were made on July 13 (V5 stage) and July 31 (R2 stage), respectively, using a Spirit motorized sprayer. The third application was made with a bicycle sprayer on August 28 (R4 stage). The fourth application was made by hand on September 5 (R5 stage) using a backpack sprayer and a boom.

Plant height was determined on October 6 by measuring 10 random plants per plot. All plants from a 3-foot section of row in each plot were cut at the soil surface on October 8. The plants were separated into the bottom 12" versus the rest and pod counts were made on each plant portion. Soybean seed yields and moisture were obtained on October 11 by harvesting the center two rows of each plot with a specialized ALMACO SPC-40 plot combine.

Seed weight was determined on 100 random seeds. Protein and oil content based on 13% moisture were determined by Dr. J. Orf's soybean research project.

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[1] Partial support for this project was provided by Cargill.

[2] Professor and assistant scientist, Southern Experiment Station, Waseca, MN

Results and Discussion - CORN

Corn grain yield, grain N concentration, ear length, plant height, kernel weight, fodder yield and silage yield were all increased over the control by the 75- and 150-lb preplant N treatments (Table 1). Grain and silage yield, grain N concentration and plant height were significantly higher for the 150-lb N rate compared to the 75-lb rate. Grain moisture was reduced with increasing N rate. Plant population was not influenced by N rate.

The application of Bright Sun did not have any effect on grain moisture, grain yield, N concentration, plant population, plant height, kernel weight, ear length, fodder yield, and silage yield (Table 1). Moreover, there was no interaction between N rate and Bright Sun application. This indicates that Bright Sun did not influence corn production even when N was limiting.

Table 1. Grain yield, moisture, plant height, kernel weight and dry matter yield as influenced by N rate and Bright Sun in 1990.

N rate	Bright Sun	Grain H_2O	Grain Yield	Grain N	Plant Popl'n	Plant Height	Kernel Weight	Ear Length	Fodder Yield	Silage Yield
lb/A		%	bu/A	%	ppA x 10^3	cm	g/100	in/ear	--- TDM/A	----
0	No	24.0	85.4	1.12	28.0	230	17.7	6.12	2.14	4.96
0	Yes	24.6	82.8	1.12	27.8	226	18.2	5.88	1.96	4.67
75	No	19.7	128.1	1.18	28.1	251	19.0	7.42	2.82	7.25
75	Yes	20.2	131.1	1.17	27.9	243	18.6	7.35	3.03	7.29
150	No	19.2	148.5	1.27	28.1	254	19.6	7.55	3.16	7.98
150	Yes	18.8	149.4	1.29	28.1	254	19.3	7.48	2.91	7.74
N rate										
0		24.3	84.1	1.12	27.9	227	17.9	6.00	2.05	4.81
75		20.0	129.6	1.17	28.0	247	18.8	7.39	2.93	7.27
150		19.0	149.0	1.28	28.1	254	19.4	7.51	3.04	7.86
Signif. Level (%):		99	99	99	69	99	96	99	99	99
BLSD (.05) :		1.0	6.3	0.05	-	7	1.2	.19	0.20	0.26
Bright Sun										
No		21.0	120.6	1.19	28.1	245	18.8	7.03	2.70	6.73
Yes		21.2	121.1	1.29	28.0	240	18.7	6.90	2.64	6.56
Signif. Level (%):		34	12	14	79	83	13	88	56	85
N rate x Bright Sun Interaction										
Signif. Level (%):		40	31	22	37	46	27	40	91	56
CV (%) :		5.0	5.4	3.9	0.8	2.9	5.8	2.8	7.8	4.1

NIRS analyses of the fodder (not ensiled) indicated that crude protein, acid detergent fiber (a measure of non-digestible fiber), neutral digestible fiber, (more easily digestible cell walls) K and Ca were all increased by the preplant N rates over the control (Table 2). The highest N rate resulted in the highest protein levels and K concentrations. Phosphorus and Mg concentrations were not influenced by the N rates.

Bright Sun increased crude protein of the fodder by 10% and resulted in a slight increase in K concentration (Table 2). Some of this protein increase could have been due to the liquid fertilizer adsorbed onto the fodder tissue rather than absorbed into the cell tissue. There were no interactions between N rates and Bright Sun applications.

Results and Discussion - SOYBEANS

Soybean seed yield, moisture, protein and oil content were not influenced by P and K application rates (Table 3). Bright Sun significantly reduced soybean seed yield but did not affect seed moisture, protein or oil content. Because no phytotoxicity symptoms were observed and visual observations did not reveal height differences, one can suspect that physical disturbance caused by walking through the bushy and somewhat lodged soybeans to apply the last two treatments may have caused this yield depression. Application of foliar materials by ground driven means was impossible because severe traffic damage would have resulted. There was no interaction between P & K rate and Bright Sun application.

Table 2. Nutrient concentrations in the fodder at physiological maturity as influenced by N rate and Bright Sun in 1990.

N rate	Bright Sun	Crude Protein	ADF	NDF	P	K	Ca	Mg
lb/A		%						
0	No	3.25	41.5	63.4	0.22	1.15	0.17	0.15
0	Yes	3.79	42.1	63.5	0.22	1.20	0.17	0.14
75	No	3.93	44.1	67.6	0.22	1.26	0.20	0.15
75	Yes	4.16	43.9	66.8	0.22	1.27	0.21	0.15
150	No	4.70	44.2	66.9	0.22	1.29	0.22	0.15
150	Yes	5.13	44.5	66.8	0.22	1.31	0.23	0.15
N rate								
0		3.52	41.8	63.4	0.22	1.18	0.17	0.14
75		4.05	44.0	67.2	0.22	1.26	0.21	0.15
150		4.91	44.3	66.9	0.22	1.30	0.22	0.15
Signif. Level (%):		99	99	99	22	99	99	78
BLSD (.05) :		.30	0.8	1.5	-	.03	.02	-
Bright Sun								
No		3.96	43.2	66.0	0.22	1.23	0.22	0.15
Yes		4.36	43.5	65.7	0.22	1.26	0.20	0.15
Signif. Level (%):		99	54	35	54	95	61	46
N rate x Bright Sun Interaction								
Signif. Level (%):		41	32	16	4	61	18	32
CV (%) :		7.4	1.9	2.3	4.9	2.4	11.	6.6

Table 3. Soybean seed yield, protein and oil content as influenced by three levels of phosphorus and potassium fertilizer and Bright Sun.

P_2O_5 rate	K_2O rate	Bright Sun	Seed H_2O	Seed Yield	Seed Protein	Seed Oil
lb/A			%	bu/A	%	%
0	0	No	12.1	50.2	35.6	17.0
0	0	Yes	12.0	45.9	35.6	16.8
25	40	No	12.2	51.8	35.8	16.8
25	40	Yes	12.1	46.4	35.9	16.8
50	80	No	12.2	52.2	36.1	16.6
50	80	Yes	12.1	45.7	35.9	16.8
Rate of $P_2O_5+K_2O$ ----- lb/A ----						
0	0		12.0	48.0	35.6	16.9
25	40		12.1	49.1	35.9	16.8
50	80		12.2	49.0	36.0	16.7
Signif. Level (%):			29	47	90	85
Bright Sun						
No			12.2	51.4	35.8	16.8
Yes			12.0	46.0	35.8	16.8
Signif. Level (%):			62	99	18	<1
$P_2O_5+K_2O$ x Bright Sun Interaction						
Signif. Level (%):			5	48	36	41
CV (%) :			2.2	4.1	1.0	1.1

Soybean yield components (plant height, seed weight, and pod count) were also not influenced significantly (P = 95% level) by the P & K rates (Table 4). Bright Sun did significantly reduce the number of pods on the lower portion of each plant but did not influence the other yield components. Again, interactions between Bright Sun and P & K applications were not evident.

Table 4. Plant height, seed weight and pod distribution on plant as influenced by three levels of phosphorus and potassium fertilizer and Bright Sun.

P_2O_5 rate	K_2O rate	Bright Sun	Plant Height	Seed Weight	Pod Distribution Bottom 1'	Above 1'	Total
------ lb/A ------			in.	g/100 seeds	---------- No. pods/plant ----------		
0	0	No	35.5	18.6	18.5	23.0	41.5
0	0	Yes	35.2	18.5	14.0	19.8	33.8
25	40	No	36.2	19.0	17.7	21.2	39.0
25	40	Yes	36.0	18.8	15.5	22.2	37.8
50	80	No	36.8	18.7	13.5	21.0	34.5
50	80	Yes	36.0	18.9	13.0	20.5	33.5
Rate of $P_2O_5+K_2O$							
---- lb/A ----							
0	0		35.4	18.6	16.2	21.4	37.6
25	40		36.1	18.9	16.6	21.8	38.4
50	80		36.4	18.8	13.2	20.8	34.0
Signif. Level (%):			88	78	94	31	87
Bright Sun							
No			36.2	18.8	16.6	21.8	38.3
Yes			35.8	18.7	14.2	20.8	35.0
Signif. Level (%):			70	30	95	66	92
$P_2O_5+K_2O$ x Bright Sun Interaction							
Signif. Level (%):			17	45	62	79	76
CV (%) :			2.6	1.9	18.	11.	12.

Conclusions

Foliar applications of Bright Sun to corn and soybeans did not result in yield or quality improvement under the soil and climatic conditions of this study.

CONSERVATION TILLAGE FOR CORN AND SOYBEAN PRODUCTION[1]

Waseca, 1990

G. W. Randall and J. B. Swan[2]

ABSTRACT: This was the 16th and final year of a study to evaluate five primary tillage systems for corn and soybean production on a Nicollet-Webster soil complex. Surface residue amounts ranged from 4% with MP tillage to 97% with NT. Corn yields were reduced by about 80 bu/A with NT due primarily to very aggressive foxtail growth. Yields were not different among the MP, CP, RP and SD systems but were enhanced 7 bu/A by the former starter fertilizer applications with all tillage systems. Intensive soil sampling showed marked decreases in soil pH in the top two inches with NT and in the surface of the RP ridge. Soil test P and K were highly stratified in the CP, RP, SD and NT systems. Starter fertilizer applied for 10 of 16 years greatly increased soil test P and K in the top 6" of all tillage systems.

