Saskatchewan Irrigation Development Centre

901 McKenzie St. S., Box 700
Outlook, Saskatchewan
S0L 2N0
Phone (306)867-5400; Fax (306)867-9656
e-mail: pf22400@em.agr.ca

Annual Review

April 1, 1997 to March 31, 1998

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This report and other SIDC publications are available at our internet address:
http://www.agr.ca/pfra/sidcgene.htm

Introduction

Manager's Report

On behalf of the Saskatchewan Irrigation Development Centre (SIDC), it is my pleasure to present the annual progress report. This report summarizes the wide range of activity conducted, funded or facilitated by the Centre in 1997. Please note in response to numerous requests by irrigation producers, the report incorporates both SI and Imperial units of measure. Hopefully, this will make it more useful. I would personally like to thank all who contributed to this report. Special thanks is also extended to members of the Centre Management Committee: Gerry Luciuk (PFRA), Harvey Fjeld & John Linsley (Sask Water). Their input and support have been integral to the success of the Centre.

1997 was a good year for irrigated crop production. Hot, dry conditions emphasized the true benefit of irrigated crop production. This, combined with an unusually long growing season, resulted in excellent yield and crop quality.

SIDC continued its focus on rural growth and resource care issues, particularly as they applied to irrigation. There is a need to diversify and adapt irrigated cropping practices in Saskatchewan to encourage sustainable production of higher value crops. SIDC's major impact has been through crop diversification and intensification. Work by SIDC has supported and intensified the development of seed potato, dry bean, canola, mint, and other industries in the irrigated areas of Saskatchewan. Interest in this work is very evident through the large attendance at our annual field day and evening tour. In addition, commodity specific tours were in demand and well attended. Clearly, there is a need and desire for information on irrigated crop production and, in particular higher valued alternatives. The Prairie Medicinal and Aromatic Plants Conference co-organized by SIDC was a huge success, and another example of the need for information on alternative crops.

... SIDC has supported and intensified the development of seed potato, dry bean, canola, and mint.

Resource care studies conducted at SIDC have emphasized investigating the impact of irrigation on the environment. These issues are critical to sustainable irrigation development.

Adequate funding is, of course, critical to the operation of SIDC. Funding is provided through federal and provincial A-base dollars, along with agreement dollars. The Canada/Saskatchewan Agreement on Water-Based Economic Development (PAWBED) has provided an excellent source of irrigated research and demonstration funding. Benefit cost analysis of the R & D portion of this program managed by SIDC has shown excellent returns ranging from 3/1 for cereals to 12/1 for potatoes. The federal portion of this agreement will end on March 31, 1998. Funding to continue this valuable work is key to the further development of the irrigation industry in Saskatchewan.

A recent industry-driven program, the Canada/Saskatchewan Agri-Food Innovation Fund (AFIF), will provide opportunities for the agricultural and irrigation sectors in Saskatchewan. This program has provided funding to SIDC to act as a spoke site for research and demonstration of irrigated specialized crops. In addition, SIDC has received funding for potato, herb, and vegetable crop research and demonstration, and for infrastructure to facilitate R & D.

Partnerships continue to be key to the future of SIDC....

Partnerships continue to be key to the future operation of SIDC. A Memorandum of Understanding (MOU) regarding operation of SIDC which includes Canada, Saskatchewan and Industry at the management table has been agreed upon in principle and awaits finalization and signature. In addition, a formal tri-province linkage was made through the signing of an MOU called the Prairie Irrigated Crop Diversification Group. The purpose of this MOU is to enhance the ability of the SIDC, the Manitoba Crop Diversification Centre (MCDC) and the Alberta Crop Diversification Centre (ACDC) to assist the Agri-Food Industry across the prairies in addressing issues, needs and opportunities in irrigated crop diversification and value adding. This will be through joint efforts in R & D, technology transfer and industry development.

History

The Saskatchewan Irrigation Development Centre (SIDC) was established in 1986 as a jointly-funded federal/provincial agency resulting from an MOU between Agriculture and Agri-Food Canada, PFRA, and Saskatchewan Agriculture. Its purpose is to conduct, fund and facilitate irrigated research and demonstration responsive to producer needs. The goal of the Centre is to promote economic security and sustainable rural development primarily through the diversification and intensification of irrigated crop production.

SIDC has provided physical facilities and a management structure for applied research and demonstration and has linkages to other developmental initiatives. Since the formation of SIDC, Canada and Saskatchewan have delivered irrigated research and demonstration information to their clients using core resources, along with incremental support from federal/provincial initiatives such as SIBED, PAWBED, Green Plan, and AFIF.

Objectives

1) Identify higher value cropping opportunities through market research to help target research and demonstration efforts.
2) Conduct, fund, and facilitate applied irrigated research and demonstration to meet the needs of irrigation producers and industry in the province.
3) Develop, refine, and test methods of diversifying and intensifying irrigated crop production in co-operation with research agencies.
4) Demonstrate sustainable irrigated crop production methodology.
5) Promote and extend sustainable irrigated crop production methods to ensure clients are well served.
6) Evaluate the environmental sustainability of irrigation through its impact on physical resources.
7) Promote a Western Canadian approach to irrigation sustainability by interacting with staff from similar institutions and industry across Western Canada to increase levels of co-operation in marketing, research and demonstration that support diversification and value-added processing, along with transfer of such technology to strengthen the industry.

Staff

Administration

L. Tollefson	Manager
M. Martinson	Administration
J. Clark	Secretarial
H. Clark	Market Analyst
P. Ackerman / J. Harrington	Technology Transfer

Applied Research and Demonstration Program

R. B. Irvine	Field Crops Agronomist
G. Larson	Technical support
T. Hogg	Irrigation Sustainability
M. Pederson	Technical support
J. Wahab	Specialty Crops Agronomist
C. Burns	Technical support

Farm and Site Operations

B. Vestre	Field Operation
D. David	Irrigation
A. MacDonald	Maintenance
L. Sexton	Irrigated Forage Project

Programs

Specialty/Horticultural Crops

A specialty crops development program was initiated at SIDC in 1987. This program involves the evaluation of specialty crop production under irrigated conditions with the intent of developing cropping alternatives suitable to irrigated conditions in Saskatchewan. This program involves a wide range of activity including varietal evaluation, irrigation, and agronomic adaptation studies. A concerted effort has been made to identify the most promising market opportunities to concentrate activity in this area. Examples of projects include varietal and agronomic evaluation of dry bean, pea, lentil, fababean, chickpea, caraway, coriander, fenugreek, etc.

More recently, a much greater emphasis has been placed on horticultural crop production. Particular emphasis has been placed on supporting and developing the potato industry through varietal and agronomic studies. In addition, work on vegetable production technology, medicinal herbs, and spices, etc., has been expanded.

Field Crops (Cereals, Oilseed and Forages)

Field crops are a major part of any irrigated rotation. In 1997, greater than 90% of the irrigated acreage in Saskatchewan was planted to field crops. While desirable to introduce new and specialized crops, a priority must be placed on improving the profitability of the more conventional field crops. This includes examining new and/or existing genetic material (varietal trials) under irrigated conditions with improved disease and lodging tolerance or novel quality traits that could service a niche market. Suitable varieties must be identified and tested for agronomic performance under irrigated conditions. Evaluation of agronomic factors which can lead to more efficient water use, optimize production and lower input costs must be determined.

Examples of projects include irrigated varietal and agronomic evaluation of canola, flax, barley, durum, alfalfa and turf grass seed. Other projects include CPS and durum wheat development, semi-dwarf barley development, sclerotinia control in canola, micro and macronutrient evaluation, and irrigation scheduling.

Environmental Sustainability

This program attempts to quantify the effect of irrigation on the environment. It was initiated in 1991 with funding from the Environmental Sustainability Initiative and was intensified in 1993 using Canada/Saskatchewan Agriculture Green Plan funding. This program enabled the installation of subsurface drainage and reclamation of a saline area. Current activity includes evaluating the effect of agrochemicals under an irrigated environment, water conservation, effluent irrigation, trickle irrigation, irrigation scheduling and improving irrigation application efficiency.

Marketing

Marketing of produce is key to sustainable irrigated production. This program was developed to identify and evaluate potential markets for irrigated produce, and to evaluate opportunities for value-added processing with the goal of promoting economic activity and development in the irrigated areas.

Technology Transfer

This program ensures that information developed at SIDC is made available to farmers, extension personnel, private industry and the general public. It includes the annual field day, newsletters, extension meetings, an internet website, and scientific publications.

Centre Funding

Base Funding

Funding for the Saskatchewan Irrigation Development Centre is provided by the Prairie Farm Rehabilitation Administration (PFRA) and Saskatchewan Water Corporation (Table 1).

Proposal Based Research and Demonstration

A major role of SIDC has been to fund irrigated research and demonstration activity. This has been funded from the Partnership Agreement on Water-Based Economic Development (PAWBED). Twenty-six research projects and 106 field scale demonstration projects have been conducted. Twenty-two of these demonstrations were completed in the southwest Saskatchewan irrigation projects.

Additional funding for a further four projects has been provided through the Agri-Food Innovation Fund (AFIF).

The projects are listed on page 11.

Table 1. SIDC funding for 1997/98.

	PFRA A-Base	Sask Water A-Base	PAWBED On-Station	PAWBED Proposal-based	AFIF
Salaries	$274,000	$19,190	$269,560		$111,400
Operating	216,800	935	217,170		26,250
Capital	42,000				850
Research				$455,801	
Demonstration				35,148	
TOTAL	**$532,800**	**$20,125**	**$486,730**	**$490,949**	**$138,500**

Activities

Tours

Tours of the facility and the field programs are an important function of SIDC. Noteworthy tours during 1997/98 were:

1) Vegetable Producers	April 8
2) PAWBED Program 2.0 Committee	May 1
3) International Grasslands Conference	June 17
4) Lamb Weston Executive	June 26
5) Agri-Food Equity Fund Committee	July 4
6) Canadian Special Crops Association	July 5
7) University of Saskatchewan soil scientists	July 8
8) SIDC Field Day	July 11
9) Agriculture Development Fund	July 15
10) SIDC Evening tour	July 16
11) Canadian Seed Trade Association	July 17
12) Agri-Food Innovation Fund Hort. Advisory Committee	July 21
13) Canadian Seed Trade Association	July 28
14) Manitoba Crop Development	July 29
15) Canadian Canola Council	July 31
16) Australian farmers	August 6
17) Australian farmers	August 11
18) T. Askin (Credit Union) with African delegation	August 14
19) PAWBED Agreement Management Committee	August 20
20) Bioriginal Food and Science Corp.	August 25
21) Rural Development Officers	August 27
22) Australian farmers group	September 3
23) Ag. and Bioresource Engineering students	September 9
24) Lamb Weston agronomists	September 17
25) Chinese government delegation	September 30
26) McCains agronomists	October 28
27) PFRA Division Heads tour	November 21
28) Chinese government delegation	November 28
29) Outlook High School students	December 4
30) Triprovincial Irrigation committee	December 11
31) Yugoslavian tour	February 23

SIDC Display

SIDC presented a display at the following trade shows and conferences:

Saskatoon:
- Crop Production Show
- Prairie Ventures
- Indian Business Conference
- Green Plan Sustainable Agriculture Conference
- Agri-Food Innovation Fund Special Crops Meeting
- Prairie Medicinal and Aromatic Plants Conference
- Wheat Protein Symposium

PFRA Shelterbelt Centre Field Day

Lucky Lake Annual Trade Fair

Committees

L. Tollefson

- Agri-Food Innovation Fund, Horticulture Committee
- Canadian Commission on Irrigation and Drainage, Secretary/Treasurer
- Dept. of Agric. and Bioresource Engineering, Research Associate
- Effluent Irrigation Project Liaison Committee
- Green Plan Irrigation Sustainability Technical Committee
- International Commission on Irrigation and Drainage Crops and Water Use Subcommittee
- Manitoba Crop Diversification Centre Technical Advisory Committee
- National Water Quality and Availability Management Project (Egypt), Canadian Co-ordinator
- Organizing Committee for USCID conference- 'Irrigation and Drainage in the New Millenium'
- Partners for the Saskatchewan River Basin Technical Committee
- PAWBED Irrigation Improvement Subcommittee
- PFRA Sustainable Development Water Task Team
- PFRA Operations Committee
- Prairie Crop Diversification Task Force
- SIDC Management Committee

T. Hogg

- Environmental Management Strategy (EMS) Planning Committee
- Green Plan Irrigation Sustainability Technical Committee
- Prairie Irrigated Crop Diversification Working Group
- PAWBED SSRID Rehabilitation Technical Committee
- PFRA Working Group on the Provincial Water Managment Strategy
- PFRA Pesticide Review Committee
- SIDC Strategic Planning Committee

J. Wahab

- National Potato Research Network
- National Potato Advisory Council
- Potato Land Suitability Committee
- Prairie Potato Council
- Prairie Regional Recommendation Committee on Grains
- Prairie Medicinal and Aromatic Plant Conference Organizing Committee
- Saskatchewan Seed Potato Growers Association
- Western Expert Committee on Grains (production section)
- Western Canadian Joint Task Force on Seed Potato Export

R. B. Irvine

- Agri-Food Innovation Fund Forage Seed Committee and Nutraceutical Committee
- Organizing committee of the Soils and Crops Workshop
- Prairie Regional Recommendation Committee on Grains

H. Clark

- Agriculture and Agri-Food Canada Ethanol Working Group
- PFRA Human Resources Strategy Group
- Prairie Medicinal and Aromatic Plants Conference Organizing Committee
- Saskatoon Branch of the Sask. Institute of Agrologists, Executive Member

B. Vestre

- Environmental Management Strategy (EMS) Planning Committee
- Joint Occupation Safety and Health Committee
- PFRA Pesticide Review Committee

M. Martinson

- Environmental Management Strategy (EMS) Planning Committee
- PFRA Communicator Newsletter Working Group
- Women in the Workplace Advisory Committee
- SIDC Strategic Planning Committee

Presentations

SIDC staff gave presentations at several meetings and conferences:

Saskatchewan:

- Canada/Saskatchewan Agriculture Green Plan Research Summary meeting
- Herbs and Spice Association annual meeting, Regina
- Irrigation Crop Diversification Corporation co-operators meeting
- Medicinal Herb Production meetings (Industry-sponsored) in Humboldt, Arborfield and Prince Albert
- Prairie Medicinal and Aromatic Plants Conference, Saskatoon
- Saskatchewan Pulse Growers Association meeting, Saskatoon
- Soils and Crops Workshop, Saskatoon
- South Saskatchewan River Irrigation District Rehabilitation Technical Committee meeting, Outlook
- Wheat Protein Symposium

Alberta:

- Canadian Water Resources Association annual conference, Lethbridge
- Prairie Potato Council annual meeting, Red Deer
- Trickle Irrigation meeting, Killam

Manitoba:

- Prairie Medicinal and Aromatic Plant Conference, Brandon

Publications

1) T.J. Hogg and P. Ackerman. 1998. Late Nitrogen Application to Improve Grain Protein of Irrigated Sceptre Durum Wheat. D.B. Fowler et al eds. In: Wheat Protein Symposium. March 9 and 10, 1998. Saskatoon, Sask. University Extension Press, University of Saskatchewan.
2) J. Wahab, T. Hogg, and D. Waterer. 1997. Potato Irrigation Scheduling Studies at SIDC. Proceedings of the Prairie Potato Council Meetings, Red Deer, Alberta.
3) J. Wahab, D. Waterer, and T. Hogg. 1997. Effects of Seed Piece Spacing and Irrigation on Seed Potato Yield. Proceedings of the Soils and Crops Workshop, Saskatoon, Sask.
4) J. Wahab. 1997. Saskatchewan Herbs and Spice Industry...What's New. Prairie Medicinal and Aromatic Plants Conference '97, Brandon, Manitoba.
5) R.B. Irvine, and G. Larson. 1997. Are Your Rotations Costing Your Money? Proceedings of the Soils and Crops Workshop, Saskatoon, Sask.
6) H. Clark. 1997. Market Potential for Herbs and Spices. Proceedings of the Soils and Crops Workshop, Saskatoon, Sask.
7) T.J. Hogg, and L.C. Tollefson. 1997. Sustainable Effluent Irrigation. Water Quality Symposium, Winnipeg, Manitoba
8) T.J. Hogg, G. Weiterman, and L.C. Tollefson. 1997. Effluent Irrigation: The Saskatchewan Perspective. Canadian Water Resources Journal Vol. 22, No. 4:445-455.
9) L.C. Tollefson, and T.J. Hogg. 1997. Irrigation Sustainability - Saskatchewan Activity. Canadian Water Resources Journal, Vol. 22, No. 4:457-465.
10) K. Kelk-Whenham. 1997. Prairie Provinces Trickle Irrigation Manual. Irrigation Sustainability Program, Saskatchewan Irrigation Development Centre.
11) L.C. Tollefson, R. Wettlaufer & A. Kassem. 1997. National Water Quality and Availability Management. Water News. Vol. 16, No. 4:20-22.
12) L.C. Tollefson. 1996. Thematic Paper 4: Requirement for improved interactive communication between researchers, managers, extensionists and farmers. In: Irrigation scheduling from theory to practice. Food & Agriculture Organization of the United Nations. Report 8:215-226.
13) L. C. Tollefson and J. Wahab. 1996. Better research-extension-farmer interaction can improve the impact of irrigation scheduling techniques. In: Irrigation scheduling from theory to practice. Food & Agriculture Organization of the United Nations. Report 8:227-235.

Factsheets

The following factsheets were developed and are available from the SIDC. Please contact the Centre for copies.

***Cereals*:**

Early Seeding of Irrigated Cereals
Decision Guide for Foliar Disease Control in Irrigated Wheat
Late Nitrogen to Increase Protein in Durum

***Forages*:**

Kentucky Bluegrass Establishment for Seed Production
Effect of Cutting Height on Alfalfa Yield and Quality
Irrigated Timothy Trials at SIDC
Alfalfa Establishment under Irrigated Conditions

Herbs and Spices:

Herbs, Spices and Essential Oils Research & Demonstration
Annual Caraway Trials at SIDC
Coriander Trials at SIDC
Dill Seed Trials at SIDC
Irrigated Scotch Spearmint Production in Saskatchewan

Marketing:

Vegetable Price Comparison
Ginseng Production and Marketing on the Prairies
Ethanol Industry Set for Recovery

Oilseeds:

Date of Seeding, Seed Rate, and Row Spacing of Irrigated Flax
Seeding Rate and Row Spacing for Irrigated Canola
Crop Management for Sclerotinia Control in Canola
Innovations in Canola Production

Pulse Crops:

Dry Bean Production under Irrigation in Saskatchewan
Irrigated Dry Bean Production Package
Intercropping Pea with Oilseeds under Irrigation
Management of Field Pea under Irrigation
Faba Bean Trials at SIDC
Management of Irrigated Lentil
Irrigated Chickpea Trials at SIDC

Soils and Fertilizers:

Reclamation of a Saline Field using Subsurface Drains
Rate and Placement Effects of P and K Fertilizer on Peas
Fertility Management of Irrigated Canola
Canola Fertilization Trials at SIDC
Hog Effluent Research and Demonstration

Other:

Crop Varieties for Irrigation
Overview of SIDC
Geographic Information System at SIDC
"Northern Vigor" in Seed Potato
Xeriscape Demonstration Project at SIDC
Fruit Crops in Saskatchewan
Plastic Mulches for Commercial Vegetable Production

Projects

Partnership Agreement on Water-Based Economic Development (PAWBED)

Research Projects

PROJECT NAME AND CO-OPERATOR	TERM	1997 EXPENDITURES	TOTAL $
Evaluation of Semi-dwarf Durum and Breeding Lines for Irrigated Production in Saskatchewan Principal: J. Clarke, Ag Canada, Swift Current	Final year of three	$6,300.00 COMPLETED	$96,300.00
Developing Semi-dwarf Cereal Varieties for Irrigation Production in Saskatchewan Principal: B. Rossnagel, U of S	Final year of three	$26,441.05 COMPLETED	$173,817.00
The Development of Industrial and Canlin Varieties of Flax Specifically for Irrigation and the Development of a Selection Technique for Lodging Principal: G. Rowland, U of S	Final year of three	$5,499.78 COMPLETED	$30,195.00
Demonstration of New Alfalfa Varieties Resistant to Verticillium Wilt on Irrigation in Southwestern Saskatchewan Principal: P. Jefferson, Ag Canada, Swift Current	Final year of three Extended for 1997	$46,855.00 COMPLETED	$162,855.00
Development of Non-shattering Dry Bean Germplasm for Irrigated Production in Western Canada Principal: A. Slinkard, U of S	Final year of three	$12,014.02 COMPLETED	$129,725.00
Development of Specialty Faba Bean Varieties for Irrigated Production in Western Canada Principal: G. Rowland, U of S	Final year of three	$16,376.41 COMPLETED	$49,050.00
Seed Yields of Grass Species and Varieties under Irrigated Conditions in Saskatchewan Principal: Sask Forage Council	Final year of three	$2,965.00 COMPLETED	$74,895.00
Management and Evaluation of Species and Cultivars for Irrigated Forage in Seed Production Principal: B. Coulman, Ag Canada, Saskatoon	Final year of three Extended for 1997	$11,221.81 COMPLETED	$95,322.00
Production of Timothy for the Export of Long Fibre Hay Principal: A. Kielly, Ag Canada, Swift Current	Final year of three	$1,500.00 COMPLETED	$28,710.00
Evaluation of Spice Crops under Irrigated Conditions in Saskatchewan Principal: F. Sosulski, U of S	Final year of three	$232.72 COMPLETED	$21,450.00
Control of Potato Scab Through Integrated Soil Fertility and Moisture Management Principal: D. Waterer, U of S	Final year of two	$13,858.20 COMPLETED	$50,400.00
Management of Plastic Mulches to Enhance Vegetable Crop Production Principal: D. Waterer, U of S	Final year of three	$29,310.30 COMPLETED	$49,700.00

PROJECT NAME AND CO-OPERATOR	TERM	1997 EXPENDITURES	TOTAL $
Comparative Salinity Tolerances of Alternate Crops Grown under Irrigation Principal: H. Steppuhn, Ag Canada, Swift Current	Final year of two	$12,640.00 COMPLETED	$24,640.00
Grass Seed Industry Development: Control of Silvertop in Irrigated Grass Seed Fields Principal: J. Soroka, Ag Canada, Saskatoon	Final year of two	$12,650.00 COMPLETED	$48,950.00
Development of Disease Resistant Field Pea Germplasm under Irrigation Principal: A. Slinkard, U of S	Final year of two	$47,923.17 COMPLETED	$99,000.00
Development of Production Package for Seed Potatoes Principal: D. Waterer, U of S	Final year of two	$26,333.35 COMPLETED	$63,360.00
Forage Quality of Alternative Salt Tolerant Grasses Principal: D. Kielly, Ag Canada, Swift Current	Final year of two	$12,000.00 COMPLETED	$44,550.00
Energy Conservation and Application Uniformity for Centre Pivot Linear Move Irrigation Systems When Operated at Varying Pressures Principal: J. Gillies, U of S	Final year of three	$37,119.00 COMPLETED	$76,120.00
A Crop Diversification Opportunity: Potential of Ryegrass as a Seed Crop Under Irrigation in Saskatchewan Principal: B. Coulman, Ag Canada, Saskatoon	Second year of three	$19,660	$33,990.00
Dormancy Management in Seed and Table Potatoes, Phase II Principal: K. Tanino, U of S	Final year of two	$40,037.00 COMPLETED	$75,900.00
	TOTAL RESEARCH	$455,800.85	$1,428,929.00

Demonstration Projects

West Central:

PROJECT NAME AND CO-OPERATOR	TERM	1997 EXPENDITURES	TOTAL $
Saskatoon Berry Water Use (4 sites) Co-operators: G. Schultz, Waldheim; Last Mountain Berry Farm, Southey; Prairieland Orchards, D'Arcy; Topp Berry Farm, White City	Final year of two	$500.00 $500.00 $500.00 $500.00	$1,000.00 $1,000.00 $1,000.00 $1,000.00
Lower Energy Irrigation Systems Evaluation Co-operator: D. Eliason, J. Eliason, Riopka Brothers, Outlook	Final year of two Extended for 1998	--- --- $202.67	$1,000.00 $1,000.00 $2,500.00
Dandelion Control in Alfalfa Co-operators: G. Sommerfeld, G. Solnicka, Outlook	Project cancelled		
Remedial Pruning of Hail Damaged Saskatoon Berries Co-operator: Topp Berry Farms, White City	Second year of three	$750.00	$2,250.00
ICDC Crop Manager Demonstrations Co-operator: ICDC	First year of three	$12,782.11	$60,000.00
	WEST CENTRAL DEMONSTRATION TOTAL	$15,734.78	$70,750.00

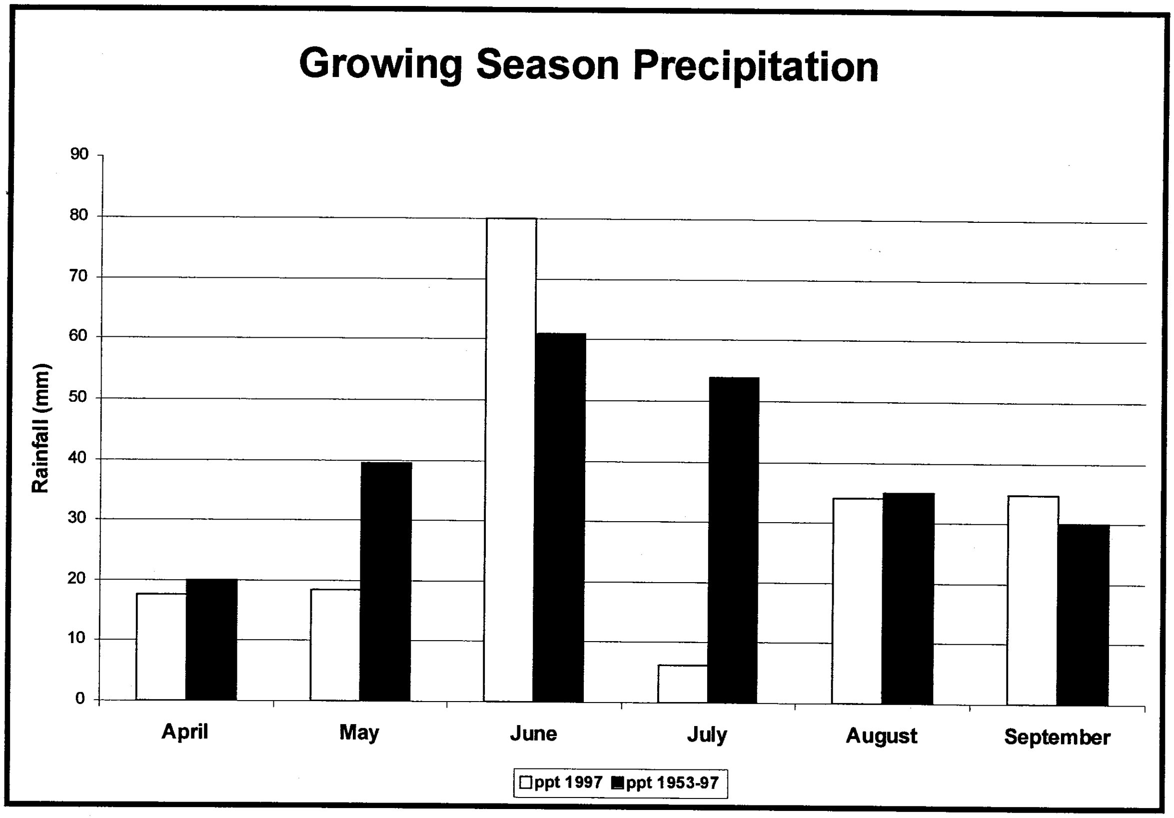
Southwest:

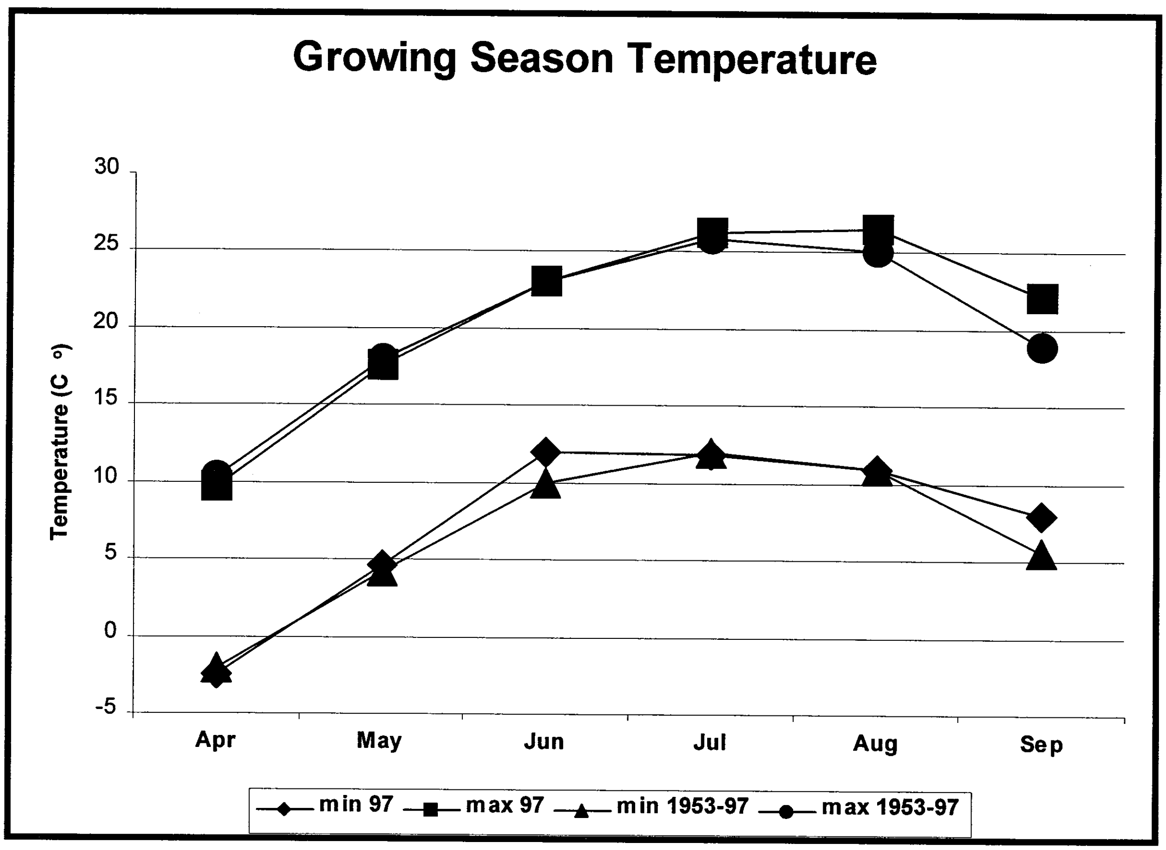
PROJECT NAME AND CO-OPERATOR	TERM	1997 EXPENDITURES	TOTAL $
Sprinkler Irrigated Alfalfa Management Co-operator: H. Gold, Maple Creek	Final year of three Extended for 1998	$788.00	$3,260.00
Fertilizer Placement - Spoke Injection vs. Deep Banding Co-operator: D. Arendt, Eastend	Final year of three Extended for 1998	$334.78 COMPLETED	$1,830.00
Fertilizer Placement for Spring Flooded Grasses (three sites) Co-operator: I. Bowie, Piapot; L. Weiss, Maple Creek; H. Steinley, Rush Lake	Final year of three Extended for 1998	$354.00 $494.00 $567.28	$1,830.00 $1,830.00 $1,830.00
Fertilizer Placement for Established Irrigated Alfalfa Co-operator: L. Grant, Val Marie	Final year of three Extended for 1998	$489.00	$2,300.00
Alfalfa Varieties and Rates Co-operator: J. Wiebe, Swift Current	Final year of two Extended for 1998	$813.00	$1,500.00
Alfalfa Establishment and Varieties Co-operator: D. Halvorson, Abbey	Final year of two Extended for 1998	$597.00	$1,500.00
ICDC Forage Manager Demonstrations Co-operator: ICDC	First year of three	$14,975.96	$60,000.00
SOUTHWEST DEMONSTRATION TOTAL		$19,413.02	$75,880.00
TOTAL DEMONSTRATIONS		$35,147.80	$146,630.00

Agri-Food Innovation Fund (AFIF)

PROJECT NAME	TERM	1997 EXPENDITURES	TOTAL $
Spoke Applied Research & Demonstration: Pulse; Turf Grass Seed; Minor Use Registration of Herbicides; Sunflower Regional; Herb Agronomy	First year of five	$84,000.00	$620,000.00
Demonstration of Improved Vegetable Production Techniques for Saskatchewan	First year of three	$33,300.00	$99,900.00
Integrated Management Program in Support of Saskatchewan Seed Potato Industry	First year of three	$16,500.00	$115,500.00
Precision Farming	First year of three	$4,700.00	$50,100.00
Total		$138,500.00	$885,500.00

Meteorological Data





Irrigation Data *(mm)*

Crop	Field	May	June	July	Aug	Sept	Total
Soft Wheat	1		15	100			115
Canola\Peas	3		50	175			225
Fibre Flax	3			150			150
Peas	4		30	140		425*	170
Soft Wheat	5		30	100		425*	130
Grass Seed Trials	7		50	170			220
Crop Rotation Study	8		40	125			165
Herbs	8		40	125	45	15	225
AFIF Pea Demo	8		40	125			165
AFIF Lentil Demo	8			65			65
AFIF Chick Pea Demo	8			90			90
AFIF Faba Bean Demo	8		40	175	75		290
Potatoes	8		40	175	100		315
Soft Wheat	9		15	175			190
Sunflowers	9		15	175	25		215
Canola Trials	9		15	175	75		265
Canola Trials	10		40	175	25		240
Spearmint	10		40	175	50	25	290
Spice Crops	10		40	150	50		240
Soft Wheat	10		40	175	25		240
Grass Trials	10		40	175	25		240
Durum	11		30	90	30		150
Potato Trials	11		30	135	60		225
Trans-Genic Canola	11		30	135	60		225
Potato Trials	12		75	120	90		285
Canola\Beans	12		45	105	30		180
Soft Wheat	12		75	90			165
Demo Site (Durum)	East 1/2		96	162			258
Demo Site (Cereals)	SW 1/4		96	162	48		306
Demo Site (Oils\Pulses)	NW 1/4		90	162	51		303

* Fall Leaching

Cereals

Cereals Program

Principal: R.B. Irvine
Saskatchewan Irrigation Development Centre

Introduction

The cereal crop program at the SIDC is designed to evaluate the adaptability of cereal crops for irrigated production, to improve production efficiencies, and to define the role of cereal crops in the intensive irrigated crop rotation. This is accomplished by conducting variety trials, evaluating new production practices, assessing the value of new pest control products, and conducting crop sequence trials.

Agronomic Investigations

Relative Yields of Cereal Cultivars

Locations: Outlook, Dundurn, and Birsay
Progress: Year eight of ongoing
Objective: To determine the relative performance of CPS, Soft White, Hard Red and Durum wheats.

Plots contained six rows 4 m (13.1 ft) long with a 25.4 cm (10 in) row spacing. Long term yields indicate that AC Barrie and CDC Teal are among the highest yielding hard wheat cultivars, and appear to have yields similar to the best available durum wheat cultivars. Most CPS wheats have excellent lodging tolerance, but unless lodging or disease are severe will yield only 20% more than the higher yielding hard red spring and durum wheats. Soft white wheat is susceptible to leaf disease and black point. The new lodging resistant soft wheat cultivars may be economically viable if leaf diseases are monitored and control measures taken if required. Lodging was limited in 1997 allowing for the full expression of yield in many lodging susceptible varieties (Table 1).

Barley Regional Trial

Location: Outlook
Progress: Ongoing
Objective: To determine the yield and agronomic traits of barley cultivars.

Plots contained six rows 4 m (13.1 ft) long with a 25.4 cm (10 in) row spacing. Nitrogen was applied at 225 kg/ha (200 lbs/ac) pre-plant with an additional 45 kg/ha (40 lb/ac) applied by fertigation at heading. Phosphorus was applied to the soil surface at 225 kg/ha (200 lbs/ac) prior to planting, and an additional 20 kg/ha (18 lbs/ac) was sidebanded at planting. CDC Earl has produced the highest yield of any cultivar over the long term. In this trial, many other cultivars outyielded it, presumably due to the low levels of lodging (Table 2). Falcon and CDC Silky are hulless barley cultivars with good yield potential and tolerance to lodging. Foster, Excel and Stander are white aleurone six-row malting cultivars with acceptable performance. Robust yielded below its long term mean. CDC Fleet and Kasota are early maturing. While several cultivars have good lodging tolerance, Stetson is much shorter than other varieties.

Table 1. Yield and agronomic traits of wheat varieties.

Variety	Yield % of Teal			Lodging (1-9)			Height (cm)			Days to Mature	Test Weight (lbs/bu)		
	Bir	Dun	Out	Bir	Dun	Out	Bir	Dun	Out	Out	Bir	Dun	Out
CDC Teal (kg/ha)	**4013**	**3603**	**3851**										
CDC Teal (bu/ac)	**60**	**53**	**57**										
CPS Wheat													
AC Crystal	120	114	123	1.0	2.0	2.0	83	91	86	110	62	63	63
AC Foremost	108	112	124	1.0	1.3	1.0	78	89	78	108	60	62	64
AC Karma	116	91	117	1.3	2.0	1.8	87	98	91	110	62	62	64
AC Taber	118	116	128	1.3	1.7	1.3	81	93	87	112	61	63	63
AC Vista	120	118	136	1.3	6.0	3.3	88	94	90	113	61	63	64
LASER	94	92	97	1.3	2.0	1.3	96	108	102	104	60	61	63
Durum													
AC Melita	120	116	131	3.3	1.7	1.3	108	113	118	112	63	63	64
DT484	129	99	127	1.0	1.0	2.0	95	106	101	109	63	62	63
DT492	129	109	142	1.0	2.7	2.0	106	113	110	111	62	62	63
DT661	127	115	116	1.0	2.3	2.0	102	112	99	107	64	63	63
DT673	113	97	105	1.0	3.0	1.3	89	100	88	107	64	63	63
Durex	92	85	69	2.5	1.7	1.3	75	88	82	105	61	62	60
Kyle	107	94	106	3.3	7.0	4.8	116	125	126	113	63	63	63
Plenty	106	96	109	1.0	1.0	2.3	106	116	112	111	62	63	64
Extra Strong													
Glenlea	88	80	104	1.0	5.3	2.5	105	118	115	113	61	62	64
Hard Red Spring													
Invader	72	84	95	1.0	1.3	1.5	106	106	92	101	61	63	64
AC Barrie	101	96	94	1.5	2.7	1.3	102	103	103	108	63	64	65
AC Cadillac	94	96	74	1.0	6.0	2.0	106	111	104	104	64	65	65
AC Cora	88	92	95	1.3	2.7	1.3	100	111	103	103	62	63	65
AC Elsa	100	88	102	1.0	5.0	2.5	95	106	101	105	62	62	64
AC Majestic	73	87	63	1.0	2.3	1.0	95	105	102	108	62	64	64
BW191	95	84	95	2.0	4.3	2.0	94	103	93	101	61	62	64
BW205	112	97	112	1.3	6.0	2.8	101	104	93	105	63	63	65
BW220	89	97	86	1.0	3.3	2.5	110	107	109	109	62	64	65
BW223	89	85	98	1.0	2.3	2.0	94	103	102	106	61	63	63
BW691	97	91	111	1.3	6.7	3.3	93	95	103	106	62	62	64
BW693	102	78	111	1.0	3.3	2.8	94	102	95	104	62	63	65
BW703	101	111	107	1.0	1.7	2.0	86	85	87	106	61	63	64
BW710	88	90	98	1.8	6.7	2.5	90	96	90	104	62	64	65
CDC Teal	100	100	100	1.0	2.0	4.5	93	105	104	107	62	63	65
Columbus	72	72	75	1.5	3.3	2.3	113	112	110	111	63	64	65
Katepwa	93	81	77	2.0	5.0	2.3	100	99	109	109	61	63	64
PT403	96	91	95	1.0	1.3	1.8	93	105	103	104	63	64	64
Soft White Spring													
AC Phil	119	128	137	1.3	1.0	1.0	80	89	88	111	60	63	63
AC Reed	112	144	132	2.8	1.0	1.3	79	88	85	111	60	62	63
LSD	9	15	17	1.8	1.9	2.0	6	9	8	4	1	1	2
Bir=Birsay, Dun=Dundurn, Out=Outlook; Lodging 1=good, 9=poor													

Table 2. Yield and agronomic traits of barley varieties.

Variety	2 or 6 row	Type	Yield % of Harrington	Height (cm)	Lodging (1-9)	Days to Mature	Test Weight (lbs/bu)
Harrington (kg/ha)			**3820**				
Harrington (bu/ac)			**71**				
Excel	6	M	161	115	2.0	98	45
Stander	6	M	155	117	1.0	99	47
Foster	6	M	151	117	2.0	100	47
BT941	6	M	133	120	6.3	98	41
BT433	6	M	129	125	4.0	98	43
BT435	6	M	125	119	4.3	100	42
Robust	6	M	110	126	3.7	101	47
TR128	2	M	144	106	1.7	99	46
AC Oxbow	2	M	131	124	3.7	98	49
TR139	2	M	130	125	1.7	100	44
TR145	2	M	129	116	3.0	102	48
Stein	2	M	128	112	4.3	100	46
TR133	2	M	122	115	3.0	100	48
TR232	2	M	113	124	4.7	103	49
TR243	2	M	110	113	3.0	101	48
Manley	2	M	110	121	5.0	98	45
Harrington	2	M	100	115	6.3	103	45
CDC Silky	6	H	154	106	1.3	99	40
HB 105	6	H	137	118	3.3	101	37
HB 605	6	H	131	113	2.0	99	44
HB 326	6	H	130	118	3.3	102	53
Falcon	6	H	112	119	1.3	100	50
CDC Dawn	2	H	107	118	5.0	100	42
AC Hawkeye	6	H	91	135	6.7	100	40
CDC Earl	6	F	171	107	1.0	102	44
AC Rosser	6	F	156	118	3.0	100	44
AC Lacombe	6	F	152	118	2.3	98	41
Stetson	6	F	141	87	1.0	103	44
Kasota	6	F	138	100	1.0	98	43
AC Harper	6	F	134	111	3.0	98	40
CDC Dolly	2	F	147	112	1.0	100	50
CDC Fleet	2	F	128	107	2.0	98	49
LSD			27	10	3.0	4	6
M=malt ,H=hulless, F=feed							

Crop Sequence under Irrigation

Location: Outlook
Progress: Year two of four
Objective: To determine the effect of crop sequence on the yield of traditional crops and potatoes.