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 and Nicollet 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).

Ridges for the RP treatment in 1990 were built in June, 1989. The MP and CP treatments were performed on Nov. 3. On May 2 all plots received 150 lbs N/A as ammonium nitrate broadcast on the surface. On May 4 the MP and CP treatments were field cultivated once with the chiseled plots receiving a prior disking. The SD treatment was disked twice.

Corn (Pioneer 3578) was planted in 30" rows at a rate of 29,900 plants/A on May 18 with a John Deere 7100 planter. B&H ridge cleaners were attached for the RP treatment. No starter fertilizer was used. Broadcast P and K were not applied for the 1990 crop because of very high soil tests. Soil tests from moldboard plow plots averaged: pH = 6.9, $Bray_1$ extractable P = 66 lb/A and exchangeable K = 370 lb/A. Lasso (3.5 qts/A) + Bladex (3 lb/A) were applied broadcast to all plots on May 30. All plots except NT were cultivated with a Hiniker 5000 cultivator on June 15. As a result of the herbicides plus cultivation, weed control was excellent on all plots except no tillage.

Surface residue coverage was measured by the line-transect method on April 2 prior to spring tillage. Soil samples were taken in 2- and 3-inch increments from all plots on July 18. Yields were taken by combine harvesting the center two rows from each plot where starter and no starter fertilizer had been applied previously.

RESULTS

Surface residue amounts prior to planting were highly related to tillage system with the following ranking NT>SD=RP>CP>MP (Table 1).

Table 1. Influence of tillage methods for corn after soybeans on surface residue before spring tillage at Waseca in 1990.

Treatment	Surface Residue Coverage
	%
No tillage (NT)	97
Fall plow (MP)	4
Fall chisel (CP)	13
Ridge plant (RP)	60
Spring disk (2x) (SD)	62
Significance Level (%):	99
BLSD (.05) :	7
CV (%) :	10.

[1] Funding provided by the Southern Experiment Station, Waseca.

[2] Professors, Southern Experiment Station, Univ. of Minnesota and The Leopold Center, Iowa State U., respectively.

Corn yields were significantly affected by both tillage system and the previous starter fertilizer treatments (applied from 1979-1988) (Table 2). No tillage resulted in significantly reduced yield compared to all other tillage systems with no difference among the MP, CP, RP and SD systems. The primary reason for the very low NT yield was poor weed control. Over 6" of rain in May prevented herbicide application until 12 days after planting. By this time corn emergence curtailed application of Roundup to the carpet of foxtail that did not appear to be affected by the Lasso and Bladex application. Weed control was excellent in the other tillage systems due to secondary tillage and cultivation in conjunction with the herbicides. The residual effects of the previous starter fertilizer treatments increased corn yield by 7.0 bu/A regardless of tillage system. Grain moisture at harvest was slightly higher for the NT system.

Table 2. Influence of tillage method and residual starter fertilizer on corn production at Waseca in 1990.

Tillage	Starter Fertilizer	Moisture	Yield
		%	bu/A
No tillage	Yes	22.9	67.4
	No	23.6	60.2
Fall plow	Yes	21.9	151.3
	No	22.2	142.4
Fall chisel	Yes	20.3	147.2
	No	22.1	139.9
Ridge plant	Yes	21.2	146.7
	No	22.2	142.1
Spring disk (2x)	Yes	20.8	147.5
	No	20.0	140.3
MAIN EFFECTS			
Tillage System			
No tillage		23.3	63.8
Fall plow		22.1	146.8
Fall chisel		21.2	143.6
Ridge plant		21.7	144.4
Spring disk (2x)		20.4	143.9
Signif. Level (%):[1]		94	99
BLSD (.05) :		-	10.2
Starter Fertilizer			
Starter		21.4	132.0
No starter		22.0	125.0
Signif. Level (%):[1]		71	95
INTERACTION			
Tillage x Starter			
Signif. Level (%):[1]		39	1
CV (%) :		7.6	8.2

[1] Probability level of significant difference between means.

Soil samples taken on July 18 from all plots show a substantial effect of tillage over this 16-year period on soil pH (Table 3), soil P (Table 4), and soil K (Table 5). Soil pH was depressed by about 1.0 unit in the surface 0 - 2" layer of the NT system and in the ridge area of the RP system. Individual plots in the NT system were as low as 4.9 and may explain the foxtail growth and very poor weed control. Differences in soil pH did not appear between the no starter and starter fertilizer systems.

Extractable soil P and exchangeable K were greatly influenced by both tillage system and starter fertilizer history. Both P and K were very uniformly distributed throughout the 0 - 6" layer with MP tillage. On the other hand substantial stratification occurred throughout the 0 - 12" layer with the NT, CP, RP and SD systems. Greatest stratification occurred in the ridge of the RP system. Soil test P and K within the top 6" were considerably higher in the plots that had received 10 years of starter fertilizer regardless of tillage system. This may have led to the higher yields shown in Table 2. Stratification of P & K was greater were starter fertilizer had been applied.

Table 3. Soil pH after 16 years of continuous tillage.

Depth	Starter[1] fert.	Tillage System[2] NT	MP	CP	RP-R	RP-V	SD
inches							
0-2	No	5.4	6.6	6.2	5.6	6.1	6.6
2-4	No	6.0	6.9	6.5	6.0	6.6	6.8
4-6	No	6.4	7.0	6.8	6.5	6.8	7.1
6-9	No	6.6	7.0	7.1	6.7	6.8	7.2
9-12	No	6.7	7.3	7.1	6.8	6.8	7.2
0-2	Yes	5.5	6.6	6.4	5.8	6.2	6.3
2-4	Yes	5.9	6.8	6.7	6.1	6.6	6.4
4-6	Yes	6.5	6.9	6.9	6.6	6.8	6.8
6-9	Yes	6.6	6.9	7.1	6.7	6.8	7.0
9-12	Yes	6.7	7.1	7.2	6.7	6.8	7.0

[1] Starter fertilizer was applied for 10 years (1979-1988).
[2] RP-R = Ridge plant - ridge, RP-V = Ridge plant - valley.

Table 4. Extractable soil P (Bray 1) after 16 years of continuous tillage.

Depth	Starter[1] fert.	Tillage System NT	MP	CP	RP-R	RP-V	SD
inches		ppm					
0-2	No	38	22	29	44	30	32
2-4	No	27	22	22	24	19	19
4-6	No	15	22	15	13	11	11
6-9	No	12	13	8	10	8	8
9-12	No	6	6	5	9	5	6
0-2	Yes	50	37	32	65	54	45
2-4	Yes	30	39	20	46	23	25
4-6	Yes	18	32	11	22	14	13
6-9	Yes	14	17	6	17	9	11
9-12	Yes	10	9	4	16	7	7

[1] Starter fertilizer was applied for 10 years (1979-1988).

Table 5. Exchangeable soil K after 16 years of continuous tillage.

Depth	Starter[1] fert.	Tillage System NT	MP	CP	RP-R	RP-V	SD
inches		ppm					
0-2	No	216	179	201	244	207	227
2-4	No	185	193	168	177	145	157
4-6	No	142	187	140	134	117	129
6-9	No	122	141	108	118	93	102
9-12	No	99	107	95	104	97	94
0-2	Yes	265	201	187	283	244	258
2-4	Yes	186	216	149	177	165	160
4-6	Yes	136	201	122	134	123	127
6-9	Yes	118	145	99	124	96	113
9-12	Yes	101	110	89	109	102	93

[1] Starter fertilizer was applied for 10 years (1979-1988).

SUMMARY - 1990

This was the fourth crop of corn grown following soybeans in this long-term study with continuous corn from 1975 through 1982 and soybeans in 1983, 1985, 1987, and 1989. Surface residues prior to planting were greater than 50% with NT, RP, and SD tillage. Due primarily to poor weed control, corn grain yields with NT were about 80 bu/A less than with MP, CP, RP and SD tillage. Residual effects of starter fertilizer increased corn yields by 7 bu/A regardless of tillage systems. Grain moisture was slightly higher with NT but was unaffected by starter fertilizer.

SIXTEEN-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 6. 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 6.) Moldboard plow tillage in this sequence has resulted in corn yields being about 5% higher (7 bu/A) than for CP, RP and SD tillage on the starter fertilizer plots. When no starter was used this difference increased to 7% (10 bu/A). 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 6. 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 & 89	1984, 86, 88 & 90
		bu/A			
No tillage	Yes	129.2	140.6	34.5	100.4
"	No		136.0	34.3	89.2
Fall plow	Yes	154.5	170.9	51.0	147.0
"	No		170.8	50.2	141.5
Fall chisel	Yes	144.4	161.8	47.7	138.8
"	No		155.5	45.5	128.4
Ridge plant	Yes	149.2	161.5	46.9	139.8
"	No		156.4	47.2	132.6
Till plant (flat)[1]	Yes	144.9	154.8	46.8	141.7
"	No		157.4	47.1	134.2

[1] This treatment was converted to a spring disk (2x) beginning with the 1983 crop.

NITROGEN LOSS TO TILE LINES AS AFFECTED BY TILLAGE[1]

Waseca, 1990

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 1990 was 7.1" above normal and tile flow was plentiful. The slightly higher tile drainage with NT was offset by slightly higher NO_3-N concentrations with the MP system. Nitrate-N losses were not different between the two tillage systems. Corn yields, N uptake, and N removal in the grain were all significantly higher for MP compared to NT. Grain yield was 29% less with 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' x 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 1989. The stalks were chopped in October, 1989 and moldboard plots plowed.

On May 20, 180 lb N/A as ammonium nitrate was broadcast applied to the surface of all plots. The moldboard treatment was then field cultivated. Corn (Dekalb 547) was planted on May 8 at a population of 27700 plants/A with a John Deere Max-Emerge planter equipped with ripple coulters. Starter fertilizer was not used because of the high soil tests. Counter was applied at 1 lb (ai)/A to control rootworms. Weeds were controlled with a preemergence application of Lasso (3-1/2 lb/A) and Bladex (3 lb/A) applied May 11. Weed and insect control were excellent. Percent surface residue was measured on April 2 and averaged 7 and 98% 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 30 and NT = August 7) and was analyzed for N. Silage yields were taken at physiological maturity by hand harvesting 40' of row from each plot.

Grain yields were taken by combine from 2 - 45' rows. Tile lines flowed from March 27 to September 8. 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 26, 1990.

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 fifth year of nine where MP yields were significantly higher. Neither leaf N nor grain N concentration was affected by tillage, however.

Precipitation during the growing season was 6.5" above normal. Consequently, tile flow was substantially higher than in previous years and averaged about 8% higher with NT compared to MP tillage (Table 2). Flow-weighted NO_3-N concentration for the season averaged 10% higher with MP tillage. Thus, NO_3-N losses via the drainage water were not different for the two tillage systems. On an annual basis these NO_3-N losses were the equivalent of 55% of the fertilizer N added. This figure is erroneous, however, because much of the NO_3 lost, especially early in the season, would have come from the residual NO_3 remaining in the soil after the 1989 crop. Much of that residual NO_3 was probably due to carryover of unused fertilizer N in the drier years and soil mineralization especially with MP tillage.

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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.

Table 1. Influence of tillage system on corn production and N utilization at Waseca in 1990.

Tillage system	Final population	Leaf N	Silage Yield	Silage N uptake	Grain Yield	Grain N	Grain N removal
	$x10^{-3}$	%	T DM/A	lb N/A	bu/A	%	lb N/A
Moldboard Plow	25.8	2.75	8.61	143.6	146.7	1.45	100.8
No Tillage	25.9	2.62	6.66	92.8	104.8	1.28	63.5
Signif. Level (%):[1]	5	83	99	99	99	82	96
CV (%) :	4.5	3.0	2.5	1.4	4.8	7.5	11.

[1] Probability level of significance.

Table 2. Influence of tillage system on tile flow, flow-weighted NO_3-N concentration and NO_3-N loss in 1990.

Month	Tile Flow	NO_3-N Concentration[1]	NO_3-N Loss
	acre-in	ppm	lb/A
		Moldboard plow	
March	0.01	10.0	0.01
April	0.02	17.4	0.10
May	5.94	28.8	35.71
June	6.70	21.4	30.95
July	2.45	25.3	9.04
August	3.86	30.2	22.35
September	0.17	25.8	1.58
Total	19.14	23.0	99.74
		No tillage	
March	0.06	10.7	0.13
April	0.37	13.0	1.03
May	5.74	20.3	25.65
June	7.83	21.2	36.21
July	2.83	25.6	15.60
August	3.59	22.1	17.50
September	0.24	18.3	1.33
Total	20.66	20.9	97.45

Residual NO_3-N in the soil profile at the end of the 1990 growing season showed about 100 lb/A more N remaining with the MP system (Table 3). The largest differences between the two tillage systems occurred in the 2 to 5′ zone where substantially more NO_3 accumulated with MP. These results are similar to previous years except that the greatest difference between the two systems usually occurred in the top 1 to 2 feet.

Table 3. Influence of tillage systems on residual NO_3-N in the soil profile in Oct., 1990.

Profile depth	Tillage System Mb. Plow	Tillage System No Tillage
feet	NO_3-N (lb/A)	
0-1	18.3	13.5
1-2	8.1	6.1
2-3	34.1	8.4
3-4	46.5	23.9
4-5	42.9	29.2
5-6	30.7	21.2
6-7	22.7	16.4
7-8	21.2	15.7
Total (lb NO_3-N/A 0-8′)	224.5	134.4

NINE-YEAR SUMMARY

The cumulative totals for the 9-year period (1982-1990) are shown in Table 4. Corn yields over this period have averaged 14.5 bu/A better with moldboard plow tillage. Approximately 16% 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. As a result an equivalent of 51 and 44% of the applied N has been removed in the grain by the MP and NT systems, respectively. Even though total water flow and NO_3-N lost through the tile lines was 9% and 5% higher, respectively, with NT compared to MP tillage, this small difference is considered to be insignificant when considering tile flow variability among the eight plots. The equivalent of 15 to 16% of the fertilizer N applied to these plots has been lost to tile drainage over this 9-year period.

Table 4. Cumulative effects of the two tillage systems over the 9-year period.

	Tillage System	
Parameter	Mb. plow	No tillage
Fert. N applied (lb/A)	1620	1620
Corn grain removed (bu/A)	1232	1102
N removed in grain (lb/A)	825	708
N removed in grain as a percent of applied N (%)	51	44
Tile flow (acre inches)	80.4	87.5
Nitrate-N lost in tile (lb/A)	248.8	260.0
N lost via tile lines as a percent of applied N (%)	15	16

Soil samples were taken in 3- and 6-inch increments to 24" in early November, 1990 and analyzed for total Kjeldahl N. Results shown in Table 5 indicate higher N levels in the top 6 inches with NT, slightly higher N levels in the 6 to 18" layer with MP, and no difference between the tillage systems within the 18 to 24-inch depth. Assuming a bulk density of 1.2 g/cc in the 0-6" depth, 1.25 g/cc in the 6-12" depth, and 1.35 g/cc in the 12-18" depth, we found 178 pounds more soil N in the NT system than in the MP system. This amount accounts for most of the difference shown between the two tillage systems in Table 4.

Table 5. Total N in the 0-24" soil layer as affected by tillage systems.

	Tillage	
Depth	MP	NT
inches	%	
0-3	.242	.288
3-6	.248	.258
6-12	.222	.212
12-18	.148	.142
18-24	.082	.082

NITRATE LOSSES TO TILE DRAINAGE AS AFFECTED BY NITROGEN FERTILIZATION OF CORN IN A CORN-SOYBEAN ROTATION[1]

Waseca, 1990

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 1990. Results from this fourth year showed significant yield improvement over the control with all N treatments, but no significant differences among the four primary application time/method treatments. Tile lines flowed from late April through late August. Tile flow averaged 11.45" for corn and 14.73" for soybeans. Nitrate-N concentrations and losses were higher for corn than for soybeans. Highest NO_3-N losses in the corn plots occurred with the fall application of N without N-Serve while the highest losses under soybeans occurred with spring application to the previous corn crop. Nitrate-N concentrations and losses from continuous fallow plots that had received neither fertilizer N nor a planted crop for four years were twice that from the fertilized corn. This was due to high levels of NO_3 throughout the 8-foot profile as a result of soil mineralization and no crop uptake.

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 25. Average soil temperature at the 4" depth on that date was 60°F with an average of 49°F over the following 10-day period. Spring preplant treatments were applied on May 4. The sidedress portion (60%) of the split treatments was applied at the V-9 stage on July 2.

The soybean area that was planted to corn in 1990 was field cultivated once before planting. The corn area, however, was fall chiseled and field cultivated once prior to planting soybeans. Surface residue accumulation estimated by the line-transect method on April 2 showed an average of 40 and 69% for the areas that were planted to corn and soybeans, respectively, in 1989. Because of high soil P and K tests, no broadcast nor starter fertilizer was used.

Corn (Pioneer 3737) was planted at 30,200 plants/acre on May 18 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 31. Weeds were chemically controlled with a preemergence application of Lasso (3-1/2 lb/A) plus Amiben (3 lb/A). Pursuit (imazethapyr) was applied on June 18 at 0.06 lb/A plus 0.25% v/v X-77 to plots 1, 5, 6, 11, 12, 13, 15, & 16.

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.

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[2] Professor, So. Exp. Stn.; Professor, Dept. of Soil Science; Assistant Scientist, So. Exp. Stn., Waseca.

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 30) 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), cyanazine (Bladex), and imazethapyr (Pursuit) 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 18. The same technique was used to sample all fallow and corn plots and selected soybean plots on October 26.

RESULTS AND DISCUSSION

Plant

Whole plant N concentration at the silking stage was not affected by any of the N treatments (Table 1). This is in contrast to 1989 probably because of very favorable conditions for mineralization that released adequate amounts of soil N to the control plots in 1990. Dry matter accumulation was unaffected by time/method of N treatment. Although stover N concentration of the control was lowest, the 135-lb N treatments did not result in significantly (P = 90% level) higher concentrations at physiological maturity (PM). Stover yield at PM was higher than the control for all N treatments with no difference among 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		Final
Time	N-Serve	N	DM	N	Yield	Population6
		%	g/plt	%	TDM/A	ppA x 10^3
Primary trts						
Fall (Oct.)	No	1.76	90	.50	2.36	28.8
Fall (Oct.)	Yes	1.74	103	.51	2.54	28.0
Spr. (April)	No	1.78	86	.48	2.44	28.2
Split[1]	No	1.75	99	.52	2.49	28.0
Additional trts						
Check	-	1.64	79	.44	1.83	28.6
Spr. (April)	Yes	1.69	104	.56	2.55	28.3
Split[1]	Yes	1.82	94	.56	2.47	28.7
		Statistical Analysis				
Latin square (Primary Trts)						
Signif. Level (%):		6	45	12	15	36
CV (%) :		6.4	19.	12.	13.	3.1
Completely randomized (7 trts)						
Signif. Level (%):		17	74	83	96	17
BLSD (.05) :		-	-	-	.52	-
CV (%) :		10.	16.	13.	13.	3.3

[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). The 9.0 bu/A difference among the four primary time/method treatments was not significant at the P = 90% level. Grain moisture at harvest was significantly higher (P = 94% level) for the check compared to the N treatments with no difference among the four primary time/method 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. Although not statistically significant (P = 90% level), a consistent trend of lower N efficiency was noted with the fall N application without N-Serve.