There is published work indicating that potato yield is greater following rapeseed than other crops. Likewise, dryland canola yields have been shown to be considerably higher after pea than following cereal grains. These are currently not recommended practices, but may have considerable economic importance if they can be duplicated under irrigated conditions in Saskatchewan.

Potato yield was not significantly greater following canola rather than wheat despite an apparent increase of 8% (Table 3). Crops grown on their own stubble had lower yields than after any other crop. Wheat yield was the same on stubble of pea, flax, or canola. The lower yield was the result of reduced seed size, possibly as a result of take-all root rot. Protein contents did not differ. This is in contrast to other work where wheat yields were greater after pea, but similar to previous irrigated results where the only reduction in yield was wheat on wheat. Flax yield was equal on pea, wheat, or canola stubble. Pea yield was equal on wheat and flax stubble and slightly lower on canola stubble.

Table 3. Effect of previous crop on yields in the current crop year.

1996 Crop	Crop grown in 1997									
	Potato		Wheat		Canola		Flax		Pea	
	T/ha	Cwt/ac	kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac
Pea	37.7	336	5435	80.6	1513	24.0	2019	32.1	**2142**	31.8
Flax	36.8	328	5843	86.7	1748	31.1	**1388**	22.1	2705	40.1
Wheat	36.4	324	**3835**	56.9	1428	25.4	2097	33.3	2730	40.5
Canola	39.3	350	5843	86.7	**1330**	23.7	1986	31.6	3176	47.1
Straw treatment	ns		ns		ns		ns		ns	
Previous crop	ns		601		365		676		671	
pcrop x straw	ns		ns		ns		ns		ns	

Yields in **bold** within a column are yields of the crop on its own stubble

Effect of Foliar and Root Disease Control on Wheat Yield

Location: Outlook
Progress: Year one of one
Objective: To determine the effect of controlling leaf and root disease on seed yield of wheat.

Previous research had indicated that take-all root rot was controlled by the product Dividend, resulting in yield increases of up to 50%. Take-all root rot does not occur at high levels every year or in every field, but when it does occur loss is severe. Soft wheat and CPS wheat appear to be affected to a greater extent than hard red spring or durum wheat. The desert durum Durex has been shown to be extremely susceptible to leaf diseases which can be controlled by Tilt. If controlling leaf disease increases the yield of this cultivar, it might be possible to grow this variety under contract for the U.S. market since it has high gluten strength. Pasta makers in the US appear willing to pay a premium for this type of quality. The variety DT 673 is a better adapted durum than Durex, and appears to have similar grain quality.

Durex, AC Morse, and DT 673 durum wheat, AC Reed soft white spring wheat, and AC Barrie hard red spring wheat were planted in six-row plots 4 m (13.1 ft) long with a 25.4 cm row (10 in) spacing. All cultivars were planted at 225 and 300 seeds/m^2 (1.4 and 1.9 bu/ac for durum, and 1.2 and 1.5 bu/ac for SWS and HRS). The trial was planted at Birsay, Dundurn, and Outlook on May 9, 12, and 14, respectively. Dividend was applied as a seed treatment and Tilt was applied (0.2 L/ac) in-crop to all cultivars on the same date. Dates of Tilt application were July 4, 9, and 10 for Outlook, Birsay, and Dundurn, respectively. Leaf disease ratings were made four weeks later. Ten flag leaves were rated using a computer program "DISTRAIN" to ensure consistent ratings. Samples were taken for evaluation of root disease, but the amount of disease was low and ratings were not done. Plant counts, head numbers, seed weights, protein content, yield and test weights were determined.

Table 5. Effect of fungicide on the yield of wheat varieties in 1997.

	Birsay		Dundurn		Outlook	
Fungicide	kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac
Dividend	3998	59.3	3171	47.0	4393	65.2
Tilt	4281	63.5	3845	57.0	4627	68.6
Div + Tilt	4221	62.6	3691	54.8	4705	69.8
None	4012	59.5	3116	46.2	4312	64.0
Variety						
DT 673	4334	64.3	3357	49.8	4546	67.4
Durex	3442	51.1	3105	46.1	3589	53.2
AC Morse	4760	70.6	3791	56.2	5311	78.8
AC Reed	4231	62.8	3828	56.8	5398	80.1
AC Barrie	3874	57.5	3199	47.5	3700	54.9
Analysis of Variance						
Fungicide	199		ns		ns	
Variety	243		297		309	
Fung x Var	ns		ns		ns	

Dividend did not increase yields at any site, presumably since take-all root rot did not occur to significant levels (Table 5). While significant only at Birsay, Tilt appeared to increase yields by 6-20% at all sites. Leaf disease levels were relatively low for all varieties except Durex (Table 6). Despite the fact there were significant variety x fungicide interactions for leaf disease ratings, the variety x fungicide treatment interaction was not significant for seed weight. Seed weights were increased by the application of tilt by 3-7% (Table 6) although this was not always a significant difference. There were major differences in protein levels between varieties, but fungicide application had very little impact on protein. Bushel weight was not affected by fungicide application.

Table 6. Effect of fungicide application on leaf disease, seed weight, and protein levels of five wheat varieties.								
	1000 seed Weight (g)			Protein %			Flag leaf disease (% damage)	
Fungicide	Birsay	Dun	Out	Birsay	Dun	Out	Birsay	Out
Dividend	38.9	37.6	37.6	13.9	14.2	14.3	16.9	29.2
Tilt	40.9	40.8	39.1	14.2	14.2	14.3	10.0	24.2
Div + Tilt	41.2	40.1	39.3	13.8	14.3	14.3	12.0	24.2
None	38.9	37.7	38.4	13.9	14.2	14.4	18.4	22.7
Variety								
DT 673	44.0	42.3	41.1	14.3	14.2	14.9	9.5	21.5
Durex	39.9	40.5	39.5	13.9	14.3	14.4	30.5	49.6
AC Morse	43.0	41.9	41.4	14.0	14.4	14.5	10.7	18.5
AC Reed	34.6	33.0	34.3	12.1	12.2	11.8	12.0	16.6
AC Barrie	38.1	37.7	36.6	15.4	16.0	16.0	9.0	21.2
Analysis of Variance								
Fungicide	1.3	ns	2.1	0.2	ns	ns	ns	ns
Variety	0.9	1.3	1.5	0.2	0.3	0.2	5.6	6.9
Fung x Var	ns	ns	ns	ns	ns	ns	11.6	13.6

Soft Wheat Co-operative Test

Location: Outlook
Progress: Year one
Objective: To determine the relative performance of soft wheat lines.

Plots contained six rows 4 m (13.1 ft) long with a 25.4 cm (10 in) row spacing. Nitrogen was applied at 205 kg/ha (182 lb/ac) preplant with an additional 45 kg/ha (40 lb/ac) applied via the irrigation system. Phosphorus was applied to the soil surface at 225 kg/ha (200 lb/ac) prior to planting. An additional 20 kg/ha (18 lb/ac) was sidebanded at planting.

Several potential cultivars in this trial outyielded the check varieties, AC Phil and AC Reed. Lodging was low in this trial despite the very high fertility levels (Table 7.) Samples were sent to the Grain Research Lab for quality evaluation. At the time of writing, the quality of these lines is unknown.

Table 7. Yield and Agronomic traits of Soft White Wheat varieties (Public Co-op trial).					
Variety	Yield % of AC Phil	Height (cm)	Lodging (1-9)	Days to Mature	Weight (lb/bu)
AC Phil (kg/ha)	**6362**	93	1.0	112	62
AC Phil (bu/ac)	**94**				
AC Reed	101	93	1.0	112	62
96DH-812	122	95	1.0	114	62
96DH-809	119	94	1.0	115	63
96DH-824	113	92	1.0	115	62
96B-37	111	96	1.0	113	63
96PR-329	111	98	1.0	114	61
96B-132	110	96	1.0	114	63
96DH-818	109	91	1.0	112	62
96DH-814	106	91	1.0	113	60
96DH-234	105	95	1.0	115	63
96B-155	105	100	1.0	113	61
96DH-235	105	102	1.0	115	63
96B-113	103	95	1.0	112	61
96DH-100	102	96	1.0	113	59
95PR-152	100	99	1.3	113	62
96DH-236	100	89	1.0	111	63
96B-134	100	98	1.0	112	61
94PR-220	99	99	1.3	114	63
93B-18	96	100	1.0	116	63
96DH-518	96	94	1.0	112	59
96B-108	96	99	1.0	112	60
96B-157	96	95	1.0	113	61
94PR-130	90	100	1.0	112	59
95PR-202	90	103	1.0	113	61
LSD	13	6	0.6	2	1
Lodging: 1=good, 9=poor					

High Yield Wheat Co-operative Test

Location: Outlook
Progress: Year five of five
Objective: To determine the relative performance of CPS wheat lines.

Plots contained six rows 4 m (13.1 ft) long with a 25.4 cm (10 in) row spacing. Nitrogen was applied at 205 kg/ha (182 lb/ac) preplant with an additional 45 kg/ha (40 lb/ac) applied via the irrigation system. Phosphorus was applied to the soil surface at 225 kg/ha (200 lb/ac) prior to planting. An additional 20 kg/ha (18 lb/ac) was sidebanded at planting. Samples were sent to Swift Current for quality evaluation.

Check cultivars of CPS Red and White spring wheats were among the highest yielding varieties in the trial (Table 8). Lodging was limited in this trial despite the high fertility and moisture levels.

Table 8. Yield and agronomic traits of high yielding wheats (Public Co-op trial).					
Variety	Yield % of Neepawa	Height (cm)	Lodging (1-9)	Protein	Days to Mature
Neepawa (kg/ha)	**5039**	111	2.5	16.5	106
Neepawa (bu/ac)	**75**				
HY443	134	91	1.5	14.9	110
HY960	132	86	2.5	13.5	110
HY631	129	92	1.5	14.0	111
HY447	127	94	1.3	16.9	110
HY340	126	97	1.0	14.1	112
HY395	126	93	2.5	14.1	110
HY413	126	98	4.3	14.5	111
HY444	125	82	1.0	15.4	111
HY433	123	85	1.0	14.0	109
HY441	121	96	2.5	14.7	111
HY445	121	94	1.8	14.5	111
HY637	121	98	2.5	15.0	112
HY639	121	98	2.8	15.7	109
HY380	120	89	4.0	13.8	111
HY957	120	88	1.5	13.9	109
HY442	119	91	1.5	14.7	113
HY961	119	93	1.0	14.7	112
HY417	118	90	1.0	13.8	110
HY636	115	121	2.8	14.5	109
HY638	112	100	1.0	15.5	111
HY635	110	123	3.5	14.6	108
HY446	110	92	1.0	15.0	111
HY437	108	89	1.0	14.3	110
HY634	104	95	1.5	14.4	108
LSD	10	5	1.3	0.3	2
Lodging 1=good, 9=poor					

Forage Barley Co-operative Test

Location: Outlook
Progress: Year one of one
Objective: To determine the relative performance of barley varieties for forage yield.

Plots contained six rows 4 m (13.1 ft) long with a 25.4 cm (10 in) row spacing. Nitrogen was applied at 225 kg/ha (182 lb/ac) preplant with an additional 45 kg/ha (40 lb/ac) applied by fertigation. Phosphorus was applied to the soil surface at 225 kg/ha P_2O_5 (200 lb/ac) prior to planting with an additional 20 kg/ha (18 lb/ac) sidebanded at planting. This trial was one of five sites grown in Western Canada under high moisture conditions. The genetic material evaluated included hooded and smooth awned types in addition to some of the rough awned material. Several lines including EX44-1, EX467-5, and RG003 had forage yields in excess of 15,680 kg/ha (7 t/ac) combined with good lodging tolerance at the time of harvest. Forage quality is not available at this time. Barley cultivars with hooded awns and high forage yields will enhance the value of barley as green feed. Further work with barley varieties underseeded with annual ryegrass may provide additional information of value to livestock producers.

Table 9. Yield and agronomic traits of forage barley lines.

Variety	Dry Matter (kg/ha)	Dry Matter (t/ac)	Height (cm)	Lodging (1-9)	Days to heading
AC Lacombe	14502	6.47	109	1.5	58
Duke	13613	6.07	100	1.0	60
Virden	14051	6.27	124	1.5	61
Westford	15431	6.88	118	1.5	64
EX445-1	16257	7.25	120	2.8	59
EX467-5	16159	7.21	109	1.5	59
EX446-1	16080	7.17	114	5.8	59
RG003	15917	7.10	121	2.5	61
EX446-8	15795	7.04	120	7.3	59
BM9220-7	15215	6.79	123	1.3	60
BZ593-15	15125	6.75	111	1.8	63
EX428-5	15107	6.74	114	4.8	60
EX446-4	14931	6.66	115	5.3	59
BZ593-15	14618	6.52	126	4.3	63
SB91717	12764	5.69	108	1.0	63
SB91715	12488	5.57	111	1.0	70
LSD	2005	0.89	6	2.9	2

Evaluation of Semi-dwarf Durum Breeding Lines for Irrigated Production in Saskatchewan

Principal: J.M. Clarke, Agriculture and Agri-Food Canada, Semiarid Prairie Agricultural Research Centre, Swift Current, Saskatchewan
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Progress: Final year
Co-investigator: R.B. Irvine, SIDC
Locations: Swift Current and Outlook
Objective: To identify superior durum wheat lines for production under irrigation in Saskatchewan.

Irrigated field experiments were planted near Outlook and Swift Current in 1997. These tests included short and semi-dwarf durums from A, B, and Co-op tests, from advanced breeding lines, and from lines introduced from the U.S. and Europe. The results help to select potential new varieties that perform well under irrigation. The semi-dwarf lines introduced from other countries will provide new parents for crossing with Canadian varieties.

Yields of durum varieties for the 1994 to 1997 period are summarized in Table 1. The new variety AC Avonlea, registered in 1996 from our program, performed very well on irrigation and on dryland. AC Avonlea has higher protein than other varieties. AC Avonlea, AC Melita, DT673, and Sceptre all have shorter straw than Kyle and Plenty.

DT673 is a semi-dwarf line tested through this project at Outlook since 1991, and in the Durum Cooperative Test in 1996 and 1997. It has shown good yield potential under both irrigation and dryland conditions. DT673 has desirably stronger gluten than other Canadian durum varieties, and is being market-tested by the Canadian Wheat Board. It has the potential to supply customers in North America and Europe with premium quality durum. At present only 'desert durum' from California and Arizona, and more recently Australian durum going into Europe, can supply these markets.

Table 1. Grain yield and grain protein of durum wheat varieties grown under irrigation near Birsay in 1994 and 1995 and near Outlook in 1996 and 1997.

Variety	Yield			Protein %
	kg/ha	bu/ac	Yield % of Kyle	
Kyle	4307	64	100	14.7
Plenty	4175	62	97	14.7
Sceptre	4403	66	101	13.9
AC Melita	3720	55	84	14.5
AC Avonlea	4733	70	127	15.4
DT673	4552	68	124	14.3

Sceptre was not in the 1997 test.

Developing Semi-dwarf Cereal Varieties for Irrigation Production in Saskatchewan

Principal: B.G. Rossnagel, Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan

Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED); Crop Development Centre

Co-investigators: P. Hucl, R. Baker, and B. Harvey, University of Saskatchewan

Progress: Final

Locations: Outlook, Bradwell, and Saskatoon

Objectives:

a) To develop semi-dwarf varieties of hard red spring, soft white spring, and Canada Prairie spring wheats, and of hulless, feed, and malting barleys adapted to irrigated production in Saskatchewan.

b) To provide irrigation farmers with the best possible opportunity to profitably produce premium quality high value cereal crops in the rotation.

Advanced semi-dwarf genotypes from the Crop Development Centre wheat and barley breeding programs were identified annually, and were included in the project testing at three irrigated sites at Saskatoon, (U. of Sask., Preston plots), Bradwell, Outlook, and Birsay (1995 only). Over three years of testing, 100 advanced hard red spring wheat selections, more than 50 advanced soft white spring wheat selections, and nearly 50 advanced Canada Prairie spring wheat selections were evaluated. In addition, more than 200 advanced malt barley selections, over 100 hulled feed barley selections, and more than 70 hulless barley selections were tested.

Standard plant breeding and small plot cereal trial experimental procedures and statistical analyses were used for all trials. All trials were replicated three or four times and grown at three sites each year. All sites were irrigated as necessary to achieve maximum yield. Fertility was maintained by fertilizing prior to and at planting according to soil test recommendations. Weed control was achieved using registered herbicides with some hand weeding as required.

Field data collected included date of heading, plant height, straw strength, maturity rating, and grain yield. Disease ratings were made when natural infestations were present. The majority of the disease ratings were collected from disease nurseries elsewhere in the Crop Development Centre wheat and barley program. Standard advanced breeding program quality evaluations were conducted annually on non-replicated samples from appropriate sites for milling and baking quality in wheat, and for feed, food, or malting quality in barley.

Semi-dwarf Non-malting Barley (B.G. Rossnagel)

One of six six-row hulled lines remaining in the test in 1996 had yield similar to the checks, but was susceptible to lodging. The six-row hulless lines were similarly dropped from further testing.

Of twenty two-row hulless lines under evaluation, three were advanced to the 1997 Co-op variety trials. Two other lines were entered in the 1997 Eastern Prairie Barley test. All have demonstrated threshability similar to Condor, yield similar to CDC Dawn, and much improved straw strength.

Twenty-three hulled two-row genotypes including four anther culture derived double haploids and four foreign introductions were evaluated. Two of the 23 lines were advanced to the 1997 Semi-dwarf Co-op test.

Should any of the four hulled or four hulless two-row lines in the Co-op tests become registered varieties, they will be well suited to irrigated production because they have been identified and selected for strong straw and good disease resistance.

Semi-dwarf Malting Barley (B. L. Harvey)

Semi-dwarf material exists at all levels of the breeding program. In general it is difficult to combine adequate yield and malting quality in the semi-dwarfs. This is especially true of the six-row types.

More than 200 semi-dwarf malting barley lines were evaluated at various levels throughout the 1994 - 1996 project period. Of these, 50 were advanced to the multi-site irrigated trials under this project.

Several lines from the 1994 -1995 PAWBED project trials, in particular two-rows with good yield, straw strength, and malting quality were advanced for further testing. One six-row line completed three years of Co-op testing in 1996, but was discarded due to having a primarily blue aleurone. Six two-row lines are still in Co-op tests, with three in the second year and three in the first year of testing in 1997.

Hard Red Spring Wheat (P. Hucl)

During the course of this project, 110 short statured hard red spring wheat lines were evaluated. Ten of these were entered in the registration tests. Three of the ten lines have progressed to the second year of Co-op testing. One of the lines is 26 cm shorter than Katepwa, and has satisfactory disease resistance. Should this line be registered, it would be ideal for irrigated production, and would have been identified in part through this project.

Canada Prairie Spring and Soft White Spring Wheat (R. J. Baker)

Over the three years of this project, 66 advanced lines of Soft White Spring wheat have been evaluated. Two have received further testing in the Soft White Spring wheat Co-op. While both were judged unsuitable for licensing, one proved to be unique in quality characteristics and is being used as a parent for further development.

Fifty-seven advanced lines of potential Canada Prairie Spring wheat were evaluated under irrigation during the same period. Of these, seven were evaluated for two years. Six of the CPS lines are being turned over to the new wheat breeder at the University of Saskatchewan for possible inclusion in the Co-op test, and for use as parental material in the breeding program.

Conclusion

Of the more than 100 hard red spring wheat lines evaluated, three are currently in the second year of Co-op testing, and thirteen others are still being evaluated in the CDC program. Of the 50 soft white spring wheat lines evaluated, none are being tested further. Six of 50 Canada Prairie spring wheat lines are still under evaluation. Of more than 200 malting barley lines tested, three are in the second year and three are in first year of Co-op testing. Ten are still under evaluation. Of the more than 100 hulled feed barley lines evaluated, two are in Co-op tests and two are in the pre-Co-op Eastern Prairie Barley test. Out of more than 70 hulless barley lines, three are in Co-op tests and one is in the EPB test.

These lines have been selected for high yield, improved straw strength, and suitable disease resistance. Should the most promising lines survive the rigourous Co-op testing and be registered, they will provide Saskatchewan irrigation producers with improved, productive, and marketable wheat and barley varieties. The potential for the release of an appropriate hard red spring wheat, a hulless barley, and a two-row malting barley are good, with releases possible in 1999 and 2000.

In addition to the advancement of lines to Co-op tests, the best selections have been returned to the CDC breeding programs as parents for further crossing and future selection of improved strong strawed progeny.

Oilseeds

Oilseeds Program

Principal: R.B. Irvine
Saskatchewan Irrigation Development Centre

Introduction

The SIDC oilseed crops program is aimed at evaluating current and potential crop varieties through variety testing, and at refining management practices for improved yield through agronomic trials. The work is concentrated on the major oilseed crops: canola, flax, solin, and sunflower.

Agronomic Investigations

Fall Seeding of Canola

Progress: Year one of two
Objective: To evaluate the effectiveness of seeding canola in the fall vs spring.

Cyclone canola was planted October 26, 1997, at 5 and 10 kg/ha (4.5 and 9 lb/ac). Three seed treatments were evaluated: None, TYC , and TYC+Trichodema (supplied by Cornell University). The trial was a three-replicate factorial arranged in randomized blocks. Plant emergence was extremely variable but the higher seeding rate resulted in significantly more plants (Table 1). Both seed treatments reduced plant stands relative to the untreated control. This was more pronounced at the high seeding rate. The result was that the untreated control was 18-32% higher yielding than the other treatments. The variability in the treatments suggest that factors other than the treatments may have caused some of the differences. In separate plots, fall seeded canola yielded 3557 kg/ha (63.3 bu/ac) compared to 3119 kg/ha (55.5 bu/ac) for canola planted May 21,1997. This difference is not significant. Given the risk of failure and the likelihood that higher seeding rates will be required, fall seeding under irrigated conditions cannot be recommended at this time.

Table 1. Effect of germination inhibitors and seed rate on yields of fall seeded canola.

Seed Rate		Treatment	Plant Population		Seed Yield	
kg/ha	lb/ac		plants/m^2	plants/ft^2	kg/ha	bu/ac
5	4.5	none	21	2.0	1405	25
5	4.5	tyc	28	2.6	1758	31
5	4.5	tyc&tri	32	3.0	2645	47
10	9.0	none	91	8.5	3490	62
10	9.0	tyc	44	4.1	2889	51
10	9.0	tyc&tri	42	3.9	2390	43
Analysis of variance						
Seed Rate			*		*	
Seed Treatment			ns		ns	
Seed Rate x Seed Treatment			ns		(893)	
(numbers in brackets are the LSD for that factor)						

Performance of Canola Varieties under Irrigated Conditions

Location: Birsay, Dundurn, and Outlook
Progress: Ongoing
Objective: To determine the relative performance of canola cultivars.

Plots consisted of six rows 8 m (26.2 ft) long with a 25.4 cm (10 in) row spacing. Seeding dates were May 12, May 14, and June 3, 1997, for Birsay, Dundurn, and Outlook, respectively. The late seeding at Outlook was due to the fact that the first seeding in early May had poor emergence. The varieties in this trial were those suggested by the breeding companies and by seed retailers in the area.

Global yielded extremely well at the early seeding dates at Dundurn and Birsay. Yields at Dundurn were very high compared to normal. The Invigor 2153 Liberty Link hybrid had the best overall performance in the three trials, but given the soil and random variability, several other varieties may perform in a similar manner.

Table 2. Yield and agronomic traits of canola varieties in an irrigated regional variety trial.

Variety	Seed Yield % of Global			Height (cm)			Lodging (1-5)		Days to Mature
	Bir	Dun	Out	Bir	Dun	Out	Dun	Out	Out
GLOBAL (kg/ha)	**2822**	**3590**	**2142**						
GLOBAL(bu/ac)	**50**	**64**	**38**						
44A89	87	85	112	113	111	108	1.5	1.8	90
45A71	83	92	117	117	120	115	2.9	2.6	93
46A65	97	85	116	119	112	109	1.9	1.9	94
46A72	87	75	110	120	121	112	1.7	2.1	94
CORONET	85	84	123	113	123	111	1.7	1.8	93
CYCLONE	90	96	116	111	114	112	2.1	2.9	92
EAGLE	98	84	122	117	117	106	1.3	1.8	90
EBONY	99	89	108	130	126	118	1.0	0.7	94
GLOBAL	100	100	100	137	128	114	1.3	0.8	95
IMPULSE	94	87	112	122	127	118	1.3	0.8	93
INNOVATOR	81	79	92	111	116	101	2.6	2.1	90
LG3260	85	73	108	112	112	102	2.2	1.5	92
LG3310	92	90	95	116	127	109	1.5	1.1	92
LG3369	94	77	107	117	127	114	1.5	1.9	94
MAGNUM	93	90	109	115	125	107	2.1	2.1	93
OAC DYNAMITE	103	93	117	114	117	109	1.4	1.8	91
INVIGOR2153	110	99	119	112	125	116	1.7	1.8	90
QUANTUM	91	92	113	117	115	117	1.8	1.5	93
QUEST	86	85	100	116	117	106	2.5	3.1	93
SPONSOR	95	79	107	132	127	120	0.6	0.6	95
SWLM02578	91	87	124	128	129	118	0.6	0.8	93
SWLM02579	88	89	113	126	132	105	0.7	1.0	93
LSD	15	12	18	10	11	12	1.0	2.0	1.4

Bir=Birsay, Dun=Dundurn, Out=Outlook
Lodging: 1=good, 5=poor

Effect of Early Seeding and Seeding Rates on Yield of Canola

Location: Outlook
Progress: One year only
Objective: To determine the effect of early seeding and of low seeding rates on the yield and quality of canola.

The trial was planted in a four-replicate split plot design with main plots being seeding date and subplots being seeding rates. Plots were 3 m x 6 m (9.8 ft x 19.6 ft) with the entire plot harvested for seed. Quest (Roundup Ready) canola was planted at 60, 80, 100, 120 and 140 seeds/m^2 (1.9, 2.5, 3.2, 3.8 and 4.4 lb/ac based on a 3.5 g/1000 seed weight). Seed weights of canola vary considerably (coated seed and hybrid seed are significantly heavier). The early seeding date was April 24, 1997, and the normal seeding date was May 20. Roundup was applied at 0.5 L/ac for weed control.

Crop stands were erratic at the early seeding date; despite this the CV for seed yields was less than 7%. The combination of cold soils and low vigour of the seed lot were likely responsible for the poor stands. Conclusions are difficult to make based on the erratic emergence of the early seeding date. This trial indicates no advantage to early seeding relative to normal seeding with both yielding about 2210 kg/ha (39 bu/ac) (Table 3). High seeding rates did not increase yields at either seeding date. This trial should be conducted over several seasons as 1997 did not have high temperatures early in the growing season which could adversely affect canola development.

Table 3. Effect of seeding rate and seeding date on seed yields of Quest canola in 1997.

Seeding rate		Planted April 24		Planted May 20	
Seeds/m^2	lb/ac	kg/ha	bu/ac	kg/ha	bu/ac
60	1.9	2362	42	2147	38
80	2.5	1998	36	2210	39
100	3.2	2293	41	2235	40
120	3.8	2185	39	2304	41
140	4.4	2244	40	2203	39
Mean	3.2	2216	39	2220	39
Analysis of variance					
Seed Rate		ns			
Treatment		ns			
S x T		ns			

Canola Production Package under Irrigation

Location: Birsay and Dundurn
Progress: One year only
Objective: To determine the relative performance of Roundup Ready and Liberty Link canola cultivars vs conventional canola cultivars with and without a fungicide to control sclerotinia.

Plots consisted of six rows 8 m (26.2 ft) long with a 25.4 cm (10 in) row spacing. Seeding dates were May 12, and May 14, 1997, for Birsay and Dundurn, respectively. While each treatment was seeded at 80 and 120 seeds/m² (2.5 and 3.7 lb/ac), information is reported on the entire plot since crop response in terms of lodging and flowering was identical. Nitrogen was sidebanded at 108 kg/ha (96 lb/ac) with 40 kg/ha (36 lb/ac) of P_2O_5. Benlate was applied at 40% bloom on July 9 and July 14 at Birsay and Dundurn, respectively.

There were no significant differences in yield due to fungicide application nor was there an interaction of fungicide and variety at either site (Tables 4 and 5). This lack of response was not surprising since sclerotinia levels were too low to be rated. The low levels of sclerotinia are likely due to the lack of lodging and the fact that from July 1 to August 15 less than 25 mm (1") of rain fell. Although irrigation was continued, the canopy dried every day. This resulted in an unfavourable microclimate for the development of sclerotinia. There were differences in yield between varieties. These could not be considered to be due to the herbicide resistance, but rather to the genetic background of the material.

Table 4. Effect of variety and disease control on canola yields at Birsay in 1997.

Treatment	Seed yield (kg/ha)	Seed yield (bu/ac)	Lodging (1-5)	Plants /m²	1000 seed weight (g)
Fungicide					
Benlate	2200	39.2	2.1	62.8	3.2
None	2391	42.6	2.5	67.3	3.3
Variety					
Quest	2104	37.5	1.8	64.5	2.8
Quantum	2277	40.5	2.1	61.5	3.4
Invigor 2135	2504	44.6	3.0	69.4	3.6
Analysis of Variance					
Fungicide	ns		ns	ns	ns
Variety	(218)		(0.8)	ns	(0.3)
Fung x Var	ns		ns	(5.1)	ns

(Numbers in brackets are LSD for this factor)
Lodging: 1=good, 5=poor

Table 5. Effect of variety and disease control on canola yields at Dundurn in 1997.

Treatment	Seed yield (kg/ha)	Seed yield (bu/ac)	Lodging (1-5)	Plants /m²	1000 seed weight (g)
Fungicide					
Benlate	2564	45.6	2.8	78	3.4
None	2509	44.7	3.1	79	3.4
Variety					
Quest	2054	36.6	3.1	66	2.9
Quantum	2636	46.9	2.6	74	3.5
Invigor2135	2920	52.0	3.1	96	3.7
Analysis of Variance					
Fungicide	ns		ns	ns	ns
Variety	(555)		ns	(12)	(0.1)
Fung x Var	ns		ns	ns	ns

(Numbers in brackets are LSD for this factor)
Lodging: 1=good, 5=poor

Irrigated Canola Co-operative Test

Location: Outlook
Progress: Ongoing
Objective: To determine the relative performance of *Brassica napus* canola lines.

The public Co-ops of *Brassica napus* for irrigation were planted May 15, 1997, in six-row plots 25 cm (10 in) apart and 6 m (19.7 ft) long. Yield was determined by harvesting the entire plot.

It is interesting to note that the mean of the check varieties was about 392 kg/ha (7 bu/ac) higher in napus #2 than napus #1, despite apparently uniform seeding, watering, and fertility management. A significant number of potential varieties had yields superior to the checks.

Table 6. Irrigated napus Coop # 1 at Outlook, 1997.

Variety	Seed Yield		Height (cm)	Lodging (1-5)	Days to mature
	kg/ha	bu/ac			
Cyclone	2179	38.8	99	2.0	93
Excel	2106	37.5	104	2.0	93
Legend	2203	39.2	93	2.8	93
94-22685	2784	49.6	101	1.3	93
HCN 28	2008	35.8	111	1.0	95
HCN 31	2306	41.0	102	2.3	92
HCN 35	2487	44.3	104	2.0	92
MBR 194	2449	43.6	105	2.0	95
NS 2047	2270	40.4	105	2.8	92
NS 2082	2628	46.8	95	2.0	91
NS 2135	2554	45.5	103	2.0	92
NS 2206	2728	48.6	100	2.0	93
NS 2335	2367	42.1	104	1.8	94
PHY 31	2769	49.3	101	2.3	92
PR 3534	2399	42.7	100	2.0	92
PR 3904	2173	38.7	100	1.8	94
PR 4108	2445	43.5	104	1.5	94
PR 4230	1983	35.3	103	1.8	95
ZCN 6008E	2282	40.6	92	1.5	93
ZCN 6009E	2162	38.5	88	1.8	93
GRAND MEAN	2364	42.1	101	1.9	93
CHECK MEAN	2163	38.5	99	2.3	93
LSD	191	3.4	10	0.7	1

Lodging: 1=good 5=poor

Table 7. Irrigated napus Co-op #2 at Outlook, 1997.				
Variety	Seed Yield kg/ha	Seed Yield bu/ac	Lodging (1-5)	Days to Mature
Cyclone	2549	45.4	1.9	95
Excel	2632	46.8	2.9	96
Legend	2420	43.1	2.5	95
4.23	2958	52.7	1.7	97
5.189	2960	52.7	1.5	96
Apollo	2058	36.6	3.3	98
NS 2177	3057	54.4	1.0	97
PR 3907	2685	47.8	1.2	98
PR 3924	3033	54.0	2.2	96
PR 4374	2810	50.0	1.8	95
PR 4385	3069	54.6	2.1	95
PR O2-96	2490	44.3	2.2	95
SW 02582	2930	52.2	2.1	96
SW 02605	2080	37.0	1.0	100
SW 02621	3020	53.8	2.7	94
SW 02622	2696	48.0	2.5	95
SW 02623	2646	47.1	2.3	97
ZCN 6012E	2605	46.4	1.4	97
ZCN 6014E	2649	47.2	1.9	98
ZCN 6020E	2185	38.9	1.8	97
GRAND MEAN	2677	47.6	2.0	96
CHECK MEAN	2533	45.1	2.4	95
LSD	255	4.5	0.7	2
Lodging: 1=good, 5=poor				

Regional Flax Trials

Locations: Outlook and Birsay
Progress: Ongoing
Objective: To determine the yield of flax varieties.

Plots contained six rows 8 m (26.2 ft) long (10 m (32.8 ft) at Birsay) with a 25.4 cm (10 in) row spacing. At Outlook P_2O_5 was broadcast at 225 kg/ha (200 lb/ac) before planting with an additional 20 kg/ha (18 lb/ac) sidebanded at planting. Nitrogen was broadcast at 157 kg/ha (140 lb/ac) prior to planting with an additional 45 kg/ha (40 lb/ac) applied at flowering. The Birsay site had 100 kg/ha (89 lb/ac) of N and 40 kg/ha (36 lb/ac) of P_2O_5 sidebanded at planting. The seeding rate was 500 seeds/m^2 (28 lb/ac).

There were few differences between cultivars at Outlook and yields were considerably higher than at Birsay. Lodging was limited in 1997, thus allowing lodging prone cultivars to express their genetic potential (Table 8).

Table 8. Yields and agronomic traits of flax cultivars under irrigation in 1997.								
Variety	Yield % Norlin		Height (cm)		Lodging (1-5)	Days to mature	Seed weight (g/100)	
	Bir	Out	Bir	Out	Out	Out	Bir	Out
Norlin (kg/ha)	**1668**	**2612**						
Norlin (bu/ac)	**27**	**42**						
AC Emmerson	105	99	60.1	61.1	1.3	110	6.8	6.6
AC Linora	111	102	66.4	63.6	1.5	113	6.3	6.2
AC McDuff	113	103	61.4	61.5	1.3	114	6.3	6.1
AC Watson	125	100	58.3	57.9	1.0	112	6.7	6.7
CDC Normandy	153	102	61.8	65.0	1.3	113	6.5	5.9
CDC Triffid	141	102	62.8	62.8	2.3	114	6.5	6.3
CDC Valor	119	99	56.9	59.6	2.5	110	6.6	6.1
Flanders	143	103	58.3	63.9	1.3	115	6.0	5.8
Linola™989	103	100	54.3	61.6	1.0	111	6.3	6.0
Norlin	100	100	54.3	58.6	1.8	111	6.5	6.4
Somme	135	102	62.5	67.3	1.5	113	6.3	6.3
Vimy	126	102	59.4	60.6	1.3	114	5.8	5.6
LSD	11	24	4.5	6.1	0.9	1.5	0.2	0.2
Lodging: 1=good, 5=poor, Bir= Birsay, Out=Outlook								

Flax Co-operative Test

Location: Outlook
Progress: Ongoing
Objective: To determine the relative performance of potential new flax varieties under irrigation.

Plots contained six rows, 25.4 cm (10 in) apart and 4 m (13.1 ft) long. The crop was planted May 9, 1997. Nitrogen was applied prior to planting at 112 kg/ha (100 lb/ac) and 45 kg/ha (40 lb/ac) of nitrogen was applied at flowering. Phosphorus was broadcast prior to planting at 225 kg/ha (200 lb/ac) P_2O_5. The trial was direct seeded.

Lodging was not rated since none occurred. Several potential cultivars were high yielding. McDuff, Flanders and Linola™ 989 performed poorly in this trial.

Table 9. Yield and agronomic traits of potential flax varieties.			
Variety	Yield % of Norlin	Height (cm)	Days to Mature
NorLin (kg/ha)	**3037**		
NorLin (bu/ac)	**48**		
Flax			
FP 1051	111	68	111
FP 1077	109	66	109
CDC Normandy	106	65	111
AC Linora	105	66	111
FP 1071	104	68	112
FP 1072	103	59	111
NorLin	100	66	113
FP 1050	98	71	113
FP 1026	96	60	110
FP 1070	93	59	109
FP 1042	90	57	111
Flanders	90	60	114
AC McDuff	89	63	115
FP 1048	87	59	110
FP 1030	87	59	113
FP 1082	85	61	114
FP 1043	85	59	111
FP 1069	82	57	111
Solin			
SP 1092	104	61	113
SP 1084	94	61	114
SP 1091	86	62	113
Linola™ 989	85	59	112
SP 1085	82	61	113
SP 1083	81	62	114
SP 1089	80	59	113
Linola™ 947	79	57	114
SP 1090	57	53	104
LSD	12	4.5	2.5

Irrigated Sunflower Co-operative Test

Funding: Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Location: Outlook
Progress: Year one of three
Objective: To determine the relative performance of sunflower lines.

Sunflowers were planted May 14, 1997, in two-row plots 60 cm (24") apart and 6 m (19.7 ft) long. Plant numbers were adjusted to a constant number by hand thinning. All heads were bagged after flowering to prevent bird damage. Yields were determined by harvesting the entire plot (Table 10). Samples were sent to Agriculture Canada in Saskatoon for oil content determination.

Table 10. Sunflower Co-op at Outlook 1997.

Variety	Seed Yield kg/ha	Seed Yield lb/ac	Height (cm)	Days to Mature
IS 7000	3184	2834	127	121
CAPRI	3178	2829	131	124
CADET	3165	2816	125	119
COMET-C	3716	3307	120	126
IS 8004	3650	3249	159	122
XF361	3655	3253	138	128
846	3235	2879	116	125
IS 6111	3334	2967	102	122
IS 5757	3653	3251	139	124
SF 270	3388	3015	114	121
IS 5077	3631	3232	111	124
XF462	4077	3629	145	125
6230	3646	3245	138	124
SF 128	3313	2948	140	124
SF 187	3899	3470	122	123
LSD	696		17	3

Effect of Crop Rotation and Tillage System on the Development of *Sclerotinia*

Location: Outlook
Progress: Ongoing
Objective: To determine the effect of shortening the rotation on yields of canola and pea and on the level of disease development in direct seeded and conventional tillage management systems.

This trial, which began in 1993, compares pea-canola and pea-flax rotations with a recommended four-year rotation (canola-wheat-flax-wheat). The pea-canola rotation is being conducted under direct seeding and conventional tillage systems. The remaining treatments are direct seeded using a seeder with low disturbance openers. All parts of the four-year and two-year rotations are planted each year. Plots are 6.7 x 15.2 m (22 x 50 ft) with row spacings of 25.4 to 30.5 cm (10-12in). Normal weed control and fertility management is conducted each season.

All plots were harvested separately, samples were taken for moisture, and net yield after dockage was determined for the dry moisture level for each crop.

Canola and pea yields were not affected by seeding method in any season (Table 11). In 1996 and 1997, the yield of canola on pea stubble was 9% lower than canola on wheat stubble. While this is significant, high canola prices combined with low wheat prices could make this rotation profitable in the short term provided a blackleg resistant canola cultivar is planted and previous history of the land did not indicate a history of blackleg or sclerotinia. The canola yields were only about 35% of CPS wheat yields in 1997 and 1998. This is down from 50% in 1995. This is not the result of a drop in canola yields, but of higher wheat yields. Sclerotinia and blackleg levels were too low to be accurately rated. Christen and Sieling (J. Agron. and Crop Sci. 174:265-271) found rapeseed yields were 3340 kg/ha (59.5 bu/ac) in a rapeseed-barley rotation vs 3460 kg/ha (61.6 bu/ac) in a rapeseed-wheat-oats-wheat rotation. A rapeseed-wheat-pea rotation outyielded a rapeseed-wheat-wheat rotation by 12% (3770 vs 3336 kg/ha). Townley-Smith (Sask Pulse Crop Newsletter 12(1):11-12) found that canola yields were almost 30% higher after pea than after wheat, while pea yields were 9% higher on cereal stubble than on canola stubble. It would appear that a three-year pea-canola-wheat rotation may provide the best overall returns with limited risk.

Table 11. Yield of crops in traditional and non-traditional rotations.