Total N removal in the grain ranged from 92.1 to 101.8 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 31 to 38% for the six N treatments. Nitrogen efficiency based on total plant uptake ranged from 36 to 48% for the six N treatments. These efficiency values are slightly less than in 1989.

Total N uptake by the plants receiving fertilizer N prior to silking (Fodder N yield at silking) divided by total N uptake at PM shows that from 75 to 86% of the N was accumulated by the plants prior to silking (Table 3). NEW N in the grain (assumed to be taken up by the plant after silking and translocated to the grain) ranged from -31% in the check treatment to between 14 and 25% for all treatments receiving fertilizer N. Under the 1990 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	146.1	29.2	1.33	92.1	6.33	115.7
Fall (Oct.)	Yes	146.0	29.6	1.44	99.0	6.51	124.9
Spr. (April)	No	142.2	26.6	1.44	96.5	6.31	120.0
Split[1]	No	151.2	28.2	1.42	101.3	6.59	127.1
Additional trts							
Check	-	107.5	32.4	.98	50.3	4.76	66.4
Spr. (April)	Yes	158.0	27.8	1.36	101.8	6.84	130.9
Split[1]	Yes	147.5	27.7	1.40	97.9	6.47	125.3
				Statistical Analysis			
Latin square (Primary trts)							
Signif. Level (%):		52	56	80	88	21	71
CV (%) :		5.2	9.4	5.0	4.8	7.2	6.6
Completely randomized (7 trts)							
Signif. Level (%):		99	94	99	99	99	99
BLSD (.05) :		13.3	-	.12	10.6	.75	15.8
CV (%) :		6.7	8.3	6.6	8.5	8.2	9.9

[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	99.5	23.6	92.1	75.9	16.2	18
Fall (Oct)	Yes	110.9	25.8	99.0	85.0	14.0	14
Spr (April)	No	95.2	23.5	96.5	71.8	24.7	25
Split[4]	No	107.0	25.8	101.3	81.2	20.1	20
Additional trts							
Check	-	82.8	16.1	50.3	66.7	-16.4	-31
Spr (April)	Yes	110.5	29.0	101.8	81.5	20.3	19
Split[4]	Yes	109.4	27.4	97.9	82.0	15.9	17
				Statistical Analysis			
Latin square (Primary trts)							
Signif. Level (%):		27	22	88	19	11	12
CV (%) :		21.	18.	4.8	26.	112.	109.
Completely randomized (7 trts)							
Signif. Level (%):		44	97	99	11	85	98
BLSD (.05) :		-	8.3	10.6	-	-	35
CV (%) :		22.	20.	8.5	28.	151.	182.

[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

Weather conditions during the 1990 growing season were slightly warmer than normal but were 6.5" wetter than normal. Rainfall during May through August totaled 8.33" above normal. This resulted in tile flow from April 27 through August 30. Tile drainage volumes shown in Table 4 indicate highest flows in May and June. Drainage from the 16 corn plots averaged 11.45 with a 4.03" range among the four time/method treatments. Soybeans showed greater tile drainage compared to corn with an average of 14.73" from the 16 plots but only a range of 1.71" among the four time/methods. Ideally, drainage should be uniform among the time/method treatments because crop growth was not different; however, normal soil and drainage variability exists in these plots and results in these unfortunate differences.

Monthly flow-weighted NO_3-N concentrations were markedly higher for corn compared to soybeans throughout the year (Table 5). Fall application of N without N-Serve to corn resulted in consistently higher NO_3-N concentrations compared to the inclusion of N-Serve. However, both fall treatments gave higher NO_3-N concentrations than the spring or split treatments. An opposite trend occurred under soybeans where N had been applied in either October, 1988 or spring 1989 for the 1989 corn crop. In this case, lowest and highest NO_3-N concentrations were associated with the fall and spring treatments, respectively. Nitrate-N concentrations under a 4-yr continuous fallow system (no fertilizer N applied) were approximately 2X and 3X higher than for corn and soybeans, respectively.

Under corn, substantially higher NO_3-N losses occurred with the fall treatment without N-Serve (Table 6). This was due to both higher tile flow and NO_3-N concentration. Little difference was observed among the NO_3-N losses from the fall + N-Serve, spring, and split treatments. Interestingly, NO_3-N losses under soybeans were lowest for the fall N treatments that were applied for the 1989 corn crop compared to the spring-applied treatments. Very high NO_3-N losses occurred under the fallow system where the mineralization of the soil organic matter was the nitrate source. This emphasizes the importance of growing a crop to absorb N released from these high organic matter soils.

Table 4. Tile water discharge from the corn, soybean, and fallow plots in 1990.

N application		Month					Year
Time	N-Serve	April	May	June	July	August	Total
		acre-inches					
		CORN					
Fall (Oct.)	No	0.00	4.61	5.66	0.73	2.93	13.93
Fall (Oct.)	Yes	0.03	3.51	3.71	0.58	2.47	10.30
Spr. (April)	No	0.00	3.48	3.48	0.60	2.34	9.90
Split	No	0.08	3.90	4.68	0.85	2.16	11.67
		SOYBEANS					
Fall (Oct.)[1]	No	0.05	5.44	5.78	1.37	2.45	15.09
Fall (Oct.)[1]	Yes	0.00	4.72	6.15	1.23	2.27	14.37
Spr. (April)[1]	No	0.01	4.33	6.18	1.26	2.10	13.88
Split[1]	No	0.00	4.92	6.22	1.62	2.83	15.59
		FALLOW					
NONE		0.05	4.26	4.34	1.23	1.81	11.69

[1] N applied for the 1989 corn crop.

Table 5. Flow-weighted NO_3-N concentrations for each month from the corn, soybean, and fallow plots in 1990.

N application		Month					Year
Time	N-Serve	April	May	June	July	August	Avg.
		mg NO_3-N/L					
		CORN					
Fall (Oct.)	No	-	36.3	38.4	40.6	25.0	34.7
Fall (Oct.)	Yes	38.3	29.9	33.8	37.5	18.8	29.5
Spr. (April)	No	-	28.7	29.6	32.1	19.8	26.9
Split	No	25.0	28.0	29.0	28.1	23.2	27.8
		SOYBEANS					
Fall (Oct.)[1]	No	21.9	15.4	17.1	19.2	12.3	15.1
Fall (Oct.)[1]	Yes	-	17.6	19.5	29.4	13.1	19.0
Spr. (April)[1]	No	16.2	21.3	23.4	28.3	15.3	22.3
Split[1]	No	-	18.8	21.3	21.7	14.2	18.4
		FALLOW					
NONE		42.8	69.8	62.6	57.6	47.4	56.6

[1] N applied for the 1989 corn crop.

Table 6. Nitrate-N loss for each month from the corn, soybean and fallow plots in 1990.

N application		Month					Year
Time	N-Serve	April	May	June	July	August	Total
		lb NO_3-N/A					
		CORN					
Fall (Oct.)	No	0.00	37.68	48.54	6.86	16.25	109.33
Fall (Oct.)	Yes	0.26	23.55	29.70	4.84	10.41	68.76
Spr. (April)	No	0.00	23.40	22.12	4.29	10.53	60.34
Split	No	0.44	25.24	31.02	5.36	11.45	73.51
		SOYBEANS					
Fall (Oct.)[1]	No	0.30	18.58	21.29	5.12	6.40	51.69
Fall (Oct.)[1]	Yes	0.00	18.65	28.05	7.90	7.08	61.68
Spr. (April)[1]	No	0.03	21.66	32.97	7.68	7.78	70.12
Split[1]	No	0.00	20.50	28.91	6.87	8.76	65.04
		FALLOW					
NONE		0.50	61.94	54.66	14.74	18.12	149.96

[1] N applied for the 1989 corn crop.

Nitrate-N losses to the tile drainage water were normalized to tile water flow to minimize the influence of water flow volume among the N treatments on the interpretation of the data (Table 7). Normalized values show highest losses for fall-applied N without N-Serve to corn. Spring applications showed slightly less loss than fall N + N-Serve. On the other hand, fall applications without N-Serve to corn in the year ahead of the soybeans resulted in lower NO_3-N losses compared to the spring and fall with N-Serve applications. Nitrate-N losses for the corn-soybean system were highest for the fall application without N-Serve and lowest for the split application. Additional years with adequate drainage losses are necessary to determine if these findings are consistent over time.

Table 7. "Flow-normalized" NO_3-N losses to tile drainage in a corn-soybean sequence in 1990.

Crop[1] System	Time/Method of N Application: Fall, No N-Serve	Fall, N-Serve	Spring, No N-Serve	Split, No N-Serve
	NO_3-N Lost (lb/A/inch of drainage)			
Corn	7.85	6.67	6.09	6.35
Soybean	3.41	4.29	5.06	4.17
C-Sb System	5.54	5.28	5.49	5.10

[1] Continuous fallow (4 years without fertilizer N) = 12.8

Soil

Nitrate-N remaining in the 0-8' soil profile in mid-April was very high in the fallow plots (429 lb/A) compared to those where either soybeans or corn were grown in 1989 (Table 8). Soybeans that had not received fall-applied N averaged 98 lb/A with 69 lb/A remaining in the top 5'. Very low amounts of residual NO_3-N remained in the 0-8' profile when corn receiving no N fertilizer was the previous crop (54 lb/A). Residual NO_3-N remaining from the 1989 crop was increased by 30 to 60 lb/A with the previous fall, spring preplant, and split 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 one foot following soybeans and unfertilized corn. Corn receiving N showed increased levels of NO_3 down to the 4' depth.

Table 8. Nitrate-N in the soil profile in April, 1990 as influenced by previous crop and N treatment for corn in 1989.

Profile depth	1989 Crop Fallow	Soybean	Corn[1] 0 lb N	Fall	Preplant	Split
	lb/A[2]					
0-1	77.1	25.8	20.5	22.3	25.4	25.6
1-2	74.2	9.5	5.4	16.3	23.6	12.3
2-3	67.2	12.6	4.7	10.4	15.6	12.3
3-4	59.8	10.6	4.7	9.3	13.8	13.5
4-5	55.8	10.3	4.0	7.3	13.5	8.4
5-6	39.0	11.2	4.8	6.8	8.7	7.3
6-7	31.4	10.3	5.0	6.3	7.2	6.9
7-8	24.2	8.0	5.1	7.7	6.0	5.6
Total in						
0-5′ profile	334.1	68.8	39.3	65.8	91.9	72.1
0-8′ profile	428.7	98.3	54.2	86.6	113.8	91.9

[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, 1990 (Table 8) with those amounts found in the same plots in October, 1989, shows the spring NO_3 levels to be approximately the same as in the previous fall for the plots that did not receive fertilizer N (fallow and 0-lb rate). Results from the plots that received N were mixed with the fall and spring preplant applications showing 41 and 22% less soil NO_3 (0-8′), respectively, while 27% more was found in the spring with the split treatment.

Residual NO_3-N remaining in the 0 to 5′ profile after the 1990 season shows approximately the same amount of nitrate as after the 1989 season except in the fallow treatment (Table 9). Approximately 25% less nitrate remained in the fallow plots compared to 1989. However, more nitrate was found in the 5 to 8′ zone for all treatments in 1990. Higher amounts of nitrate were found consistently in the top 5′ with the N-Serve treatments. The reason for these differences is not clear but may be highly related to the excessive amount of precipitation in 1990. Differences among the time of N application were not shown. A comparison between the amount of NO_3-N in the 0 to 5′ profile of the fallow plots this fall with that in the spring (Table 8) shows 69 lb less NO_3-N in the fall. Nitrate-N losses through the tile totaled 150 lb/A (Table 6). Thus at least 80 lb of NO_3-N was added to the 0 to 5′ system due to soil mineralization during the growing season.

Table 9. Residual NO-N remaining in the 0-8′ soil profile after harvest as influenced by time of N application and N-Serve.

Profile depth	Fallow	Check	Application Time: N-Serve Fall	N-Serve Preplant	N-Serve Split	No N-Serve Fall	No N-Serve Preplant	No N-Serve Split
	lbs NO_3-N/A[1]							
0-1	62.8	27.3	29.7	39.2	38.0	31.2	28.8	33.2
1-2	30.3	5.7	7.3	6.8	9.3	9.8	5.1	11.3
2-3	47.3	3.9	4.7	6.9	9.2	2.6	3.9	9.6
3-4	69.0	4.3	20.2	16.1	17.2	11.4	9.8	10.6
4-5	55.4	6.0	26.7	20.2	19.6	18.4	14.6	11.6
5-6	46.5	7.5	18.2	16.1	17.1	32.5	16.4	33.3
6-7	36.1	7.3	13.7	12.1	13.0	18.3	11.8	14.0
7-8	29.8	6.0	13.1	12.3	10.0	16.4	11.5	10.4
Total in								
0-5′ profile	265	47	89	89	93	73	62	76
0-8′ profile	377	68	134	130	133	141	102	134

[1] Avg. of 4 replications

CONCLUSIONS

The warm and wet conditions resulted in good corn production and excellent tile drainage. Corn production was greatly improved by the various N treatments over the control. However, differences among the time/methods of N application were not generally significant. Tile flow was higher for soybeans while NO_3-N concentrations and NO_3-N losses were higher for corn compared to soybeans. Fall application of N without N-Serve to corn showed highest NO_3 losses while losses in the "residual year" when soybeans were grown were highest for the spring application. Continuous fallowing (no N for four years) resulted in NO_3-N losses 2X to 3X as high as when either corn or soybeans were grown. These data indicate the importance of growing a crop to utilize the N mineralized from these high organic matter soils.

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
G. Randall, J. Anderson, G. Malzer, B. Anderson,
D. Buhler, D. Wyse and J. Nieber

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. Corn yields were not improved with split or sidedress N applications. No tillage resulted in lower yields at two sites and lower nitrate-N concentrations in the soil water at all three sites. Yields from the residual manure treatments (manure applied in 1987 and 1988) were significantly lower than the fertilized plots due to plant use of N in 1989 and leaching of nitrate out of the root zone in 1990. High rainfall amounts leached nitrate that had accumulated in the top five feet in the last 3 years to the 7.5' depth at two sites. When profitability was highest, NO_3-N concentrations in the lysimeter water at 5' averaged between 25 and 30 mg/L.

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 1990 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 four replications was established in the fall of 1986 and was continued in 1990. 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 13, 1989. Spring N fertilizer treatments were applied on May 2 and again on July 5, 1990. Liquid hog manure was not applied in 1989 or 1990. All plots except the no-till treatment were disked on May 3.

Corn (Pioneer 3751) was planted on May 24 at 30,200 plants/A. Lasso (3 lb/A) and Bladex (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 July 6.

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 yields were taken from 20' of row at physiological maturity (Oct. 10). Grain yields and moisture were determined by combine harvesting two rows, each 60' long on Oct. 19. All samples were weighed, dried, ground and analyzed for total N.

Soil samples were obtained from each plot on April 20 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).

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 3, June 6, July 5, August 2, and September 5.

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 2 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 on July 6 with the ridge plots being ridged at that time.

[1] Funding provided by the Legislative Commission on Minnesota Resources, Center for Agricultural Impacts on Water Quality, and the Minnesota Agricultural Experiment Station.

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 1990. 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 November 14, 1989. Anhydrous ammonia was applied preplant on May 29. All chisel plots were disked on May 29.

Corn (Pioneer 3751) was planted at 30,200 plants/A on May 30. Prowl (1.5 lb/A) and Bladex (2.5 lb/A) was applied at 2 leaf stage (June 6). Force (8 oz/1000 ft) was applied 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 5-leaf stage (June 27) and 7 to 8-leaf stage (July 5).

Plant sampling procedures at silking and at PM were essentially the same as at the Olmsted Co. site. Soil sampling to the 8-foot depth on May 2 and November 14 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 8, June 8, July 5, Aug. 2, Aug. 31 and Nov. 1 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 manure 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 1990. Twelve N treatments were established for a total of 48 plots. Each plot measures 20' wide by 65' long.

Fall chiseling was conducted on November 13, 1989. The preplant anhydrous ammonia treatments were applied on May 7. A field cultivator was used as secondary tillage just prior to planting.

Corn (Pioneer 3751) was planted at 30,200 plants/A on May 24. 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 27) and the 8 to 9-leaf stage (July 5).

Whole plant and soil sampling procedures were identical to those used in Olmsted Co. Grain yields were taken by hand harvesting two rows each 40' long at physiological maturity (October 9). Stainless steel and PVC suction lysimeters were installed in 1987 at the 5' depth in six treatments (24 plots). PVC suction lysimeters were installed in 1988 at the 5' depth in three additional treatments and at the 7.5' depth in six treatments. These were sampled on May 7, June 6, July 5, Aug. 2, Sept. 5 and Nov. 15 to determine NO_3 and pesticide concentrations in the extracted soil water.

RESULTS AND DISCUSSION

Olmsted County

Corn grain yields in 1990 were increased significantly by the fertilizer N treatments (Table 1). The addition of 75 lb N/A increased yield by 69 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. Although the yields for the fall-applied treatments were not statistically lower (P=95% level) than the spring preplant 150-lb treatment, the 7 to 10 bu/A depression put the fall treatments at an economic disadvantage. Split application of N resulted in the same yield as the single preplant application. This was the first year in four where the no tillage plots yielded less than chisel tillage. Yields from the two manure treatments were significantly less than the fertilizer treatments because no manure had been applied since April, 1988. Under the high rainfall conditions in 1990, the corn suffered from N deficiency early in the season because the residual NO_3 from the manure had been leached below the top three feet. The corn recovered somewhat in August when the roots moved down into a higher zone of nitrate accumulation; hence yields that were 30 to 45 bu better than the control. Average 4-year yields showed greatest economic return to the 150-lb PP application with no advantage to higher rates, fall application, or split treatments.

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 15 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 1989, fall applications of N, regardless of the inclusion of N-Serve, showed much higher NO_3-N concentrations than the spring preplant applications. For the first time in four years no tillage had nitrate-N concentrations about 30% lower than the similar 150-lb rate applied to chisel tillage. Perhaps the no tillage system had reached an equilibrium and mineralization was reduced compared to annual chiseling. Due to no manure applied in 1989 or 1990 and the high precipitation in May-July, nitrate-N concentrations at the 5' depth were greatly reduced for the two manure treatments. However, leaching from the 5-foot depth caused the concentrations to escalate markedly at the 7.5-foot depth. It should be cautioned that these 5 and 7.5-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 potential environmental contribution and ranking of the treatments.