Crop Sequence				Tillage	1995		1996		1997	
94	95	96	97		kg/ha	SE	kg/ha	SE	kg/ha	SE
canola	pea	canola	pea	conv	-		1663	43	2968	183
canola	pea	canola	pea	NT	-		1655	188	3623	1155
flax	wheat	canola	wheat	NT	5173	157	1821	73	6878	128
pea	canola	pea	canola	conv	2136	245	1921	122	2184	69
pea	canola	pea	canola	NT	2010	192	1612	72	2360	283
pea	flax	pea	canola	NT	-		1862	265	2332	165
canola	wheat	flax	wheat	NT	5353	530	1753	278	6098	139
wheat	flax	wheat	canola	NT	1852	270	4672	623	2332	165
wheat	canola	wheat	potato	NT	2494	273	6138	313	40318	2451
flax	pea	flax	potato	NT	2190	187	1639	32	34107	1501
Crop Sequence				**Tillage**	**1995**		**1996**		**1997**	
94	95	96	97		bu/ac	SE	bu/ac	SE	bu/ac	SE
canola	pea	canola	pea	conv	-		29.6	0.8	44.0	2.7
canola	pea	canola	pea	NT	-		29.5	3.3	53.7	17.1
flax	wheat	canola	wheat	NT	76.7	2.3	32.4	1.3	102.0	1.9
pea	canola	pea	canola	conv	38.0	4.4	28.4	1.8	38.9	1.2
pea	canola	pea	canola	NT	35.8	3.4	23.9	1.0	42.0	5.0
pea	flax	pea	canola	NT	-		27.6	3.9	41.5	2.9
canola	wheat	flax	wheat	NT	79.4	7.9	27.9	4.4	90.5	2.1
wheat	flax	wheat	canola	NT	29.4	4.3	69.3	9.2	41.5	2.9
wheat	canola	wheat	potato	NT	44.4	4.9	91.0	4.6	358	2451
flax	pea	flax	potato	NT	32.5	2.8	26.0	0.5	304	1501

Potato yields in Cwt/ac fresh weight

Development of Industrial and Solin Varieties of Flax Specifically for Irrigation Production and the Development of a Selection Technique for Lodging under Irrigation

Principal: G. Rowland, Crop Development Centre, University of Saskatchewan
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigators: Y. Hormis, Crop Development Centre
R.B. Irvine, Saskatchewan Irrigation Development Centre
Progress: Final
Location: Outlook
Objectives:

a) To develop industrial and solin varieties of flax specifically for irrigated production.
b) To develop a selection technique for lodging under irrigation.

No flax or solin variety has been developed specifically for irrigated production. Current flax varieties have straw that is too weak for irrigation and tend to produce too much straw. The main objectives of this project were to identify, under irrigated conditions, lines that would be 12-20 cm shorter than Flanders, be equal in lodging resistance to AC McDuff, and be slightly later maturing than AC McDuff. Potentially suitable lines were identified and were evaluated in irrigation yield trials to determine yield potential and oil quality. The eventual outcome of this work will be the release of both traditional flax and solin varieties that are suited to irrigated production.

During the three years of the project, 4447 flax and solin lines from different crosses were grown in plots at irrigation sites in and around Outlook, Sask. Of these, 988 lines were selected that showed some lodging tolerance. 531 lines were yield tested in 1996: 288 brown seeded and 135 yellow seeded lines from 1995 selections, and 108 lines from 1994 selections.

A total of 28 brown seeded lines (1995 selections) from the 1996 Flax Lodging Yield Test produced higher yields than the check variety McGregor. These lines, and eight other lines, produced higher yields than the other check variety AC McDuff. McGregor and AC McDuff are considered lodging tolerant varieties. The plant height of the majority of the 28 lines is less than the check variety McGregor. Sixteen of these lines were earlier maturing than the two check varieties.

Four yellow seeded lines (1995 selections) from the 1996 Flax Lodging Yield Test produced higher yields than the check variety Linola™ 947.

Sixteen lines from the 1994 selections produced higher yields than the check variety AC McDuff in the 1996 yield trial.

Further yield testing is needed to evaluate the lodging tolerance of the lines selected in the 1996 yield test. Flax lines with acceptable yield and that are 15-20 cm (6-8 in) shorter than conventional varieties have been identified under conditions of limited lodging. The release of new lines with improved lodging tolerance is at least five years away as they must now pass through the Co-op testing system.

The second component of this project was the development of a method to artificially produce lodging in the field, and to test the hypothesis that lodging of flax appears to be related to above ground traits rather than root slippage. Late seeding at high seeding rates has been effective in developing a system for evaluating lodging. Frequent watering near the end of the growing season is essential to ensure that all lines express their lodging potential. Yield evaluation is required as some lines do not lodge because their yield potential is low.

The use of irrigation to induce lodging in early generation breeding lines of flax and solin was successful. The inclusion of lines in the test that had been identified in 1993 as having some lodging tolerance, and whose lodging tolerance was verified in 1994, 1995, and 1996, has demonstrated that there is consistency in results from one year to the next. The fact that certain crosses have very few lodging tolerant lines while others have numerous lodging tolerant lines shows that lodging tolerance has a genetic basis. The lodging tolerant lines that were selected and yield tested produced good seed yield under irrigation in 1996. The development of high yielding, lodging tolerant varieties specifically for irrigation should become a reality.

Transgenic and Hybrid Canola Variety Development

Principal: Kevin Morin, AgrEvo Canada Inc., Saskatoon, Sask.
Progress: Ongoing
Location: SIDC
Objectives: To test potential Argentine and Polish canola varieties under irrigated conditions

Registration of new canola varieties requires that each line be tested at a number of sites across western Canada. Outlook is considered part of the irrigated zone, and provides a location where varieties can be evaluated prior to entry into the public co-operative variety testing system. SIDC provides a prepared test plot area, pivot irrigation, and assistance throughout the season. The Centre is expected to remain a testing area for AgrEvo into the future as it offers a longer season irrigated zone within one hour of the Saskatoon Canola Breeding facility.

Results from the hybrid canola trials are presented in Table 1. Results for open pollinated lines are shown in Table 2.

Table 1. AgrEvo/PGS Private Co-op for hybrid *Brassica napus* lines.

Hybrid trial 1 (NBN7S67A)		Hybrid trial 2 (NBN7S67B)	
Line	Yield % of checks	Line	Yield % of checks
Hybrid 1	136	Hybrid 1	127
Hybrid 2	135	Hybrid 2	124
Hybrid 3	129	Hybrid 3	122
Hybrid 4	126	Hybrid 4	120
Hybrid 5	121	Hybrid 5	120
Hybrid 6	121	Hybrid 6	119
Hybrid 7	120	Hybrid 7	116
46A65	120	Hybrid 8	116
Hybrid 8	120	Hybrid 9	115
Hybrid 9	119	Hybrid 10	115
Hybrid 10	119	Hybrid 11	115
Hybrid 11	118	Hybrid 12	113
Hybrid 12	116	Hybrid 13	112
Hybrid 13	112	Hybrid 14	111
Hybrid 14	111	Hybrid 15	110
Hybrid 15	110	Hybrid 16	109
Hybrid 16	110	Hybrid 17	108
Hybrid 17	109	Hybrid 18	107
Hybrid 18	108	46A65	106
Hybrid 19	108	Hybrid 19	105
Hybrid 20	106	Hybrid 20	102
Hybrid 21	106	Hybrid 21	102
Hybrid 22	105	Hybrid 22	102
Hybrid 23	105	Quantum	101
Quantum	103	Hybrid 23	95
Checks:			
Legacy	109	Legacy	110
Defender	99	Defender	94
Excel	92	Excel	96
Check mean	100	Check mean	100
% CV	13.9	% CV	8.7

Table 2. AgrEvo/PGS Private Co-op for open pollinated *Brassica napus* lines.

Line	Yield % of checks
OP 1	116
OP 2	115
OP 3	114
OP 4	112
OP 5	108
OP 6	107
OP 7	106
Quantum	104
46A65	104
OP 8	102
OP 9	102
OP 10	102
OP 11	102
OP 12	99
OP 13	99
OP 14	96
OP 15	94
OP 16	92
Innovator	92
OP 17	85
OP 18	82
Checks:	
Legacy	108
Defender	98
Excel	95
Check mean	100
% CV	8.5

Forages

Forage Program

Principal: R.B. Irvine,
Saskatchewan Irrigation Development Centre

Introduction

The forage program conducted by the SIDC is designed to increase returns for forage hay producers, and to develop production practices for forage seed production. The work focuses on methods of forage establishment, management of mature stands, and weed control practices.

Agronomic Investigations

Alfalfa Establishment Alternatives

Location: Outlook
Progress: One of four
Objective: To determine the economics of using pea as a companion crop to establish alfalfa versus solo seeding of alfalfa.

The registration of Pursuit for pea and for alfalfa allows the opportunity to obtain high pea yields while establishing alfalfa. Previous work at the SIDC has shown less than a 10% reduction in alfalfa yields when alfalfa is established with various companion crops under centre pivot irrigation. Low returns to alfalfa in the establishment year have limited the use of alfalfa in crop rotations and cause producers to retain stands for extended periods of time.

Pioneer 5454, a rapid regrowth alfalfa cultivar, was planted at 8 and 12 kg/ha (7 and 10.5 lb/ac), with and without Carneval pea at 80 seeds/m^2 (170 lb/ac). The test was planted June 4, in six-row plots 5 m long (16.4 ft) with a 25.4 cm (10 in) row spacing. The pea crop was swathed and the alfalfa harvested on September 6.

Although the alfalfa yield appeared higher at the 12 kg/ha seeding rate, the variability was too high to determine if this was significant (Table 1). In both years the gross return from direct seeded alfalfa was greater than the pea companion crop due to low pea yield. Smart canola should

Table 1. Effect of alfalfa seed rate and pea companion crop on the yield and returns from alfalfa and pea in the establishment year.

Treatment	Yield (kg/ha)		Yield (t/ac for alfalfa, bu/ac for pea)		Gross ($/ac)	
	1996	1997	1996	1997	1996	1997
alfalfa forage (8 kg/ha)	7158	6126	3.19	2.73	287	246
alfalfa forage (12 kg/ha)	8285	6713	3.68	2.99	331	269
pea seed (alfalfa @ 8 kg/ha)	2664	1087	39.5	16.1	237	97
pea seed (alfalfa @ 12 kg/ha)	2385	1484	35.4	22.0	212	132
Assumptions: Alfalfa=$90/ton Pea=$6.00/bu						

be tried in 1998 since it is more competitive with alfalfa. This is similar to previous research conducted by the SIDC on other crops. Alfalfa yield in Year 2 did not differ significantly whether direct seeded or sown with a companion crop in Year 1. This may be due to the statistical design, since there appeared to be about a 10% drop in yield in Year 2 due to the presence of a companion crop in the establishment year.

Establishment of Grasses with Companion Crops

Location: Outlook
Progress: Year one of four
Objective: To evaluate the effect of companion crops on the yield of grass seed.

Profitable production of grass seed depends on the establishment of good stands. Most grasses do not produce seed in the year of planting. Stands must be kept for several years to compensate for the loss of income in the establishment year, or a companion crop can be used in the establishment year. Previous research has shown that flax was the most suitable companion crop for bluegrass since it is less competitive than other crops. The fine fescues can tolerate Poast Flax Max, therefore flax may be a good choice since these species have weak seedlings. Tall fescue is a much more competitive species and can tolerate Puma, and thus, wheat may be the best companion crop. Perennial ryegrass is planted after the harvest of an early maturing crop or is broadcast into a standing crop prior to harvest. Crops such as canola could be used since irrigation could be applied without damaging crop quality.

Establishment trials were three replicate RCBD with eight 6 m (19.7 ft) rows on a 20 cm (8 in) row spacing. With the exception of the perennial ryegrass trials, both grass and companion crop were planted May 16. The grass was planted parallel to the crop row and about 2 cm (1 in) to one side of the crop row. In previous work, flax at 40 cm (16 in) row spacings did not have greatly reduced yields. Canola yields were low due to poor stands, as a result of low seed vigor (observed in other trials sown with this seed source). Tall fescue was very competitive with flax. Perennial ryegrass established very well when broadcast into stands of canola, mustard, or barley. Planting after harvest of these crops was possible in 1997 due to the excellent harvest weather.

Grass Weed Control in Turf Grass Crops

Funding: Canada/Saskatchewan Agri-food Innovation Fund (AFIF)
Location: Outlook
Progress: Year one of four
Objective: To develop information to support minor use registration of herbicides for grass seed production.

Fine Fescue Seedlings

The fine fescues were planted at Outlook on June 6, 1997, at 4 kg/ha (3.5 lb/ac) on 20 cm (8 in) row spacings. The broadleaf and grass weed control protocols were arranged in four replicate RCBD. Willma chewings fescue and Basic Barcrown slender creeping fescue were sown at a depth of 0.5 cm (0.2 in). Both the broadleaf and the grass weed control products were applied in 100 L/ha (40 L/ac) when the crop was in the four leaf stage.

Both fine fescue species showed good tolerance to Target, Refine Extra, Puma plus Buctril M, Prestige, Buctril M, Assure, Poast, Venture, Accord, and Horizon. These products are not registered and may react differently in other environments.

Kentucky Bluegrass Seedlings

Boreal kentucky bluegrass was planted at Outlook on June 6, 1997, at 4 kg/ha (3.5 lb/ac) with a 20 cm (8 in) row spacing. This trial was a four-replicate RCBD. Both the broadleaf and the grass weed control products were applied in 100 L/ha (40 L/ac) of solution on July 2, 1997. The crop was in the four leaf stage. Weed control was by hand weeding followed by two mowings at a height of 5 cm (2 in).

Kentucky bluegrass seedlings tolerated Banvel, Buctril M, Refine Extra, Target, Basagran, Estaprop and Prestige. These products are not registered and may react differently in other environments.

Perennial Ryegrass

Perennial ryegrass is grown on irrigation by broadcasting seed into a standing crop in early August, or by planting after the harvest of a crop such as barley in late August. This crop would normally be sprayed in the spring. Fortress was applied in late October at 11 kg/ha (10 lb/ac) of product to a stand of Blazer II perennial ryegrass established August 22, 1997. At the time of application, the perennial ryegrass plants had four to six leaves. The majority of treatments will be applied in the spring of 1998.

Seed was harvested from a perennial ryegrass trial planted in 1996. Norlea perennial ryegrass was planted July 8, 1996, and sprayed August 1, 1996, when most plants had four to five leaves. Weeds were controlled by hand weeding. Visual ratings of crop damage were made on August 11. Weed control ratings were done using a visual damage rating as per the Expert Committee on Weeds (0=no damage). Seed yields were determined in August of 1997 by swathing the crop and combining the dry seed.

Achieve caused the most visual damage in 1996 and appeared to reduce seed yields in 1997. Puma and Assert SC-300 appeared to have negative effects on seed yields at the 2x rates. Damage was less when the latter two herbicides were mixed with phenoxy herbicides. Further testing of tank mixes of Puma and Assert SC-300 with phenoxy herbicides is warranted. These products are not registered and may react differently in other environments.

Tall Fescue

Courtney tall fescue was planted at 8 kg/ha (7 lb/ac) in rows 20 cm (8 in) apart on May 14, 1997, into a seedbed prepared by preplant application of Roundup. Both broadleaf and grass herbicide trials were four replicate RCBD. Herbicides were applied June 17 when the plants were in the four to five leaf stage. There was a significant population of chickweed in the grass weed control trial. This was treated with Refine Extra three weeks after the grassy weed control products were applied. This delayed application resulted in significant weed competition. Hand weeding was done on the weeded check but caused some crop damage. The hand weeded check was abandoned. The trials were clipped to a height of 15 cm (6 in) four times during the growing season to control tall weeds.

Tall fescue had good tolerance to Refine Extra, Refine Extra plus 2,4-D, Banvel plus 2,4-D, 2,4-D amine, MCPA amine, Buctril M, Attain, Accord, Target, Puma, and Achieve. These products are not registered and may react differently in other environments.

Grass Seed Industry Development: Control of Silvertop in Irrigated Grass Seed Fields

Principal: J. Soroka, Agriculture and Agri-Food Canada Research Centre, Saskatoon, Saskatchewan
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigators: B. Gossen and B. Coulman, Research Centre, Saskatoon
Location: Outlook
Progress: Second year of two
Objective: To examine residue management practices that influence silvertop in grass seed production.

In silvertop of grasses, the seed head becomes papery white and sterile, decreasing seed yields. Many kinds of insects have been associated with silvertop, but the exact cause or causes remain unknown. In 1995, we initiated a two-year, seven-location study on silvertop in grasses to examine: 1) the reaction of grass species to various insect pests, 2) timing of chemical control, and 3) residue management practises that could influence silvertop. Although the project ended with the 1996 season and results were reported in the 1997 Research Highlights, we reapplied the following residue treatments to a seven-year old stand of Troy Kentucky bluegrass at Outlook in the fall of 1996: 1) mowing and removing the residue (similar to a baling procedure), 2) burning of the aftermath, and 3) scalping with a flail mower to a height of 1 to 2 cm (0.4 to 0.8 in) and removing the residue. The insect populations in each plot were sampled on July 17, 1997. The seedhead densities and incidence of silvertop were determined, and seed yields were taken from areas within plots and from entire plots.

The number of beneficial insects in plots of each treatment was approximately 10% of the total number of insects sampled. The number of types of insects found were similar among treatments (Table 1). The number of seed heads was significantly higher in the burn plots than in plots of the other two treatments, while the percentage of heads with silvertop was lower. Yields were low, perhaps due to the age of the stand, but the burned plots outyielded the scalped ones, with mowed plots yielding between the two. In previous trials, seed yields from scalped treatments equalled or surpassed burn treatments. The sensitivity of the stand to scalping may be a function of the age of the stand.

Table 1. Impact of post-harvest residue management in 1996 on silvertop in Kentucky bluegrass at Outlook, in 1997 (n=4).

Residue Treatment	No. Insects/ 5 Sweeps	Stem Density (#/m^2)	% Silvertop	Yield (kg/ha)	Yield (lbs/ac)
Burn	170 a	58.2 a	14.7 a	167 a	149 a
Scalp	156 a	43.3 b	20.1 b	88 b	78 b
Mow	154 a	37.8 b	22.4 b	109 ab	97 ab

Values in a column followed by the same letter are not statistically different at $P \leq 0.05$ (LSD).0

Demonstration of New Alfalfa Varieties Resistant to Verticillium Wilt on Irrigation in SW Saskatchewan

Principal: P.G. Jefferson, Semiarid Prairie Agricultural Research Centre (SPARC), Swift Current, Saskatchewan
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigators: B. Gossen, Saskatoon Research Centre
B. Neudorf, SPARC
Location: Miry Creek (Cabri), Ponteix, Swift Current
Progress: Final year
Objectives:

a) To demonstrate the agronomic and economic value of new alfalfa varieties that are genetically resistant to Verticillium wilt disease in southwestern Saskatchewan.
b) To determine the effect of irrigation level and harvesting frequency on the development of Verticillium wilt disease of alfalfa in southwestern Saskatchewan.

Verticillium wilt (VW) disease of alfalfa occurred in a line-source gradient experiment. Barrier, a resistant variety, exhibited fewer VW diseased plants (Figure 1) and greater stand longevity (Figure 2) than Beaver, a susceptible variety. As expected, higher amounts of irrigation caused more VW disease in Beaver but not in Barrier alfalfa. Irrigation projects with reliable water supplies for two harvests per year will likely have more VW disease than projects with only spring irrigation.

Winterkill in 1995-96 at Swift Current, Miry Creek (Cabri) and Ponteix resulted in the loss of all 1994-seeded variety trials. Variety differences indicate the need to combine cold tolerance with high levels of VW resistance. The best survival was exhibited by Trumpetor, a moderately VW resistant cultivar that has been de-registered for sale in Canada. Barrier and AC Blue J, two highly VW resistant varieties that were developed in western Canada, did not exhibit better winter survival than other VW resistant varieties that were developed in the USA.

In a 1989-seeded trial at Miry Creek, a VW susceptible but otherwise persistent variety tested as SC Mf3713 (AC Yellowhead) exhibited less stand decline than Barrier, a VW resistant cultivar. We suggest that stand decline on irrigation in southwestern Saskatchewan results from the combined effects of VW infection and stress (cold, drought, heat, defoliation). Dryland varieties with superior stress tolerance should be used in VW resistance alfalfa breeding programs to improve the longevity of new irrigated alfalfa stands.

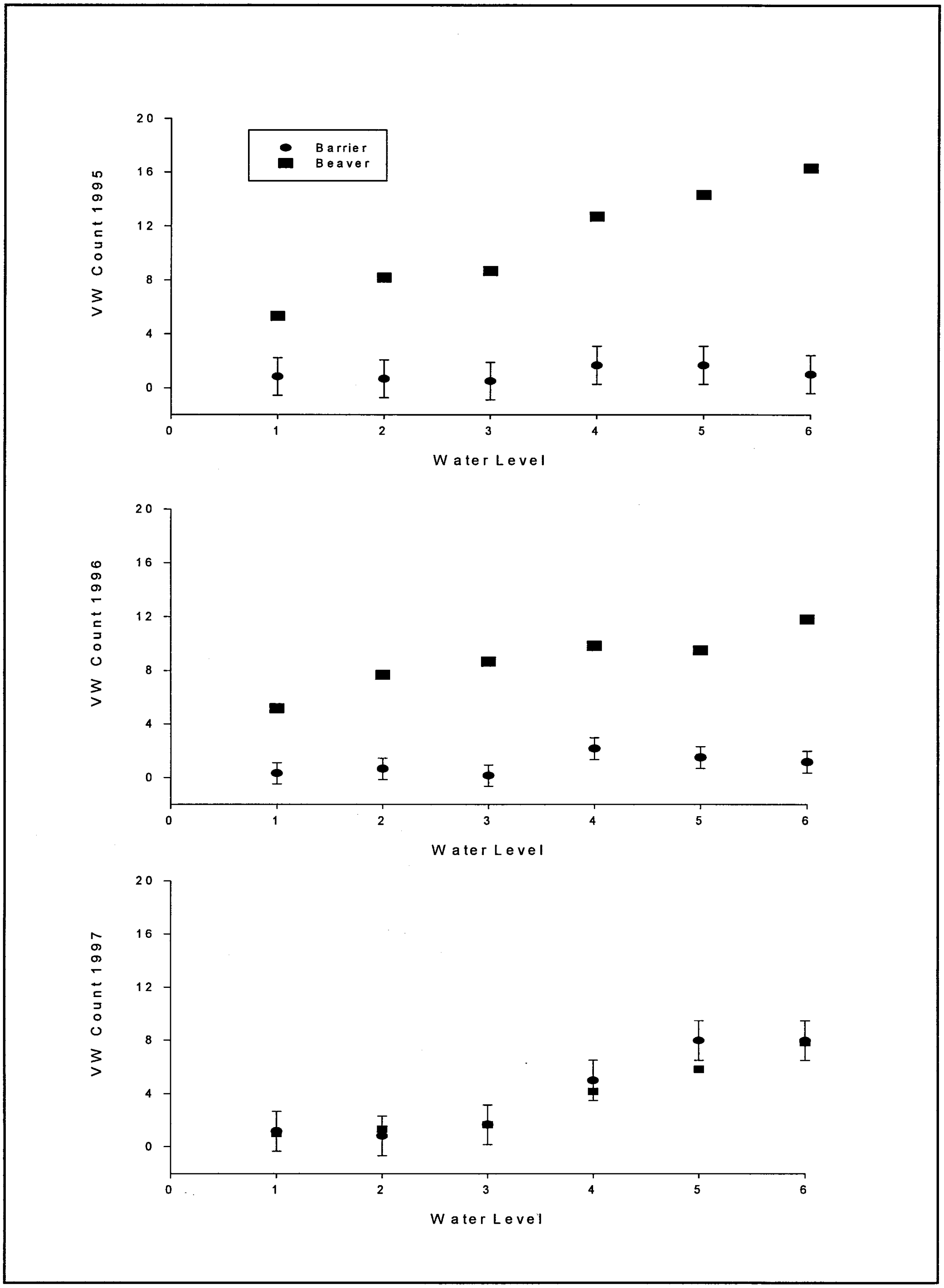


Figure 1. Verticillium wilt-infected plant counts in 1995, 1996, and 1997 for Beaver (●) and Barrier (■) alfalfa as affected by irrigation water level (1=low, 6=high). Error bars represent the standard error of the mean.

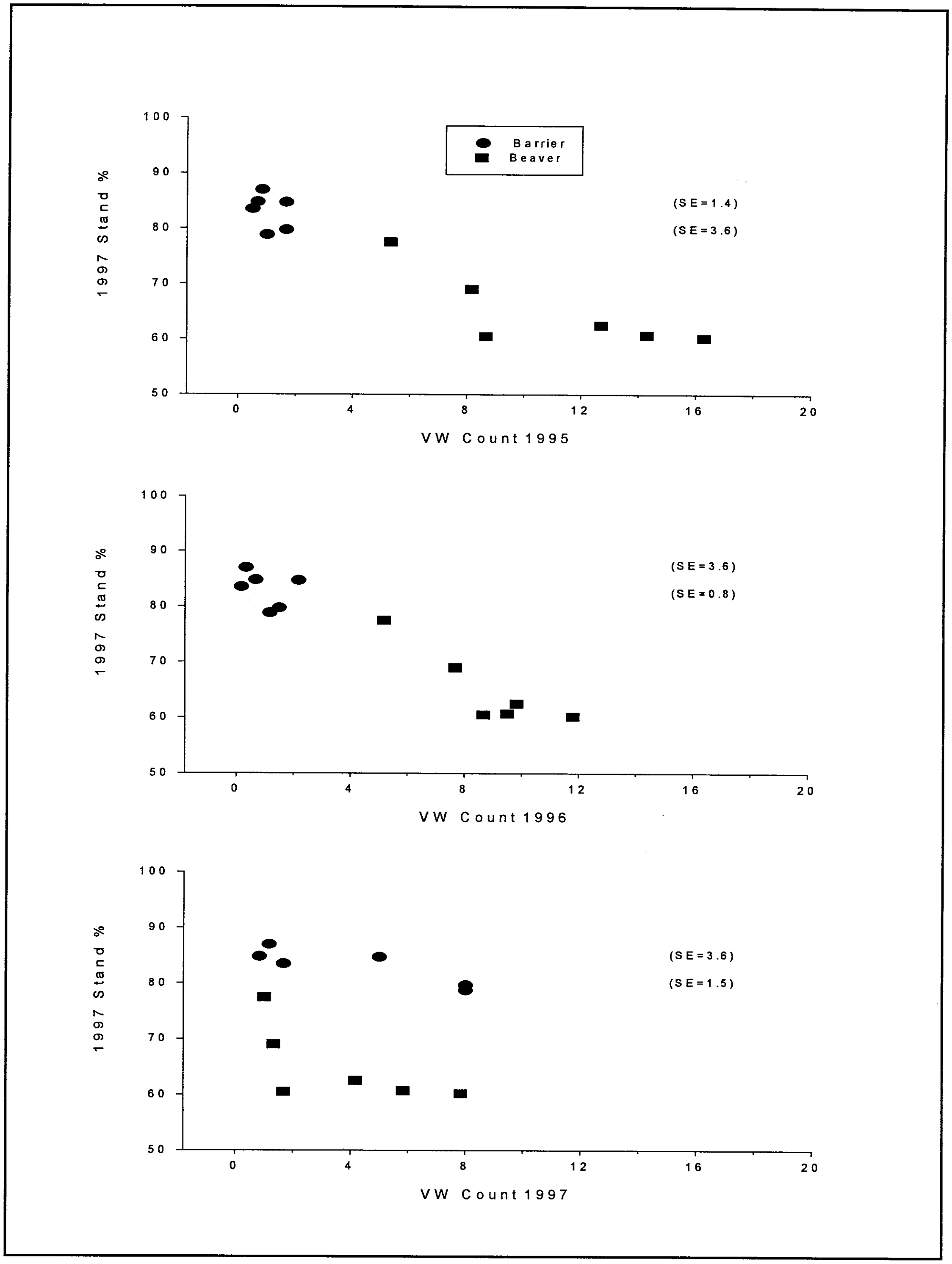


Figure 2. Stand density for Beaver (●) and Barrier (■) alfalfa as affected by Verticillium wilt-infected plant counts in 1995, 1996, and 1997. Standard error of the mean for each variable is shown on the figure.

A Crop Diversification Opportunity: Potential of Ryegrass (*Lolium* SPP) as a Seed Crop under Irrigation in Saskatchewan

Principal: B. Coulman, Agriculture & Agri-Food Canada Research Centre, Saskatoon, Saskatchewan
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigators: H. Loeppky, D. Murrell, and G. Kruger, Research Centre, Saskatoon, Saskatchewan
Location: SIDC
Progress: Second year of three
Objectives:
The overall objective of this project is to evaluate the potential of, and develop basic agronomic packages for, ryegrass (*Lolium* spp.) as a new multi-purpose crop in Saskatchewan. The specific objectives are:
a) To evaluate the potential of Italian, Westerwolds and perennial ryegrass for seed production under irrigated conditions and;
b) To evaluate agronomic practices such as companion cropping and weed management which may be constraints to the development of a ryegrass seed industry.

Seed yields of Westerwold ryegrass, an annual, were lower in 1997 than 1996, likely due to hot conditions in July and August. Aubade was the highest yielding cultivar in both years (Table 1). There were no significant differences in the yield of Aubade seeded at five different seeding rates and three different row spacings (Table 2), showing the capacity of this species to tiller and produce heads, even under a low plant density. Uneven ripening of heads was again a problem, and higher seeding rates/closer row spacing did not increase the synchrony of head ripening (data not shown) as hypothesized. Combine residue of moderate forage quality remained after seed harvest and there was considerable regrowth available by mid-October. Thus, Westerwold ryegrass produces an economic yield consisting of both seed and forage production in the same year. An Italian ryegrass (biennial type) cultivar trial seeded in 1996 completely winterkilled, thus no seed was harvested in 1997.

Seed was harvested in 1997 from a perennial ryegrass cultivar trial seeded in the spring of 1997. Yields were highly variable (Table 3) with an approximate five-fold difference between the lowest and highest yielding cultivars. Mowing spring seeded perennial ryegrass stands in October had a deliterious effect on winter survival and subsequent seed yields (Table 4). The mowing reduced seed yields by about 30%, although the magnitude of reduction was variable among different cultivars (data not shown). A seeding rate trial (Table 5) of Norlea and Barlinda perennial ryegrasses showed no significant differences in seed yield amongst rates of 4, 8 and 12 kg/ha (3.5, 7.0 and 10.5 lb/ac). The 8 kg/ha rate was numerically superior for both cultivars.

A trial was seeded in 1996 to compare the seed yields of Italian and perennial ryegrasses and tall fescue in spring and fall (August 15) seedings, and under companion crops in spring seedings. Yields of Italian ryegrass (Table 6) were generally low due to winterkill, but the fall seeding was superior to the spring seeding. Spring seedings under companion crops were generally superior to spring seedings with no companion crop. For perennial ryegrass, fall seedings also resulted in higher seed yields than most of the spring seeded treatments. For tall fescue, there were no significant differences, however, the trends were opposite to the ryegrass results with the spring seeded, no companion treatment having the highest numerical yield.

Table 1. Westerwolds ryegrass cultivar trial, SIDC, Outlook, 1997 results.

Variety	28-Aug Head Number		03-Sep Seed Yield		27-Sep 1996 Yield		Average Yield		
	per m²	per ft²	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	% of Aubade
Aubade	755	70	633	565	1145	1022	889	794	100
SW WWR9016	664	62	563	503	882	787	722	645	81
Barspectra	589	55	562	501	773	690	668	596	75
Barwoltra	563	52	573	511	726	648	650	580	73
Agraco	640	60	546	487	657	587	601	537	68
Mean	642	60	575	514	836	746	706	630	
CV%	23		25		17				
F-Value	1.25		0.27		8.6**				
L.S.D.(0.05)	n.s.		n.s.		196				

Table 2. Westerwolds seeding rate, row spacing trial, SIDC, Outlook.

Aubade ryegrass		13-Jun Plant Number		28-Aug Inflorescences		03-Sep Seed Yield	
Rate		per m²	per ft²	per m²	per ft²	kg/ha	lb/ac
8 kg/ha	7 lb/ac	117	11	706	66	540	482
12 kg/ha	11 lb/ac	153	14	755	70	507	453
16 kg/ha	14 lb/ac	164	15	716	67	542	484
20 kg/ha	18 lb/ac	243	23	727	68	509	455
24 kg/ha	21 lb/ac	231	21	732	68	500	447
Row Space							
10cm	4"	206	19	758	71	557	497
20cm	8"	176	16	691	64	506	452
30cm	12"	164	15	733	68	497	443
Mean:		182	17	727	68	520	464
CV%		39	39	21	21	20	20
F-Value		3.2**		0.7		0.7	
LSD(0.05)		90		n.s.		n.s.	

Table 3. 1996 Perennial Ryegrass Cultivar Trial, SIDC, Outlook, 1997 results.				
	26-May Spring Stand	05-Aug Seed Yield		Overall Seed Yield as
Variety	Rating %	kg/ha	lb/ac	% Norlea
Catalina	84	607	542	114
SWE225	75	542	484	101
Norlea	**80**	**534**	**477**	**100**
Terry	82	516	461	97
Brightstar	69	513	458	96
Affinity	66	490	438	92
Gettysburg	88	477	426	89
Stallion Select	80	427	382	80
SWER8744	60	386	344	72
Leon	82	344	307	64
Yatsyn1	38	331	296	62
SWUER8782	55	317	283	59
Figaro	63	308	275	58
Barlano	62	299	267	56
Barrage	71	298	266	56
Barcredo	64	284	254	53
Barlatra	42	277	247	52
Barball	65	270	241	50
Barlinda	69	268	239	50
Baristra	63	247	221	46
Bardessa	72	245	219	46
Sabor	67	239	213	45
Ronja	49	215	192	40
Rosalin	40	211	189	40
Barylou	67	196	175	37
Spelga	36	196	175	37
Barlet	52	194	173	36
Moy	48	184	164	34
Barmaco	50	182	163	34
Sommora	77	169	151	32
Barclay	53	162	144	30
Barezane	50	118	105	22
Mean	63	314	280	
CV%	32	40	40	
LSD (0.05)	26	158	141	

Table 4. Effect of October mowing on perennial ryegrass, SIDC, Outlook, 1997 results.						
	26-May Spring Stand Rating %		05-Aug Seed Yield			
			kg/ha		lb/ac	
32 VARIETIES	Unmowed	Mowed	Unmowed	Mowed	Unmowed	Mowed
Mean	75	45	361	243	322	217
CV%	20	53	34	51		

Table 5. 1996 perennial ryegrass seeding rate trial, SIDC, Outlook, 1997 results.					
			26 - May Spring Stand	5 - Aug Seed Yield	
Treatment	kg/ha	lb/ac	Rating %	kg/ha	lb/ac
Norlea	4	4	80	455	406
Norlea	8	7	78	552	493
Norlea	12	11	81	428	382
Barlinda	4	4	58	243	217
Barlinda	8	7	58	288	257
Barlinda	12	11	59	260	232
Mean			69	371	331
CV%			19	31	31
LSD (0.05)			17	153	137

Cultivar	Stand%	Yield	
Norlea	80*	478*	427*
Barlinda	58	264	236
Rate			
4 kg/ha	69	349	312
8 kg/ha	68	420	375
12 kg/ha	70	344	307

*=significantly different at alpha=0.05
Rate X Cultivar interaction not significant at 0.05 level

Table 6. Seed yields with and without companion crops. SIDC, Outlook, July 28, 1997.

a.

Cover Crop	Seeding Rate		Maris Ledger Italian Ryegrass (kg/ha)	(lb/ac)
NONE	FALL SEEDED		207	185
	(kg/ha)	(lb/ac)		
FLAX	40	35	180	161
FLAX	20	18	59	53
WHEAT	100	90	59	53
WHEAT	50	45	43	39
NONE	SPRING SEEDED		2	2
		Mean:	92	82
		CV%	37	37
		F-Value	8.52**	8.52**
		LSD (0.05)	45	41

b.

Cover Crop	Seeding Rate		Norlea Perennial Ryegrass kg/ha	lb/ac
NONE	FALL SEEDED		568	507
	(kg/ha)	(lb/ac)		
FLAX	220	18	458	409
WHEAT	50	45	454	405
FLAX	40	35	445	397
WHEAT	100	90	387	346
NONE	SPRING SEEDED		383	342
		Mean:	449	401
		CV%	19	19
		F-Value	3.21*	3.21*
		LSD (0.05)	110	98

c.

Cover Crop	Seeding Rate		Courtenay Tall Fescue kg/ha	lb/ac
NONE	SPRING SEEDED		334	298
	(kg/ha)	(lb/ac)		
FLAX	20	18	315	281
WHEAT	100	90	307	274
FLAX	40	35	271	242
WHEAT	50	45	236	211
NONE	FALL SEEDED		206	184
		Mean	278	248
		CV%	29	
		F-Value	1.84	
		LSD (0.05)	n.s.	

Seed Yields of Grass Species and Varieties under Irrigated Conditions in Saskatchewan

Principal: Saskatchewan Forage Council
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigators: B. Coulman, A. Kielly, P. Jefferson, and D. Murrell
Location: SIDC, Outlook
Progress: Extended one year (final report submitted in 1996).
Objective: To obtain data on the relative seed yields of grass forage, turf, and amenity species and varieties under irrigation in Saskatchewan. These data will provide producers, extension staff, and researchers with information on which to make more knowledgeable decisions on diversification, recommendations, and research needs.

In 1993, trials of 106 varieties of 25 species of forage and turf grasses were seeded at Outlook and Swift Current to evaluate their seed yield potential under irrigation in Saskatchewan. Additional trials of Kentucky bluegrass, fescues, timothy, and orchardgrass were seeded in 1996.

In 1997, only those trials seeded in 1996 were harvested.

a. Kentucky bluegrass (Table 1):
Spring stands were adequate and filled in as the season progressed in 1997. Silvertop was not a problem in 1997, but some varieties were severely affected by mildew. Almost all varieties produced large numbers of heads, but seed yields were generally low, with the top yield being 229 kg/ha (204 lb/ac). A possible explanation of the low yields was very hot temperatures in July. Varieties were highly variable in yield with about a six-fold difference between the lowest and highest.

Table 1. 1996 Kentucky bluegrass cultivar trial - seed production, SIDC, Outlook, 1997

Variety	18-Jun		23-Jun	21-Jul	
	HEAD NO.		MILDEW	YIELD	
	per m^2	per ft^2	5=severe	kg/ha	lb/ac
Opal	1887	176	1	229	204
Haga	1733	161	1	150	133
Jefferson	1417	132	1	143	128
Baron	1647	153	3	143	128
Barzan	1473	137	1	126	112
Baruzo	1377	128	0	125	112
Bluestar	1250	116	3	121	108
Sydsport	1480	138	2	115	103
Unique	2137	199	1	113	101
Baronie	1337	124	2	104	93
Platini	1303	121	2	89	79
Midnight	783	73	3	72	64
Bartitia	1247	116	3	64	58
Blacksburg	1507	140	4	63	56
Barcelona	1853	172	3	50	44
Lato	667	62	2	39	35
Mean	1444	134	2	109	97
CV%	38	38	42	36	36
LSD (0.05)	774	691	1	55	50

b. Fescues (Table 2):
All stands, except Merlov, were good in the spring of 1997. Silvertop incidence was not high. Head production was high especially for a number of the fine fescue species. The tall fescues produced exceptional yields, with Tomahawk yielding over 1500 kg/ha (1418 lb/ac) of

seed. Yields of meadow fescue were also good, but the fine fescues produced relatively low yields. Yields of slender creeping red fescue, a new type under test, were particularly low.

Table 2. 1996 Fescue Cultivar Trial-Seed Production, SIDC, Outlook, 1997.

Entry	Species	Head No. per m^2	Head No. per ft^2	Harvest Date	Yield kg/ha	Yield lb/ac	Yield as % Courtenay
Tomahawk	Tall	1429	133	1-Aug	1588	1418	119
Courtenay	Tall	811	75	28-Jul	1339	1195	100
Kokanee	Tall	659	61	28-Jul	1308	1168	98
Apache II	Tall	1579	147	1-Aug	1102	984	82
Bar Fa 209	Tall	1621	151	1-Aug	954	852	71
Eldorado	Tall	1627	151	1-Aug	947	845	71
Barbizon	Tall	1192	111	1-Aug	943	842	70
Stargazer	Tall	643	60	28-Jul	900	804	67
Dovey	Tall	685	64	28-Jul	780	696	58
Barfelix	Tall	1315	122	1-Aug	681	608	51
Prevail	Meadow	1043	97	28-Jul	635	567	47
Barcel	Tall	965	90	28-Jul	625	558	47
Merifest	Meadow	1605	149	21-Jul	601	537	45
Montebella	Tall	605	56	28-Jul	593	530	44
Maximize	Tall	819	76	28-Jul	587	524	44
Premil	Meadow	1120	104	28-Jul	471	421	35
Shademaster	Creeping Red	2499	232	21-Jul	322	287	24
Bargreen	Chewings	2995	279	15-Jul	220	197	16
Discovery	Hard	4928	458	9-Jul	187	167	14
Baruba	Chewings	2235	208	15-Jul	150	134	11
Barnica	Chewings	2931	273	9-Jul	137	122	10
Baroxi	Chewings	2179	203	15-Jul	136	122	10
Barlander	Sl. Creeping	2480	231	9-Jul	114	102	9
Barcrown	Sl. Creeping	973	91	21-Jul	66	59	5
Barskol	Sl. Creeping	819	76	21-Jul	54	48	4
Merlov	Meadow	0	0	-	0	0	0
	Mean	1529	142		594	530	
	CV%	35	35		26	26	
	LSD (0.05)	675	63		197	176	
Species		per m^2	per ft^2	Date	kg/ha	lb/ac	
Tall		1073	100	30-Jul	950	848	
Meadow		942	88	26-Jul	427	381	
Hard		4928	458	9-Jul	187	167	
Chewings		2585	240	14-Jul	161	144	
Creeping Red		2499	232	Jul 21	322	287	
Slender Creeping Red		1424	132	17-Jul	78	70	
LSD (0.05)		522	49		73	65	

c. Timothy and orchardgrass (Table 3):
Yields of timothy and orchardgrass were relatively low in 1997. In the case of orchardgrass, it appeared to be caused by a low number of heads. Low yield of timothy could have resulted from the hot weather in July. None of the orchardgrasses outyielded the check variety, Kay. One Danish line of timothy, DP 91-86, outyielded the check variety Champ.