Table 1. Effect of N treatments on the 1990 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	1990	1987-90	5'	7.5'
		lb N/A		bu/A		mg/L	
1	Chisel	0	—	76.0	83.6	1	2
2	Chisel	75	Spr., preplant	144.8	155.5	11	8
3	Chisel	150	Spr., preplant	154.9	172.5	29	18
4	Chisel	225	Spr., preplant	156.4	167.1	43	42
5	Chisel	150	Fall, post tillage	145.0	169.4	43	-
6	Chisel	150+NI[1]	Fall, post tillage	147.6	169.1	50	-
7	Chisel	150-Split	50% Spr., preplant 50% SD, 8-leaf	154.2	168.4	47	-
8	No Tillage	150	Spr., preplant	139.6	168.0	20	-
9	Chisel	315[2]	Spr., disked in	108.0	165.9	15	23
10	Chisel	490[2]	Spr., disked in	122.0	168.4	25	49
	Significance level (%):			99			
	BLSD (.05) :			14.3			
	CV (%) :			8.0			

[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 or 1990. Total N rates were 315 and 490 lb N/A/yr or approximately 175 and 265 lb "available" N/A/yr.

[3] September 5, 1990.

Corn yields in the pesticide study were quite variable and thus statistical differences among treatments were not found (Table 2). However, similar to the 4-year average, yields were highest with the moldboard and chisel treatments and lowest with no tillage.

Table 2. Effect of tillage treatments on the 1990 corn yields in Olmsted Co.

	Grain Yield	
Tillage	1990	1987-90 Avg.
	bu/A	
Moldboard plow	150.7	168.2
Chisel plow	147.2	164.4
Ridge till	140.6	155.7
No tillage	136.2	152.1
Significance level (%):	57	
BLSD (.05) :	-	
CV (%) :	9.0	

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 150-lb spring PP treatment. The highest yield, although not statistically speaking, was obtained with the split 100 + 50-lb treatment. Yields with no tillage were consistently less, and at some N rates were significantly less than with chisel tillage. 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.

Four-year average grain yields also show: (1) optimum N rate to be between 100 and 150 lb/A, (2) no improvement in yield with either split or sidedress N application, and (3) slightly lower yields at all N rates with no tillage compared to chiseling.

Nitrate-N concentrations in the soil water extracted from the 5-foot depth on Aug. 31 related closely to N rate applied (Table 3). Similar to Olmsted Co., NO_3-N concentrations were consistently less with no tillage. Highest nitrate-N concentrations occurred with the 150-lb rate sidedress applied at the 6-leaf stage.

Table 3. Corn yield and NO_3-N concentration in the soil water at 5' as affected by N treatments in Goodhue Co. in 1990.

	Treatment			Grain Yield		Nitrate-N[3] Conc. in Water at
No.	Tillage[1]	N rate	Time/Method	1990	1987-90	5'
		lb N/A		------- bu/A -----		mg/L
1	Chisel	0	———	96.4	89.4	6
2	Chisel	50	Spr., preplant (PP)	125.2	128.6	-
3	Chisel	100	Spr., preplant (PP)	134.6	143.4	22
4	Chisel	150	Spr., preplant (PP)	142.4	146.9	39
5	Chisel	200	Spr., preplant (PP)	144.1	147.5	-
6	No tillage	0	———	88.1	77.4	-
7	No tillage	100	Spr., preplant (PP)	120.2	137.2	17
8	No tillage	150	Spr., preplant (PP)	121.0	141.4	28
9	No tillage	200	Spr., preplant (PP)	126.4	140.0	-
10	Chisel	50+50	Spr. PP + SD 9-lf	142.6	142.4	-
11	Chisel	50+100	Spr. PP + SD 9-lf	141.4	145.6	-
12	Chisel	100+50	Spr. PP + SD 9-lf	146.6	148.2	-
13	Chisel	100	SD 6-lf	134.8	140.0	-
14	Chisel	150	SD 6-lf	143.7	146.2	62
15	Chisel	150+NI[2]	Spr. PP	144.9	150.3	-
16	Chisel	150+NI	SD 6-lf	137.3	145.3	-
	Significance level (%):			99		
	BLSD (.05) :			17.4		
	CV (%) :			9.8		

[1] Chiseling was done in Nov., 1989
[2] NI = N-Serve
[3] Aug. 31, 1990

Winona Co.

Corn grain yields were improved over the 0-lb control by over 55 bu/A with all of the N treatments (Table 4). Yields were optimized by the 100-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.

Four-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 rates greater than 50 lb/A at this site which was in alfalfa from 1983-85. Nitrate-N concentrations in the soil water at 5' after four years of experimentation still are at 13 mg/L where no N has been used. Concentrations ranged between 22 and 64 mg NO_3-N/L for the treatments that received fertilizer N, with a positive relationship to N rate. Nitrate-N concentrations were slightly lower with no tillage. The very high nitrate-N concentration with the split-applied treatment is similar to the results found in Olmsted and Goodhue Counties. Leaching conditions early in the summer apparently contributed to the nitrate-N concentrations at 7.5' being markedly higher than in 1989. These high values throughout the profile must be a result of the previous alfalfa crop which received manure in 1985 and the very dry conditions in 1988 that severely limited yields and N uptake by the crop.

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 1990.

	Treatment			Grain Yield		Nitrate-N[2] Conc. in Water	
No.	Tillage[1]	N rate	Time/Method	1990	1987-90	5′	7.5′
		lb N/A		------- bu/A ------		---- mg/L ---	
1	Chisel	0	———	117.2	126.7	13*	-
2	Chisel	50	Spr., preplant	173.7	153.1		-
3	Chisel	100	Spr., preplant	178.1	155.7	30	40*
4	Chisel	150	Spr., preplant	181.9	157.8	34*	36*
5	Chisel	200	Spr., preplant	187.6	163.0	63	74*
6	No tillage	0	———	116.9	128.0	-	-
7	No tillage	100	Spr., preplant	178.6	155.8	22	-
8	No tillage	150	Spr., preplant	182.0	151.8	-	32
9	No tillage	200	Spr., preplant	184.7	155.8	49	40
10	Chisel	50+50	Spr. PP + SD 9-lf	179.1	156.7	-	-
11	Chisel	50+100	Spr. PP + SD 9-lf	184.9	160.2	64	59
12	Chisel	150	SD 6-lf	180.8	152.0	-	-
	Significance level (%):			99			
	BLSD (.05) :			12.8			
	CV (%) :			5.8			

[1] Chiseling was done in November, 1989
[2] Sept. 5, 1990
* - Average of only two samples

SUMMARY

The following summarizes the yield results from the fourth year of these studies:

1) N rates for continuous corn were optimized at between 100 and 150 lb/A at all three sites.
2) No apparent yield advantages were found with split or sidedress applications of N at any of the three sites. Yet, nitrate-N concentrations in the soil water were consistently higher.
3) Yields at two of the sites were lower with no tillage. However, nitrate-N concentrations in the soil water were also lower at all three sites with no tillage.
4) High precipitation and leaching conditions from May-July resulted in lower nitrate-N concentrations in the soil water at the 5-foot depth but increased concentrations at the 7.5-foot depth at the two locations where suction lysimeters are at both depths. Nitrate-N concentrations related very closely to rate of N application.
5) Previous crop and manure history apparently still impacts corn yield and N management at the Winona Co. site.
6) 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.
7) 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.

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Swine Research

ANIMAL SCIENCE
SWINE
1990 ANNUAL REPORT
Mark E. Wilson

A. Progress report - ongoing studies:

1. Determining Nutrient levels for Tomorrow's Economy: A New Approach - H. Chester-Jones, J.E. Pettigrew, V. Eidman, L. Jacobson, S.Cornelius, R.L. Moser, M.E. Wilson

Data analysis for this study is incomplete. The objectives of the study are: a) to quantify the response in performance and carcass qualify of growing and finishing pigs to diets continuing varying energy (fat) and lysine (soybean meal) levels at various environmental temperatures, and b) to use the response function so produced to estimate economically optimal diets to be fed to growing - finishing pigs in various situations. A progress summary is as follows. A total of 1600 pigs were used for a two-year study to evaluate the performance and carcass quality of growing and finishing pigs fed diets containing varying energy (from supplementary fat) and lysine (from varying corn:soybean meal rations) levels under various environmental temperatures. In the first year 160 pigs (16 pens of 10 barrows or 10 gilts/pen) from each of 5 consecutive farrowing groups were assigned to selected lysine (.3, .6, .7 or 1.0%) and animal fat/vegetable oil soapstock blend levels (0,3.0, 4.5, and 7.5%). Positive growth responses to lysine level in all pigs were observed when fed increasing lysine from .3 to 7%. Pig performance tended to plateau at higher lysine levels. Highest average daily gains (ADG; 1.93 lb) for gilts (G) were attained at 4.5% supplementary fat fed with .7% lysine and highest gain/feed (G/F; .38 lb)) at 3.0% with 1.0% dietary lysine. Barrows (B) attained their best (ADG; 1.88 lb) and (G/F; .37 lb) when fed 7.5% supplementary fat with .7% lysine. Differentials between B and G for percent lean muscle was demonstrated. Greatest amounts of lean muscle was shown in all pigs fed diets containing 1.0% lysine, but no apparent differences due to dietary fat level. In the second year a total of 800 pigs from five consecutive farrowing groups were assigned to .4, .567, .734 or .9% lysine fed with 0, 2.5, 5.0 or 7.5% blended fat in a 4 x 4 factorial design with 16 pens of 10 pigs (8 pens of B and 8 pens of G) from each farrowing. In the second year B and G attained their best overall performance (ADG, B-2 lb, G-1.92 lb; G/F, B-.38 lb; G-.41 lb) when fed .9% lysine with 7.5% supplementary fat although barrows fed 5.0% supplementary fat with .9% lysine. Gain/fed increased with increments of fat level in all pigs except those fed .4% lysine. Lean muscle percentages were again highest in gilts during the second year regardless of dietary levels of fat and lysine. Economic implications of the study cannot be defined until environmental temperature effects have been applied to the performance data. There appears to be practical benefits for separating pens of gilts from barrows to optimize production efficiencies.

MILK PRODUCTS IN STARTER DIETS IMPROVE SUBSEQUENT PIG PERFORMANCE

J.F.F. Stairs, M.D. Tokach, J.E. Pettigrew and M.E. Wilson

Introduction: Today there is much emphasis on utilizing milk products in starter diets to give increased growth performance, reduce post weaning lag and to reduce the number of days to market. A previous study at the University of Minnesota demonstrated that milk products in the starter diet reduced this post weaning growth lag and suggested that this advantage was maintained in the grower and finishing phase of production. A two or three phase feeding program was devised for the nursery pigs by Kansas State University as a means to gradually convert the young pig from a high fat milk diet to a corn-soybean diet. The bottom line is cost comparison between simple diet (corn-soy) and phase feeding program when comparing performance differences.

Objective: To examine the effects of various milk products in starter diets on growth performance during starting, growing and finishing phases.

Experimental procedure:

A total of 200 pigs (initially 16.28 lbs and an average of 26 days of age) were blocked by weight (5 blocks) and allotted to four dietary treatments. The starting phase was split into two stages. Stage 1 was for weeks 1 and 2 and stage 2 was for week, three four, and five. Treatments were corn-soybean meal-based diets with varying inclusions of milk products. During stage 1 the treatments were: Treatment 1, no milk products; Treatment 2, 20% dried whey, Treatment 33 20% dry skim milk plus 20% dried when during week 1. Followed by 20% dried whey in treatments 2, 3 and 4 during the 2nd week. During stage 2, diets in Treatments 1, 2 and 3 included no milk products but treatment 4 included 20% dried whey. Stage 1 diets were formulated to contain 1.4% lysine, and stage 2 diets 1.15% lysine. During the growing and finishing phases all pigs received the same corn-soy diets formulated to contain .70% and .63% lysine, respectively.

Results and discussion:

Addition of milk products to the diet increased ($P < .01$) starting phase average dairy gain (ADG) and daily feed intake (DFI). In the growing phase average daily gain was improved ($P < .02$) by milk products. There were no improvements in average daily gain or daily feed intake during the finish phase of production. The number of days from weaning to 224 lbs was reduced ($P < .01$) by the inclusion of milk products in the starter phase. There were no differences among the three milk product treatments in days to 224 lbs. Results are shown in the table below.

Treatment	Starting ADG, lbs	Starting DFI, lbs	Growing ADG	Growing DFI	Finishing Avg	Finishing DFI	Days to 224 lbs
T1	.88	1.46	1.65	4.08	2.01	6.70	133
T2	.90	1.49	1.76	4.23	2.01	6.70	129
T3	.94	1.57	1.75	4.45	2.00	6.78	128
T4	1.02	2.24	1.71	4.22	1.98	6.56	129

In conclusion milk products fed in the starter diet improved growth rate while being fed and in the subsequent growing phase and reduced the number of days to market. There are many factors that must go into comparing costs such as changing ingredient prices, market prices and importance of increased through put in each operation to evaluate whether a phase feeding program should be used on the early weaning pig.

AN EVALUATION OF CHEESE FOOD AS A SUBSTITUTE FOR DRY SKIM MILK IN EARLY-WEANED PIG DIETS

T.T. Lohrmann, S.G. Cornelius, J.E. Pettigrew and M.E. Wilson

Summary

An experiment was conducted to evaluate the use of cheese food as a substitute for dry skim milk in the diet of weanling pigs. This experiment was a 28-day growth trial with 140 pigs weaned at 24 ± 2 days of age. From 0 to 14 days postweaning, pigs received one of 5 corn-soy diets containing 20% dried whey and 4.38 g lysine/Mcal ME. Diet A contained 20% dry skim milk and 5% soy oil; diets B, C, D and E contained 5, 10, 15, and 20% cheese food, respectively, substitute for dry skim milk and progressively reduced levels of soy oil to obtain the appropriate ME levels. From 14 to 28 days postweaning, all pigs received the same diet (F) containing 20% dried whey and no cheese food or dry skim milk. The substitution of cheese food for dry skim milk linearly depressed average daily gain ($P < .05$) and average daily feed intake ($P < .01$) during days 0 to 14, with no effect on feed efficiency. There was a quadratic reduction ($P < .03$) in average daily gain during days 14 to 28.

These results show that, for weanling pigs, cheese food reduces diet acceptability and growth rate when compared to dry skim milk.

Introduction

In numerous university studies, the use of milk products in the diets of pigs weaned at 3 weeks of age or less has been shown to improve growth and feed intake responses when compared to similar diets containing no milk products. A study from Kansas State University has shown that both the protein and carbohydrate fractions of dry milk products are more readily digested in the young pig than are other protein and carbohydrate sources; however, the cost effectiveness of using dry milk products, such as dry skim milk, in weanling pigs diets is often questioned.

Recent research from the University of Minnesota has shown that the additional weight gain by early-weaned pigs fed diets containing milk products, during days 0 to 14 postweaning, is maintained until market time. These results showed that milk products reduced the days to market and that there was no compensatory gain made later by similar pigs fed simple corn-soy diets during these critical first 14 days postweaning.

The present experiment was designed to evaluate a commercial feed product called cheese food (brand name Pro 88, manufactured by Morgan Manufacturing Company of Paris, Illinois) as a substitute for dry skim milk in weanling pig diets. Cheese food, a byproduct of the cheese industry, is manufactured from cheese trimmings and edible grade cheeses beyond their freshness dates. As a protein source, cheese food is similar in amino acid profile to dry skim milk, but considerably lower in cost.

The objective for this experiment was to determine by growth whether cheese food could be used as a low-cost substitute for dry skim milk in high-nutrient-density starter pig diets without reduction of pig performance.

Experimental Procedure

The animals used in this experiment were housed in an environmentally controlled nursery with continuous light and were allowed ad libitum access to water. Pigs were housed in 4 x 4 ft raised decks with plastic-coated expanded metal floors and allowed ad libitum access to a pelleted diet. Diets were pelleted using a 1-inch-thick die. Pellets were 3/16 inch in diameter.

The growth trial was designed to determine the effect of progressive substitution of cheese food for dry skim milk. It used 140 pigs (14.9 lbs) at weaning at 22 to 26 days of age. The pigs ere individually weighed, blocked by starting date and weight, and randomly allotted within each of the five blocks to one of five dietary treatments. There were either 5 or 6 pigs per pen. Pig weights and feed consumption were recorded weekly.

This experiment started upon weaning (day 0) and terminated 28 days postweaning (day 28). A nutrient dense diet (A) containing 20% whey and 20% dry skim milk was used as a control in this study, while graded substitutions (25, 50, 75 and 100%) of cheese food were made for the 20% dry skim milk fraction in diets B-$. Diets A-E were formulated to be isocaloric and isolysinic by substation of soybean oil and/or L-lysine HCl for ground corn while soybean meal inclusion levels remained constant across the five treatments. During the second stage, days 15 to 28, all pigs were fed a 20% whey, corn-soy diet (F) to examine whether there would be compensatory gain during this period.

Results and Discussion

The pigs in this experiment had excellent growth rate regardless of the dietary treatment, but there were both linear ($P<.03$) and quadratic ($P<.03$; $P<.06$) effects of cheese food additions. Substitutions of cheese food linearly depressed average daily gains during the first half of the experiment (0-14 d). Complete substitution reduced growth rate by 18%. The reduction of growth rate extended through the second phase (15-28 d), though all animals were then fed the same diet. Linear reduction of average daily feed intake ($P>.01$) by cheese food was found only during the 0-14 d period (19% reduction from complete substitution), with the second phase and overall (0-28 d) average daily feed intake being similar across treatments. Feed efficiency results were different from those of average daily feed intake, with cheese food having no effect during 0 to 14 d but a quadratic response ($P<.03$) during the 15-28 d and overall periods. It is not clear why this effect of cheese food on feed efficiency during the 15 to 28 day period occurred, as all animals were consuming the same diet (F) during that time and no differences were seen during days 0 to 14 when the experimental treatments were applied.

Although this experiment showed that cheese food in the diet supports accurate gains in early weaned pigs, it is evident that cheese food is not an equal substitute for dry skim milk based on this growth trial. Certainly, ingredient cost is a major factor to consider when formulating diets. However, reducing diet costs through the use of lower cost alternative feedstuffs at a critical time such as the first two weeks postweaning (when feed intakes are low anyway) may, in fact, significantly lower the animals growth potential and increase the overall days to market.

PROVISION OF ADDITIONAL B VITAMINS TO WEANLING PIGS

M.E. Wilson, J.E. Pettigrew, L.J. Johnston, J.D. Hawton
J.W. Rust and H. Chester-Jones

Summary

Two series of experiments were conducted to evaluate effects of injectable B complex vitamins on growth performance of weanling pigs. In Series 1, conducted at three branch experiment stations, treated pigs received a 3-cc injection of B complex vitamins using a commercial product on the day of weaning, while control pigs received 3 cc distilled water. Dose of B vitamins exceeded NRC daily recommendations by 3 to 10 times. All pigs were fed a corn-soybean meal diet that met or exceeded NRC recommendations. Single injection of B vitamins on the day of weaning significantly increased total weight gain during a 28-day period, compared with the control, in three of five comparisons. Feed intake of pigs was also increased by B vitamins. Experiments in Series 2 were designed to evaluate which component of the commercial product used in Series 1 may be responsible for improved performance. In Series 2 experiments, pigs received a 2-cc injection of vitamin B_{12} or 2 cc of distilled water on the day of weaning. A single injection of vitamin B_{12} significantly increased total weight gain and feed intake during a 28-day period to three comparisons. While further research is needed to understand effects of B vitamin injections, it appears that provision of supplemental B vitamins to weanling pigs may be a useful management practice.