Table 3. 1996 Orchardgrass and Timothy Seed Production Trial SIDC, Outlook, 1997.

ENTRY	SPECIES	YIELD kg/ha	YIELD lb/ac	Yield as % Champ	Yield as % Kay
DP 91-86	Timothy	339	303	147	
Kay	Orchardgrass	283	252		100
Champ	Timothy	231	206	100	
OG 1	Orchardgrass	159	142		56
OG 1A	Orchardgrass	129	116		46
DP 91-3	Timothy	97	86	42	
DP 91-5	Timothy	81	72	35	
Shawnee	Orchardgrass	59	53		21
Elsie	Orchardgrass	56	50		20
Mean		159	142		
C.V.%		27	27		
LSD (0.05)		53	48		

Forage Quality of Alternative Salt Tolerant Grasses for Irrigation in Southwest Saskatchewan

Principal: A. Kielly, Semiarid Prairie Agricultural Research Centre (SPARC), Swift Current, Saskatchewan

Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)

Co-investigators: D. Glover, R. Cohen, University of Saskatchewan; P. Jefferson, SPARC

Progress: Final

Objectives:

a) To determine the forage quality of 11 alternative grass species grown under flood irrigation on a saline site in southwestern Saskatchewan when harvested at different growth stages.
b) To determine feed intake and digestibility of these species when harvested as hay.
c) To determine the agronomic performance of these species when grown under flood irrigation on a saline site in southwestern Saskatchewan.

Alfalfa is widely grown under irrigation and has excellent forage quality. Alfalfa is only moderately tolerant of saline soils. Many species of grass are more salt tolerant than alfalfa, but the forage quality of many of these grasses is not well known. To further confound forage quality information, many samples are taken on a calendar date basis rather than a specific growth stage which makes it difficult to make comparisons. The purpose of this study was to compare the agronomic factors and forage quality of eleven grass species at similar stages of maturity and at different times in the growing season.

In 1991, plots of 11 grasses were established on a clay loam soil at Swift Current. The grasses studied were: Smooth Bromegrass, Meadow Bromegrass, Tall Wheatgrass, Crested Wheatgrass, Intermediate Wheatgrass, Slender Wheatgrass, Altai Wildrye, Russian Wildrye, Dahurian Wildrye, Reed Canarygrass, and Creeping Foxtail. All are moderately to strongly salt tolerant.

The plots were 0.9 ha (2.25 ac) in area, replicated twice, and flood irrigated to meet crop needs. The plots were cut for hay once per year. Quarter metre square quadrats were clipped at the three leaf, head emergence, and seed set growth stages for agronomic and feed quality analysis. Total tract digestibility trials were made using sheep in individual metabolic stalls, with three ram lambs in each.

Creeping Foxtail, Intermediate Wheatgrass, Russian Wildrye, and Smooth Bromegrass had the highest persistence of all species at the seed set stage. Meadow Bromegrass had the lowest persistence, and allowed weeds to invade the plots. Yield results for three cutting stages are shown in Table 1. Clipping at the three leaf stage was completed in late May, and only small differences were observed. Yield differences at heading, the usual time of hay harvest, were more pronounced. Meadow Bromegrass and Dahurian Wildrye yielded the least at heading while yield differences between the other species were not statistically significant (P=0.05).

Table 1. Yield of 11 alternative salt tolerant grasses at three stages of maturity in 1995 and 1996.

	Yield (kg/ha)			Yield (lb/ac)		
Grass	3 leaf	Heading	Seed set	3 leaf	Heading	Seed set
Altai Wildrye	1590 ab	3450 ab	5240 a	1420	3070	4660
Dahurian Wildrye	820 ab	1470 bc	2780 bc	730	1310	2470
Russian Wildrye	1970 a	2890 abc	2790 bc	1750	2570	2480
Crested Wheatgrass	1160 ab	2790 abc	2320 c	1030	2480	2070
Intermed. Wheatgrass	1060 ab	3890 ab	5020 a	940	3460	4470
Slender Wheatgrass	1130 ab	3810 ab	4220 ab	1010	3390	3760
Tall Wheatgrass	670 ab	3460 ab	5610 a	600	3080	4990
Meadow Bromegrass	520 b	630 c	530 d	460	560	470
Smooth Bromegrass	1580 ab	4910 a	5680 a	1410	4370	5060
Creeping Foxtail	1770 ab	3840 ab	5450 a	1580	3420	4850
Reed Canarygrass	1160 ab	2340 abc	4540 ab	1030	2080	4040
Pooled S.E.	270	600	470			

abcd values in columns followed by different letters differ significantly at P=0.05

The superior yield of Smooth Bromegrass, Creeping Foxtail, and Intermediate Wheatgrass at all growth stages suggest that these may be valuable as hay or pasture species. The higher yield of Altai Wildrye and Tall Wheatgrass suggest a use for late season grazing. Forage quality data are shown in Table 2. Crude protein levels decreased over the growing season. Smooth Bromegrass, Reed Canarygrass, and Slender Wheatgrass decreased dramatically. Russian Wildrye, Meadow Bromegrass, and Altai Wildrye, species with greater basal leaf growth and a large leaf to stem ratio, maintained greater crude protein levels. Russian Wildrye had significantly greater protein levels at seed set.

Phosphorus levels decreased as the growing season progressed, but there were few significant differences between species at each growth stage. Acid detergent (ADF) and neutral detergent (NDF) fibre levels increased through the season. Differences between species were greatest at seed set. Intermediate Wheatgrass had the lowest percent NDF of all species (Table 2).

Table 2. Average crude protein, Phosphorous, NDF, and ADF levels at heading of 11 alternative salt tolerant grasses in 1995 and 1996.

Grass	Crude protein (%)	Phosphorous (%)	NDF (%)	ADF (%)
Altai Wildrye	10.6	0.26 ab	62.4 ab	34.9 ab
Dahurian Wildrye	10.8	0.28 a	59.0 abc	33.8 abc
Russian Wildrye	11.4	0.24 ab	59.2 abc	30.8 bc
Crested Wheatgrass	9.7	0.23 ab	58.8 abc	33.1 abc
Intermediate Wheatgrass	10.4	0.24 ab	55.4 c	29.8 c
Slender Wheatgrass	10.7	0.23 ab	58.1 bc	31.4 bc
Tall Wheatgrass	8.8	0.23 ab	63.8 a	37.3 a
Meadow Bromegrass	9.0	0.23 ab	59.5 abc	33.1 abc
Smooth Bromegrass	10.3	0.20 b	55.4 c	29.4 c
Creeping Foxtail	11.2	0.24 ab	55.8 c	31.1 bc
Reed Canarygrass	11.0	0.25 ab	57.7 bc	32.9 abc
Pooled S.E.	1.3	0.02	1.9	1.8

abcd values in columns followed by different letters differ significantly at P=0.05

Intake is a primary factor controlling ruminant production from forages. Digestibility is also an important factor affecting forage quality. The feed used in the study was chopped to 5 cm (2 in) length and free fed to lambs twice per day. Intake was evaluated over a seven day period. Dry matter intake as a proportion of body weight was lowest for Altai Wildrye and Reed Canarygrass. Dahurian Wildrye and Intermediate Wheatgrass had the highest total intake of nine grasses studied (Table 3).

Apparent digestibility is the difference between the nutrient content of the feed consumed and the nutrient content remaining in the feces expressed as a percent of the total nutrient intake. Intermediate Wheatgrass had the highest apparent digestibility, and Creeping Foxtail had the lowest (Table 3). Of the nine species tested, Intermediate Wheatgrass appears to have the best feed characteristics for ruminant production. Creeping Foxtail and Reed Canarygrass had the poorest nutritive value.

To properly evaluate forages and rank species by feed value, both agronomic and quality characteristics must be considered. Crude protein and digestibility are the most important quality measures, while yield is the most important agronomic factor. Yields of crude protein and digestible dry matter on an area basis are shown in Table 4. Smooth Bromegrass and Creeping Foxtail had the highest yield of digestible dry matter at heading. Smooth Bromegrass also had the greatest crude protein yield at heading.

By taking total dry matter, crude protein, and digestible dry matter yields at the different stages of maturity (3 leaf, heading, and seed set), it is possible to rank the salt tolerant grass species according to their value for hay, early, and late pasture under irrigated conditions. These rankings are presented in Table 5.

Table 3. Energy, apparent digestibility, and voluntary intake of nine grasses fed to sheep in 1995.

Grass	Energy (Mcal/kg)	Apparent Digestibility (%)	Voluntary Intake by sheep (g/kg body wt.)
Altai Wildrye	4.30 ab	53.9 bcd	17.5 d
Dahurian Wildrye	4.26 abc	54.1 bcd	26.3 a
Russian Wildrye	4.26 abc	54.8 bc	25.0 ab
Intermediate Wheatgrass	4.33 a	59.7 a	26.6 a
Slender Wheatgrass	4.27 abc	51.4 cd	24.2 abc
Tall Wheatgrass	4.21 c	58.3 ab	22.3 abc
Smooth Bromegrass	4.24 bc	52.8 cd	22.9 abc
Creeping Foxtail	4.06 e	48.8 d	20.6 bcd
Reed Canarygrass	4.14 d	48.7 d	20.2 cd
Pooled S.E.	0.02	1.3	1.1

abcd values in columns followed by different letters differ significantly at P=0.05

Table 4. Digestible dry matter and crude protein yield for 11 salt tolerant grass species at heading.

	Digestible dry matter yield		Crude protein yield	
Grass	kg/ha	lb/ac	kg/ha	lb/ac
Altai Wildrye	2118 ab	1890	281 abc	251
Dahurian Wildrye	1003 ab	895	119 bc	106
Russian Wildrye	1798 ab	1605	263 abc	235
Crested Wheatgrass	1790 ab	1598	210 abc	187
Intermediate Wheatgrass	2189 ab	1954	315 abc	281
Slender Wheatgrass	2143 ab	1913	306 abc	273
Tall Wheatgrass	1977 ab	1764	296 abc	264
Meadow Bromegrass	545 b	486	47 c	42
Smooth Bromegrass	2944 a	2628	428 a	382
Creeping Foxtail	2210 ab	1972	402 ab	359
Reed Canarygrass	1416 ab	1264	239 abc	213
Pooled S.E.	379		60	

abcd values in columns followed by different letters differ significantly at P=0.05

the yield of established irrigated alfalfa at this particular site. Several site years of data are required before definite conclusions on the benefit of aeration for established irrigated alfalfa can be made.

Further work is required on additional sites.

Table 1. Aeration effects on established irrigated alfalfa yield.

Treatment	Dry Matter Yield					
	1st cut		2nd cut		Total	
	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
control	6035	5377	5674	5056	11709	10433
fall	6414	5715	5495	4896	11909	10611
spring	6752	6016	6084	5421	12836	11437
1st cut	6083	5420	5509	4909	11592	10328
fall + spring	7212	6426	5261	4688	12473	11113
fall + 1st cut	6855	6108	5180	4615	12035	10723
spring + 1st cut	6017	5361	5309	4730	11326	10091
LSD (0.05)	NS[1]		NS		NS	

[1] NS - not significant

Rudy Rosedale Community Pasture Irrigation Project

The Rudy Rosedale irrigated alfalfa project was established to demonstrate large scale irrigated alfalfa production, and to provide hay for the community pasture system. The project consists of a one section centre pivot on Sec-1-31-7-W3 pumping from drain 1C of the SSRID.

Hay production and protein content are shown in Table 1. The NE quarter is an alfalfa/grass mix which now contains a high proportion of grass. The SE quarter is in the second full year of alfalfa production. Hay from this quarter is primarily alfalfa. The SW quadrant was broadcast sown to alfalfa using no companion crop in 1997. The alfalfa seedlings on some of the knolls on this quarter were sand blasted and establishment was slow. These areas were re-seeded using a barley cover crop and were well established by fall. The NW quarter was sown to greenfeed barley. This quarter has poor internal drainage and contains a large number of sloughs and waterlogged areas. This reduced the average greenfeed production for the quarter.

Pocket gophers are a perennial nuisance which increased as the season progressed. The problem was less severe than normal on the west half in 1997.

In past years winterkilled areas were tilled and re-sown. In 1997, these areas were re-sown directly into the sod using a disc opener type of no-till seed drill. Alfalfa establishment was highly successful by this means.

A major change in field operations was made at Rudy Rosedale in the 1997 season. The baling of the hay was tendered out for custom hire. This will reduce capital equipment purchases and lower hay costs in the long term.

The contractor was able to perform the baling in a timely, efficient manner. By being freed of the task of baling, the SIDC staff were able to pick bales, fertilize, and irrigate promptly after each quarter was baled. The custom baling allowed staff to perform previously neglected jobs such as

Table 5. Ranking of salt tolerant grass forages into most suitable uses based on yield, crude protein, and digestibility.		
Hay	Pasture	
	Early	Late
Smooth Bromegrass	Creeping Foxtail	Russian Wildrye
Creeping Foxtail	Russian Wildrye	Smooth Bromegrass
Intermediate Wheatgrass	Reed Canarygrass	Creeping Foxtail
Slender Wheatgrass	Crested Wheatgrass	Intermediate Wheatgrass
Altai Wildrye	Altai Wildrye	Slender Wheatgrass
Tall Wheatgrass		Altai Wildrye
		Dahurian Wildrye
		Tall Wheatgrass

Soil Aeration Effects on Established Irrigated Alfalfa

Principals: T. Hogg, M. Pederson, and L. Sexton, Saskatchewan Irrigation Development Centre
Co-investigator: C. King, AerWay, Holland Hitch Western Limited, Surrey, B.C.
Location: Rudy Rosedale Irrigated Alfalfa Project (SE-01-31-07-W3)
Progress: Year two
Objective: To determine the effect of soil aeration on established irrigated alfalfa productivity.

Intensively irrigated alfalfa stands are subjected to heavy traffic from equipment during harvesting and fertilizing operations. Compaction of the soil can occur resulting in lower productivity and reduced stand longevity. Aeration has been suggested as one way to alleviate the problems associated with soil compaction and thus increase stand longevity. Increased stand longevity can reduce the costs of production.

Results for one site year of aeration trials on an established irrigated alfalfa stand at the PFRA Rudy Rosedale Irrigated Alfalfa Project near Outlook, Saskatchewan, indicated no effect of aeration treatments that were applied in the spring of the year on irrigated alfalfa yield.

In the fall of 1996, a demonstration was established on the SE 01-31-07-W3 to determine the effect of fall and spring aeration treatments on established irrigated alfalfa yield. The soil at this site is classified as an Asquith S-LS. Treatments were arranged in a randomized complete block design with four replicates.

Aeration treatments were applied October 25, 1996 (fall treatment), May 1, 1997 (spring treatment) and July 14, 1997 (1st cut treatment) using an AerWay ground-driven, rolling tined aerator/cultivator. Individual treatments measured 7.3 m x 15.2 m (24 ft X 50 ft).

Dry matter yield for the treatments is presented in Table 1. There were no significant differences in dry matter yield ($P<0.05$) among the treatments. There appears to be no effect of aeration on ditching to improve surface drainage, and maintenance of the yard site. The allocation of hay to the various pastures in 1997 is shown in Table 2.

Table 1. Hay production and protein for the Rudy Rosedale hay project, 1997.

Quarter	# bales*	Production	Yield		% Protein
			t/ha	tons/ac	
1st cut:					
NE	651	310.7 t	5.65	2.54	9.2
SE	529	256.8 t	4.67	2.09	13.2
SW	391	181.3 t	3.30	1.48	14.6
Total 1st cut	1571	748.8 t			
2nd cut:					
NE	447	222.8 t	4.05	1.82	8.9
SE	556	256.8 t	4.67	2.09	14.6
Total 2nd cut	1003	479.6 t			
NW greenfeed	408	215.3 t	3.91	1.75	8.4
All feed	2982	1443.7 t			

* Five foot hard core round bales; average weight = 456.5 kg (1004 lb).

Table 2. Allocation of Rudy Rosedale hay for 1997.

Pasture	Number of Bales Delivered	
	Alfalfa/grass Hay	Greenfeed
Antelope Park	206	---
Auvergne - Wise Creek	68	34
Bitter Lake & Bull station	136	68
Caledonia	300	---
Excel - Key West	120	---
Garry	68	34
Ituna	68	34
Laurier	136	---
Mantario	136	---
Monet	---	68
Progress	68	---
Royal	68	68
Rudy Rosedale/ Spring Creek station	1,012	68
Shamrock	34	---
Swift Current - Webb	34	34
Wellington	120	---
TOTAL	2,574	408

Specialty Crops

Pulse Crop Program

Principal: T.J. Hogg
Saskatchewan Irrigation Development Centre
Locations: SIDC (NW-12-29-09-W3); Off-station site (SW-15-29-08-W3) and Riverhurst (NE-27-22-7-W3)

Introduction

The pulse crop program at the SIDC is designed to evaluate the adaptability of pulse crops for irrigation, and to develop and refine production practices for irrigated conditions. This is achieved by conducting varietal evaluations and agronomic trials.

Agronomic Investigations

Benlate Rate and Timing of Application for *Sclerotinia* Control in Irrigated Dry Bean

Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Progress: Year one
Objective: To quantify the effect of benlate rate and timing of application on the yield of irrigated dry bean.

Dry bean plants are susceptible to a number of diseases. *Sclerotinia*, a major fungal disease of dry bean, can cause severe crop loss. The disease is most serious in crops with a dense canopy and in cool moist conditions. The disease is almost always a problem under irrigation. Control measures include crop rotations, variety selection, wide row spacing to reduce canopy density, and application of benlate just prior to or at the first bloom stage. Results from large scale demonstrations have indicated increased yield with a second benlate application. The economics of applying a second application depends on the increase in yield obtained and the rate of benlate applied. Further work is required to quantify the benefit of a second benlate application.

A study was initiated at the SIDC in the spring of 1997. Treatments consisted of four benlate rate x application time combinations (1x at flowering + 0.5x 10-14 days later; 0.5x at flowering + 0.5x 10-14 days later; 1x at flowering + 1x 10-14 days later; 1x at flowering) and two pinto bean varieties (Othello - Type III indeterminate sprawling vine and CDC Camino - Type I upright determinate). Othello and CDC Camino pinto bean were seeded in rows at a target plant population of 30 seeds/m^2 (105 lb/ac) using a 60 cm (24 in) row spacing. A factorial arrangement of treatments in a randomized complete block design with four replicates was used. Each treatment measured 2.4 m x 6 m (8 ft X 20 ft).

Benlate application had no significant effect on either Othello or CDC Camino dry bean yield and seed weight (Table 1). There was little *Sclerotinia* observed in the plot throughout the growing season probably due to the hot dry growing conditions through July and August.

Further work is required to quantify the effect of a second benlate application on irrigated dry bean yield.

Table 1. Benlate rate and timing of application effects on Othello and CDC Camino pinto bean yield and seed weight.

BENLATE[1]	Yield				Seed Weight (mg)	
	Othello		CDC Camino		Othello	CDC Camino
	kg/ha	lb/ac	kg/ha	lb/ac		
1x + 0.5x	2593	2310	2882	2568	343	352
0.5x + 0.5x	3104	2766	2670	2379	351	363
1x + 1x	2908	2591	2736	2438	345	353
1x	3187	2840	2883	2569	347	352
ANOVA LSD(0.05)						
Treatment (T)	NS[2]				NS	
Variety (V)	NS				8	
T x V	NS				NS	

[1]First application at flowering and second application 10-14 days later. Application 1x or 0.5x recommended rate of 1.0 kg a.i./ac.
[2]not significant

Response of Irrigated Dry Bean to Nitrogen Fertilization

Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Progress: Year one
Objective: To determine the response of irrigated dry bean to nitrogen fertilizer applications.

Dry bean requires adequate fertility to maintain optimum yield. A large part of the nitrogen requirements can be met by inoculation with the appropriate *Rhizobium* strain. Application of some additional fertilizer nitrogen may be required where soil available nitrogen levels are low. Excess nitrogen can delay dry bean maturity and make plants more susceptible to disease.

A study was initiated at the SIDC in the spring of 1997. Treatments included nitrogen fertilizer rates of 0, 30, 60, 90 and 120 kg N/ha (0, 27, 54, 81, and 108 lb N/ac) applied either as a side band or broadcast application. Ammonium nitrate (34-0-0) was the nitrogen source used. Othello pinto bean was seeded in rows at a target plant population of 30 seeds/m^2 (90 lb/ac) using a 60 cm (24 in) row spacing. A factorial arrangement of the fertilizer rate and placement treatments plus a control in a randomized complete block design with four replicates was used. Each treatment measured 2.4 m x 6 m (8 ft X 20 ft).

Spring soil analysis (Table 2) indicated that there was sufficient soil available nitrogen present to grow an irrigated crop of dry bean according to current soil test guidelines.

Table 2. Spring soil analysis for the irrigated dry bean nitrogen response trial.

Depth	pH	1:2 E.C.	NO_3-N	P	K	SO_4-S
			lb/ac			
0-12	7.9	0.6	25	1	52	96+
12-24	7.9	1.6	54	9	8	65

Nitrogen fertilizer rate had no significant effect on the yield, seed weight, plant stand, days to flowering or plant height for irrigated Othello pinto bean (Table 3). Nodulation decreased with nitrogen application indicating reduced nitrogen fixation. Total dry matter yield increased with nitrogen applications (Table 4a and 4b) but there was no subsequent increase in seed yield. Preliminary indications are that the current soil test guidelines correctly predict the nitrogen requirements of irrigated dry bean.

Table 3. Agronomic data for the irrigated dry bean nitrogen fertilizer trial.

Nitrogen Treatment			Yield		Seed Weight (mg)	Plant Stand (#/m^2)	Flowering (days)	Plant Height (cm)	Nodule Rating[1]
Placement	Rate kg/ha	Rate lb/ac	kg/ha	lb/ac					
	0	0	2539	2262	337	25	49	37	5.8
Side Band	30	27	3036	2705	338	28	49	39	6.3
	60	54	3004	2677	343	30	50	35	6.5
	90	81	3295	2936	337	28	50	38	4.8
	120	108	3201	2852	345	28	49	35	3.8
Broadcast	30	27	2931	2612	331	29	50	37	6.0
	60	54	2972	2648	326	27	51	34	5.3
	90	81	3268	2912	328	28	51	39	4.5
	120	108	2993	2667	339	29	50	39	4.3
Factorial LSD(0.05)									
Placement (P)			NS[2]		5	NS	1	NS	NS
Rate (R)			NS		NS	NS	NS	NS	1.1
P x R			NS		NS	NS	NS	NS	NS

[1] 0 - no N fixation potential; 8 - fully effective nodulation
[2] not significant

Table 4a. Total dry matter yield for the irrigated dry bean nitrogen fertilizer trial.

Nitrogen Placement	Total Dry Matter Yield (kg/ha) — Nitrogen Rate (kg/ha) 0	30	60	90	120	Mean
	6484					
Side Band		6106	7078	7126	8058	7092
Broadcast		6209	7409	7138	7482	7059
Mean		6157	7244	7132	7770	

Factorial LSD(0.05)

Placement (P)	NS[1]
Rate (R)	907
P x R	NS

[1] not significant

Table 4b. Total dry matter yield for the irrigated dry bean nitrogen fertilizer trial.						
Nitrogen Placement	Total Dry Matter Yield (lb/ac)					Mean
	Nitrogen Rate (lb/ac)					
	0	27	54	81	108	
Control	5777					
Side Band		5440	6306	6349	7180	6319
Broadcast		5532	6601	6360	6666	6290
Mean		5486	6454	6355	6923	
Factorial LSD(0.05)						
Placement (P)	NS[1]					
Rate (R)	808					
P x R	NS					

[1] not significant

Seeding Rate Effects on Irrigated Pea

Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Progress: Year four
Objective: To determine the effect of seeding rate on the yield of irrigated pea.

Seed constitutes a major input cost for irrigated pea production. This is particularly significant with the high seed cost for newly released cultivars. A three year study conducted from 1994-1996 indicated different results each year. Results indicated that the optimum seeding rate varied for the different cultivars. The semi-leafless varieties Carneval and Keoma required higher seeding rates than normal leaf variety Grande and the tare leaf variety Express. Further studies are required to determine the optimum seeding rate for irrigated pea production.

A pea seeding rate trial was established in the spring of 1997 at the SIDC.Treatments included five target seeding rates and four pea varieties (Table 5). Normal fertilizer, weed control and irrigation practices for irrigated pea production were followed. A factorial arrangement of the treatments in a randomized complete block design with four replicates was used. Each treatment measured 2.4 m x 6 m (8 ft x 20 ft).

Table 5. Seeding rates and varieties used for the irrigated pea seeding rate trial.				
Seeding Rate (seeds/m^2)	Seeding Rate (lb/ac)			
	Express (tare leaf)	Keoma (semi-leafless)	Carneval (semi-leafless)	Grande (normal leaf)
20	35	32	42	38
40	70	64	84	76
60	105	96	126	114
80	140	128	168	152
100	175	160	210	190

Plant stand increased as the seeding rate was increased and varied somewhat among the varieties used in the trial (Table 6). Keoma had the lowest overall plant stand for the four varieties.

Table 6. Effect of seeding rate on irrigated pea plant stand (#/m ^{2}).

Seeding Rate (seeds/m^2)	Plant Stand (#/m^2)				Mean
	Express	Keoma	Carneval	Grande	
20	25	28	24	28	26
40	42	50	28	45	41
60	68	65	67	67	67
80	90	90	65	72	79
100	104	96	86	83	92
Mean	66	66	54	59	61

Factorial ANOVA LSD(0.05)

Variety (V)	7
Seeding Rate (SR)	8
V x SR	NS[1]

[1] not significant

Irrigated pea yield was significantly affected by both variety and seeding rate (Table 7). Yield averaged over all seeding rates was of the order Grande>Carneval>Express>Keoma. Both Grande and Carneval produced significantly higher yield than either Express or Keoma. Yield averaged over the four varieties increased as the seeding rate increased up to 80 seeds/m^2. There were differential yield responses to seeding rate within varieties. Keoma and Carneval, semi-leafless pea varieties, showed 34% and 42% yield increases, respectively, as seeding rate was increased from 20 to 80 seeds/m^2. For Grande, a normal-leaf pea variety, optimum yield occurred at a seeding rate of 60 seeds/m^2 with a 17% yield increase over the lowest seeding rate. Express, a tare-leaf pea variety, showed little change in yield beyond a seeding rate of 40 seeds/m^2 where a 6% increase over the lowest seeding rate occurred. Optimum yield occurred at a seeding rate of 80 seeds/m^2 for the semi-leafless varieties Keoma and Carneval, 60 seeds/m^2 for the normal leaf variety Grande and at 40 seeds/m^2 for the tare-leaf variety Express. The greatest yield increase occurred for the two semi-leafless varieties. The tare and normal-leaf pea varieties may be able to compensate for low plant population by producing more branches and thus more pods per plant.

Seed size was different for the varieties used in the trial, consistent with data from varietal evaluation trials. For Keoma, higher seeding rates produced smaller seeds. Seeding rate had no effect on the seed weight of the other varieties (Table 8).

Table 7. Effect of seeding rate on irrigated pea yield.										
Seeding Rate (seeds/m^2)	Yield								Mean	
	Express		Keoma		Carneval		Grande			
	kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac
20	3716	55.2	2986	44.3	3567	53.0	4167	61.9	3608	53.6
40	3942	58.5	3504	52.0	4364	64.8	4626	68.7	4109	61.0
60	3675	54.6	3855	57.2	4692	69.7	4887	72.4	4275	63.5
80	3882	57.6	4004	59.5	5057	75.1	4666	69.3	4402	65.4
100	3995	59.3	4164	61.8	4661	69.2	4771	70.8	4398	65.3
Mean	3842	57.1	3702	55	4468	66.3	4621	68.6	4158	61.7

Factorial ANOVA LSD(0.05)	kg/ha	bu/ac
Variety (V)	163	2.4
Seeding Rate (SR)	182	2.7
V x SR	364	5.4

Table 8. Effect of seeding rate on irrigated pea seed weight (mg).					
Seeding Rate (seeds/m^2)	Seed Weight (mg)				Mean
	Express	Keoma	Carneval	Grande	
20	196	245	244	231	229
40	186	241	250	242	230
60	192	234	248	241	229
80	193	233	249	227	226
100	187	222	246	243	225
Mean	191	235	247	237	228

Factorial ANOVA LSD(0.05)	
Variety (V)	6
Seeding Rate (SR)	NS[1]
V x SR	13

[1] not significant

Fertilizer Response and Placement With Irrigated Pea and Dry Bean

Funding: Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Progress: Year one
Objective: To determine the effect of starter fertilizer rate and placement on the establishment, nodulation and yield of irrigated pea and dry bean.

Pulse crops require adequate soil fertility to maintain optimum yield. Application of fertilizer at or near seeding is required where soil available nutrient levels are low to ensure an adequate nutrient supply early in the growing season. High concentrations of fertilizer placed with the seed can cause seedling damage and reduced plant stand. Fertilizer placed in close proximity to the seed can reduce the effectiveness of the *Rhizobium* inoculant resulting in reduced nitrogen fixation. Information on rate and placement of starter fertilizer is required by pulse crop growers to ensure optimum production.

A starter fertilizer response trial was established in the spring of 1997 at the SIDC. A separate trial was established for each crop. Treatments included starter fertilizer rates of 0, 50, 100 and 150 kg/ha (0, 45, 90, and 135 lb/ac) applied either as a side band or seed place application during the seeding operation. The fertilizer used was a 13-20-10-10 blend composed of ammonium sulfate (21-0-0-24), monoammonium phosphate (12-51-0) and potassium chloride (0-0-60). Carneval pea was seeded at a target plant population of 80 seeds/m^2 (170 lb/ac) using a 20 cm (8 in) row spacing. Othello pinto bean was row crop seeded at a target plant population of 30 seeds/m^2 (105 lb/ac) using a 60 cm (24 in) row spacing. A factorial arrangement of the fertilizer rate and placement treatments plus a control in a randomized complete block design with four replicates was used. Each treatment measured 2.4 m x 6 m (8 ft X 20 ft).

Soil analysis of samples collected in the spring prior to plot establishment are presented in Table 9. Current soil test recommendations indicated phosphorus and sulfur levels were low for irrigated production of pea and dry bean. Recommendations were for 30-35 lbs P_2O_5/ac and 10-15 lbs S/ac.

Table 9. Spring soil analysis for the pea and dry bean starter fertilizer response trial.

Crop	Depth (in.)	pH	1:2 E.C. (dS/m)	NO_3-N	P	K	SO_4-S
				lb/ac			
Pea	0-12 12-24	7.7 8.0	0.2 0.2	37 23	24	686	9 96+
Dry Bean	0-12 12-24	8.0 8.2	0.2 0.2	36 28	13	536	8 8

Pea

There was a significant treatment effect on plant stand (LSD(0.05) = 19), days to maturity (LSD(0.05) = 1) and yield (LSD(0.05) = 495) (Table 10). The highest rate of seed placed starter fertilizer reduced the plant stand to the greatest extent, prolonged maturity and reduced yield. Although plant stand was significantly reduced for all rates of seed placed fertilizer compared to the two highest rates of side band fertilizer, only the highest rate of seed placed fertilizer significantly reduced yield. This coupled with the fact that there was no significant effect of fertilizer placement on seed weight would indicate that the reduced pea stand probably compensated by increased branching and production of more pods per plant. Even with proper placement of the fertilizer away from the seed in a side band application there was no significant increase in yield above that of the control treatment.

There was no significant effect of fertilizer rate or placement on plant height or nodulation.

Table 10. Agronomic data for the Carneval pea starter fertilizer response trial grown under irrigation.									
Fertilizer Treatment			Yield		Seed Weight (mg)	Maturity (days)	Plant Stand (#/m^2)	Plant Height (cm)	Nodule Rating[1]
Place	Rate kg/ha	Rate lb/ac	kg/ha	bu/ac					
	0	0	4290	63.7	247	96	62	84	6
Seed	50	45	4389	65.2	244	99	53	88	5
	100	90	4256	63.2	242	101	48	82	6
	150	135	3870	57.5	244	104	34	82	6
Mean			4172	62.0	243	101	45	84	6
Side Band	50	45	4433	65.8	241	98	68	90	5
	90	90	4704	69.9	240	99	74	89	5
	135	135	4654	69.1	243	99	74	89	5
Mean			4597	68.3	241	99	72	89	5
Factorial LSD(0.05)									
Placement (P)			303	4.5	NS	1	12	NS	NS
Rate (R)			NS[2]	NS	NS	5	NS	NS	NS
R x P			NS	NS	NS	5	NS	NS	NS

[1] 0 - no N-fixation potential; 8 - fully effective nodulation
[2] not significant

Dry Bean

Both rate and placement of the starter fertilizer significantly affected dry bean growth (Table 11). Plant stand was significantly reduced with seed placed fertilizer with the highest rate causing the greatest reduction. Maturity was prolonged by the addition of fertilizer with seed placement causing a slightly greater delay than side band placement. Seed yield was significantly reduced at the two highest rates of seed placed compared to side band fertilizer applications. This decrease in yield for the seed placed fertilizer was probably caused by a reduction in the number of plants which resulted in a reduction in the number of seeds produced. The fewer number of actively growing plants were not able to compensate by increased branching and production of a greater number of pods per plant to overcome the reduction in plant stand. This was indicated by a lower harvest index for seed placement compared to side band placement of the starter fertilizer (Table 12). The greater seed size for the highest rate of seed placed fertilizer was not enough to compensate for the lower number of seeds produced. Even with proper placement of the fertilizer away from the seed in a side band application there was no significant increase in yield above that of the control treatment.

Starter fertilizer rate and placement did not affect dry bean plant height.

Table 11. Agronomic data for the Othello pinto bean starter fertilizer response trial grown under irrigation.

Place	Rate kg/ha	Rate lb/ac	Yield kg/ha	Yield lb/ac	Seed Weight (mg)	Maturity (days)	Plant Stand (#/m²)	Plant Height (cm)
	0	0	2816	2509	335	93	31	48
Seed	50	45	2763	2462	329	95	23	48
	100	90	2385	2125	340	97	14	46
	150	135	2195	1956	353	99	8	45
Mean			2448	2181	341	97	15	46
Side Band	50	45	2615	2330	331	94	30	48
	100	90	2894	2579	341	94	30	48
	150	135	3037	2706	335	95	27	48
Mean			2849	2538	336	94	29	48
Factorial LSD(0.05)								
Placement (P)			218	194	NS	1	4	NS
Rate (R)			NS[1]	NS	8	1	5	NS
R x P			377	336	12	NS	NS	NS

[1] not significant

Table 12. Dry matter yield for the Othello pinto bean starter fertilizer response trial grown under irrigation.

Place	Rate kg/ha	Rate lb/ac	Pods kg/ha	Pods lb/ac	Total kg/ha	Total lb/ac	Harvest Index[1]
	0	0	4793	4271	7800	6950	0.61
Seed	50	45	3565	3176	6221	5543	0.57
	100	90	4298	3830	7313	6516	0.59
	150	135	3625	3230	7044	6276	0.49
Mean			3829	3412	6859	6111	0.55
Side Band	50	45	4564	4067	7359	6557	0.62
	100	90	5166	4603	8048	7171	0.65
	150	135	4802	4279	7207	6421	0.67
Mean			4844	4316	7538	6716	0.65
Factorial LSD(0.05)							
Placement (P)			NS		NS		0.07
Rate (R)			NS		NS		NS
R x P			NS		NS		NS

[2] Harvest Index = (Pods DM)/(Total DM)

[1] not significant

Seeding Rate and Row Spacing Effects on Irrigated Dry Bean

Funding: Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Progress: Year one
Objective: To demonstrate the effect of seeding rate and row spacing on the yield of different dry bean market classes under irrigated conditions.

Seed yield of dry bean generally increases as plant density increases. However, high plant density is often associated with low aeration, high humidity and prolonged periods of dampness within the canopy that can result in the development of white mold (*Sclerotinia*). These factors will be affected by both plant architecture and by row spacing. The currently recommended seeding rate for irrigated production of dry bean is in the range of 25-30 seeds/m^2 using a row spacing ranging from 60 - 80 cm (24
- 32 in). Preliminary results from work conducted at the SIDC indicate an optimum seeding rate of 20 seeds/m^2 with small variations among the different market classes. Lower seeding rates would reduce the seeding costs of producers. Further work is required to verify these results.

A dry bean seeding rate x row spacing trial was established in the spring of 1997 at the SIDC. A separate trial was established for each of pinto, black and navy dry bean market classes. Treatments consisted of three seeding rates, three row spacings (20, 60 and 80 cm or 8, 24 and 32 in) and two varieties for each dry bean market class (Table 13). Normal fertilizer, weed control and irrigation practices for irrigated dry bean production were followed. The treatments were arranged in a strip-split-plot design. Varieties and seeding rate treatments were randomized within the row spacing strips. All treatments were replicated four times. Each treatment measured 2.4 m x 6 m (8' x 20').

Table 13. Seeding rates and varieties used in the irrigated dry bean seeding rate x row spacing trial.

Market Class	Variety	Plant Type	Seeding Rate (lb/ac) 20 seeds/m^2	25 seeds/m^2	30 seeds/m^2
Pinto	Othello	Type III indeterminate vine	69	87	104
	CDC Camino	Type I upright determinate	64	80	96
Black	UI 906	Type I upright determinate	31	39	47
	Expresso	Type I upright determinate	28	35	42
Navy	Seafarer	Type I determinate bush	40	50	60
	Skipper	Type I upright determinate	34	42	51

Irrigated dry bean was affected by both seeding rate and row spacing. Reducing the seeding rate of navy bean from 30 to 20 seeds/m^2 did not affect yield (Table 14). This indicates that a lower seeding rate is a viable option with economic benefits to the producer. However, for pinto and black bean market classes a higher seeding rate of 30 seeds/m^2 should be maintained for optimum yield (Tables 15 and 16). Row spacings of 20 and 60 cm (8 and 24 in) produced the highest yield for all dry bean market classes tested. Increasing row spacing beyond 60 cm (24 in) to 80 cm (32 in) reduced yield. This can be attributed to inter-row plant competition resulting in reduced plant stands (Figures 1-3) and inefficient utilization of the growing area at the higher row spacing. There were no observed effects of seeding rate or row spacing on days to 50% flowering or on maturity for the pinto, black, or navy dry bean. There was also very little disease present, probably a result of the hot dry growing conditions. There was no effect of seeding rate or row spacing on dry bean seed weight.

Table 14. Seeding rate and row spacing effects on yield for Seafarer and Skipper navy bean grown under irrigation.

Variety	Seeding Rate (seeds/m^2)	20 cm (8 in)		60 cm (24 in)		80 cm (32 in)		Mean	
		kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
Seafarer	20	2464	2195	2335	2080	2205	1965	2335	2080
	25	2664	2374	2414	2151	1997	1779	2359	2102
	30	2508	2235	2629	2342	2156	1921	2431	2166
Mean		2545	2268	2459	2191	2120	1889	2375	2116
Skipper	20	2352	2096	2050	1827	1894	1688	2098	1869
	25	2203	1963	2137	1904	1779	1585	2039	1817
	30	2145	1911	2287	2038	1975	1760	2136	1903
Mean		2233	1990	2158	1923	1882	1677	2091	1863

ANOVA	LSD(0.05)
Row Spacing (RS)	202
Seeding Rate (SR)	NS[1]
RS x SR	NS
Variety (V)	85
RS x V	NS
SR x V	NS
RS x SR x V	NS

[1] not significant

Table 15. Seeding rate and row spacing effects on yield for Othello and CDC Camino pinto bean grown under irrigation.

Variety	Seeding Rate (seeds/m^2)	20 cm (8 in)		60 cm (24 in)		80 cm (32 in)		Mean	
		kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
Othello	20	3124	2783	3072	2737	2596	2313	2931	2612
	25	3129	2788	2798	2493	2486	2215	2804	2498
	30	3101	2763	3154	2810	2745	2446	3000	2673
Mean		3118	2778	3008	2680	2609	2325	2912	2595
Camino	20	2631	2344	2517	2243	2086	1859	2411	2148
	25	2666	2375	2536	2260	2496	2224	2566	2286
	30	2725	2428	2619	2334	2461	2193	2602	2318
Mean		2674	2383	2557	2278	2348	2092	2526	2251

ANOVA	LSD(0.05)
Row Spacing (RS)	309
Seeding Rate (SR)	109
RS x SR	NS[1]
Variety (V)	115
RS x V	NS
SR x V	NS
RS x SR x V	NS

[1] not significant

Table 16. Seeding rate and row spacing effects on yield for UI 906 and Expresso black bean grown under irrigation.