Introduction

Weaning, particularly early weaning, stresses piglets, resulting in postweaning depression of growth rate. Poor pig performance due to the stress of weaning may be exhibited as weight loss, postweaning scours, depletion of adipose stores and low feed intake. Several different management schemes to reduce stress and prevent depressed performance have been considered.

Veterinarians and beef feedlot managers commonly inject newly received cattle with B complex vitamins to help maintain performance during this stressful period. However, there is not strong evidence to support this widely accepted practice.

B vitamins have well-defined roles in metabolism of carbohydrates, lipids and protein. B vitamins are supplied to pigs in feed, usually in quantities at least as great as the NRC considers necessary to support maximal performance. Little research has been conducted with nursery pigs to determine effects of provision of extra B vitamins in the feed. We found no research dealing with injectable B vitamins for this age pig. However, if decreased feed intake occurs during the immediate postweaning period, then the pig may have a greater need for fat catabolism to provide energy. This may increase the actual requirement of B vitamins for the newly weaned pig beyond what is supplied normally. If so, the injectable form of the vitamin must be used during this period to ensure an adequate supply of B vitamins.

Experiments were designed to determine whether a practical management procedure could be developed to inject B vitamins into pigs at weaning to improve performance during this stressful period.

Experimental Procedure

Series 1. Experiments were conducted at three branch experiment stations (Waseca, Grand Rapids and Morris) to test effects of injectable B vitamins on performance of crossbred pigs. The commercial vitamin B complex[a] contained thiamine, riboflavin, pyridoxine, niacinamide, pantothenic acid, and cyanocobalamin. All pigs were fed a corn-soybean meal based diet calculated to contain B vitamins at concentrations that met or exceeded NRC recommendations for starting pigs. At Waseca, pigs were assigned randomly to a control or B vitamin treatment. At the other stations, pigs were separated into initial weight blocks (light and heavy at Grand Rapids; light, medium and heavy at Morris) and were randomly assigned to treatment within weight group.

Control pigs received an intramuscular injection of 3 cc distilled water on the day of weaning. B vitamin treated pigs received a 3-cc injection of the injectable B complex product. This does of B vitamins exceeded NRC recommendations for daily intake by 3 to 10 times.

In the first experiment at Waseca, a third treatment was included. This treatment consisted of two 3-cc injections of the B vitamin product, one at weaning and the other 3 days later. Pigs assigned to the other two treatments in this experiment received a 3-cc injection of distilled water 3 days after weaning.

Series 2. Two experiments were conducted at Waseca to determine whether the response observed in Series 1 could be obtained by injection of vitamin B_{12} (cyanocobalamin), one of six vitamins included in the commercial product. In experiment 1 pigs were allotted randomly to two treatments; and, in experiment 2 pigs were allotted randomly within light and heavy weight groups. Control pigs received a single 2-cc intramuscular injection of distilled water on the day of weaning, while treated pigs received an injection of vitamin B_{12}. The dose delivered exceeded the NRC daily requirement by slightly more than tenfold.

Both Series. All pigs were fed a corn-soybean meal based diet calculated to contain B vitamins at concentrations that met or exceeded NRC recommendations for starting pigs. Pigs were weighed and feed consumption measured weekly during the 28-day experiments, except that feed consumption was not measured in Experiment 1 or Series 2. In the first trial at Waseca in Series 1, a scours score was recorded for each pen daily, to determine whether the vitamins decreased postweaning scours.

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[a] Vitamin B Complex Forte; Vedco, Inc., St. Joseph, MO 64504.

Results and Discussion

Series 1. Total weight gain was increased (10% on the average) by injection of B vitamins (Table 1), significantly in three of five comparisons. Treatment effects were similar across weight groups at Morris, so data from all weight groups in the Morris experiment were combined. At Grand Rapids, the increase in gain from B vitamins was greater in pigs that were smaller at the beginning of the study. Feed intake also was increased by B vitamins (Table 2), but no significant effects on feed efficiency was observed.

The third treatment applied in the first experiment at Waseca consisting of two injections instead of one, produced average total gain/pig (21.5 lb.) not different from that of the single injection (22.6 lb.). There were no differences in scour scores among treatments in that experiment.

TABLE 1. AVERAGE TOTAL GAIN/PIG (LBS)

Location	Reps	Control	Treated	SE
Waseca -- Exp 1	7	19.9	22.6	.52
-- Exp 2	12	19.9	21.8*	.27
Grand R. -- Light	8	17.1	20.0*	.04
-- Heavy	8	19.8	22.2*	.04
Morris	12	16.5	17.2	.14

* Treated vs control, P<.05.

TABLE 2. AVERAGE TOTAL FEED CONSUMED/PIG (LBS)

Location	Reps	Control	Treated	SE
Waseca -- Exp 1	7	36.0	38.2	.56
-- Exp 2	12	35.8	36.9*	.36
Grand R. -- Light	8	28.6	33.9*	.73
-- Heavy	8	34.7	35.4*	.73
Morris	12	33.3	34.1	.16

* Treated vs control, P<.05.

Series 2. Total weight gain was increased ($P<.05$) by vitamin B_{12} injection in all three comparisons (Table 3). No significant effects on weight gain were found during the first weed, but significant effects ($P<.05$) were observed during the second and third weeks. Feed intake was increased by vitamin B_{12} (Table 4; $P<.05$), but feed efficiency was not affected.

TABLE 3. AVERAGE TOTAL GAIN/PIG (LBS)

Experiment	Weight	Reps	Pigs/rep	Control	Treated	SE
1		5	5	19.1	21.9*	.29
2	Light	10	10	20.7	23.9*	.42
	Heavy	10	10	23.9	24.8*	.34

* Treated vs control, P.05.

TABLE 4. AVERAGE TOTAL FEED INTAKE/PIG (LBS)

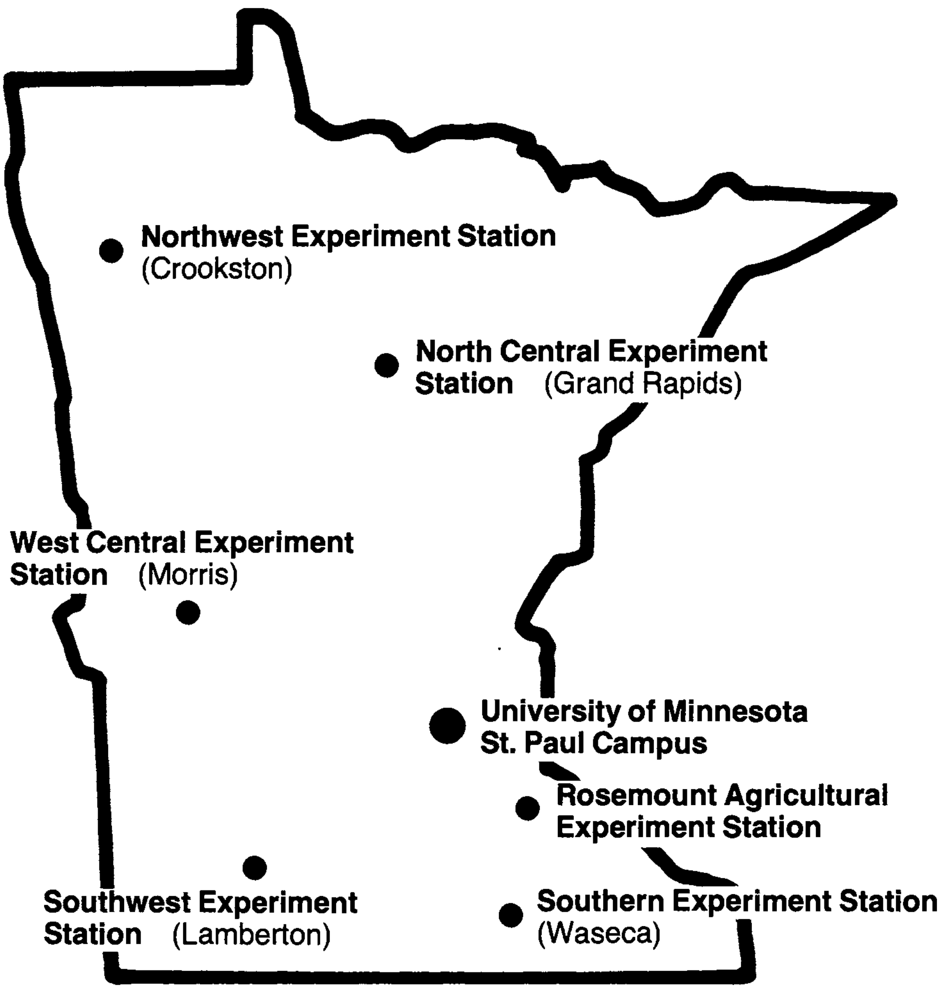
Experiment	Weight	Reps	Pigs/rep	Control	Treated	SE
2	Light	5	10	33.9	36.7*	.36
	Heavy	5	10	36.4	42.6*	.29

* Treated vs control, P<.05.

Discussion. In Series 1, growth rate of starting pigs was increased by a single intramuscular injection of B vitamins on the day of weaning. Further investigations are required to determine the conditions under which this response can be expected and whether it can be obtained by simply increasing vitamin supplementation of the diet instead of giving an injection. l The increase was obtained at three of our branch experiment station, but was small and nonsignificant at the station (Morris) with the poorest environment for starting pigs. If the response can be obtained widely in commercial pork production, it would appear to be a cost-effective method for improving growth rate of starting pigs.

Results of Series 2 suggest that the benefits may be due largely to vitamin B_{12}, one of the vitamins included in the commercial complex used in Series 1. The increase in total gain was of similar magnitude in both series of experiments. This is not to say that vitamin B_{12} is the only vitamin involved in the growth response and does not preclude that increasing vitamins in the feed will give the same increase in growth performance.

Minnesota Agricultural Experiment Station Locations



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