Variety	Seeding Rate (seeds/m²)	20 cm (8 in)		60 cm (24 in)		80 cm (32 in)		Mean	
		kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
UI 906	20	2383	2123	2615	2330	1989	1772	2329	2075
	25	2503	2230	2644	2356	2238	1994	2462	2194
	30	2654	2365	2647	2358	2292	2042	2531	2255
Mean		2513	2239	2636	2349	2173	1936	2441	2175
Expresso	20	2111	1881	1984	1768	1296	1155	1797	1601
	25	2240	1996	1983	1767	1615	1439	1946	1734
	30	3472	3094	2114	1884	1920	1711	2502	2229
Mean		2608	2324	2027	1806	1610	1435	2082	1855

ANOVA	LSD(0.05)
Row Spacing (RS)	434
Seeding Rate (SR)	361
RS x SR	NS[1]
Variety (V)	268
RS x V	NS
SR x V	NS
RS x SR x V	NS

[1] not significant

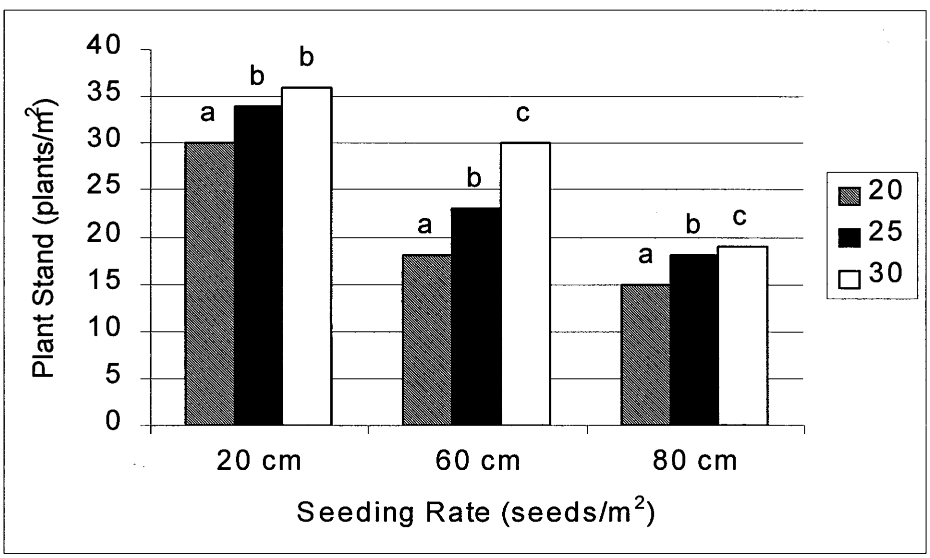


Figure 1. Seeding rate and row spacing effects on irrigated pinto bean plant stand. (Row spacings within a seeding rate with the same letter are not significantly different at p=0.05).

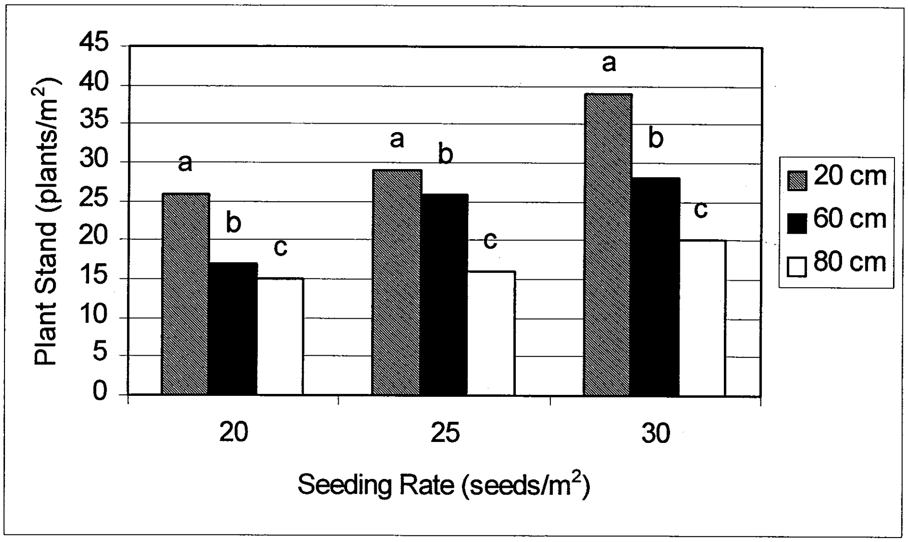


Figure 2. Seeding rate and row spacing effects on irrigated black bean plant stand. (Row spacings within a seeding rate with the same letter are not significantly different at $p=0.05$).

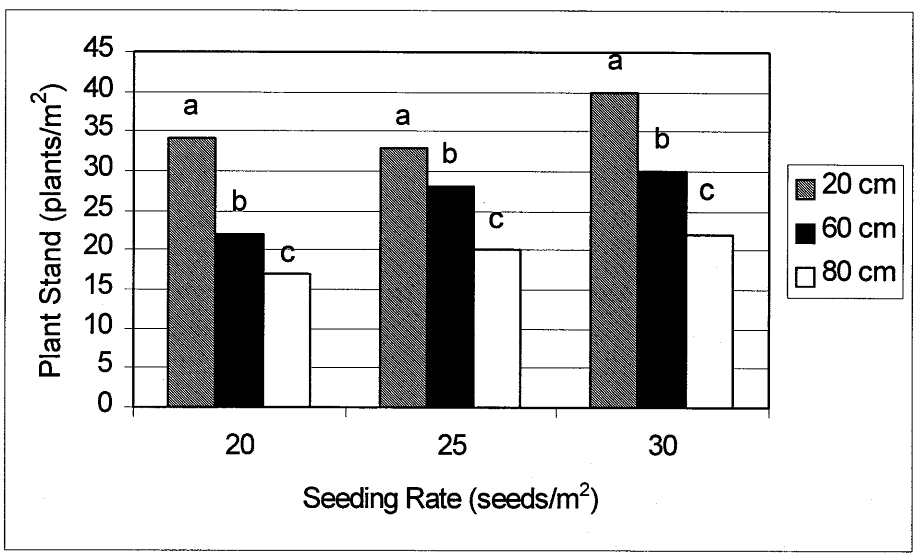


Figure 3. Seeding rate and row spacing effects on irrigated navy bean plant stand. (Row spacings within a seeding rate with the same letter are not significantly different at $p=0.05$).

Response of Irrigated Pea and Dry Bean to Potassium Fertilizer

Funding: Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Progress: Year one
Objective: To determine the effect of potassium fertilizer on irrigated pea and dry bean yield and seed quality.

Pulse crops require adequate soil fertility to maintain optimum yield. Large quantities of the macronutrients N, P, K and S are removed by pulse crops. Generally, levels of soil available potassium have been considered adequate. Response may occur under certain conditions, for example, soils testing low in available potassium or cool soil temperatures associated with early seeding.

A potassium fertilizer response trial was established in the spring of 1997 at the SIDC. A separate trial was established for each crop. Treatments included potassium rates of 0, 10, 20, 30 and 40 kg K_2O/ha applied as a side band application at seeding. Potassium chloride (0-0-60) was the source of potassium. Carneval pea was seeded at a target plant population of 80 seeds/m^2 (170 lb/ac) using a 20 cm (8 in) row spacing. Othello pinto bean was row crop seeded at a target plant population of 30 seeds/m^2 (105 lb/ac) using a 60 cm (24 in) row spacing. The treatments were arranged in a randomized complete block design with four replicates. Each treatment measured 2.4 m x 6 m (8 ft X 20 ft).

Soil analysis indicated that the soil available potassium level was adequate for irrigated production of pea and dry bean (Table 17).

Table 17. Spring soil analysis for the pea and dry bean potassium fertilizer response trial.

Crop	Depth (in.)	pH	1:2 E.C. (dS/m)	NO_3-N	P	K	SO_4-S
				lb/ac			
Pea	0-12	7.8	0.1	36	1	50	8
	12-24	8.1	0.2	37	8	4	8
Dry Bean	0-12	7.8	0.1	26	2	61	9
	12-24	8.1	0.2	23	1	6	8

The growing season in 1997 was hot and dry resulting in good response to irrigation. There was no observed difference among the potassium fertilizer treatments for days to flowering or maturity for either pea or dry bean. Pea required 56 days for 10% flowering and 98-100 days to reach maturity. Dry bean required 50 days for 50% flowering and 96-99 days to reach maturity. There was very little disease present in either crop, probably a result of the hot dry growing conditions.

There was no effect of potassium fertilizer application on yield, seed size, plant stand, plant height or nodulation of either Carneval pea or Othello pinto bean (Tables 18 and 19). Soil available potassium was sufficient to produce normal irrigated yields of 5000 kg/ha (74 bu/ac) pea and of 3500 kg/ha (3119 lb/ac) dry bean.

Preliminary indications are that the current soil test guidelines correctly predict the potassium requirements of irrigated pea and dry bean. Monitoring of soil fertility through an adequate soil testing program is the best way to determine fertilizer requirements.

Table 18. Agronomic data for the Carneval pea potassium fertilizer response trial grown under irrigation.

K_2O Rate		Yield		Seed Weight (mg)	Plant Stand (#/m^2)	Plant Height (cm)	Nodule Rating[1]
kg/ha	lb/ac	kg/ha	bu/ac				
0	0	5129	76.2	240	59	93	6
10	9	5148	76.4	238	60	95	6
20	18	5136	76.3	235	56	94	7
30	27	5050	75.0	231	61	95	7
40	36	5072	75.3	236	66	97	6
LSD (0.05)		NS[2]		NS	NS	NS	NS

[1] 0 - no N-fixation potential; 8 - fully effective nodulation
[2] not significant

Table 19. Agronomic data for the Othello dry bean potassium fertilizer response trial grown under irrigation.

K_2O Rate		Yield		Seed Weight (mg)	Plant Stand (#/m^2)	Plant Height (cm)	Nodule Rating[1]
kg/ha	lb/ac	kg/ha	lb/ac				
0	0	3360	2994	340	30	52	6
10	9	3644	3247	354	30	51	6
20	18	3398	3028	356	29	51	6
30	27	3501	3119	350	31	52	6
40	36	3616	3222	350	31	53	6
LSD (0.05)		NS[2]		NS	NS	NS	NS

[1] 0 - no N-fixation potential; 8 - fully effective nodulation
[2] not significant

Response of Irrigated Pea and Dry Bean to Micronutrient Fertilizer

Funding: Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Progress: Year one
Objective: To determine the effect of soil and foliar applied copper, zinc and boron micronutrient fertilizer on irrigated pea and dry bean.

Pulse crops require adequate soil fertility to maintain optimum growth and yield. Large quantities of the macronutrients are removed by pulse crops. The micronutrients are just as essential for optimum growth and yield although they are required in much smaller quantities. Micronutrient requirements are dependent on both plant uptake and soil availability. Generally, levels of soil micronutrients have been considered adequate. Response may occur under certain conditions, such as zinc application to dry bean on high pH soils, and if early season weather is cool and wet.

A micronutrient fertilizer response trial was established in the spring of 1997 at the SIDC. A separate trial was established for each crop. Treatments included three micronutrient fertilizer sources (copper, zinc and boron) seed placed during the seeding operation and foliar applied at flower initiation. Granular micronutrients were seed placed while liquid micronutrients were used as foliar applications. Carneval pea was seeded at a target plant population of 80 seeds/m^2 (170 lb/ac) using a 20 cm (8 in) row spacing. Othello pinto bean, Expresso black bean, and Skipper navy bean were row crop seeded at a target plant population of 30 seeds/m^2 (105, 42 and 60 lb/ac) using a 60 cm (24 in) row spacing. The trial utilized a factorial arrangement of the treatments in a randomized complete block design with four replicates. Each treatment measured 2.4 m x 6 m (8 ft X 20 ft).

Current soil test recommendations indicated the soil available micronutrient levels at this site were adequate for irrigated production of pea and dry bean (Table 20).

Table 20. Spring soil analysis for the irrigated pea and dry bean micronutrient fertilizer response trials.

Crop	Depth (in)	pH	1:2 E.C. (dS/m)	NO_3-N	P	K	SO_4-S	Cu	Mn	Zn	B	Fe
				lb/ac								
Pea	0-12	7.8	0.2	31	16	492	8	2.6	95	4.1	3.8	38
	12-24	7.8	0.3	30			8					
Dry Bean	0-12	8.0	0.2	31	20	654	9	2.6	78	3.5	3.9	40
	12-24	8.2	0.2	25			8					

Pea

There was no effect of the micronutrient applications on irrigated Carneval pea yield, seed weight, plant height, days to maturity, or nodulation (Table 21).

Dry Bean

There was little to no growth for the copper seed placed treatment for all three varieties. Obviously the copper was toxic to the germinating seedlings. This treatment was left out of the analysis.

Analysis of variance indicated that there was a treatment effect on dry bean yield for zinc and boron (Table 22). Foliar application was higher yielding than soil application. As well, the mean yield for zinc application was higher than for boron application. However, none of the micronutrient applications were as high as the yield for the control treatment indicating that the micronutrient treatments reduced yield with some treatments causing a greater reduction than others. Dry bean is sensitive to micronutrient applications and care must be taken to prevent toxicity from improper application which can cause a yield reduction due to poor stand establishment or to poor growth.

Seed weight and plant height showed no significant differences due to micronutrient applications. There was no effect on days to 50% flowering or to maturity.

Preliminary indications are that the current soil test guidelines correctly predict the micronutrient requirements of irrigated pea and dry bean. Monitoring of soil fertility through an adequate soil testing program is the best way to determine micronutrient fertilizer requirements.

Table 21. Agronomic data for the Carneval pea micronutrient fertilizer response trial grown under irrigation.

Treatment		Yield		Seed Weight (mg)	Plant Height (cm)	Nodule Rating[1]
Application	Micronutrient	kg/ha	bu/ac			
	Control	4785	71.1	242	96	6
Seed place	Copper	4686	69.6	240	87	6
	Zinc	4767	70.8	244	91	6
	Boron	4727	70.2	240	93	6
Foliar	Copper	4919	73.1	245	93	6
	Zinc	4854	72.1	241	91	6
	Boron	4703	69.8	239	91	6
ANOVA LSD(0.05)		NS[2]		NS	NS	NS

[1] 0 - no N-fixation potential; 8 - fully effective nodulation
[2] not significant

Table 22. Micronutrient source and application effects on yield of Othello pinto bean, Expresso black bean and Skipper navy bean grown under irrigation.

Treatment		Yield					
Application	Micronutrient	Othello		Expresso		Skipper	
		kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
	Control	3463	3086	2122	1891	2980	2655
Seed place	Zinc	3265	2909	2170	1933	2840	2530
	Boron	2793	2489	1096	976	1955	1742
Foliar	Zinc	3150	2807	2343	2088	2734	2436
	Boron	3315	2950	1953	1740	3255	2900

Factorial LSD(0.05)	kg/ha	lb/ac
Variety (V)	219	195
Application (A)	179	159
Source (S)	179	159
V x A	NS[1]	NS
V x S	310	276
A x S	253	225
V x A x S	NS	NS

[1] not significant

Evaluation of Inoculant Formulations for Irrigated Pea and Dry Bean

Funding: Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Co-investigator: F. Walley, Department of Soil Science,
University of Saskatchewan, Saskatoon, Saskatchewan
Progress: Year one
Objective: To compare the effectiveness of seed placed and of sidebanded granular inoculants with peat and liquid inoculants.

Legume inoculants, which contain *Rhizobium* bacteria, are generally applied to the seed coat at seeding to help enhance nitrogen fixation. Inoculants are typically applied as peat based powders or as liquid formulations. Recently, manufacturers have begun to develop and formulate *Rhizobium* inoculants as granules. The granular inoculant can be applied to the soil instead of to the seed, in the same manner that the fertilizer can be applied before, or during the seeding operation. Initial results with dry bean inoculants has indicated better nitrogen fixation and higher yields for the granular formulation applied in the seed row as compared to the peat based formulation. Further work is required to determine application strategies for the granular inoculant formulation.

An inoculant evaluation trial was established in the spring of 1997 at the SIDC. A separate trial was established for each crop. Treatments included two each of liquid, peat, and granular based inoculants, an uninoculated control, and a flax control for determining nitrogen fixation. MicroBio Rhizogen (MBR) and Agrium Biologicals were the liquid sources. MBR and Liphatec were the peat and granular sources used in the study. The liquid and peat based inoculants were applied to the seed just prior to seeding. The granular inoculant treatments included both seed place and side band applications. A granular and peat based pseudomonad in combination with granular inoculant (MBR) seed placed treatments were included in the pea trial. Carneval pea was seeded at a target plant population of 80 seeds/m^2 (170 lb/ac) using a 20 cm (8 in) row spacing. Othello pinto bean was row crop seeded at a target plant population of 30 seeds/m^2 (105 lb/ac) using a 60 cm (24 in) row spacing. The treatments were arranged in a randomized complete block design with four replicates. Each treatment measured 2.4 m x 6 m (8 ft X 20 ft).

There were no trends indicating that any one specific inoculant formulation was superior for irrigated Carneval pea (Table 23). Nitrogen fixation accounted for between 50% and 65% of the nitrogen present in the pea seed (Table 24).

For Othello dry bean no differences were observed in yield for the different inoculant formulations tested (Table 25). The granular inoculants were superior to the liquid inoculants in regards to nitrogen fixation (Table 26). Nitrogen fixation accounted for between 20% and 70% of the nitrogen present in the dry bean seed.

Table 23. Agronomic data for the Carneval pea inoculant formulation evaluation trial grown under irrigation.

Treatment	Yield kg/ha	Yield bu/ac	Seed Weight (mg)	Plant Height (cm)	Nodule Rating[1]
Control	4922	73.1	244	91	3.5
MBR Liquid	4886	72.6	244	95	5.8
Agrium Liquid	4970	73.8	241	95	5.5
MBR Peat	4932	73.2	242	93	4.0
Liphatec Peat	4890	72.6	243	93	5.5
MBR Granular Seed Place	4859	72.2	240	95	5.0
Liphatec Granular Seed Place	4874	72.4	241	96	3.8
MBR Granular Side Band	4986	74.1	239	97	5.5
Liphatec Granular Side Band	4993	74.2	248	98	5.3
MBR Granular + Pseudomonad Granular	4756	70.6	239	94	6.5
MBR Granular + Pseudomonad Peat	4897	72.7	245	91	5.3
ANOVA LSD(0.05)	NS[2]		NS	NS	1.6

[1] 0 - no N-fixation potential; 8 - fully effective nodulation
[2] not significant

Table 24. Nitrogen fixation data for the Carneval pea inoculant formulation evaluation trial grown under irrigation.

Treatment	Seed %N	Seed N Uptake[1] (kg/ha)	Seed N Uptake[1] (lb/ac)	%NDFA ^{15}N Natural Abundance[2]	%NDFA N Uptake[3]
Control	3.07	151	135	52	62
MBR Liquid	3.40	166	148	61	65
Agrium Liquid	2.94	146	130	51	60
MBR Peat	2.88	142	127	49	59
Liphatec Peat	3.10	152	135	42	61
MBR Granular Seed Place	2.59	126	112	58	53
Liphatec Granular Seed Place	3.16	155	138	57	62
MBR Granular Side Band	3.32	166	148	51	65
Liphatec Granular Side Band	2.92	146	130	57	60
MBR Granular + Pseudomonad Granular	2.82	134	119	52	57
MBR Granular + Pseudomonad Peat	2.32	114	102	65	49
ANOVA LSD(0.05)	0.53	28	25	10	9

[1] Seed yield x %N
[2] %N derived from the atmosphere based on ^{15}N natural abundance
[3] %NDFA based on seed N uptake (Pea seed N uptake - Flax seed N uptake), where Flax seed %N = 3.52 and Flax seed yield = 1621 kg/ha (1444 lb/ac)
[4] not significant

Table 25. Agronomic data for the Othello pinto bean inoculant formulation evaluation trial grown under irrigation.

Treatment	Yield kg/ha	Yield lb/ac	Seed Weight (mg)	Plant Height (cm)	Nodule Rating[1]
Control	2889	2574	330	51	6.0
MBR Liquid	2806	2500	340	52	6.8
Agrium Liquid	2973	2649	339	49	7.3
MBR Peat	3024	2694	335	47	6.5
Liphatec Peat	3354	2988	341	48	6.5
MBR Granular Seed Place	3284	2926	348	53	6.0
Liphatec Granular Seed Place	3004	2677	337	49	6.3
MBR Granular Side Band	3286	2928	353	52	6.5
Liphatec Granular Side Band	3102	2764	348	49	4.5
ANOVA LSD(0.05)	NS[2]		13	NS	1.3

[1] 0 - no N-fixation potential; 8 - fully effective nodulation
[2] not significant

Table 26. Nitrogen fixation data for the Othello pinto bean inoculant formulation evaluation trial grown under irrigation.

Treatment	Seed %N	Seed N Uptake[1] (kg/ha)	Seed N Uptake[1] (lb/ac)	%NDFA ^{15}N Natural Abundance[2]	%NDFA N Uptake[3]
Control	2.56	74	66	53	24
MBR Liquid	2.54	72	64	55	20
Agrium Liquid	2.56	76	68	47	26
MBR Peat	2.68	81	72	44	31
Liphatec Peat	2.74	92	82	42	38
MBR Granular Seed Place	2.90	95	85	59	41
Liphatec Granular Seed Place	2.89	87	78	52	34
MBR Granular Side Band	2.77	90	80	61	37
Liphatec Granular Side Band	2.99	93	83	68	39
ANOVA LSD(0.05)	NS[4]	14	12	NS	12

[1] Seed yield x %N
[2] %N derived from the atmosphere based on ^{15}N natural abundance
[3] %NDFA based on seed N uptake (Pea seed N uptake - Flax seed N uptake), where Flax seed %N = 3.52 and Flax seed yield = 1621 kg/ha
[4] not significant

Irrigated Pea Seed Fungicide Treatment x Inoculant Formulation Trial

Funding: Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Progress: Year one
Objective: To evaluate irrigated pea seed fungicide treatment-inoculant interactions.

Soil borne fungi such as *Rhizoctonia, Pythium* and *Fusarium* can cause seed decay and root rot in pulse crops. These diseases can reduce or weaken stands, resulting in lower yields. To counteract these diseases, seed is generally treated with a fungicide prior to seeding. Pulses are capable of fixing a large percentage of their nitrogen requirements provided they are inoculated with specific bacterial *Rhizobium* strains. This inoculant is often applied as a seed coating. There exists the possibility of a negative effect of the fungicide seed treatment on the beneficial *Rhizobium* seed coat inoculant. Applying the inoculant as a granular formulation to the soil may alleviate this potential problem.

An irrigated pea fungicide seed treatment-inoculant formulation trial was established in the spring of 1997 at the SIDC. Treatments included two fungicides, Apron (metalaxyl) and Apron + Thiram (metalaxyl + thiram), plus a control, and two inoculant formulations, liquid and granular, plus a control. The fungicides were applied to the seed in liquid form and allowed to dry. The liquid inoculant formulation was applied to the fungicide treated seed just prior to seeding. The granular inoculant was seed placed during the seeding operation. Carneval pea was seeded at a target plant population of 80 seeds/m^2 (170 lb/ac) using a 20 cm (8 in) row spacing. The trial utilized a factorial arrangement of the treatments in a randomized complete block design with four replicates. Each treatment measured 2.4 m x 6 m (8 ft x 20 ft).

There was no effect of the fungicide-inoculant treatments on yield, seed size, plant stand, plant height, or nodulation for Carneval pea (Tables 27). All treatments appeared healthy with good inoculation through-out the growing season. Applying the inoculant just prior to seeding possibly prevented the fungicide seed treatments from having any detrimental effect on nodulation and plant growth. There was no effect of the fungicide seed treatments or the inoculant formulations when compared to the control treatment.

Table 27. Agronomic data for the Carneval pea fungicide seed treatment-inoculant formulation trial grown under irrigation.

Treatment		Yield		Seed Weight (mg)	Plant Stand (#/m^2)	Plant Height (cm)	Nodule Rating[1]
Fungicide	Inoculant	kg/ha	bu/ac				
Control	Control	4857	72.1	243	70	98	6
	Liquid	4838	71.8	246	70	97	6
	Granular	4814	71.5	245	70	96	7
Apron	Control	4884	72.5	245	72	95	6
	Liquid	4859	72.2	244	69	95	6
	Granular	4890	72.6	244	74	95	7
Apron + Thiram	Control	4877	72.4	245	69	95	6
	Liquid	4803	71.3	244	70	92	6
	Granular	4919	73.0	246	76	95	6
Factorial LSD(0.05)							
Fungicide (F)		NS[2]		NS	NS	NS	NS
Inoculant (I)		NS		NS	NS	NS	NS
F x I		NS		NS	NS	NS	NS

[1] 0 - no N-fixation potential; 8 - fully effective nodulation; [2] not significant

Varietal Evaluations

Prairie Regional Dry Bean Wide-Row Co-operative Test

Funding:	Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigators:	H. Mundel and J. Braun, Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, Alberta
Progress:	Ongoing
Objective:	To evaluate new dry bean germplasm for irrigation under wide row cropping conditions for western Canada.

This project evaluates dry bean germplasm for its adaptation to western Canada. The germplasm sources include advanced lines of entries from Agriculture and Agri-Food Canada Lethbridge Research Centre and Harrow Research Centre, the Crop Development Centre, University of Saskatchewan, and cultivars from private companies. These lines are compared to a standard registered variety within each market class.

An irrigated site was conducted at the SIDC. Normal fertilizer, weed control, and irrigation practices for irrigated dry bean production were followed. All entries were row crop seeded using a 60 cm (24 in) row spacing. The test included 21 entries in a randomized complete block nested design with five bean types (Pinto, Pink, Red Mexican, Great Northern and Dark Red Kidney). Individual plots measured 1.2 m x 3.7 m (4 ft x 12 ft). The entire plot was harvested to determine yield.

Great Northern Bean L94E137 produced the highest overall yield (Table 28). The Pinto, Red Mexican and Pink bean types also had entries that were very high yielding. Lowest yield was produced by the Dark Red Kidney bean types. Earlier flowering and reduced days to maturity as compared to the check varieties are evident in some of the new lines.

Prairie Regional Dry Bean Narrow-Row Co-operative Test

Funding:	Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigators:	A. Vandenberg and A. Slinkard, Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan
Progress:	Ongoing
Objective:	To evaluate new dry bean germplasm for irrigation under narrow row cropping conditions in western Canada.

This project evaluates dry bean germplasm for growing conditions in western Canada. The germplasm sources include advanced lines of entries from Agriculture and Agri-Food Canada Lethbridge Research Centre and from the Crop Development Centre, University of Saskatchewan. These lines are compared to a standard registered variety within each market class.

An irrigated site was conducted at the SIDC. Normal fertilizer, weed control, and irrigation practices for irrigated dry bean production were followed. All entries were seeded using a 20 cm (8 in) row spacing. The test included 35 entries in a lattice design with three replicates. Market classes included Pinto, Pink, Small Red, Great Northern and Navy. A check variety was included for each market class. Individual plots measured 1.2 m x 3.7 m (4 ft x 12 ft). The entire plot was harvested to determine yield.

Several entries in all market classes except Navy produced higher yields than the check varieties (Table 29). The highest overall yield was obtained for the Pink market class entry LE93C2. The Great Northern market class also had entries that were very high yielding. Lowest yield was produced by the Great Northern market class entry 95-40-1W. Earlier flowering, reduced days to maturity, reduced lodging, greater pod clearance and larger seed size compared to the check varieties are evident in some of the new lines.

Table 28. Relative yield and agronomic characteristics for the dry bean wide-row co-operative variety trial.

Variety	Yield %of Othello[1]	Lodging Rating (0 standing; 5 = flat)	Seed Weight (mg)	Plant Height (cm)	Days to 50% Flower	Days to Maturity
Pinto						
Othello (check)	100	3	353	49	50	96
Apache	137	3	373	49	51	100
L94B040	115	2	334	44	49	92
L94B019	107	3	329	49	50	97
Winchester	105	1	355	49	47	94
L94B022	94	1	319	45	49	92
Red Mexican						
NW63 (check)	119	3	309	46	48	99
L94D153	138	3	294	47	46	95
L94D156	131	2	281	54	49	99
L94D186	118	3	308	48	50	95
L94D292	109	3	328	43	48	92
L94D261	107	3	278	53	51	96
L94D312	106	3	297	48	48	95
L94D303	104	3	312	45	47	91
L94D290	102	3	317	48	48	92
Pink						
Viva (check)	127	3	266	53	49	99
L94C274	135	4	297	53	46	93
Great Northern						
US1140 (check)	134	4	326	48	50	100
L94E137	139	4	277	51	50	100
Dark Red Kidney						
Montcalm (check)	78	1	510	48	51	105
HR 49	86	0	550	45	43	100
C.V.%	15.9	17	3.6	10.1	3	1.4

[1]Othello mean yield = 3707 kg/ha (3303 lb/ac)

Table 29. Relative yield and agronomic characteristics for the dry bean narrow-row co-op test.

Variety	Yield % of Othello[1]	Lodging Rating (0 standing; 5 = flat)	Pod Clearance Rating (%)	Seed Weight (mg)	Plant Height (cm)	Days to 50% Flower	Days to Maturity
Pinto							
Othello	100	3	65	345	61	50	96
95-65-6PT	112	1	84	352	60	44	97
C962	111	2	90	354	48	45	90
93708	104	1	94	365	50	47	92
93088	102	2	79	319	60	51	99
L94B010	97	1	75	319	54	43	89
95-12-40PT	95	1	71	350	61	46	92
94138	94	2	90	373	49	47	90
95-60-19PT	88	1	79	306	61	49	95
95-6-1PT	85	1	88	388	49	48	92
95-78-1CAR	80	2	74	352	62	43	89
Great Northern							
US1140	110	4	60	321	53	44	98
93128	121	4	73	374	56	43	95
93407	121	4	81	357	53	50	96
LE93E7	119	0	93	281	61	51	99
LE93E9	107	1	93	301	54	54	100
201-25LL	99	3	85	389	54	44	93
95-14-7W	94	4	88	325	51	48	98
95-40-1W	72	3	66	362	56	46	92
Pink							
Viva	98	3	68	258	61	50	98
LE93C2	129	3	85	301	56	49	91
95-34-6PK	119	4	88	343	62	46	97
93459	108	4	79	265	59	50	99
93318	107	2	83	264	55	46	97
L94C356	101	3	92	312	55	51	90
Small Red							
NW63	99	2	79	300	62	46	97
L94D156	109	2	86	303	57	48	98
L94D007	103	0	66	337	57	44	93
L94D186	102	3	81	322	51	50	94
L94D127	99	3	92	333	53	49	91
93308	94	5	81	313	59	49	92
L94D031	92	1	86	318	58	44	93
Navy							
AC Skipper	101	0	92	217	49	51	96
L94A001	86	1	97	177	50	49	96
92661LL	74	1	92	183	66	54	100
CV%	16		15.1		11.8	7.1	3.8

[1] Othello yield = 4043 kg/ha (3602 lb/ac)

Prairie Regional Pea Co-operative Test A

Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigator: T. Warkentin, Agriculture and Agri-Food Canada Morden Research Centre, Morden, Manitoba
Progress: Ongoing
Objective: To evaluate new pea germplasm for irrigation cropping conditions in western Canada.

This project evaluates pea germplasm for growing conditions in western Canada. The germplasm sources include advanced lines of later maturing entries from Agriculture and Agri-Food Canada Morden Research Centre and from the Crop Development Centre, University of Saskatchewan, as well as cultivars introduced from Europe. These lines are compared to several standard green and yellow pea varieties registered for western Canada.

An irrigated site was conducted at the SIDC. Normal fertilizer, weed control, and irrigation practices for irrigated pea production were followed. The test included 31 candidate cultivars and five checks. The checks were Carrera, Carneval, Grande, Montana, and Keoma. Tests were arranged in a randomized complete block design with three replicates. Individual plots measured 1.2 m x 3.7 m (4 ft X 12 ft). All rows of a plot were harvested to determine yield.

Carneval was the highest yielding check cultivar (Table 30). Seven new yellow cultivars out yielded Carneval while three new cultivars were equal in yield to Carneval. All green cultivars yielded less than Carneval. Seven new green cultivars had yields higher than Keoma. Two new yellow cutivars, CDC9708 and SW93574, showed lodging similar to Carneval while one new green cultivar, SW93618, had equal to or superior lodging tolerance to Carneval. All other green cultivars had a relatively poor lodging rating.

Prairie Regional Lentil Co-operative Test

Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigators: A. Slinkard and A. Vandenberg, Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan
Progress: Ongoing
Objective: To evaluate new lentil germplasm for irrigated cropping conditions in western Canada.

This project evaluates lentil germplasm for growing conditions in western Canada. The germplasm sources include advanced lines of entries from the Crop Development Centre, University of Saskatchewan. These lines are compared to standard varieties registered for western Canada.

An irrigated site was conducted at the SIDC. Normal fertilizer, weed control and irrigation practices for irrigated lentil production were followed. The test included 24 entries in a randomized complete block design with three replicates. Market classes evaluated included small yellow (4), large yellow (9), medium yellow (6), and red (5). Individual plots measured 1.2 m x 3.7 m (4 ft x 12 ft). All rows of a plot were harvested to determine yield.

Table 30. Relative yield and agronomic characteristics for the Pea Co-op A test.

Variety[1]	Yield % of Carneval[2]	Lodging (1=erect; 9=flat)	Vine Length (cm)	Days to Flower	Days to Maturity	Seed Weight (mg)
Yellow						
Carneval (SL)	100	3	95	57	96	234
CDC9705 (SL)	108	7	89	52	93	247
CDC9703 (SL)	107	6	100	61	96	230
CDC9708 (SL)	106	4	108	56	98	233
Ceb1440 (SL)	104	8	78	49	90	321
MP 1466 (SL)	104	9	87	58	93	285
4-0359.016 (SL)	102	5	117	56	93	247
MP 1382 (SL)	101	9	85	56	94	286
CDC9701 (SL)	100	7	99	52	95	211
CDC9706 (SL)	100	6	104	58	97	219
MP 1373 (SL)	100	9	90	55	95	247
CDC9709 (SL)	99	6	107	54	97	206
4-0305.035 (SL)	96	8	108	59	97	189
CDC9707 (SL)	96	8	82	57	99	266
4-9279 (SL)	96	8	105	54	99	265
SW93574 (SL)	94	3	90	51	92	260
Bridge (SL)	93	9	95	56	97	287
Carrera (SL)	93	8	77	49	92	274
Ceb1452 (SL)	92	8	78	49	88	271
Montana (SL)	92	9	78	49	91	286
MP 1396 (SL)	89	9	91	53	93	257
Mor 2648 (N)	86	7	85	49	93	353
MP 1338 (N)	79	8	103	61	96	215
Grande (N)	74	6	107	58	97	225
CRPF6 (SL)	71	7	89	58	101	213
Green						
1LP (SL)	94	6	101	53	99	275
SW93605 (SL)	94	6	91	57	100	205
MP 1170 (N)	90	9	81	53	99	304
LW88173 (SL)	88	5	88	56	98	269
MP 1407 (SL)	87	9	82	56	99	291
CDC9702 (SL)	85	8	94	58	100	272
CDC963 (SL)	84	8	89	56	98	240
Keoma (SL)	83	8	80	53	96	196
CDC961 (SL)	81	6	98	57	102	211
SW93618 (SL)	72	2	83	53	98	309
MP 1224 (N)	67	8	71	56	102	275
C.V.%	7.8	16.7	7.8	1.6	2.7	

[1] (SL) = Semi-leafless; (N) = Regular leaf-type

[2] Carneval yield = 8926 kg/ha (133 bu/ac)

The new entries were compared with standard cultivars in the respective market classes. Some new entries significantly out performed the check cultivars (Table 31). Small yellow entries 634, 512-2 (CDC Milestone), and 800-21 yielded higher than Eston. The check CDC Redwing was the highest yielding small red lentil. Large yellow entries 804-3, 652, 578-28, 752-19, 752-37, 532-1 and 523-11 out yielded Laird. Six lines had seed weight higher than that of Laird. The highest yielding entry overall was the medium yellow entry 638-8.

Table 31. Relative yield and agronomic characteristics for the lentil co-operative test.

Variety	Yield % of Eston[1]	Seed Weight (mg)	Canopy Height (cm)	Days to Flower	Days to Maturity
Small Yellow					
Eston	100	36	38	56	90
512-2	104	38	36	56	89
800-21	105	37	42	60	89
634	120	32	41	56	92
Large Yellow					
Laird	96	68	46	61	91
578-28	121	63	42	60	92
523-11	106	71	44	57	92
532-1	107	64	42	57	91
804-3	128	71	43	57	91
752-37	114	72	40	59	93
752-19	121	80	40	56	92
735-1	96	71	43	57	92
652	126	71	47	60	93
Medium Yellow					
Richlea	131	52	44	56	93
638-23	129	54	39	56	90
638-8	152	51	37	56	90
639-28	139	50	40	57	90
637-50	122	54	42	56	90
638-3	124	54	43	56	91
Red					
Redwing	127	38	40	56	90
502-44	102	40	37	56	90
B-15	120	32	39	56	90
800-56	108	37	38	56	89
803-18	101	37	36	56	91
CV%	16.5		9	2.8	1.8

[1]Eston yield = 2825 kg/ha (2517 lb/ac)

Prairie Regional Faba Bean Co-operative Test

Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)

Co-investigators: A. Slinkard and A. Vandenberg, Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan

Progress: Ongoing

Objective: To evaluate new faba bean germplasm for irrigated cropping conditions in western Canada.

This project evaluates faba bean germplasm for growing conditions in western Canada. The germplasm sources include advanced lines from the Crop Development Centre, University of Saskatchewan, as well as cultivars from European breeding programs. These lines are compared to standard varieties registered for western Canada.

An irrigated site was conducted at the SIDC. Normal fertilizer, weed control and irrigation practices for irrigated faba bean production were followed. The test included 12 entries in a randomized complete block design with three replicates. Individual plots measured 1.2 m x 3.7 m (4 ft x 12 ft). The entire plot was harvested to determine yield.

The new line TWY89-72 had the highest overall yield (Table 32). Several other lines produced higher yields, larger seed size, and shorter plants than CDC Fatima.

Table 32. Relative yield and agronomic charateristics for the faba bean co-operative test.

Variety	Yield % of CDC Fatima[1]	Plant Height (cm)	Basal Pod Height (cm)	Days to 50 % Flower	Days to Maturity	Seed Weight (mg)
CDC Fatima	100	134	40	54	108	532
TWY89-72	132	126	35	51	115	593
702/hy-6	130	128	38	51	114	831
TWY92-35	126	133	37	56	118	472
TWY89-45	125	119	35	56	114	563
DO	123	122	27	51	118	695
Divine	109	123	32	56	115	609
(9x7)(1)(10)	108	127	31	51	116	571
AGC	101	127	35	51	115	405
GSx(1)(8)	94	133	46	55	114	485
Pegasus	92	138	34	56	114	598
CDC Blitz	91	131	32	56	115	548
CV%	17	6.1	21.6	4.5	3.3	

[1]CDC Fatima yield = 3609 kg/ha (3216 lb/ac)

Regional Adaptation of Pulse Crops

Funding: Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Progress: Year one
Objective: To demonstrate a variety of pulse crop types in large plots, determining relative performance in the irrigated area of Saskatchewan.

Pulse crops are an important part of the rotation. They fix a large proportion of their own nitrogen requirements and they help to break up the disease cycle of other crops. Variety evaluation is important to determine the best crop type for a given agroecological region.

A pulse crop variety demonstration was established at the SIDC in the spring of 1997. The pulse crop types used in the demonstration included dry bean, pea, fababean, lentil and chickpea. Six dry bean, five pea and two each of fababean, lentil and chickpea varieties were used in the demonstration. Separate tests were conducted for each pulse crop type due to differences in water use and irrigation requirements. The dry bean varieties were row crop cultivated using 60 cm (24 in) row spacing while all other pulse crops were solid seeded using a row spacing of 25 cm (10 in).

Dry Bean

Expresso was the first variety to reach 50% flowering with little difference among the other varieties (Table 33). The black bean required a longer period to reach maturity than the other dry bean classes. All varieties of dry bean showed excessive growth of foliage throughout the growing season probably due to the high levels of available nitrogen present in the soil. Yield was in order of pinto> black> great northern, and was probably partly influenced by the presence of sclerotinia. The great northern dry bean which had the greatest extent of sclerotinia damage also had the most excessive growth of foliage and lodged to a greater extent than the other dry bean classes. There was a greater variability in the yield for the great northern dry bean than the other dry bean classes probably due to the spotty effect of the sclerotinia.

Table 33. Irrigated dry bean adaptation variety trial agronomic data.

Variety	Days to 50% Flowering	Days to Maturity	Pod Clearance Rating (%)	Plant Height (cm)	Lodge Rating (0=erect 5=flat)	Yield @ 16% Moisture		Seed Weight (mg)
						kg/ha	lb/ac	
Pinto								
CDC Camino	51	96	98	53	2	2740	2441	331
Othello	49	96	57	45	3	2699	1405	328
Black								
Expresso	45	100	98	51	0	2638	2350	153
UI 906	52	100	96	52	0	2531	2255	149
Great Northern								
Nordic	50	94	88	50	4	2363	2105	327
US 1140	47	98	75	48	5	2380	2121	300
S.E.	1	1	4	1		102	91	20
CV (%)	27.2	2.7	18.4	7.4		16.8	16.8	31.7

Pod clearance rating, an indicator of suitability for direct cut harvesting, varied among dry bean classes as well as between varieties within a class. Black bean had the best overall pod clearance. The newly registered pinto bean variety CDC Camino also had a pod clearance rating equivalent to that of the black bean and was much superior to that of Othello, the pinto bean variety generally recommended for irrigated production.

Pea

Ascona and Profi were the earliest flowering varieties with little difference among the other three (Table 34). Profi was the earliest while Grande was the last of the varieties to mature. Powdery mildew and mycosphaerella was present on all varieties, with Keoma and Grande being infected to the greatest extent. The green pea varieties were the shortest and lodged to the greatest extent. The two yellow pea varieties Profi and Carneval stood up the best of all varieties throughout the growing season. Yield was greater for the green as compared to the yellow pea varieties. Grande had the lowest yield of all pea varieties.

Table 34. Irrigated pea adaptation variety trial agronomic data.

Variety	Days to 10% Flowering	Days to Maturity	Plant Height (cm)	Lodge Rating (0=erect 5=flat)	Yield @ 16% Moisture		Seed Weight (mg)
					kg/ha	bu/ac	
Green							
Keoma	54	91	78	5	5415	80.4	212
Ascona	51	92	77	5	5581	82.9	223
Yellow							
Carneval	55	92	92	3	4899	72.8	193
Grande	55	94	85	4	3915	58.1	194
Profi	51	88	100	2	4863	72.2	232
S.E.	1	1	3		268	4	7
CV (%)	8.6	3.7	14.3		21	21	12.1

Fababean

There was no difference between the two varieties for flowering date. Days to maturity was higher for Aladin than Fatima (Table 35). Chocolate spot disease was present to the same extent on both varieties. Aladin grew taller and produced initial pods higher on the stem than Fatima. Initial pods higher on the stem is a desirable characteristic for swathing. Yield was greater for Fatima probably due to larger seed size.

Table 35. Irrigated fababean adaptation variety trial agronomic data.							
Variety	Days to 50% Flowering	Days to Maturity	Basal Pod Height (cm)	Plant Height (cm)	Yield @ 16% Moisture		Seed Weight (mg)
					kg/ha	lb/ac	
Aladin	57	120	45	157	3448	3072	390
Fatima	57	114	42	145	4277	3811	518
S.E.		1	5	8	287	256	29
CV (%)		2.8	27.4	12.1	18.2	18.2	15.5

Lentil

There was no difference between Eston and Richlea for time to flowering or maturity (Table 36). Richlea, a medium yellow lentil, grew taller than Eston, a small yellow type lentil. Yield was higher for Richlea than Eston probably due to the difference in seed weight.

Chickpea

Sanford, a kabuli type chickpea, had a longer growing season than Myles, a desi type chickpea, as indicated by the time to reach 50% flowering and maturity (Table 37). Sanford was taller than Myles and also had larger pods, an indication of the difference in seed size for the two chickpea types. Yield was higher for Myles than Sanford. Sanford had a larger seed size than Myles, thus the yield difference was due to a larger number of seeds produced for Myles.

Table 36. Irrigated lentil adaptation variety trial agronomic data.						
Variety	Days to 25% Flowering	Days to Maturity	Plant Height (cm)	Yield @ 14% Moisture		Seed Weight (mg)
				kg/ha	lb/ac	
Eston	56	83	38	2661	2371	34
Richlea	56	83	42	2956	2634	52
S.E.			1	68	61	4
CV (%)			6.4	6	6	22.7

Table 37. Irrigated chickpea adaptation variety trial agronomic data.						
Variety	Days to 50% Flowering	Days to Maturity	Plant Height (cm)	Yield @ 16% Moisture		Seed Weight (mg)
				kg/ha	lb/ac	
Desi						
Myles	55	102	41	3921	3494	206
Kabuli						
Sanford	59	113	54	3296	2937	502
S.E.	1	3	3	170	151	12
CV (%)	3.8	5.6	15.3	11.5	11.5	15.3

Dry Bean and Chickpea Regional Variety Trial

Funding: Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Co-investigator: A. Vandenberg, Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan
Progress: Year one
Objective: To assess the dry bean and chickpea production potential of targeted environments within Saskatchewan using current and newly released varieties.

The potential for development of the dry bean and chickpea sectors of Saskatchewan's pulse industry has been limited by the lack of adapted varieties. Adapted breeding lines from the Crop Development Centre (CDC), U of S, Saskatoon, Saskatchewan, are at the stage of recommendation for registration. The next step in the development process is regional testing of new varieties. Regional performance trials provide information on the various production regions available in Saskatchewan to assess productivity and risk. This information is used by extension personnel, pulse growers, and researchers across Saskatchewan to become familiar with these new pulse crops.

Regional variety trials were established in the spring of 1997 at the SIDC located on the SW15-29-08-W3 and at Riverhurst located on the SE27-22-07-W3 for irrigated dry bean and at Riverhurst located on the NE27-22-07-W3 for dryland chickpea. Separate trials were run for dry bean under wide row (60 cm/24 in) and narrow row (20 cm/8 in) cropping conditions. Chickpea was seeded using narrow rows. The variety treatments were arranged in a randomized complete block design with three replicates. Each treatment measured 1.2 m x 3.7 m (4 ft x 12 ft).

Dry Bean

Yield for the dry bean plots was greater for the Outlook site compared to the Riverhurst site (Table 38). The Riverhurst site did not receive adequate irrigation and had problems with volunteer cereal and disease. Similar trends were evident for the various varieties at both sites. The pinto bean variety, Othello, yielded higher under wide row compared to narrow row conditions. All other pinto varieties showed similar yields for the two row spacings. Yields were similar among the pinto varieties except for Earliray which had the lowest overall yield. For the Great Northern bean varieties, the new variety 92074 had the highest yield followed in order by US 1140 and Nordic. For the Navy bean varieties, AC Skipper yielded higher than GTS 523.

Table 38. Irrigated dry bean regional variety trial - yield.

Variety	Narrow Row		Wide Row	
	Outlook	Riverhurst	Outlook	Riverhurst
	Yield (% Othello)[1]			
Pinto				
Othello	100	100	100	100
Earliray	95	85	73	69
AC Burrito	118	97	88	99
92121 (CDC Camino)	104	117	87	86
92802-Type III	98	93	83	88
92235	116	103	90	95
92021	121	97	82	88
Great Northern				
US 1140	119	99	88	91
92070 (CDC Nordic)	96	89	83	76
92074	135	101	96	118
Navy				
AC Skipper	117	81	77	94
GTS 523	105	65	77	60
CV (%)	10.1	16.2	8.5	16.1

[1]Yield Othello: Outlook Narrow = 3271 kg/ha (2914 lb/ac)
Riverhurst Narrow = 1601 kg/ha (1426 lb/ac)
Outlook Wide = 4404 kg/ha (3924 lb/ac)
Riverhurst Wide = 1811 kg/ha (1614 lb/ac)

All bean varieties required around 50 days to flower (Table 39). Some varieties were two to three days earlier than other varieties.

The new pinto variety 92802-III matured the earliest followed closely by Earliray (Table 40). These two varieties were 7-10 days earlier than the later maturing varieties.

Pod clearance varied among the varieties (Table 41). Some of the newer pinto varieties had better pod clearance than Othello. The same was found for the Great Northern varieties where the two new varieties Nordic and 92074 had better pod clearance than US 1140. Both Navy varieties had good pod clearance with AC Skipper superior to GTS 523.

Table 39. Irrigated dry bean regional variety trial - days to flower.

Variety	Narrow Row			Wide Row		
	Outlook	Riverhurst	Mean	Outlook	Riverhurst	Mean
	Days to Flower					
Pinto						
Othello	53	53	53	49	53	51
Earliray	49	51	50	49	51	50
AC Burrito	49	55	52	50	55	53
92121 (CDC Camino)	53	51	52	52	50	51
92802-Type III	45	50	48	45	53	49
92235	52	54	53	52	53	53
92021	52	53	53	52	53	53
Great Northern						
US 1140	47	50	49	47	53	50
92070 (CDC Nordic)	50	50	50	50	51	51
92074	50	53	52	49	56	53
Navy						
AC Skipper	51	55	53	50	55	53
GTS 523	49	52	51	49	51	50
S.E.	0.4	0.4		0.3	0.3	
CV (%)	5.1	4.5		4.1	3.8	

Table 40. Irrigated dry bean regional variety trial - days to maturity.

Variety	Narrow Row			Wide Row		
	Outlook	Riverhurst	Mean	Outlook	Riverhurst	Mean
	Days to Maturity					
Pinto						
Othello	53	53	53	49	53	51
Earliray	49	51	50	49	51	50
AC Burrito	49	55	52	50	55	53
92121 (CDC Camino)	53	51	52	52	50	51
92802-Type III	45	50	48	45	53	49
92235	52	54	53	52	53	53
92021	52	53	53	52	53	53
Great Northern						
US 1140	47	50	49	47	53	50
92070 (CDC Nordic)	50	50	50	50	51	51
92074	50	53	52	49	56	53
Navy						
AC Skipper	51	55	53	50	55	53
GTS 523	49	52	51	49	51	50
S.E.	0.5	0.9		0.5	1	
CV (%)	3.2	5.5		3	6.1	

Table 41. Irrigated dry bean regional variety trial - pod clearance.						
Variety	Narrow Row			Wide Row		
	Outlook	Riverhurst	Mean	Outlook	Riverhurst	Mean
	Pod Clearance (%)					
Pinto						
Othello	99	94	97	96	100	98
Earliray	91	92	92	92	93	93
AC Burrito	94	97	96	94	100	97
92121 (CDC Camino)	98	94	96	96	100	98
92802-Type III	92	82	87	91	89	90
92235	99	97	98	98	100	99
92021	95	94	95	96	94	95
Great Northern						
US 1140	96	94	95	96	94	95
92070 (CDC Nordic)	96	94	95	94	94	94
92074	95	94	95	96	103	100
Navy						
AC Skipper	94	100	97	92	103	98
GTS 523	92	100	96	91	100	96
S.E.	2	2		2	3	
CV (%)	17	17.2		17.9	22.3	

Seed weight was generally of the order pinto > great northern > navy (Table 42). The new pinto variety 92802-III had the highest seed weight while AC Burrito had the lowest seed weight of the pinto varieties. The new great northern variety 92074 also had a high seed weight similar to 92802-III. The seed weight for the navy varieties was considerably lower than the other varieties.

Table 42. Irrigated dry bean regional variety trial - seed weight.						
Variety	Narrow Row			Wide Row		
	Outlook	Riverhurst	Mean	Outlook	Riverhurst	Mean
	Seed Weight (mg)					
Pinto						
Othello	356	316	336	392	361	377
Earliray	390	351	371	410	390	400
AC Burrito	333	304	319	336	312	324
92121 (CDC Camino)	344	307	326	381	338	360
92802-Type III	427	352	390	456	391	424
92235	387	321	354	408	376	392
92021	392	305	349	381	356	369
Great Northern						
US 1140	341	279	310	350	309	330
92070 (CDC Nordic)	371	331	351	369	319	344
92074	424	345	385	423	388	406
Navy						
AC Skipper	206	251	229	202	236	219
GTS 523	159	150	155	156	163	160
S.E.	0.6	1.3		2.2	2.5	
CV (%)	8.7	18.8		17.9	22.3	

Plant height was similar for all varieties except GTS 523 and Earliray which were the shortest (Table 43).

Table 43. Irrigated dry bean regional variety trial - plant height.						
Variety	Narrow Row			Wide Row		
	Outlook	Riverhurst	Mean	Outlook	Riverhurst	Mean
	Plant height (cm)					
Pinto						
Othello	63	55	59	58	54	56
Earliray	88	80	84	77	60	69
AC Burrito	73	80	77	70	69	70
92121 (CDC Camino)	90	78	84	90	81	86
92802-Type III	65	69	67	65	81	73
92235	72	75	74	73	58	66
92021	73	58	64	76	64	70
Great Northern						
US 1140	63	69	66	53	63	58
92070 (CDC Nordic)	88	66	77	70	81	75
92074	89	76	83	80	71	76
Navy						
AC Skipper	77	86	82	90	91	91
GTS 523	90	59	75	63	91	77

<u>Chickpea</u>

No yield data was available for the chickpea variety trial due to wildlife damage. Days to flower and maturity as well as plant height indicated the kabuli varieties were later maturing and taller than the desi varieties (Table 44).

Table 44. Chickpea regional variety trial agronomic data.			
Variety	Days to Flower	Days to Maturity	Plant Height (cm)
Kabuli			
Sanford	52	96	55
Dwelley	56	103	51
B-90	53	94	49
92037-26	53	103	53
92066-25	53	103	50
92015-15	49	96	51
92-9-2K	53	96	46
Desi			
Myles	48	92	41
Indian 20	53	92	38
92040-10	48	90	39
S.E.	0.5	1.0	1.2
CV (%)	5.0	5.6	12.8

Performance of Pea Cultivars Under Irrigated Conditions

Principal: R.B. Irvine, Saskatchewan Irrigation Development Centre
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Locations: Birsay, Dundurn, and Outlook
Progress: Ongoing
Objective: To determine the relative performance of pea cultivars.

Trials were three replicate randomized complete block designs. Plots contained six rows 4.0 m (13.1 ft) long with 25.4 cm (10 in) row spacings. Seeding dates were May 7, 12, and 14 for Outlook, Birsay, and Dundurn, respectively. The seeding rate was a constant 75 seeds/m^2 but as can be seen from the table this results in seeding rates ranging from 1.8 bu/ac to 3.7 bu/ac. Thus seed size is critical when setting the seeder to obtain an adequate plant population. Improper seeding rates may result in an additional $20-30/ac cost for seed.

Over the three sites, a large number of cultivars outyielded Radley by 20-30%.

Table 1. Yield and agronomic traits of pea cultivars under irrigation.

Variety	Seed Rate (bu/ac)	Seed Yield % of Grande			Height (cm)			Lodging (1-9)			Seed Weight (mg)			Days to Mature
		Bir	Dun	Out	Bir	Dun	Out	Bir	Dun	Out	Bir	Dun	Out	Out
Grande (kg/ha)		4317	2283	3524										
Grande (bu/ac)		64	34	52										
4-9247	2.8	77	132	106	83	85	74	1.7	3.3	5.0	260	234	260	101
Alfetta	3.7	83	139	119	80	80	75	2.0	3.7	5.3	291	228	302	100
Ascona	3.0	98	120	126	83	79	66	3.3	3.3	1.7	294	219	296	100
Canis	2.8	108	129	112	107	91	85	1.0	1.7	2.3	249	190	247	108
Carneval	2.6	94	150	110	102	95	84	1.0	1.3	1.3	229	191	229	110
Carrerra	3.3	80	132	110	78	76	74	2.0	5.0	5.3	282	230	284	100
CPB Concorde	3.4	72	134	99	85	84	74	7.3	9.0	8.7	283	224	276	100
CPB Phantom	2.1	98	110	124	83	75	70	3.7	4.0	6.3	305	229	292	102
Eiffel	3.4	81	153	124	93	83	76	2.0	2.3	3.7	309	245	307	100
Explorer	3.4	87	113	108	100	80	86	2.3	6.0	5.3	253	207	224	110
Grande	2.6	100	100	100	93	90	94	3.3	5.3	5.7	233	180	208	110
Keoma	1.8	104	110	97	77	79	72	2.3	4.3	8.7	231	178	212	100
Lantra	3.6	74	109	104	94	87	77	1.0	2.7	3.0	341	246	297	105
Majorett	2.9	60	140	107	97	91	81	1.0	3.0	2.0	265	217	255	103
Mandy	2.7	82	112	114	93	89	77	1.0	3.7	4.0	298	232	278	103
Narva	2.7	91	129	116	103	90	89	2.0	5.3	6.7	294	201	254	110
Obelisque	3.2	94	118	116	88	90	73	2.0	3.3	7.3	321	227	307	103
Olvin	2.8	74	119	95	89	86	82	4.7	7.3	8.3	292	196	267	111
P41G-9	2.2	59		76	93		85	6.7		6.0	163	155	145	113
Profi	2.9	90	155	114	102	93	93	1.0	4.7	2.3	251	219	256	100
Radley	2.6	59	114	96	88	84	80	2.7	7.3	6.7	195	159	174	111
Tenor	3.1	118	118	123	93	95	83	2	2.3	6.3	273	197	259	101
LSD		20	28	22	11	10	11	2.9	3.3	2.9	19	32	26	2.9

Bir=Birsay Dun=Dundrun Out=Outlook; Lodging 1=good 9=poor

Effect of Disease Control and Direct Seeding on Pea Lodging and Yield under Irrigated Conditions

Principal: R.B. Irvine, Saskatchewan Irrigation Development Centre
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Location: Outlook
Progress: One year only
Objective: To determine if direct seeding combined with disease control will reduce lodging by reducing mycosphaerella infection.

Carneval pea was planted May 12 at 80 seeds/m^2 (2.6 bu/ac) on durum wheat stubble. Plots were 3 m x 6 m (9.8 ft x 19.6 ft). Straw had been baled off the entire area. After the pea crop was planted, wheat straw was applied at 3 t/ac to specific treatments in both the direct seeded and conventional till plots. Bravo 500 was applied to both conventionally tilled and direct seeded areas on July 8 (start of flowering) at 1 L/ac.

Seed yields were higher under direct seeding than with conventional seeding (Table 1). Higher yields obtained under direct seeding could not be accounted for by mycosphaerella infection levels on leaves or stems since there was no difference in infection levels between the tillage treatments. Direct seeding without disease control increased yields by 9%, while the combination of direct seeding and Bravo increased yields by 20% (14.6 bu/ac). The higher yields with direct seeding can not be attributed to soil moisture conservation since the crop was irrigated with a centre pivot. In 1993, direct seeded pea outyielded conventional seeded pea on wheat stubble (straw removed) by 7%. There has been no tillage effect in a pea-canola rotation.

Table 1. Effects of seeding method and disease control on the yield and agronomic performance of pea under irrigation.

Treatment	Lodging (1-9)	Height (cm)	Mycosphaerella rating (0-9)				Seed Yield		Seed Weight (mg)
			stem	lower leaves	middle leaves	upper leaves	kg/ha	bu/ac	
Tillage									
Conventional	2.9	90	2.2	2.3	4.2	7.7	5224	77.5	230
Direct Seed	2.9	90	2.2	2.7	4.5	7.7	5712	84.7	225
Disease control									
None	3.4	87	2.4	3.0	5.7	8.6	5166	76.6	231
Bravo	1.9	92	2.2	2.6	3.1	7.0	5698	84.5	222
Straw Mulch	3.5	92	2.0	2.0	4.3	7.6	5542	82.2	230
Analysis of Variance									
Tillage	ns	ns	ns	ns	ns	*	0		ns
Disease control	ns	ns	ns	0.81	0.97	0.61	476		ns
Till Dis	ns	ns	ns	ns	ns	ns	ns		ns

( ) numbers in brackets are LSD for this factor
* significant difference with only two levels therefore LSD is not required
Lodging: 1=good 9=poor
Mycosphaerella rating (0-9): 0= no infection 9=complete infection

Bravo controlled leaf disease on the upper portion of the canopy. The straw covering of the soil also reduced leaf infection levels. Covering the soil with straw reduced infection on the lower leaves to a greater degree than Bravo, since these leaves were formed earlier. The straw may act to reduce infection levels by reducing soil splash onto the leaves and stems. Bravo reduced lodging but the reason for this reduction is not clear from the data collected. The working hypothesis of this study was that stem infection by mycosphaerella would be reduced but our data did not support this.

Tillage system or fungicide application had no effect on seed size.

Weed Control in Special Crops

Principal: R.B. Irvine, Saskatchewan Irrigation Development Centre
Funding: Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Location: Outlook
Progress: Year one of five
Objective: To determine the tolerance of special crops to various herbicide treatments.

None of these treatments are currently registered and should not be used on commercial fields.

Pinto Bean

Study Description
Seeding date: May 26
Seeding rate: 30 seeds/m^2 (95 lb/ac)
Row spacing: 25 cm (10 in)
Application volume: 100 L/ha (40 L/ac)
Date of Edge application: May 25, rotovated to a depth of 8 cm (3 in) to incorporate
Date of Odyssey application: June 17

Results and Conclusions
Crop tolerance to both products was good. The control of broadleaf weeds (variable in the plot) was better with Odyssey resulting in higher yields for these treatments.

Great Northern Bean

Study Description
Seeding date: May 26
Seeding rate: 30 seeds/m^2 (85 lb/ac)
Row spacing: 25 cm (10 in)
Application volume: 100 L/ha (40 L/ac)
Date of herbicide application: June 17

Results and Conclusions
Odyssey produced higher yields than Select treatments due to superior control of broadleaf weeds. Broadleaf weed populations were low and variable but in dry bean a single weed can be very competitive. Crop tolerance to both products was excellent.

Black Bean

Study Description
Seeding date: May 26
Seeding rate: 30 seeds/m^2 (40 lb/ac)
Row spacing: 25 cm (10 in)
Application volume: 100 L/ha (40 L/ac))
Date of herbicide applications: June 17 for all products

Results and Conclusions
Odyssey treatments led to higher yields than Select treatments due to superior control of broadleaf weeds. Broadleaf weed populations were low and variable, but in dry bean a single weed can be very competitive. Crop tolerance to both products was excellent.

Kabuli Chickpea: Pre-emergence Herbicides

Study Description
Seeding date: May 23
Seeding rate: 40 plants/m^2 (175 lb/ac)
Row spacing: 25 cm (10 in)
Application volume: 100 L/ha (40 L/ac)
Date of herbicide applications: Edge May 22, rotovated to a depth of 8 cm (3 in) to incorporate
Odyssey May 22, preplant with no incorporation

Results and Conclusions
Odyssey, applied preplant, caused stunting and yield loss. Edge provided superior control of volunteer canary seed with no crop damage.

Kabuli Chickpea: Post-emergence Herbicides

Study Description
Seeding date: May 23
Seeding rate: 40 plants/m^2 (175 lb/ac)
Row spacing: 25 cm (10 in)
Application volume: 100 L/ha (40 L/ac)
The entire plot received a preplant application of Edge and all but the Select plots an application of Select to control grassy weeds which were not controlled by the Edge.
Date of herbicide applications: Sencor 2 node: June 3
Sencor 4 node: June 9
Select: June 9
Dessicant: Reglone Pro at 30% seed moisture

Results and Conclusions
Application of Sencor at the four node stage caused stunting and delayed maturity 20 days. Other treatments, including the early application of Sencor had acceptable crop tolerance.

Desi Chickpea: Pre-emergence Herbicides

Study Description
Seeding date: May 23
Seeding rate: 40 plants/m^2 (75 lb/ac)
Row spacing : 25 cm (10 in)
Application volume: 100 L/ha (40 L/ac)
Date of herbicide applications: Edge: May 22, rotovated to a depth of 8 cm (3 in) to incorporate
Odyssey: May 22, preplant with no incorporation

Results and Conclusions
Both products had acceptable crop tolerance. The lower yields of the Odyssey plots was the result of inferior control of canary seed.

Desi Chickpea: Post-emergence Herbicides

Study Description
Seeding date: May 23
Seeding rate: 40 plants/m^2 (75 lb/ac)
Row spacing: 25 cm (10 in)
The entire plot received a preplant application of Edge and all but the Select plots an application of Select to control grassy weeds which were not controlled by the Edge.
Application volume: 100 L/ha (40 L/ac)
Date of herbicide applications: Sencor 2 node: June 3
Sencor 4 node: June 9
Select: June 9
Dessicant: Reglone Pro at 30% seed moisture

Results and Conclusions
Application of Sencor at the four node stage caused stunting and delayed maturity 20 days. Other treatments including the early application of Sencor had acceptable tolerance.

Sunflower

Study Description
Seeding date: May 23
Plant population: 2 plants/m^2 (8000 plants/ac)
Row spacing: 60 cm (24 in)
Application volume: 100 L/ha (40 L/ac)
Date of herbicide application: June 9

Results and Conclusions
Sunflower showed excellent tolerance to Select.

Borage

Study Description
Seeding date: May 20
Seeding rate: 10 kg/ha (9 lb/ac)

Row spacing: 25 cm (10 in)
Application volume: 100 L/ha (40 L/ac)
Date of herbicide application: June 17

Results and Conclusions
Borage was damaged by both Assert and Lontrel; yields were low due to shattering.

Canary Seed

Study Description
Seeding date: May 20
Seeding rate: 400 seeds/m^2 (23 lb/ac)
Row spacing: 25 cm (10 in)
Application volume: 100 L/ha (40 L/ac)
Date of herbicide application: June 21

Results and Conclusions
Both Refine and Attain caused significant damage to canary seed. The yields were lower than the weedy check.

Caraway

Study Description
Seeding date: May 20
Seeding rate: 10 kg/ha (9 lb/ac)
Row spacing: 25 cm (10 in)
Application volume: 100 L/ha (40 L/ac)
Date of herbicide application: June 21

Results and Conclusions
Crop tolerance to Select and Select plus Linuron was good. Yields will be obtained in 1998 as the biennial form of caraway was underseeded with coriander.

Coriander

Study Description
Seeding date: May 20
Seeding rate: 14 kg/ha (12.5 lb/ac)
Row spacing: 25 cm (10 in)
Application volume: 100 L/ha (40 L/ac)
Date of herbicide application: June 21

Results and Conclusions
Crop tolerance to Select and Select plus Linuron was good. Linuron controlled volunteer canola and thus treatments involving the tank mix had higher yields. When the canola was not controlled competition reduced coriander yields to the same level as the weedy check. Yields in this trial were lower than expected.

Fenugreek

Study Description
Seeding date: May 20
Seeding rate: 80 seeds/m^2 (15 lb/ac)
Row spacing: 25 cm (10 in)
Application volume: 100 L/ha (40 L/ac)
Date of herbicide application: Odyssey and Edge: applied May 19. Edge was incorporated to 8 cm (3 in) while Odyssey was not. Other products were applied June 17.

Results and Conclusions
Volunteer canola was controlled by Odyssey. This treatment was the highest yielding despite the fact that the herbicide caused significant stunting of the fenugreek.

Bean and Pea Preliminary Yield Trials

Principal:	A. Vandenberg, Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan
Funding:	Saskatchewan Agriculture Development Fund, Saskatchewan Pulse Growers, Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Co-investigator:	A.E. Slinkard, Crop Development Centre
Location:	Outlook
Progress:	Ongoing

Bean Trials

Objective: To develop high yielding, adapted dry bean varieties.

Dry bean trials were conducted at Outlook to identify early-maturing, high yielding breeding lines in the pinto, great northern, red and pink market classes for the narrow row production system. Three 18-entry trials and three 36-entry trials were grown. Each trial had two replications. Data collected in 1997 were combined with data from information from other locations to decide which lines to advance to the 1998 Prairie Dry Bean Co-op Trials - Narrow Row.

Pea Trials

Objective: To develop high yielding, early, green and yellow pea varieties.

Field pea trials conducted at Outlook identified several high-yielding green and yellow field pea breeding lines. Four two-replicate trials of 36 entries each were grown. More than 70% of the lines were resistant to powdery mildew. Lines with the highest yield and best lodging tolerance were advanced to registration recommendation trials for the 1998 season. Green-seeded lines were evaluated for tolerance to bleaching.

Development of Disease Resistant Field Pea Germplasm under Irrigation

Principal: A.E. Slinkard, Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigators: A. Vandenberg, Crop Development Centre; T.J. Hogg, SIDC
Progress: Ongoing
Locations: Saskatoon and Outlook
Objectives:

a) To develop a technique to screen field pea germplasm for resistance to mycosphaerella blight, and
b) To screen field pea lines for adaptation to irrigated production in Saskatchewan.

Ten pea genotypes differing in reaction to mycosphaerella blight were seeded in four-row plots with rows 30 cm (12 in) apart and 4 m (13 ft) long, in four replications at Outlook and Saskatoon in 1995 and 1996. Each genotype was subjected to four treatments: 1) check, 2) non-lodging (by a wire mesh grid 30 to 40 cm (12 to 16 in) above the ground), 3) sprayed (three to four applications of Bravo at 7-10 day intervals) and 4) sprayed plus non-lodging. Reaction to mycosphaerella blight was recorded on five plants from an inner row at four growth stages. Disease rating systems were used for stem infection rating, foliage infection rating, and pod infection rating. In addition, a whole plot rating was used. A breeding nursery of 36 lines was also grown at Outlook and Saskatoon and evaluated in a similar manner for reaction to mycosphaerella blight. In all experiments data were collected on seed weight and seed yield. In 1997, ten pea genotypes differing in reaction to mycosphaerella blight were grown at eight locations in western Canada and rated independently for mycosphaerella blight reaction, based on a stem rating method and a foliage rating method with 10 plants.

Table 1. The stem infection rating for estimating severity of mycosphaerella blight in field pea (Wang, M.Sc. Thesis, 1998).

Stem Infection Rating	Extent of disease development on the main stem
0	No visible symptoms
1	Small flecks
3	Few large lesions
5	Many large lesions
7	Main stem girdled
9	Plant dead

The 1995 and 1996 results indicated that prevention of lodging markedly reduced the severity of mycosphaerella blight infection, emphasizing the importance of lodging resistance in pea. Multiple sprays of Bravo also reduced the severity of mycosphaerella blight infection. The fungicide effect often was additive to the effect of reduced lodging. Screening of the breeding lines resulted in some lines with yield potential, but none of them had a meaningful level of resistance to mycosphaerella blight.

The stem infection rating was slightly better than the foliage infection rating. Both are based on five random plants. The foliage infection rating based on the whole plot did not provide an adequate index. The pod infection rating was inadequate also. Results of the 1997 comparison of rating methods confirmed the slight superiority for the stem rating method. The stem rating values for mycosphaerella blight in pea are shown in Table 1. Rating must be done at physiological maturity since late maturing lines remain green later in the season, often resulting in a lower rating (more resistant).

Horticultural Crops

Potato Development Program

Principal: J. Wahab
Saskatchewan Irrigation Development Centre

Introduction

Potato production is growing rapidly in Saskatchewan. Most of this expansion is concentrated around the Lake Diefenbaker Development Area. SIDC has expanded its potato R & D program to support this developing industry. The potato program at SIDC is designed to develop and refine agronomic information, and to provide support services to the 'seed', 'processing', and 'table' potato industries. Major focus is on:

a) germplasm evaluation (Prairie Regional Trials, Western Seed Potato Consortium Demonstration, private cultivars from Can-AGRICO Potato Corporation, Svaloff and Weibull Seed, and Lamb-Weston),
b) fertility management (nitrogen, phosphorus, potassium, and micronutrient),
c) water management,
d) soil management,
e) plant population studies,
f) seed piece handling, and
g) quality characteristics for seed, table and processing potato.

Several projects were carried out jointly with the private industry and with public institutions. The partners include Can-AGRICO Potato Corporation, Lamb-Weston, Svaloff and Weibull Seed, Saskatchewan Seed Potato Growers Association, Department of Horticulture Science, University of Saskatchewan, and Lethbridge Research Centre, Agriculture and Agri-Food Canada.

All tests were conducted at the SIDC field plots. The crop was raised utilizing standard management practices. Except in situations where specific treatments were applied, the general cultural practices included (i) pre-plant herbicide Eptam 8E, and Poast in-crop to control volunteer cereal (ii) a fertility program of 200 kg N/ha (180 lb/ac), 60 kg P_2O_5/ha (50 lb/ac), and 50 kg K_2O/ha (45 lb/ac), (iii) supplemental irrigation to maintain the soil moisture status at 65% Field Capacity, and (iv) approximately 40-50 g (2-3 oz) seed pieces planted at 91cm (36 in) between-row and 30 cm (12 in) within the row spacing. Yield estimates were taken from 6 m (20 ft) long plots. There were no major disease incidences, however, one spray of Bravo-500 was applied at row closure (July 2) as a prophylactic measure. A minor incidence of Colorado potato beetle was observed, and this was effectively controlled with Sevin XLR Plus. The crop was desiccated prior to harvest using two sprays of Reglone. The harvested tubers were graded according to their diameter: 'seed' grade included tubers between 30-70 mm (1.2-2.8 in) diameter for oblong tubers, and 30-80 mm (1.3-3.2 in) for round tubers; the 'consumption' grade included tubers larger than 45 mm (1.8 in) diameter.

Culinary characteristics were determined for processing ('consumption' grade) potato. For french fry evaluation, potato strips were fried at 190°C for 2.5 minutes and colour ratings were performed based on the USDA colour chart for french fries. A colour ranking of one or less is considered acceptable, and two or greater is unacceptable. French fry quality (colour) and the flavour attributes for boiled and baked potato in relation to cultivars and cultural practices are summarized in this report.

Agronomic Investigations

Prairie Regional Early Replicated Trial

Sixteen clones were evaluated under irrigated conditions in comparison to three commercial standards. Harvests were taken at 91 and 133 days after planting. Yield estimates, and processing quality were evaluated. Results from this trial will be utilized to support registration of new cultivars.

Prairie Regional Main Replicated Trial

Seventeen advanced breeding lines were evaluated with six commercial cultivars as checks. Yield estimates were taken after 133 days from planting. Processing characteristics were determined for the harvested tubers. Results from this trial will be utilized to support registration of new cultivars.

Western Seed Potato Consortium Demonstration

Promising new table, chipping, and french fry clones offered by the Western Seed Potato Consortium were grown in relatively large plots under irrigation at SIDC. These lines were harvested and displayed to the consortium members, industry groups, and other related organizations during a dedicated field day.

Evaluation of Commercial Potato Cultivars

Six french fry, three chipping, and eight table potato cultivars were evaluated under irrigated conditions in Outlook. The crop was raised using standard commercial practices.

For chipping potato, AC Ptarmigan produced the highest 'seed' and 'consumption' grade yields (Table 1). Among the french fry cultivars, Russet Burbank produced the highest yield for both 'seed' (54 t/ha; 482 Cwt./ac) and 'consumption' (48.5 t/ha; 433 Cwt./ac) grade tubers. Shepody and Gold Rush produced approximately 47 t/ha (419 Cwt./ac) of 'consumption' grade tubers. 'Consumption' grade yields for the red table cultivars ranged between 38.2 t/ha (341 Cwt./ac) for Red Ruby and 44.5 t/ha (397 Cwt./ac) for Dark Red Norland.

All processing cultivars (chippers and french fry) produced acceptable tuber specific gravities and acceptable french fries or chips (Table 2). As expected, the table potato cultivars generally produced tubers with lower gravity and made poor fries.

The flavour for the various cultivars after boiling and baking are summarized in Table 2.

Evaluation of Lamb-Weston Cultivars

Fambo and Proloog produced the highest and Charisma produced the lowest 'consumption' grade yield (Table 3). These cultivars produced on average 11% higher yield than Russet Burbank, 20% higher yield than Shepody, and 150% higher yield than Gold Rush.

Gold Rush produced the lowest specific gravity of 1.077. For the rest of the cultivars, the gravities ranged between 1.081 for Shepody and 1.094 for Felsine (Table 3). The reducing sugar levels were estimated using a 'One Touch Basic' diabetes monitor approximately 60 days after harvest. The reducing sugar levels for all the cultivars are within the acceptable range for good fry quality despite the 60 day time lapse after harvesting (Table 3). There is a general trend of lower reducing sugar levels with increase in tuber specific gravity.

All cultivars, except Gold Rush and Shepody, produced more than 80% USA-0 grade fries (Table 4). By contrast Shepody and Gold Rush produced approximately 63% USA-0 fries. There were no sugar end fries for all cultivars, and the incidence of sugar tips was relatively low.

Evaluation of Can-AGRICO Cultivars

Picasso and Provento produced the highest yield of approximately 81 t/ha (726 Cwt./ac) of 'seed' grade tubers (Table 5). The yield advantage of these two cultivars over Russet Burbank and Shepody were 18% and 73% respectively. Promising yield potential, greater tuber number, and relatively small uniform sized tubers for many of the Can-AGRICO cultivars indicates that high quality 'seed' of these cultivars can be grown under irrigation in Saskatchewan with considerable economic benefits to the producer.

Picasso produced the highest 'consumption' grade yields. This was superior to Russet Burbank by 26% (Table 5). The superior yield and medium tuber size of several Can-AGRICO cultivars make them good yellow-flesh table potatoes.

The french fry quality of Can-AGRICO cultivars such as Aziza, Disco, Romano, and Romina are comparable to the standards Russet Burbank and Shepody (Table 6). However, the yellow flesh colour of these cultivars is a drawback, at present, in the North American processing market.

The baking and boiling characteristics for the cultivars tested are summarized in Table 6. All Can-AGRICO entries and the check cultivars, except Alpha and Disco, produced acceptable flavour.

Evaluation of Svalof Weibull Cultivars

The yield components for 'seed' and 'consumption' grade tubers are summarized in Table 7. The tuber yields for cultivars tested are not significantly different for both market classes. This lack of significance can be attributed to the relatively high coefficient of variation.

'Seed' grade tuber yields ranged between 41.4 t/.ha (369 Cwt./ac) for Atlantic and 68.9 t/ha (615 Cwt./ac) for Russet Burbank. Promising yield potential, and relatively small uniform sized tubers for Matilda and SW88109 indicates that high quality 'seed' of these cultivars can be grown under irrigation in Saskatchewan with considerable economic benefits.

Russet Burbank potato produced the highest and SW88109 produced the second highest 'consumption' grade yields (Table 7). Matilda produced the lowest 'consumption' grade yield.

The french fry quality of the two Svalof-Weibull cultivars are comparable to the standard Russet Burbank and Shepody potato (Table 8). However, the yellow flesh colour of these cultivars is a drawback in the North American market , at present. All cultivars tested have acceptable culinary characteristics, except Alpha (Table 8).

Table 1. Yield potential for different market classes of commercial potato grown under irrigation.					
Cultivar	Market class	Seed grade tubers		Consumption Grade tubers	
		t/ha	cwt./ac	t/ha	cwt./ac
AC Ptarmigan	Chipping	52.7	470	50.8	453
Alpha	Table	46.1	411	37.0	330
Amisk	French fry	43.3	386	42.8	382
Atlantic	Chipping, table	44.4	396	49.5	442
Dark Red Norland	Table	47.1	420	44.5	397
Frontier Russet	Table, french fry	49.2	439	43.8	391
Gold Rush	Table, french fry	52.1	465	47.6	425
Niska	Chipping	44.0	393	36.6	327
Nordonna	Table	43.7	390	43.3	386
Norland	Table	44.0	393	44.5	397
Ranger Russet	French fry	49.4	441	41.8	373
Red LaSoda	Table	38.7	345	41.5	370
Red Ruby	Table	42.9	383	38.2	341
Russet Burbank	French fry	54.0	482	48.5	433
Russet Norkotah	Table	54.9	490	48.9	436
Sangre	Table	44.8	400	44.2	394
Shepody	French fry, Table	50.1	447	47.3	422
Significance		0.05		0.01	
L.S.D (5.0%)		12.9		11.9	
C.V. (%)		19.2		18.9	

Table 2. Tuber specific gravity and quality attributes for commercial potato cultivars grown under irrigation.				
Cultivar	Specific gravity	Fry colour	Baked flavour	Boiled flavour
AC Ptarmigan	1.079	0	Acceptable	Acceptable
Alpha	1.101	1	Acceptable	Acceptable
Amisk	1.086	1	Acceptable	Acceptable
Atlantic	1.104	00	Acceptable	Acceptable
Dark Red Norland	1.073	1	Acceptable	Unacceptable
Frontier Russet	1.095	0	Unacceptable	Unacceptable
Gold Rush	1.084	0	Acceptable	Acceptable
Niska	1.087	000	Acceptable	Acceptable
Nordonna	1.077	2	Acceptable	Unacceptable
Norland	1.071	1	Acceptable	Acceptable
Ranger Russet	1.098	0	Acceptable	Acceptable
Red LaSoda	1.081	2	Acceptable	Acceptable
Red Ruby	1.074	2	Unacceptable	Acceptable
Russet Burbank	1.094	0	Acceptable	Unacceptable
Russet Norkotah	1.085	1	Acceptable	Unacceptable
Sangre	1.079	2	Acceptable	Acceptable
Shepody	1.092	00	Acceptable	Acceptable
Significance	18.46			
L.S.D (5.0%)	0.005			
C.V. (%)	0.33			

Table 3. Mainstem number, tuber yields and specific gravity for potato cultivars grown under irrigation: Lamb-Weston Test.

Cultivar	Mainstem number /hill	Consumption grade yield		Specific gravity	Reducing sugar (mg/g fw)
		t/ha	Cwt./ac		
Charisma	2.9	32.9	294	1.092	1.6
Cycloon	2.6	44.4	396	1.091	1.5
Fambo	2.3	53.2	475	1.088	0.7
Felsine	2.8	46.5	415	1.094	1.8
Gold Rush	2.7	39.3	351	1.077	2.6
Morene	2.5	45.5	406	1.085	1.9
Proloog	2.7	52.8	471	1.097	0.9
Ranger Russet	2.4	37.9	338	1.092	1.8
Russet Burbank	2.3	47.4	423	1.086	1.9
Shepody	2.0	45.2	403	1.081	2.2
Significance	0.05	0.01		0.05	0.001
L.S.D. (5.0%)	0.6	7.9		0.011	0.5
C.V. (%)	15.2	12.4		0.73	18.3

fw= fresh weight

Table 4. French fry quality characteristics for potato cultivars grown under irrigation: Lamb-Weston Test.

Cultivar	French fry (%)			Sugar end (%)		Sugar tips (%)
	US #0	US #1	US #2	Major	Minor	
Charisma	94	3	3	0	0	0
Cycloon	96	0	1	0	0	4
Fambo	97	3	0	0	0	0
Felsine	91	8	1	0	0	4
Gold Rush	64	31	5	0	0	4
Morene	94	6	0	0	0	2
Proloog	98	1	1	0	0	1
Ranger Russet	97	3	0	0	0	1
Russet Burbank	82	18	0	0	0	1
Shepody	63	27	7	0	0	3
Significance	NS	-	-	-	-	-
C.V. (%)	19.7	-	-	-	-	-

Analysis of variance for US #0 french fry quality was conducted using square-root of the original data.

Table 5. Mainstem number and yield components for potato cultivars grown under irrigation: Can-AGRICO Potato Corporation Test.					
Cultivar	Main stems /hill	Seed grade yield		Consumption grade yield	
		t/ha	Cwt./ac	t/ha	Cwt./ac
Alpha	3.6	44.5	396.6	35.4	315.5
Atlantic	3.3	41.4	369.0	48.0	427.8
Aziza	3.2	51.1	455.4	43.2	385.0
Cosmos	3.3	76.8	684.5	75.7	674.7
Disco	4.2	60.2	536.5	51.6	459.9
Miriam	3.2	60.1	535.6	49.6	442.1
Picasso	3.8	80.1	713.9	78.0	695.2
Provento	3.7	81.4	725.5	74.0	659.5
Russet Burbank	3.1	68.9	614.1	60.0	534.8
Romano	2.8	47.8	426.0	50.0	445.6
Romina	3.0	54.3	483.9	48.8	434.9
Shepody	2.5	46.7	416.2	48.0	427.8
Significance	NS	0.01		0.01	
L.S.D. (5.0%)	-	27.4		21.5	
C.V. (%)	25.7	22.7		23.9	

Table 6. Culinary characteristics for potato cultivars grown under irrigation: Can-AGRICO Potato Corporation Test.			
Cultivar	Fry colour	Baked flavour	Boiled Flavour
Alpha	1	Unacceptable	Unacceptable
Atlantic	0	Acceptable	Acceptable
Aziza	0	Acceptable	Acceptable
Cosmos	1	Acceptable	Acceptable
Disco	0	Unacceptable	Unacceptable
Miriam	0	Acceptable	Acceptable
Picasso	1	Acceptable	Acceptable
Provento	1	Acceptable	Acceptable
R. Burbank	0	Acceptable	Acceptable
Romano	0	Acceptable	Acceptable
Romina	0	Acceptable	Acceptable
Shepody	0	Acceptable	Acceptable

Table 7. Mainstem number and yield components for potato cultivars grown under irrigation: Svalof-Weibull Test.

Cultivar	Main stems /hill	Seed grade tubers			Consumption grade tubers		
		Yield		Av.tub. Wt (g)	Yield		Av.tub. Wt (g)
		t/ha	Cwt/ac		t/ha	Cwt/ac	
Matilda	3.4	49.2	439	80	32.4	289	120
Alpha	3.6	44.5	397	91	35.4	316	122
Atlantic	3.3	41.4	369	164	48.0	428	206
R. Burbank	3.1	68.9	615	150	60.0	535	194
Shepody	2.5	46.7	417	231	48.0	428	271
Significance	NS	NS		0.001	0.01		0.001
L.S.D. (5.0%)	-	27.4		23.4	21.5		29.2
C.V. (%)	25.7	22.7		10.0	23.9		10.0

Table 8. Culinary characteristics for potato cultivars grown under irrigation: Svalof-Weibull Test.

Cultivar	Fry colour	Baked flavour	Boiled flavour
Matilda	0	Acceptable	Acceptable
SW88108	0	Acceptable	Acceptable
Alpha	1	Unacceptable	Unacceptable
Atlantic	00	Acceptable	Acceptable
Russet Burbank	0	Acceptable	Acceptable
Shepody	0	Acceptable	Acceptable

Nitrogen and Phosphorus Study

Co-Investigator: T.J. Hogg

Nitrogen and phosphorus are the two most important nutrients limiting to potato production, especially under irrigation. Proper fertility management is critical particularly under the relatively short growing seasons in Saskatchewan. Excess nitrogen can delay maturity and lower the specific gravity of tubers while increasing the level of reducing sugars. Delayed maturity can affect the quality of both seed and processing potato. For example lower specific gravity and higher reducing sugar levels can severely lower quality of processing potato. It is likely that the nitrogen and phosphorus requirement of potato may vary for different cultivars or for different plant populations.

This study examined the interactive effects of four levels of nitrogen (50, 100, 150, 200 kg N/ha; 45, 90, 135, 180 lb N/ac), two levels of phosphorus (60, 120 kg P_2O_5/ha; 55, 110 lb P_2O_5/ac), two seed piece spacings (15, 30 cm; 6, 12 in) for Ranger Russet, Russet Norkotah, and Shepody potato. Spring soil analyses indicated 30 kg (27 lb/ac) NO_3-N/ha, 26 kg (23 lb/ac) P_2O_5/ha, 1000 kg (900 lb/ac) K_2O/ha in the 0-30 cm (0-12 in) horizon.

Nitrogen application had a positive influence on 'seed' and 'consumption' grade tuber yields for all three cultivars although statistically significant differences were observed only for Shepody (Table 9 and 10). Both 'seed' and 'consumption' grade yields optimized at 100 kg N/ha (90 lb N/ac) for

Ranger Russet and Shepody, whereas, Russet Norkotah yields optimized at 150 kg N/ha (134 lb N/ac).

A significant nitrogen x phosphorus interaction was observed for 'seed' and 'consumption' grade yield in Russet Norkotah (Table 9). For example, with 'seed' grade yield at lower nitrogen levels (50, 100 kg N/ha; 45, 90 lb N/ac), increasing phosphorus rate increased 'seed' grade tuber yield, by contrast at higher nitrogen levels (150, 200 kg N/ha; 135, 180 lb N/ac) increasing P level decreased yields (Figure 1).

Shepody potato responded positively to the addition of 120 kg P_2O_5/ha, i.e. applying 120 kg P_2O_5/ha produced approximately 8% higher 'seed' and 'consumption' grade yield than 60 kg P_2O_5/ha (Tables 9 and 10).

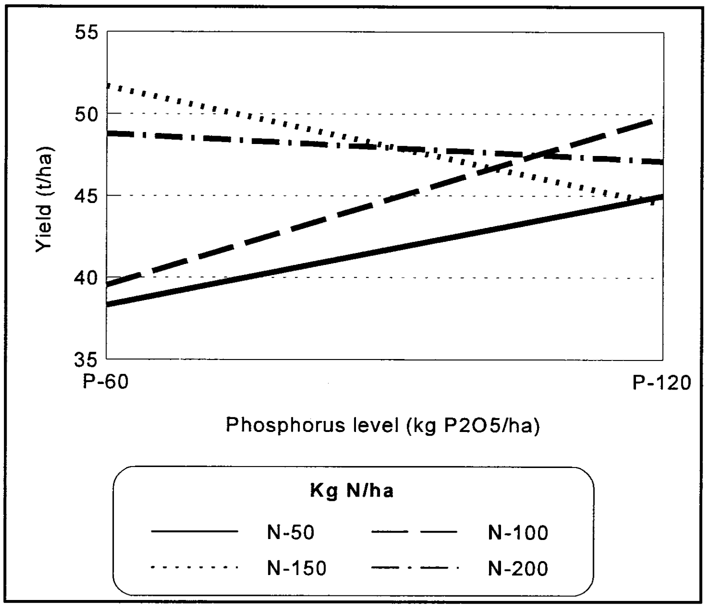


Figure 1. Consumption grade tuber yields for Russet Norkotah potato as influenced by nitrogen and phosphorus fertilization.

Table 9. Nitrogen, phosphorus, and seed piece spacing effects on seed grade tuber yield for Ranger Russet, Russet Norkotah, and Shepody potato grown under irrigation.

Factor	Level	Seed grade tuber yield					
		Ranger Russet		Russet Norkotah		Shepody	
		t/ha	Cwt./ac	t/ha	Cwt./ac	t/ha	Cwt./ac
Nitrogen (kg N/ha)[z]	50	47.3	425	52.1	465	52.5	468
	100	49.8	444	54.4	485	58.1	518
	150	49.7	443	59.5	531	58.1	518
	200	46.9	418	57.1	509	59.5	531
Phosphorus (kg P_2O_5/ha)[y]	60	47.3	422	55.0	491	54.9	490
	120	49.5	442	56.5	504	59.3	529
Seed piece spacing (cm)[x]	15	53.4	476	59.7	533	63.9	570
	30	43.5	388	51.9	463	50.3	449

Analyses of Variance

Source	**Significance**		
Nitrogen	NS	NS	**(4.1)
Phosphorus	NS	NS	**(2.9)
Spacing	**(3.6)	**(4.3)	**(2.9)
Nitrogen x Phosphorus	NS	**(8.6)	NS
Nitrogen x Spacing	NS	NS	NS
Phosphorus x Spacing	NS	NS	NS
Nitrogen x Phosphorus x Spacing	NS	NS	NS
C.V. (%)	14.8	15.3	9.9

[z]Average of phosphorus and seed piece spacing. [y]Average of nitrogen and seed piece spacing.
[x]Average of nitrogen and phosphorus.
Values within parentheses are LSD (5.0%) for the different treatments.

Doubling the seeding rate by reducing seed piece spacing from 30 cm to 15 cm (12 in to 6 in) increased 'seed' grade tuber yield by 23% for Ranger Russet, 15% for Russet Norkotah, and 27% for Shepody (Table 9). The corresponding yield increases for 'consumption' grade potato were 7% for Ranger Russet and 19% for Shepody. Russet Norkotah produced similar 'consumption' grade yields at both spacings (Table 10).

Increased nitrogen application tended to reduce tuber specific gravity for all three cultivars (Table 11). For Shepody potato, increased P application produced tubers with higher specific gravity. For Ranger Russet and Russet Norkotah, increased P application produced tubers with slightly lower specific gravity.

Table 10. Nitrogen, phosphorus, and seed piece spacing effects on consumption grade tuber yield for Ranger Russet, Russet Norkotah, and Shepody potato grown under irrigation.

Factor	Level	Consumption grade tuber yield					
		Ranger Russet		Russet Norkotah		Shepody	
		t/ha	Cwt./ac	t/ha	Cwt./ac	t/ha	Cwt./ac
Nitrogen (kg N/ha)[z]	50	35.9	320	41.7	372	49.0	437
	100	40.5	361	44.7	399	55.9	499
	150	40.6	362	48.1	429	56.1	501
	200	39.5	352	48.0	428	57.6	514
Phosphorus (kg P_2O_5/ha)[y]	60	38.2	341	44.6	399	52.7	470
	120	40.0	357	46.6	416	56.6	505
Seed piece spacing (cm)[x]	15	40.5	361	45.8	409	59.4	530
	30	37.7	336	45.4	405	49.9	445

Analyses of Variance

Source	Significance		
Nitrogen	NS	NS	**(4.1)
Phosphorus	NS	NS	**(2.8)
Spacing	NS	**(4.3)	**(2.8)
Nitrogen x Phosphorus	NS	**(8.6)	NS
Nitrogen x Spacing	NS	NS	NS
Phosphorus x Spacing	NS	NS	NS
Nitrogen x Phosphorus x Spacing	NS	NS	NS
C.V. (%)	16.2	15.3	10.3

[z]Average of phosphorus and seed piece spacing.
[y]Average of nitrogen and seed piece spacing.
[x]Average of nitrogen and phosphorus.
Values within parentheses are LSD (5.0%) for the different treatments.

Table 11. Mean effects of nitrogen, phosphorus and seed piece spacing on tuber specific gravity for Ranger Russet, Russet Norkotah, and Shepody potato.				
Factor	Level	Specific gravity		
		Ranger Russet	Russet Norkotah	Shepody
Nitrogen (kg N/ha)[z]	50	1.106	1.080	1.086
	100	1.104	1.079	1.084
	150	1.105	1.077	1.083
	200	1.103	1.078	1.081
Phosphorus (kg P_2O_5/ha)[y]	60	1.105	1.079	1.082
	120	1.104	1.078	1.085
Seed spacing (cm)[x]	15	1.106	1.079	1.084
	30	1.103	1.078	1.083
Analyses of Variance				
Source			**Significance**	
Nitrogen		NS	NS	NS
Phosphorus		NS	NS	*(0.002)
Spacing		*(0.002)	NS	NS
Nitrogen x Phosphorus		NS	NS	NS
Nitrogen x Spacing		NS	NS	NS
Nitrogen x Phosphorus x Spacing		NS	NS	NS
C.V. (%)		0.43	0.89	0.49

[z]Average of phosphorus and seed piece spacing.
[y]Average of nitrogen and seed piece spacing.
[x]Average of nitrogen and phosphorus.
Values within parentheses are LSD (5.0%) for the different treatments.

The effects of nitrogen and phosphorus application on french fry colour ratings for Ranger Russet, Russet Norkotah, and Shepody potato are summarized in Table 12. No identifiable trends were observed for the various treatment effects. The fry colour ratings were generally within the acceptable industry standards. It is not clear why Ranger Russet showed slightly darker colour than the other two cultivars. This test will be repeated to examine the effects of N and P application on fry colour characteristics for processing potato.

Table 12. Fry colour for potato cultivars as influenced by nitrogen and phosphorus fertilization and seed piece spacing.						
Nitrogen (kg N/ha)	Ranger Russet		Russet Norkotah		Shepody	
	60 kg P_2O_5/ha	120 kg P_2O_5/ha	60 kg P_2O_5/ha	120 kg P_2O_5/ha	60 kg P_2O_5/ha	120 kg P_2O_5/ha
	15 cm seed piece spacing					
50	3	1	1	1	0	0
100	1	2	0	0	0	0
150	2	1	1	1	0	0
200	2	2	1	1	1	0
	30 cm seed piece spacing					
50	2	1	1	1	1	0
100	1	1	1	1	0	1
150	1	1	1	1	1	0
200	1	1	0	2	0	00

Split Application of Nitrogen On Tuber Yield and Specific Gravity

Co-Investigator: T.J. Hogg

Rate and timing of nitrogen application is extremely important in the short growing seasons in Saskatchewan. It is likely that early and late maturing cultivars can respond differently to nitrogen application. This study examined the effect of split applying 150 and 200 kg N/ha (135 and 180 lb N/ac) for late maturing processing potato cvs. Ranger Russet and Shepody in comparison to relatively early maturing Russet Norkotah (table potato). The different split applications included (i) all N at planting, and equal splits at (ii) planting and hilling, (iii) planting, hilling and three weeks after hilling, and (iv) planting, hilling, three, and five weeks after hilling.

Nitrogen rate and the various split application treatments had no effect on 'seed' or 'consumption' grade tuber yields (Table 13). All cultivars produced similar 'seed' grade yield. Shepody potato produced significantly higher 'consumption' grade yield than Ranger Russet and Russet Norkotah (Table 13).

Table 13. Rate and timing of Nitrogen application on seed and consumption grade tuber yield for Ranger Russet, Russet Norkotah, and Shepody potato grown under irrigation.

Factor	Level	Tuber yield			
		Seed grade		Consumption grade	
		t/ha	Cwt./ac	t/ha	Cwt./ac
Cultivar[z]	Ranger Russet	59.6	532	49.7	443
	Russet Norkotah	59.1	527	45.0	402
	Shepody	59.7	533	56.1	501
N rate[y]	150 kg/ha (135 lb/ac)	58.9	526	49.0	437
	200 kg/ha (180 lb/ac)	60.0	535	51.5	460
Application time[x]	P	61.4	548	52.3	467
	P+H	59.9	535	50.8	453
	P+H+3	58.5	522	49.2	439
	P+H+3+5	58.0	517	48.7	435
Analyses of Variance					
Source		**Significance**			
Cultivar		NS		***(3.9)	
Rate		NS		NS	
Timing		NS		NS	
Cultivar x Rate		NS		NS	
Cultivar x Timing		NS		NS	
Rate x Timing		NS		NS	
Cultivar x Rate x Timing		NS		NS	
C.V. (%)		13.2		15.5	

[z]Average of nitrogen rate and time of application.
[y]Average of cultivar and time of application.
[x]Average of cultivar and nitrogen rate.

P - All at planting.
P+H - 2 equal splits: at planting and at hilling.
P+H+3 - 3 equal splits: at planting, at hilling, and three weeks after hilling.
P+H+3+5 - 4 equal splits: at planting, at hilling, three weeks after hilling, and five weeks after hilling.

Value within parenthesis is LSD (5.0%) for the different treatments.

Ranger Russet produced tubers with significantly higher specific gravity than Russet Norkotah or Shepody (Table 14). However, the gravity for Shepody is within the acceptable limit for processing.

Table 14. Effect rate and timing on nitrogen application on tuber specific gravity for selected potato cultivars.

Factor	Level	Specific gravity
Cultivar[z]	Russet Norkotah	1.085
	Ranger Russet	1.096
	Shepody	1.087
Nitrogen rate[y]	150 kg/ha (135 lb/ac)	1.093
	200 kg/ha (180 lb/ac)	1.086
Timing of application [x]	P	1.088
	P+H	1.091
	P+H+3	1.089
	P+H+3+5	1.089

Analysis of Variance

Source	**Significance**
Cultivar	*** (0.006)
Rate	**(0.005)
Timing	NS
Cultivar x Rate	NS
Cultivar x Timing	NS
Cultivar x Rate x Timing	NS
C.V. (%)	1.15

[z]Average of nitrogen rate and timing. [y]Average of cultivar and timing of application.
[x]Average of cultivar and and nitrogen rate.

Timing of nitrogen application:
- P - All at planting
- P+H - 2 equal splits: at planting and at hilling
- P+H+3 - 3 equal splits: at planting, at hilling, and three weeks after hilling
- P+H+3+5 - 4 equal splits: at planting, at hilling, three weeks after hilling, and five weeks after hilling.

Values within parentheses are LSD (5.0%) for the different treatments.

The rates or times of application of nitrogen did not appear to affect french fry characteristics for the various cultivars (Table 15).

Table 15. Fry colour for potato cultivars as influenced by rate and timing of nitrogen application.

Timing of N application	Ranger Russet		Russet Norkotah		Shepody	
	150 kg N/ha	200 kg N/ha	150 kg N/ha	200 kg N/ha	150 kg N/ha	200 kg N/ha
P	0	0	1	1	0	0
P+H	0	0	1	1	0	0
P+H+3	0	00	1	1	0	0
P+H+3+5	0	0	1	1	0	0

Timing of nitrogen application:
- P- All at planting.
- P+H- 2 equal splits: at planting and at hilling.
- P+H+3- 3 equal splits: at planting, at hilling, and 3 weeks after hilling.
- P+H+3+5- 4 equal splits: at planting, at hilling, 3 weeks after hilling, 5 weeks after hilling.

Potassium Source and Rate Study For Norland and Russet Burbank

Co-Investigator: T.J. Hogg

This study examined the effects potassium sulphate and potassium chloride as a potassium source for the production of 'seed' and 'consumption' grade tubers of Norland and Russet Burbank potato. Four rates of potassium fertilizer (100, 200, 300, 400 kg K_2O/ha; 90, 180, 270, 360 lb K_2O/ac) were studied in comparison to a check treatment (no added potassium). Spring soil analyses at the test site indicated that 30 kg (27 lb/ac) NO_3-N/ha, 26 kg (23 lb/ac) P_2O_5/ha, and 1000 kg (891 lb/ac) K_2O/ha was present at 0-30 cm (0"-12")depth.

The source and rates of potassium had no effect on 'seed' or 'consumption' grade tuber yields for both Norland and Russet Burbank (Tables 16 and 17).

The source of potassium had no effect on tuber specific gravity for both cultivars (Table 18).

Application of potassium fertilizer lowered the tuber specific gravity of Norland compared to the zero fertilizer check. For Russet Burbank, added potassium fertilizer had no effect on tuber specific gravity (Table 18).

The effects of source and rates of potassium application on french fry quality for Russet Burbank (a processing potato) did not show any source or rate effect on fry colour (Table 19).

Table 16. Potassium source and rate effects on seed grade tuber yield for Norland and Russet Burbank potato.

Factor	Level	Seed grade tuber yield			
		Norland		Russet Burbank	
		t/ha	Cwt./ac	t/ha	Cwt./ac
K source[z]	Sulphate	59.0	526	59.4	530
	Chloride	60.7	542	58.8	525
K rate (kg K_2O/ha)[y]	0	55.6	496	58.8	525
	100	55.3	493	57.9	517
	200	56.1	500	61.1	545
	300	62.0	553	57.8	516
	400	60.9	543	59.6	532

Analyses of Variance

Source	**Significance**	
K Source	NS	NS
Rate	NS	NS
K source x Rate	NS	NS
C.V.(%)	18.8	8.1

[z] Average of rates.
[y] Average of sources.

Table 17. Potassium source and rate effects on consumption grade tuber yield for Norland and Russet Burbank potato.

Factor	Level	Consumption grade tuber yield			
		Norland		Russet Burbank	
		t/ha	Cwt./ac	t/ha	Cwt./ac
K source[z]	Sulphate	48.5	433	38.9	347
	Chloride	52.1	465	42.5	379
K rate (kg K_2O/ha)[y]	0	45.7	408	38.8	346
	100	50.5	451	39.6	353
	200	47.4	423	40.7	363
	300	57.5	513	40.5	361
	400	51.8	462	42.1	376

Analyses of Variance

Source	Significance (Norland)	Significance (Russet Burbank)
K Source	NS	NS
Rate	NS	NS
K source x Rate	NS	NS
C.V.(%)	18.8	8.1

[z] Average of rates.
[y] Average of sources.

Table 18. Potassium source and rate effects on tuber specific gravity for Norland and Russet Burbank potato.

Factor	Level	Tuber specific gravity	
		Norland	Russet Burbank
K source[z]	Sulphate	1.077	1.085
	Chloride	1.076	1.083
K rate (kg K_2O/ha)[y]	0	1.083	1.086
	100	1.079	1.086
	200	1.075	1.079
	300	1.075	1.086
	400	1.077	1.084

Analyses of Variance

Source	Significance (Norland)	Significance (Russet Burbank)
K source	NS	NS
Rate	*(0.004)	NS
K source x Rate	NS	NS
C.V. (%)	0.29	0.82

[z] Average of rates.
[y] Average of sources.

Table 19. Potassium rate and source effects on fry colour for Russet Burbank potato.		
Potassium rate (kg K_2O/ha)	Potassium source	
	Potassium chloride	Potassium sulphate
Control	1	1
100	0	1
200	0	0
300	0	0
400	0	0

Micronutrient Evaluation for Norland and Russet Burbank

Co-investigator: T.J. Hogg

The effects of soil (pre-plant) and foliar applied micronutrients (Boron, Copper, Zinc) were evaluated for Norland and Russet Burbank potato. The pre-plant soil application consisted of 1.6 kg B/ha (1.4 lb/ac) in the form of granular borate, 10 kg Cu/ha (9 lb/ac) as copper chelate, and 10 kg Zn/ha (9 lb/ac) as zinc sulphate. The foliar spray consisted of commercial formulations of liquid boron, copper chelate, and zinc EDTA. The foliar spray was applied at the tuber bulking stage. Spring soil analyses showed that the soil (0-30 cm; 0-12 in depth) contained 3.4 kg Cu /ha, 87 kg Mn/ha, 2.4 kg Zn/ha, 4.4 kg B/ha, and 41 kg Fe /ha.

Table 20. Effects of micronutrients applied to the soil at planting on seed grade tuber yields for selected potato cultivars.

Cultivar	Seed grade tuber yield (t/ha)				
	Control	Boron	Copper	Zinc	*Mean*
Norland	46.3	45.2	42.9	48.9	*45.8*
Russet Burbank	43.1	46.0	43.9	53.6	*46.7*
Russet Norkotah	56.1	49.7	44.9	48.6	*49.8*
Ranger Russet	39.4	42.5	44.3	39.9	*41.5*
Shepody	38.9	43.0	43.4	43.9	*42.3*
Mean	*44.8*	*45.3*	*43.9*	*47.0*	
	Seed grade tuber yield (Cwt./ac)				
Norland	413	403	383	436	*409*
Russet Burbank	385	410	392	478	*417*
Russet Norkotah	500	443	401	434	*444*
Ranger Russet	352	379	395	356	*370*
Shepody	347	384	387	392	*377*
Mean	*400*	*404*	*392*	*419*	

Analysis of Variance

Source	**Significance**
Cultivar	NS
Nutrient	NS
Cultivar x Nutrient	NS
C.V. (%)	13.8

Type and stage of micronutrient application had no effect on 'seed' (Table 20 and 22), or 'consumption' grade yields (Table 21 and 23), and tuber specific gravity (Table 24). This lack of response can be due to high levels of micronutrients present in the soil.

Table 21. Effects of micronutrients applied to the soil at planting on consumption grade tuber yields for selected potato cultivars.

Cultivar	Consumption grade tuber yield (t/ha)				
	Control	Boron	Copper	Zinc	*Mean*
Norland	44.9	44.4	38.4	45.1	*43.2*
Russet Burbank	39.0	40.4	38.3	48.2	*41.5*
Russet Norkotah	46.0	40.3	40.2	41.6	*42.0*
Ranger Russet	35.0	38.3	40.1	35.0	*37.1*
Shepody	40.1	41.6	39.0	45.8	*41.6*
Mean	*41.0*	*41.0*	*39.2*	*43.1*	
	Consumption grade tuber yield (Cwt./ac)				
Norland	400.6	396.1	342.6	402.4	*385.4*
Russet Burbank	347.9	360.4	341.7	430.0	*370.2*
Russet Norkotah	410.4	359.5	358.6	371.1	*374.7*
Ranger Russet	312.3	341.7	357.8	312.3	*331.0*
Shepody	357.8	371.1	347.9	408.6	*371.1*
Mean	*365.8*	*365.8*	*349.7*	*384.5*	

Analysis of Variance

Source	**Significance**
Cultivar	NS
Nutrient	NS
Cultivar x Nutrient	NS
C.V. (%)	12.3

Table 22. Effects of foliar applied micronutrients on seed grade tuber yields for selected potato cultivars.

Cultivar	Seed grade tuber yield (t/ha)				
	Control	Boron	Copper	Zinc	*Mean*
Norland	49.2	50.3	45.1	45.7	*47.6*
Russet Burbank	52.4	53.6	53.9	57.5	*54.4*
Russet Norkotah	51.5	49.7	50.3	53.1	*51.2*
Ranger Russet	39.3	47.3	49.2	41.5	*44.3*
Shepody	44.6	43.3	43.6	46.1	*44.4*
Mean	*47.4*	*48.8*	*48.4*	*48.4*	
	Seed grade tuber yield (Cwt./ac)				
Norland	438.9	448.8	402.4	421.1	*424.7*
Russet Burbank	467.5	478.2	480.9	529.9	*485.3*
Russet Norkotah	459.5	443.4	448.8	489.3	*456.8*
Ranger Russet	350.6	422.0	438.9	382.4	*395.2*
Shepody	397.9	386.3	389.0	424.8	*396.1*
Mean	*422.9*	*435.4*	*431.8*	*446.0*	

Analysis of Variance

Source	**Significance**
Cultivar	***(4.7)
Nutrient	NS
Cultivar x Nutrient	NS
C.V. (%)	11.6

Table 23. Effects of foliar applied micronutrients on consumption grade tuber yields for selected potato cultivars.

Cultivar	Consumption grade tuber yield (t/ha)				
	Control	Boron	Copper	Zinc	*Mean*
Norland	44.4	46.6	42.7	43.1	*44.2*
Russet Burbank	44.3	46.5	45.2	49.6	*46.4*
Russet Norkotah	43.2	41.2	41.9	44.2	*42.6*
Ranger Russet	39.3	43.4	44.9	37.4	*41.1*
Shepody	43.0	43.0	43.3	46.5	*44.0*
Mean	*42.8*	*44.1*	*43.6*	*44.2*	
	Consumption grade tuber yield (Cwt./ac)				
Norland	396.1	415.7	380.9	384.5	*394.3*
Russet Burbank	395.2	414.9	403.3	442.5	*414.0*
Russet Norkotah	385.4	367.6	373.8	394.3	*380.1*
Ranger Russet	350.6	387.2	400.6	333.7	*366.7*
Shepody	383.6	383.6	386.3	414.9	*392.5*
Mean	*381.8*	*393.4*	*389.0*	*394.3*	

Analysis of Variance

Source	**Significance**
Cultivar	NS
Nutrient	NS
Cultivar x Nutrient	NS
C.V. (%)	13.7

Table 24. Effects of micronutrients and method of application on tuber specific gravity for selected potato cultivars.

Factor	Level	Time of application	
		At planting (soil)	Foliar spray
Cultivar[z]	Norland	1.063	1.070
	Russet Burbank	1.083	1.094
	Russet Norkotah	1.079	1.083
	Ranger Russet	1.090	1.099
	Shepody	1.081	1.085
Micronutrient[y]	Control	1.076	1.085
	Boron	1.079	1.088
	Copper	1.079	1.086
	Zinc	1.080	1.085

Analyses of Variance

Source	**Significance**	
Cultivar	***(0.009)	***(0.006)
Nutrient	NS	NS
Cultivar x Nutrient	NS	NS
C.V. (%)	1.01	0.64

[z]Average of micronutrients. [y]Average of cultivars.
Values within parenthesis are LSD estimates @ P<0.05

Application of micronutrients did not appear to affect fry colour for processing cultivars (Table 25). Foliar micronutrients tended to produce lighter coloured fries of the table potato, Norland, as compared soil application.

Table 25. Micronutrient effects on fry colour for selected potato cultivars.				
Cultivar	Control	Boron	Copper	Zinc
		Soil application		
Norland	2	2	2	1
Russet Burbank	00	1	1	00
Russet Norkotah	0	0	0	1
Ranger Russet	00	00	00	00
Shepody	1	00	00	0
		Foliar application		
Norland	00	0	0	0
Russet Burbank	000	00	00	00
Russet Norkotah	0	0	0	00
Ranger Russet	00	00	00	00
Shepody	000	00	00	000

Hill Type and Seed Piece Spacing Effects on Yield

This study examined the response of Shepody and Russet Norkotah potato grown in peaked hills and in flat hills. Seed piece spacings of 15 and 30 cm (6 and 12 in) were compared in relation to 'seed' and 'consumption' grade tuber yields.

On the average, 15 cm (6 in) seed piece spacing produced 27% higher 'seed' grade yield than 30 cm (12 in) seed piece spacing (Table 26). The increase in 'seed' grade yield at the narrow seed spacing was 40% under flat hills, and was 14% under peaked hills. For Russet Norkotah, the yield difference between the two seed piece spacings was more pronounced under flat hills as compared to peaked hills.

Table 26. Effects of hill type and seed piece spacing on seed grade tuber yield for Russet Norkotah and Shepody potato.

Hill type	Seed piece spacing	Seed grade tuber yield					
		Russet Norkotah		Shepody		Mean	
		t/ha	Cwt./ac	t/ha	Cwt./ac	t/ha	Cwt./ac
Peaked hill	30 cm (12 in)	41.2	367.6	38.9	367.6	40.1	357.8
	15 cm (6 in)	41.5	370.2	49.3	370.2	45.4	405.0
	Mean	*41.4*	*369.4*	*44.1*	*369.4*	*42.8*	*381.8*
Flat hill	30 cm (12 in)	32.2	287.3	40.4	287.3	36.4	324.7
	15 cm (6 in)	53.4	476.4	47.9	476.4	50.7	452.3
	Mean	*42.8*	*381.8*	*44.2*	*381.8*	*43.6*	*389.0*
Mean		*42.1*	*375.6*	*44.2*	*375.6*	*43.2*	*385.4*

Analysis of Variance

Source	**Significance**
Hill type	NS
Cultivar	NS
Spacing	***
Hill type x Cultivar	NS
Hill type x Spacing	*
Cultivar x Spacing	NS
Hill type x Cultivar x Spacing	**
C.V. (%)	13.2

Tighter planting by reducing seed piece spacing on the average produced 21% higher 'consumption' grade yield than wider seed piece spacing (Table 27). The effects of tighter planting was more marked under flat hills (32% yield increase) compared to peaked hills (10% yield increase).

Table 27. Effects of hill type and seed piece spacing on consumption grade tuber yield for Russet Norkotah and Shepody potato.

Hill type	Seed piece spacing	Consumption grade tuber yield					
		Russet Norkotah		Shepody		Mean	
		t/ha	Cwt./ac	t/ha	Cwt./ac	t/ha	Cwt./ac
Peaked hill	30 cm (12 in)	37.3	332.8	37.4	333.7	37.3	332.8
	15 cm (6 in)	33.8	301.5	48.0	428.2	40.9	364.9
	Mean	*35.6*	*317.6*	*42.7*	*380.9*	*39.1*	*348.8*
Flat hill	30 cm (12 in)	29.8	265.9	39.7	354.2	34.8	310.5
	15 cm (6 in)	45.8	408.6	45.8	408.6	45.8	408.6
	Mean	*37.8*	*337.2*	*42.8*	*381.8*	*40.3*	*359.5*
Mean		*36.7*	*327.4*	*42.8*	*381.8*	*39.7*	*354.2*

Analyses of Variance

Source	**Significance**
Hill type	NS
Cultivar	*
Spacing	**
Hill type x Cultivar	NS
Hill type x Spacing	NS
Cultivar x Spacing	NS
Hill type x Cultivar x Spacing	*
C.V. (%)	16.9

Effect of Deep Ripping of Soil on Potato Productivity

Deep tillage is beneficial to potato production particularly under heavier soil conditions. This study examined the effects of deep ripping on potato productivity when grown under supplemental irrigation. This test included cultivars Atlantic, Norland, Russet Burbank, and Shepody planted into pre-formed hills in comparison to conventional planting.

Deep ripping of soil or planting methods had no effect on 'seed' (Table 28) or 'consumption' (Table 29) grade yields or their yield components. This is likely due to the lighter nature of the loamy soil in which the test was conducted.

Effect of Covering Haulms on Tuber Set and Yield Components

This study examined the influence of covering potato shoots immediately after emergence on tuber yield and yield components (tuber number per hill and average tuber weight) for Alpha, Atlantic, Norland, Russet Burbank, Russet Norkotah, Ranger Russet, and Shepody potato. Haulm covering treatments included covering shoots at 5 cm (2 in) and 10 cm (4 in) stage, and conventional practice (i.e. no covering).

Covering haulms after emergence did not affect 'seed' grade yields (Table 30), covering haulms significantly reduced 'consumption' grade yield (Table 31). The various covering treatments did not affect tuber number per hill for 'seed' or 'consumption' grades (Table 32). The traditional planting method, however, produced larger 'seed' grade tubers than the covering treatments.

Table 28. Deep ripping and planting method effects on seed grade tuber yield components for selected potato cultivars.

Treatments	Seed grade tubers			
	Yield (t/ha)	Yield (Cwt./ac)	Tuber No. /hill	Av. tuber weight (g)
Ripping:				
Deep ripping	50.6	451.4	4.9	144.0
No ripping	51.0	455.0	5.1	143.0
Planting method:				
Into pre-formed beds	51.3	457.7	5.1	142.0
Conventional planting	50.3	448.8	4.9	146.0
Cultivar:				
Atlantic	50.2	447.9	5.2	133.0
Norland	51.5	459.5	4.8	150.0
Russet Burbank	51.6	460.3	6.2	114.0
Shepody	49.9	445.2	3.9	178.0
	Analyses of Variance			
Source	**Significance**			
Ripping (R)	NS		NS	NS
Planting (P)	NS		NS	NS
Cultivar (C)	NS		***(0.42)	***(17)
R x P	NS		NS	NS
R x C	NS		NS	NS
P x C	NS		NS	NS
R x P x C	NS		NS	NS
C.V. (%)	12.7		12.3	10.7

Values within parentheses are LSD (5.0%) for the respective treatments.

Table 29. Deep ripping and planting method effects on seed grade tuber yield components for selected potato cultivars.

Treatments	Consumption grade tubers			
	Yield (t/ha)	Yield (Cwt./ac)	Tuber No. /hill	Av. tuber weight (g)
Ripping:				
Deep ripping	43.4	387	3.2	351
No ripping	43.0	384	3.1	351
Planting method:				
Into pre-formed beds	43.6	390	3.2	350
Conventional planting	42.8	382	3.1	352
Cultivar:				
Atlantic	45.3	404	3.8	302
Norland	50.0	446	3.3	356
Russet Burbank	36.4	325	2.8	328
Shepody	45.1	402	2.7	417
	Analyses of Variance			
Source	**Significance**			
Ripping (R)	NS		NS	NS
Planting (P)	NS		NS	NS
Cultivar (C)	***(14.1)		***(0.76)	***(40)
R x P	NS		NS	NS
R x C	NS		NS	NS
P x C	NS		NS	NS
R x P x C	NS		NS	NS
C.V. (%)	15.9		18.1	7.9

Values within parentheses are LSD (5.0%) for the respective treatments.

Table 30. Effects of covering haulms on seed grade tuber yields for selected potato cultivars

Cultivar	Seed grade tuber yield							
	No covering		Cover at 5 cm (2 in)		Cover at 10 cm (4 in)		*Mean*	
	t/ha	Cwt./ac	t/ha	Cwt./ac	t/ha	Cwt./ac	*t/ha*	*Cwt./ac*
Alpha	37.1	331.0	30.3	270.3	36.9	329.2	*34.8*	*310.5*
Atlantic	41.3	368.5	35.2	314.0	36.6	326.5	*37.7*	*336.3*
Norland	49.6	442.5	37.8	337.2	41.0	365.8	*42.8*	*381.8*
Russet Burbank	44.2	394.3	43.7	389.9	36.7	327.4	*41.5*	*370.2*
Russet Norkotah	42.5	379.2	40.5	361.3	38.2	340.8	*40.4*	*360.4*
Ranger Russet	42.4	378.3	38.5	343.5	36.6	326.5	*39.2*	*349.7*
Shepody	40.9	364.9	34.5	307.8	41.2	367.6	*38.8*	*346.2*
Mean	*42.6*	*380.1*	*37.2*	*331.9*	*38.2*	*340.8*		

Analysis of Variance

Source	**Significance**
Cultivar	NS
Burying	*(4.6)
Cultivar x Burying	NS
C.V. (%)	18.0

Value within parenthesis is LSD (5.0%) for haulm covering main effect.

Table 31. Effects of covering haulms on consumption grade tuber yields for selected potato cultivars.

Cultivar	Consumption grade tuber yield							
	No covering		Cover at 5 cm (2 in)		Cover at 10 cm (4 in)		*Mean*	
	t/ha	Cwt./ac	t/ha	Cwt./ac	t/ha	Cwt./ac	*t/ha*	*Cwt./ac*
Alpha	20.7	184.7	14.1	125.8	20.4	182.0	*18.4*	*164.2*
Atlantic	37.2	331.9	32.2	287.3	32.7	291.7	*34.0*	*303.3*
Norland	46.3	413.1	34.4	306.9	38.7	345.3	*39.8*	*355.1*
Russet Burbank	38.3	341.7	36.7	327.4	29.0	258.7	*34.7*	*309.6*
Russet Norkotah	38.3	341.7	35.1	313.1	33.6	299.8	*35.7*	*318.5*
Ranger Russet	38.2	340.8	32.9	293.5	32.5	289.9	*34.5*	*307.8*
Shepody	40.5	361.3	32.4	289.1	39.5	352.4	*37.4*	*333.7*
Mean	*37.1*	*331.0*	*31.1*	*277.5*	*32.3*	*288.2*		

Analysis of Variance

Source	**Significance**
Cultivar	***(6.6)
Burying	*(4.3)
Cultivar x Burying	NS
C.V. (%)	20.0

Table 32. Effects of covering haulms on yield components for seed and consumption grade tuber of several potato cultivars.

Factor	Level	Seed grade tubers		Consumption grade tubers	
		Tuber No./hill	Av. tuber weight (g)	Tuber No./hill	Av. tuber weight (g)
Cultivar	Alpha	10.9	88	3.5	267
	Atlantic	6.3	166	4.4	392
	Norland	6.1	191	4.6	432
	Russet Burbank	7.8	148	4.8	361
	Russet Norkotah	6.9	160	4.8	369
	Ranger Russet	6.8	159	4.7	370
	Shepody	5.3	204	4.0	471
Covering	Check	7.4	167	4.8	387
	Burying at 5 cm	7.0	154	4.1	378
	Burying at 10 cm	7.1	158	4.3	374

Analysis of Variance

Source	**Significance**			
Cultivar	***(1.1)	***(17)	***(0.8)	***(36)
Burying	NS	*(11)	NS	NS
Cultivar x Burying	NS	NS	NS	NS
C.V. (%)	15.7	11.1	17.7	9.7

Production Package for Seed Potatoes

Principal:	D. Waterer, Department of Horticulture Science University of Saskatchewan, Saskatoon, Saskatchewan
Funding:	Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigator:	J. Wahab, Saskatchewan Irrigation Development Centre (Outlook)
Location:	Saskatoon; SIDC, Outlook
Progress:	Project completed
Objectives:	To develop cost-effective agronomic practices to increase yields and quality of seed potatoes of the varieties in demand in local and export markets.

Nordonna Agronomics

Nordonna is a newly released red skinned table variety that has potential to replace Norland which tends to lose colour during storage. There is a concern that Nordonna is slow maturing and may lack the yield potential of Norland. Plant populations (seed piece spacing) has a strong influence on yields, tuber size distribution and rate of maturity in potatoes. This trial evaluated the impact of seed piece spacing on yields of Nordonna under irrigated and dryland conditions.

The trial was conducted at the University of Saskatchewan Potato Field Research Station. Whole seed was planted at 17, 26, 35 and 52 cm in-row spacings (6, 10, 14 and 20") with between row spacing at 1 m (3.3'). Half of each plot was irrigated once soil water potentials reached -50 kPa. Total rainfall over the growing season was 11 cm (4.3"), while the total moisture applied as irrigation was 38 cm (15").

The 1997 growing season was exceptionally long, with excellent growing conditions throughout. Yields in 1997 should represent the optimum expected for Saskatchewan. The Nordonna canopy was more uniform than Norland but slower to establish. While the Norland crop had senesced by early September, the Nordonna crop was still growing vigorously at top kill in mid-September.

Yields and tuber size distribution were similar for the various in-row spacings tested when the crop was grown under dryland conditions (Figure 1). Yields on dryland were, on average, only 26% lower than when the crop was irrigated. This suggests that Nordonna is relatively drought tolerant, as rainfall was limited during the 1997 cropping season. When

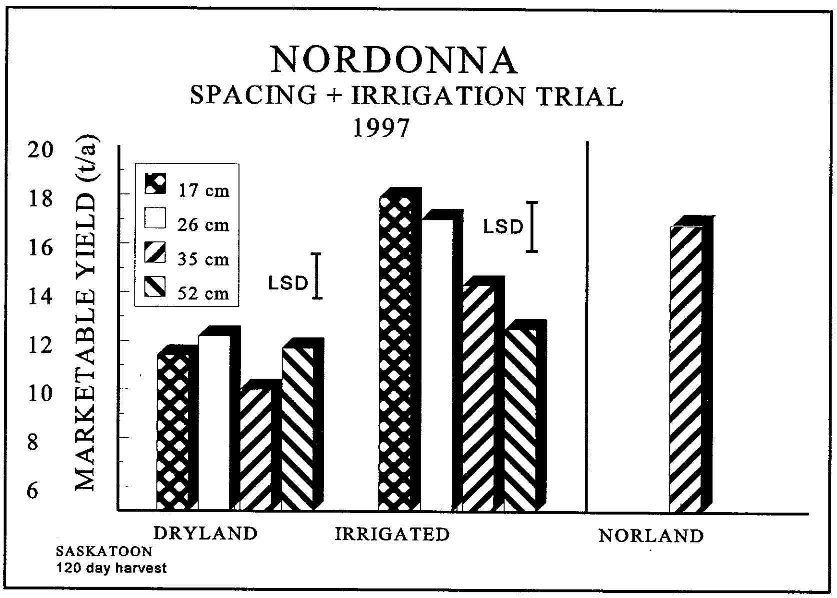


Figure 1. Marketable yields for Nordonna as influenced by irrigation practices and in-row spacings.

the crop was irrigated, yields in all tuber size categories increased as the in-row spacing decreased. Nordonna does not produce as many oversize tubers as does Norland. Yields of Nordonna were lower than Norland at standard in-row spacings (30 cm; 12 in), but when planted very close together, Nordonna produced yields comparable to Norland.

Spacing and Seed Type Under Irrigated and Dryland Conditions

i) *Shepody* (Saskatoon)

Shepody is renowned for its limited and unpredictable tuber set, making it a challenging cultivar to grow for seed. This trial evaluated the impact of two in-row spacings and the use of whole versus cut seed on yields and tuber size distribution of Shepody potatoes under both dryland and irrigated conditions.

Trials were conducted in 1995 through 1997 at the University of Saskatchewan Potato Field Research Station in Saskatoon and at the SIDC in Outlook. Elite III single cut or equivalent size drop seed was planted at 26 or 35 cm (10 or 14") in-row spacings in mid-May. Between row spacing was 1 m (3.3'). Half the plots were irrigated once soil water potentials reached -50 kPa, while the other plots were managed without irrigation.

The yields for the three test seasons at the Saskatoon and Outlook sites are summarized in Tables 1a and 1b.

This trial clearly demonstrated the unpredictability of Shepody in its responses to management variables. Use of whole seed was generally beneficial (or at least neutral) in terms of its effects on yields. Seed type had no effect on tuber size distribution; using whole seed increased yields in all size categories. Planting the seed closer together in the rows was consistently effective at both increasing yields and shifting tuber size distribution towards the size desired for seed use. The benefits of close in-row spacings were most apparent when the crop was provided with ample moisture. Contrary to expectation, close in-row spacing did not have any detrimental effects on yields in any of the dryland trials. Based on the data presented, dryland growers may be able to safely consider increasing plant populations. This would increase yield potential in wet years without presenting an undue risk (except the added cost of seed) in dry years.

ii) *Alpha, Atlantic, Russet Burbank, Shepody* (SIDC, Outlook)

Potato cultivars Alpha, Atlantic, Russet Burbank, and Shepody were evaluated. Whole (drop seed), half (single cut), and quarter (two cuts) seed pieces weighing approximately 45-50 g (1.5 -2 oz) were planted at 15 cm (6"), 20 cm (8"), and 30 cm (12") spacing within the row. The row spacing was maintained at 91 cm (36"). The crop was grown under irrigation with standard management practices.

Atlantic produced the highest and Alpha the lowest 'seed' and 'consumption' grade tube yields (Table 1b).

Tighter planting produced higher 'seed' grade yield. The different seed piece spacings tested (15-30 cm) had no effect on 'consumption' grade yield (Table 1c).

Table 1a. Influence of in-row spacing and seed-type on yields of Shepody potatoes under dryland and irrigated conditions in Saskatoon and Outlook in 1995-1997.									
	1995 Yield (t/ha)			1996 Yield (t/ha)			1997 Yield (t/ha)		
	Total	Medium	Small	Total	Medium	Small	Total	Medium	Small
OUTLOOK									
Irrigated									
Whole Seed	32.6	26.1	2.2	36.1	28	1.5	32.6	26.8	3
Cut Seed	30.3	25	1.5	27.8	23.6	1.6	28	23.4	2.8
	NS	NS	NS	**	**	NS	**	**	NS
26 cm (10 in)	34	27.6	2.5	35.4	28.6	1.9	31.6	26.6	3.3
35 cm (14 in)	29.1	23.5	1.2	28.5	23.1	1.4	28.8	23.6	2.5
	**	*	**	**	**	*	NS	NS	*
Dryland									
Whole Seed	20.6	17.8	2	14.9	11.8	1.8	14.3	8.1	5.5
Cut Seed	18.5	15.9	1.6	13	9.7	1.4	12	6.8	4.7
	*	*	NS	NS	*	*	*	**	NS
26 cm (10 in)	20.3	17.8	2	14.6	11.2	1.9	13.3	7.3	5.8
35 cm (14 in)	18.8	16.2	1.6	13.1	10.2	1.2	13.1	7.8	4.5
	NS	*	NS	NS	NS	*	NS	NS	**
SASKATOON									
Irrigated									
Whole Seed	41.1	32.3	5	46.2	37.5	4.1	46.8	39	2.1
Cut Seed	28.9	31.9	3.9	40.8	30.8	3.3	42.6	36.2	2.9
	NS	NS	NS	*	*	NS	**	**	*
26 cm (10 in)	41.6	32.6	5	47	36.8	4.2	46.6	39.1	3.1
35 cm (14 in)	37.8	31.5	3.9	10	31.4	3.1	43	36.6	2.2
	NS	NS	NS	*	*	*	**	NS	*
Dryland									
Whole Seed	41.1	33.9	5.4	24.6	16.2	7.2	38.8	33.9	3.2
Cut Seed	40.2	34	4.9	20.2	13.8	5.8	35.8	31.1	2.9
	NS	NS	NS	**	*	**	**	**	*
26 cm (10 in)	41.9	34.5	5.4	22.2	13.8	7.8	41.2	36.2	3.6
35 cm (14 in)	39.6	34.6	4.8	22.6	16.2	5.2	33.5	28.6	2.6
	NS	NS	NS	NS	*	**	**	**	*

NS = not significant; * P=0.05; ** P=0.01

Table 1b. Influence of in-row spacing and seed-type on yields of Shepody potatoes under dryland and irrigated conditions in Saskatoon and Outlook in 1995-1997.

	1995 Yield (cwt/ac)			1996 Yield (cwt/ac)			1997 Yield (cwt/ac)		
	Total	Medium	Small	Total	Medium	Small	Total	Medium	Small
OUTLOOK									
Irrigated									
Whole Seed	306	245	21	339	263	14	306	252	28
Cut Seed	284	235	14	261	216	15	263	220	26
	NS	NS	NS	**	**	NS	**	**	NS
26 cm	320	259	24	333	268	18	297	250	31
35 cm	273	221	11	268	217	13	270	222	23
	**	*	**	**	**	*	NS	NS	*
Dryland									
Whole Seed	194	167	19	140	111	17	134	76	52
Cut Seed	174	150	15	122	91	13	112	56	44
	*	*	NS	NS	*	*	*	**	NS
26 cm (10 in)	191	167	19	137	105	18	125	68	54
35 cm (14 in)	177	152	15	123	96	11	123	73	42
	NS	*	NS	NS	NS	*	NS	NS	**
SASKATOON									
Irrigated									
Whole Seed	386	303	47	434	352	38	435	367	20
Cut Seed	272	297	37	383	289	31	400	340	2.7
	NS	NS	NS	*	*	NS	**	**	*
26 cm (10 in)	391	306	47	442	345	39	438	367	29
35 cm (14 in)	355	296	37	94	295	29	404	338	21
	NS	NS	NS	*	*	*	**	NS	*
Dryland									
Whole Seed	386	319	51	231	152	68	364	310	30
Cut Seed	377	320	46	190	129	55	336	292	27
	NS	NS	NS	**	*	**	**	**	*
26 cm (10 in)	393	324	51	208	129	73	387	340	34
35 cm (14 in)	372	325	45	212	152	49	314	269	24
	NS	NS	NS	NS	*	**	**	**	*

NS = not significant; * P=0.05; ** P=0.01

Table 1c. Effects of seed piece form, and within-row spacing on seed and consumption grade tuber yields for selected potato cultivars.

Factor	Level	Seed grade tuber yield		Consumption grade tuber yield	
		t/ha	Cwt./ac	t/ha	Cwt./ac
Cultivar[z]	Alpha	33.2	296	17.3	154
	Atlantic	42.4	378	37.0	330
	Russet Burbank	41.8	373	30.3	270
	Shepody	37.9	338	35.6	318
Seed form[y]	Whole tuber	39.4	352	30.2	269
	Half	37.7	336	29.2	261
	Quarter	39.4	352	30.7	274
Spacing[x]	15 cm	43.6	389	29.2	261
	20 cm	39.4	352	30.7	274
	30 cm	33.5	299	30.2	269

Analyses of Variance

Source	Significance	
Cultivar	***(3.5)	***(2.2)
Form	NS	NS
Spacing	***(3.0)	*(2.7)
Cultivar x Form	***(6.0)	*(5.5)
Cultivar x Spacing	NS	NS
Form x Spacing	NS	NS
Cultivar x Form x Spacing	NS	NS
C.V. %	19.1	22.4

[z]Average of seed form and spacing. [y]Average of cultivar and spacing.
[z]Average of cultivar and and seed form.

Different cultivars responded differently to type of seed piece used. Figure 2 illustrates the interactive response between cultivars and seed piece form in relation to 'seed' grade yield. For example, (i) single cut seed pieces produced lower yields for oblong potato cvs. Russet Burbank and Shepody, (ii) whole seed was better for Alpha, and (iii) single cut was superior for Atlantic. Further studies will be conducted to establish the importance of seed piece type with different potato cultivars.

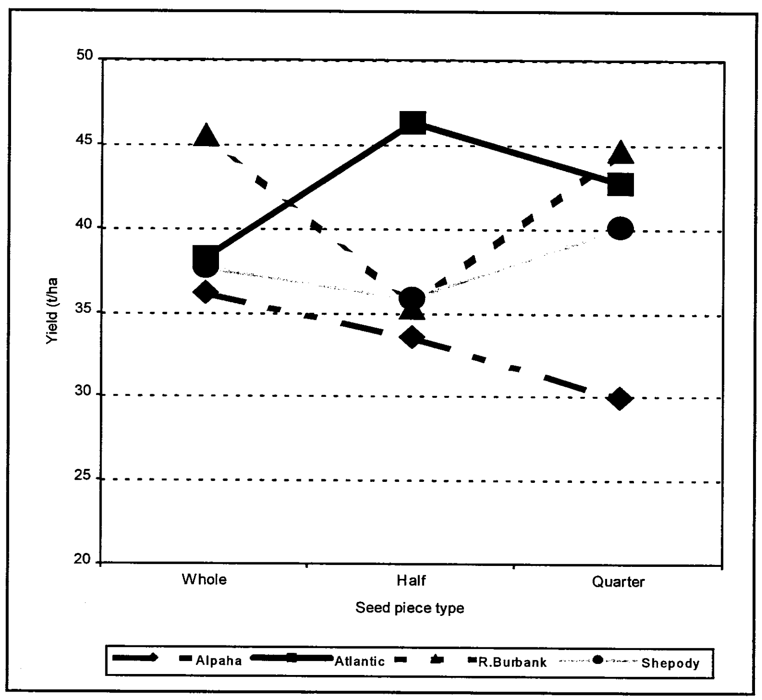


Figure 2. Interactive effects of cultivars and seed piece form on seed grade tuber yield.

Shepody - Seed Handling Techniques

Saskatoon

Potato crops grown from physiologically old seed tubers produce more mainstems, set more tubers relatively early in crop development, and senesce prematurely. The resulting crop has a small average tuber size distribution. In cultivars like Shepody, where tuber set is low, advancing the physiological age of the seed may improve yields of the tuber size categories suited for use as seed. This study examined the impact of various seed handling techniques on yields and tuber size distribution of Shepody grown for seed purposes.

The trial was conducted in 1996 and 1997 at the University of Saskatchewan Potato Field Research Station in Saskatoon. Elite III Shepody seed was treated as follows:

1) No aging - (whole seed) - stored at 4°C (39°F) until one week prior to planting then warmed to 15°C (59°F)
2) No aging (cut) - as in treatment 1, except seed cut just prior to planting
3) Short-term aging - as in treatment 1 except seed stored at 15°C (59°F) in the dark for two weeks in mid-March.
4) Green-sprouting - as in treatment 3, except seed held in the light during aging treatment.
5) Long-term aging - as in treatment 3, except seed held for 6 weeks at 15°C then desprouted prior to planting.

The crop was planted in mid-May. Standard management practices for an irrigated crop were utilized. The crop was harvested and graded as previously described.

Results in 1996 and 1997 were very similar and only the 1997 data is presented in Table 2. The only consistent treatment effect was the superior performance of the whole seed treatments relative to the cut seed. The poor performance of the cut seed again probably reflects loss of stand or limited mainstem development due to decay of the cut seed pieces. Green-sprouting and a limited degree of aging produced minor (non-significant) improvements in yields relative to the control treatments. Extreme aging had a less than expected negative effect on performance of the seed. Although this seed was desprouted and quite dehydrated by planting, it yielded as well as the best seed tested. This demonstrates the vigour of Saskatchewan grown seed.

Table 2. Influence of seed handling regimes on yields and tuber size distribution of Shepody seed potatoes (1997).

	YIELDS						Average Tuber Wt	
	Total		Medium		Drop Seed			
	t/ha	cwt/ac	t/ha	cwt/ac	t/ha	cwt/ac	(g)	(oz)
Green-sprouted	44.5	418	35.2	331	3.6	34	221	7.8
Short-term aged	43.2	406	33.3	313	3.6	34	220	7.8
Long-term aged	35.2	331	30.1	282	2.8	26	196	6.9
No aging (whole)	37.2	350	30.3	285	3.6	34	228	8.0
No aging (cut)	33.5	315	27.9	262	2.6	24	196	6.9
LSD (0.05)	**7.8**	**73**	**6.1**	**57**	**1.1**	**10**	**26**	**0.9**

Shepody and Norkotah - Planting/Harvest Date Trial

Saskatoon

Seed growers attempting to control tuber size by shortening the growing season have the option of planting late or harvesting early. This study examined yields and tuber size distribution for Shepody and Russet Norkotah potatoes grown for three different 90 day intervals during the 1996 and 1997 growing seasons.

In 1996, the growing season running from late May to late August 29 produced higher yields of medium or marketable size tubers than either the earlier or later regimes. Cold and wet conditions during the spring of 1996 could have contributed to the poor performance of the early regime. However, conditions did not improve significantly until well after all three plantings were established. Yields of the late planting may have been reduced by heat stress in late August, yet the second planting was also in the field during most of the stress period.

In 1997, the trial was conducted in Saskatoon under irrigated and dryland conditions. Elite III single cut seed was planted in mid-May, late May or mid-June for harvest 90 days later. The crop was managed and graded as previously described.

In the dryland trial, the two cultivars responded in a similar manner to the planting/harvest dates (Table 3). The second and third planting/harvest date produced superior total yields and yields of medium size tubers. In the Norkotahs, the first planting produced the largest proportion of drop size seed.

Table 3. Yields and tuber size distribution for Russet Norkotah and Shepody potatoes grown for 90 days at three points during the 1997 season - dryland trial.

	Total		Medium		Drop		Avg. Wt. (g)
	t/ha	tubers/ha X 1000	t/ha	tubers/ha X 1000	t/ha	tubers/ha X 1000	
Russet Norkotah							
mid-May to mid-Aug.	14.6 a	147 a	8.6 b	66 a	5.9 a	88 a	100 b
late May to late Aug.	16.8 a	155 a	12.0 a	77 a	4.8 ab	78 a	109 ab
mid-June to mid-Sept.	13.8 a	114 b	10.2 ab	64 a	3.2 b	50 b	121 a
Shepody							
mid-May to mid-Aug.	14.0 b	130 b	9.8 b	70 b	3.4 a	59 b	130 c
late May to late Aug.	21.5 a	190 a	16.1 a	101 a	4.4 a	87 a	156 b
mid-June to mid-Sept.	19.5 a	138 b	16.1 a	95 ab	3.1 a	45 b	186 a
	Total		Medium		Drop		Avg. Wt. (oz)
	cwt/ac	000/ac	cwt/ac	000/ac	cwt/ac	000/ac	
Russet Norkotah							
mid-May to mid-Aug.	137 a	59 a	81 b	26 a	55 a	35 a	3.5 b
late May to late Aug.	157 a	62 a	113 a	31 a	45 ab	31 a	3.5 ab
mid-June to mid-Sept.	130 a	46 b	97 ab	26 a	30 b	20 b	4.3 a
Shepody							
mid-May to mid-Aug.	131 b	52 b	92 b	28 b	32 a	24 b	4.6 c
late May to late Aug.	202 a	76 a	151 a	40 a	41 a	35 a	5.5 b
mid-June to mid-Sept.	183 a	55 b	151 a	38 ab	29 a	18 b	6.5 a

Values within columns followed by the same letter are not significantly different.

Under irrigation, the earliest planting/harvest combination was superior in all yield categories for the Norkotahs, while the middle combination was optimal for the Shepodys (Table 4).

The results from the trial are not unexpected given the growing conditions encountered in 1997. The 1997 growing season was exceptionally hot and dry through July and mid-August. The early planted crop grown without irrigation was exposed to adverse conditions throughout tuber set and bulking, resulting in poor yields. However, when irrigation was available, the heat was favourable to canopy development resulting in superior yields for the first or second planting combinations. The Shepodys were less adversely affected by the drought stress than the Norkotahs. The slower developing Shepodys may have undergone tuber set and enlargement late in the season under more favourable conditions.

Table 4. Yields and tuber size distribution for Russet Norkotah and Shepody potatoes grown for 90 days at three points during the 1997 season - irrigated trial.

	Total		Medium		Drop		Avg.
	t/ha	tubers/ha X 1000	t/ha	tubers/ha X 1000	t/ha	tubers/ha X 1000	Wt. (g)
Russet Norkotah							
mid-May to mid-Aug.	47.8 a	227 a	38.5 a	167 a	3.0 a	50 a	209 a
late May to late Aug.	35.0 b	175 b	29.8 b	131 b	2.2 a	36 a	209 a
mid-June to mid-Sept.	33.2 b	153 b	27.6 b	101 b	3.2 a	50 a	212 a
Shepody							
mid-May to mid-Aug.	17.4 b	120 a	12.3 b	646	2.2 a	53 a	150 a
late May to late Aug.	28.2 a	150 a	22.8 a	112 a	2.2 a	43 a	178 a
mid-June to mid-Sept.	18.9 a	120 a	14.8 b	716	2.8 a	48 a	155 a
	Total		**Medium**		**Drop**		**Avg.**
	Cwt/ac	000/ac	Cwt/ac	000/ac	Cwt/ac	000/ac	(oz)
Russet Norkotah							
mid-May to mid-Aug.	449 a	91 a	361 a	67 a	28 a	20 a	7.4 a
late May to late Aug.	329 b	70 b	280 b	52 b	21 a	14 a	7.4 a
mid-June to mid-Sept.	312 b	61 b	259 b	40 b	30 a	20 a	7.5 a
Shepody							
mid-May to mid-Aug.	163 b	48 a	116 b	26 b	21 a	21 a	5.2 a
late May to late Aug.	265 a	60 a	214 a	45 a	21 a	17 a	6.3 a
mid-June to mid-Sept.	177 a	48 a	139 b	28 b	26 a	19 a	5.5 a

Values within columns followed by the same letter are not significantly different.

SIDC, Outlook

A similar test was conducted with Shepody and Russet Norkotah potato at SIDC. This study examined three planting times (May 16, May 26, June 5) and three harvest times (August 14, August 25, September 4). Two seed piece spacings (15, 30 cm; 6, 12 in) were also compared in this test.

For Russet Norkotah, early planting and late harvesting produced higher 'seed' and 'consumption' grade yields than late planting and early harvesting (Table 5a). The 15 cm (6 in) seed piece spacing produced 26% higher 'seed' grade yield than 30 cm (12 in) spacing. However, tighter planting produced only a slight (non-significant) yield increase in 'consumption' grade yield.

Table 5a. Planting and harvesting dates, and seed piece spacing effects on seed and consumption grade tuber yields and tuber specific gravity for Russet Norkotah potato.

Factor	Level	Seed grade yield		Consumption grade yield		Specific gravity
		t/ha	Cwt./ac	t/ha	Cwt./ac	
Planting date[z]	Early	45.9	409	36.4	325	1.094
	Mid	42.1	376	31.4	280	1.086
	Late	39.7	354	31.4	280	1.080
Harvest date[y]	Early	36.4	325	25.0	223	1.082
	Mid	44.1	393	35.2	314	1.091
	Late	47.2	421	39.0	348	1.088
Seed spacing[x]	15 cm	48.0	428	34.7	310	1.087
	30 cm	38.0	339	31.5	281	1.087

Analyses of Variance

Source	Seed grade yield	Consumption grade yield (Significance)	Specific gravity
Planting	***(4.3)	***(4.3)	*(0.011)
Harvesting	***(4.3)	**(4.3)	NS
Spacing	***(3.5)	NS	NS
Planting x Harvest	NS	NS	NS
Planting x Spacing	NS	NS	NS
Harvesting x Spacing	NS	NS	NS
Plant. x Harvest. x Spac.	NS	NS	NS
C.V. (%)	16.9	22.0	1.7

[z]Average of harvest date and seed piece spacing.
[y]Average of planting date and seed piece spacing.
[x]Average of planting date and harvest date.

For Shepody, there was a significant planting data x harvest date x spacing interaction for 'seed' grade yield (Table 5b), i.e. the optimum planting date will depend on the harvest date and spacing. The trends observed for Shepody can be summarized as follows:

(i) The yield response for the 90 day crop, that corresponds to Early planting-Early harvest, Mid planting-Mid harvest, and Late planting-Late harvest, depends on the seed piece spacing. For example, at 15 cm spacing, May 26 planting produced more than double the yield than the crop planted on May 16, and planting on June 6 resulted in a 7% yield loss compared to the May 26 crop. Under wider spacing, there was a progressive increase in yield for consecutive planting dates and the yield increase was approximately 78 % between the first and the second planting dates and only 8% between the second and the third planting dates.

(ii) At 15 cm seed piece spacing: For the August 14 harvest, the highest yield was obtained for May 16 planting. For August 25 and September 4 harvests, both May 16 and June 6 plantings produced similar yields. At 30 cm seed piece spacing: For all three harvest dates, late planting produced lower yields than early planting.

Table 5b. Effects of planting and harvesting dates and seed piece spacing on seed grade tuber yield for Shepody potato.

Seed piece spac.	Planting date	Harvest date / Seed grade tuber yield							
		Early		Mid		Late		*Mean*	
		t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac	*t/ha*	*Cwt/ac*
15 cm	Early	22.8	203	43.7	390	44.4	396	*37.0*	*330*
	Mid	24.6	219	49.0	437	44.1	393	*39.3*	*351*
	Late	11.1	99	34.7	310	45.6	407	*30.5*	*272*
	Mean	*19.5*	*174*	*42.3*	*377*	*44.7*	*399*	*35.6*	*318*
30 cm	Early	19.0	170	31.9	285	44.9	401	*31.9*	*285*
	Mid	19.8	177	33.9	302	36.8	328	*39.3*	*351*
	Late	13.0	116	27.1	242	28.5	254	*22.9*	*204*
	Mean	*17.3*	*154*	*31.0*	*277*	*36.7*	*327*	*31.4*	*280*
Mean		*18.4*	*164*	*36.7*	*327*	*40.7*	*363*		

Analysis of Variance

Source	**Significance**
Planting (P)	***(3.5)
Harvesting (H)	***(6.0)
Spacing (S)	***(2.5)
P x H	NS
P x S	NS
H x S	*(4.3)
P x H x S	*(7.4)
C.V. (%)	15.9

Irrigation and Seed Piece Spacing Study

<u>SIDC, Outlook</u>

Potato responds well to irrigation. The optimum plant population depends on cultivars and the soil moisture regimes under which the crop is grown. It is reported that maximum potato yields are obtained when the soil moisture status is maintained at 65% Field Capacity. This study investigated the effects of plant population (15, 20, 30 cm; 6, 8, 12 in seed piece spacing) for Atlantic, Norland, Russet Burbank, Russet Norkotah, and Shepody potato grown under 65% FC, 40% FC, and dryland conditions. The 1997 growing season received 174 mm (6.9 in) rain and required 229 mm (9.0 in) and 305 mm (12.0 in) of supplementary irrigation to maintain the soil moisture levels at 40% and 65% FC, respectively.

Under dryland conditions the overall 'seed' grade yield was 15.8 t/ha or 141 Cwt./ac (Table 5c). The 40% FC soil moisture regime outyielded the dryland by 162%. The 65% FC regime produced 24% higher yield than 40% FC. Under dryland cropping, all seed piece spacing tested produced similar yields.

Table 5c. Seed grade tuber yields for selected potato cultivars grown at different plant populations and irrigation regimes.

Factor	Level	Seed grade tuber yield					
		Dryland		40% Field capacity		65% Field capacity	
		t/ha	Cwt./ac	t/ha	Cwt./ac	t/ha	Cwt./ac
Cultivar[z]	Atlantic	17.8	159	40.6	362	54.2	484
	Norland	17.0	152	43.6	389	52.6	469
	Russet Burbank	15.5	138	44.1	393	51.4	459
	Russet Norkotah	13.6	121	44.4	396	49.7	443
	Shepody	15.1	135	35.6	318	49.6	443
Spacing[y]	15 cm	15.8	141	44.4	396	52.8	471
	20 cm	16.3	145	42.9	383	52.9	472
	30 cm	15.3	136	37.6	335	48.8	435
Analyses of Variance							
Source		**Significance**					
Cultivar		***(1.9)		*(6.4)		NS	
Spacing		NS		*(5.0)		*(3.4)	
Cultivar x Spacing		NS		NS		**(7.7)	
CV (%)		14.6		18.7		10.5	

[z] Average of spacing. [y] Average of cultivars.

Under 40% soil moisture, reducing seed piece spacing from 30 to 15 cm produced progressively higher yields, however, the yield differences between the 15 and 20 cm spacing was not significant. The 20 cm spacing outyielded the 30 cm spacing by 14%. The difference between the 15 cm and 20 cm spacing was only 3%.

Under 65% soil moisture, the 20 cm seed piece spacing produced 8% higher yield than the 30 cm spacing, while the 20 and 15 cm spacings produced similar 'seed' grade yields (Table 3c). Under 65% soil moisture, different cultivars responded differently to change in seed piece spacing. For Atlantic, Norland, and Russet Norkotah, an increase in seed piece spacing tended to decrease tuber yield (Figure 3). Shepody produced the highest and Russet Burbank produced the lowest 'seed' grade yield at 20 cm seed spacing. Further studies are being carried out to determine the optimum seed piece spacing for various potato cultivars grown under different moisture regimes.

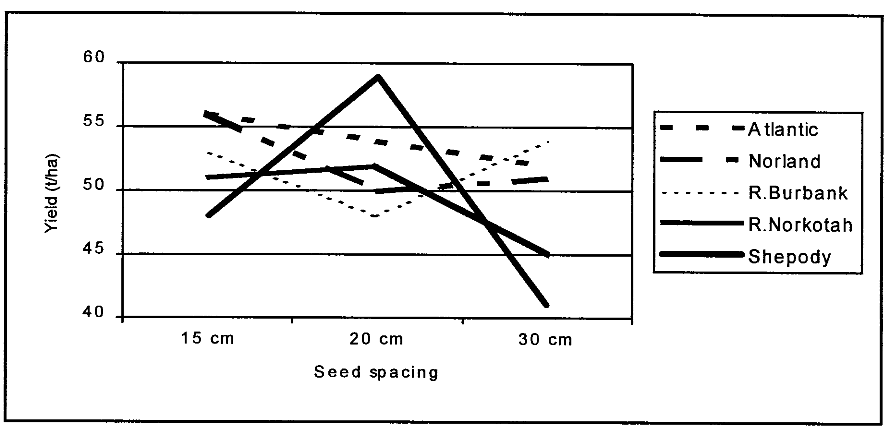


Figure 3. Interactive effects of seed piece spacing and cultivar on seed grade yield for potato grown under 65% Field Capacity.

Effects of Seed Piece Spacing Uniformity and Soil Moisture Status on 'Seed' Grade Yield

SIDC, Outlook

Russet Burbank, Russet Norkotah, and Shepody potato were planted at two plant populations (approximately 73,000 and 35,500 hills/ha; 29,400 and 14,300 hills/ac) and three seed piece spacing treatments. Seed pieces were hand planted (to simulate skips and misses) to provide zero, 32% and 65% variability for seed piece distribution (coefficient of variation based on the uniformity of seed piece spacing). For example, zero variability indicates the seed pieces are spaced uniformly. 65% C.V. represents the most variable seed piece distribution within the row. Similar tests were carried out under dryland, 40%, and 65% available soil moisture situations.

Under the dryland situation, uniform spacing (i.e. zero variability) produced the highest 'seed' grade tuber yield. The most variable seed distribution produced the lowest tuber yield (Table 5d). The yield response to spacing variability is generally similar for the different cultivars and plant populations.

Table 5d. Effects of seed piece spacing and uniformity of distribution on seed grade tuber yield for Russet Burbank, Russet Norkotah, and Shepody potato grown under dryland conditions.

Cultivar	Seed spacing variability (C.V.%)	Seed grade tuber yield					
		73000 hills/ha		35500 hills/ha		Mean	
		t/ha	Cwt./ac	t/ha	Cwt./ac	t/ha	Cwt./ac
Russet Burbank	0	22.1	197	19.5	174	20.8	186
	32	19.0	170	19.7	176	19.3	172
	65	18.3	163	16.7	149	17.5	156
	Mean	19.8	177	18.4	164	19.1	170
Russet Norkotah	0	17.3	154	17.0	152	17.1	153
	32	17.5	156	17.3	154	17.4	155
	65	17.7	158	16.0	143	16.8	150
	Mean	17.5	156	16.8	150	17.1	153
Shepody	0	20.5	183	17.9	160	19.2	171
	32	17.4	155	18.6	166	18.0	161
	65	18.0	161	16.7	149	17.3	154
	Mean	18.6	166	17.7	158	18.1	161
Mean		18.6	166	17.6	157	18.1	161

Analysis of Variance

Source	**Significance**
Cultivar	** (1.3)
Population	NS
Variability	*(1.3)
Cultivar x Population	NS
Cultivar x Variability	NS
Population x Variability	NS
Cultivar x Population x Variability	NS
C.V. (%)	12.1

Under 40% soil moisture situation, the response to seed piece spacing variability was dependent on both cultivars and plant population (i.e. significant Cultivar x Spacing x Variability interaction: Table 5e). There were no identifiable trends on productivity in relation to plant population, spacing variability or cultivar effects. However, tuber yields tended to decrease with increase in stand variability. This phenomenon was more pronounced at the higher plant population for Russet Burbank, and at the lower plant population for Russet Norkotah.

Table 5e. Effects of seed piece spacing and uniformity of distribution on seed grade tuber yield for Russet Burbank, Russet Norkotah, and Shepody potato grown under 40% available soil moisture.

Cultivar	Seed spacing variability (C.V.%)	Seed grade tuber yield					
		73000 hills/ha		35500 hills/ha		Mean	
		t/ha	Cwt./ac	t/ha	Cwt./ac	t/ha	Cwt./ac
Russet Burbank	0	44.7	399	40.9	365	42.8	382
	32	42.2	376	40.3	360	41.3	368
	65	36.7	327	48.1	429	42.4	378
	Mean	*41.2*	*368*	*43.1*	*385*	*42.2*	376
Russet Norkotah	0	42.5	379	41.9	374	42.2	376
	32	44.9	401	40.4	360	42.7	381
	65	43.4	387	33.3	297	38.4	343
	Mean	*43.6*	*389*	*38.5*	*343*	*41.1*	367
Shepody	0	44.7	399	35.9	320	40.3	360
	32	45.3	404	38.2	341	41.8	373
	65	44.3	395	34.1	304	39.2	350
	Mean	*44.8*	*400*	*36.1*	*322*	*40.4*	360
Mean							

Analysis of Variance

Source	**Significance**
Cultivar	NS
Population	***(2.3)
Variability	NS
Cultivar x Population	***(3.9)
Cultivar x Variability	NS
Population x Variability	NS
Cultivar x Population x Variability	**(6.8)
C.V. (%)	11.6

Under 65% soil moisture level, only plant population showed significant treatment effect, i.e. tighter planting produced 11% higher 'seed' grade yield (Table 5f). It appears that under optimum soil moisture conditions, seed piece spacing variability has less impact on yield than under dryland or restricted moisture situations such as 40% FC.

Table 5f. Effects of seed piece spacing and uniformity of distribution on seed grade tuber yield for Russet Burbank, Russet Norkotah, and Shepody potato grown under 65% available soil moisture.

Cultivar	Seed spacing variability (C.V.%)	Seed grade tuber yield					
		73000 hills/ha		35500 hills/ha		Mean	
		t/ha	Cwt./ac	t/ha	Cwt./ac	t/ha	Cwt./ac
Russet Burbank	0	46.2	412	44.3	395	45.2	403
	32	53.5	477	44.5	397	49.0	437
	65	41.7	372	44.1	393	42.9	383
	Mean	*47.1*	*420*	*44.3*	*395*	*45.7*	408
Russet Norkotah	0	53.1	474	50.2	448	51.65	461
	32	50.1	447	43.7	390	46.9	418
	65	45.1	402	40.3	360	42.7	381
	Mean	*49.4*	*441*	*44.7*	*399*	*47.1*	420
Shepody	0	49.2	439	47.2	421	48.2	430
	32	51.8	462	44.0	393	47.9	427
	65	56.2	501	43.2	385	49.7	443
	Mean	*52.4*	*467*	*44.8*	*400*	*48.6*	434
Mean		*49.6*	*443*	*44.6*	*398*	*47.1*	*420*

Analysis of Variance

Source	**Significance**
Cultivar	NS
Population	**(3.4)
Variability	NS
Cultivar x Population	NS
Cultivar x Variability	NS
Population x Variability	NS
Cultivar x Population x Variability	NS
C.V. (%)	15.4

Seed Generation Effects on Productivity

SIDC, Outlook

Seed potatoes are grown for several generations in the field before marketing. It is perceived that in the relatively cooler northern climates the incidence of virus carrying insects and other pathogens are considerably less. Therefore, it is likely that lower generation seed-tubers will also be of higher quality.

This study compares the yield potentials ('seed' and 'consumption' grade tubers) for E-1, E-2, and E-3 seed generations of Dark Red Norland, Russet Burbank, Ranger Russet, Viking, and Yukon Gold grown under irrigation.

Significant cultivar x generation interaction was observed for 'seed' grade yield (Figure 4). However, there were no consistent trends in relation to seed generation effects for the various cultivars. The different seed generations produced similar 'consumption' grade yield for the various cultivars (Figure 5). This is indicative of the superior quality of high and low generation seed potato grown in the pristine, disease-free environment in Saskatchewan.

Analysis of Variance	
Source	**Significance**
Cultivar	***(4.0)
Generation	NS
Cultivar x Generation	**(6.9)
C.V. (%)	9.9

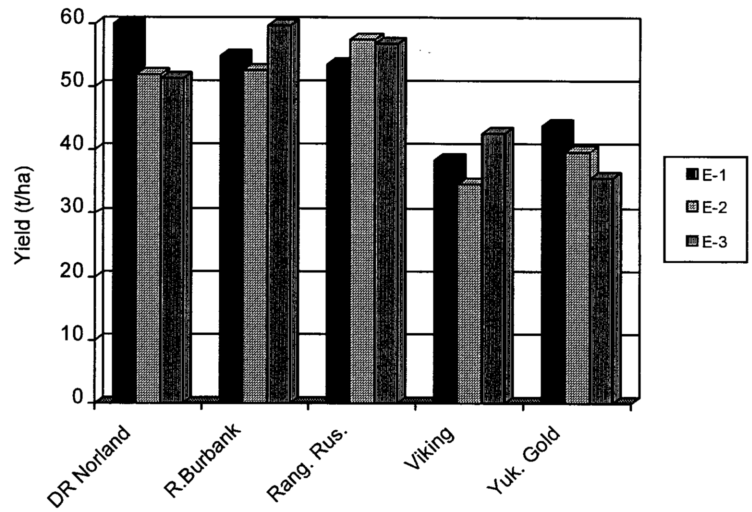


Figure 4. Seed grade tuber yields for E-1, E-2, and E-3 generations of selected potato cultivars.

Analysis of Variance	
Source	**Significance**
Cultivar	***(4.9)
Generation	NS
Cultivar x Generation	NS
C.V. (%)	13.6

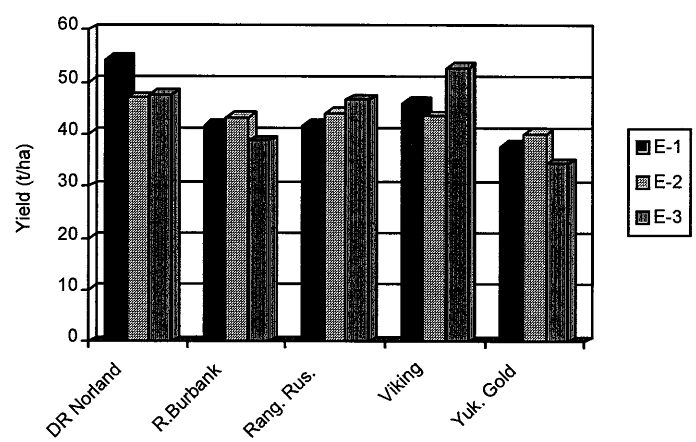


Figure 5. Consumption grade tuber yields for E-1, E-2, and E-3 generations of selected potato cultivars.

The authors wish to thank the Seed Potato Growers of Saskatchewan for their support in these trials. The projects depended on the capable technical help provided by Jackie Bantle, Celine Burns and Arlen Kapiniak.

Dormancy Management in Seed and Table Potatoes - Phase II

Principal: K. Tanino, Department of Horticulture, University of Saskatchewan, Saskatoon
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-investigators: M. Bandara, D. Waterer, Department of Horticulture;
J. Wahab, Saskatchewan Irrigation Development Centre;
P. Dyck, Lakeview Growers Inc., Saskatoon
Location: Outlook
Progress: Final year of two
Objectives:
To examine the potential for utilizing carvone extracted from locally grown caraway and dill seeds and for using various plant growth regulators [Abscisic acid (ABA), methyl jasmonate (MJ), GA_3, paclobutrazol and Na-salt of NAA (αNaphtalic acetic acid)] as a means of inhibiting sprout growth in table potatoes and extending or breaking dormancy in seed potatoes. Treatments with CIPC and maleic hydrazide were included to serve as standard treatments for extending dormancy in table potatoes.

Effective suppression of sprout growth during storage is critical for cost-effective production of table, processing and seed potatoes. Treatment with CIPC is the standard means for sprout suppression in table and processing potatoes in North America. CIPC is presently under regulatory review due to suspected health problems associated with low level residues of the products and due to concerns that CIPC may be involved in depletion of atmospheric ozone. Excessive sprout growth during storage is a common problem, particularly when growers are storing cultivars with a short natural dormancy period. The effects of any sprout inhibition treatment must be reversible and without any adverse impact on the vigor of seed potatoes. This project examines the potential for utilizing extracts from caraway and dill seeds, the pure form of carvone (major active component of caraway and dill seed extracts), and natural and synthetic plant growth regulators (mainly for seed potatoes) as a means of regulating dormancy in seed potatoes and inhibiting sprout growth in table and processing potatoes. Treatments with CIPC (post-harvest treatment) and maleic hydrazide (10 g/L; pre-harvest foliar-treatment) were included to serve as standard treatments for sprout suppression in table potatoes.

Norland and Snowden potatoes were treated with (+) carvone or methyl jasmonate (MJ) at 300 mg(a.i.)/kg [0.005 oz (a.i.)/lb] of potatoes, or 150 mg of carvone + 150 mg of MJ/kg (0.0025 oz of carvone +0.0025 oz of MJ/lb) of potatoes, in powder form, using perlite as a carrier. Treatments were imposed as repeated applications at about five weeks (1st application) and ten weeks (2nd application) after storage at 9°C. In a separate study, tubers of both cultivars were treated with water (control), aqueous solutions of 2% or 4% (+) carvone, caraway seed extract containing 4% (+) carvone, 2% MJ, and 2% MJ + 2% (+) carvone at 5 mL of solution/kg of potatoes. Applications were made at five weeks and ten weeks after storage at 9°C. Both CIP and maleic hydrazide were found to be the most effective treatments for suppressing sprout growth in potatoes. Carvone and MJ applied as a powder, and carvone, caraway seed extract, or MJ applied as an emulsion effectively suppressed sprout growth of both cultivars for over eight weeks relative to the controls.

In a separate study, Norland and Snowden potatoes were treated with (+) carvone vapour at 60 or 100 mL/m^3, (1.6 or 2.8 oz/$yard^3$), caraway seed extract at 60 mL/m^3 (1.6 oz/$yard^3$), 30 ml of MJ + 30 mL of carvone/m^3 (0.8 oz of MJ + 0.8 oz of carvone/$yard^3$), or diallyl disulphide at 60 mL/m^3 (1.6 oz/$yard^3$), as vapours by exposing tubers to the compounds for four days, at five weeks (1st application) and ten weeks (2nd application) after storage at 9°C. The treatments effectively suppressed sprouting in both potato cultivars for at least eight weeks more than the untreated controls. Diallyl disulphide vapour treatments appear to be the most effective sprout suppressant compared to the carvone and MJ treatments. Its effect was similar to that of CIPC and maleic hydrazide.

Field-grown Norland, Snowden and Russet Burbank potatoes were foliar-treated with ABA, MJ or jasmonic acid derivative (PDJ) (at 100 mg/L at early stolon initiation, and at 100 mg/L at mid bulk stage), paclobutrazol (at 450 mg/L at early stolon initiation, and at 1000 mg/L at mid bulking stage) or giberellic acid (GA_3) at 200 mg/L (at mid bulking stage) to examine the treatment effect on sprout behaviour in storage at 4°C. Both treated and untreated tubers of the three cultivars are still dormant and the investigation is in progress.

Integrated Control of Potato Common Scab

Principal:	D. Waterer, Department of Horticulture Science University of Saskatchewan, Saskatoon, Saskatchewan
Funding:	Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Location:	Saskatoon and the Saskatchewan Irrigation Development Centre (Outlook)
Progress:	Project completed
Objectives:	To develop an integrated strategy for common scab control through management of soil fertility, moisture and crop development.

pH Effects

The common scab organism (*Streptomyces scabies*) prefers soil pH from 5.5 - 8.0, which corresponds to the pH of most Saskatchewan soils. This trial (1995-1997) examined whether scab could be controlled by shifting the soil pH without adversely affecting the crop. The soil pH in plots at Outlook and Saskatoon was altered by applying $CaCO_3$ or S to a range of pH levels. The moderately scab resistant variety Norland was used as the test variety. Where possible, the Norland seed used at the Outlook site was heavily infested with scab in order to introduce adequate inoculum. Each test plot consisted of four 8 m (26') long rows arranged in a randomized complete block design with four replicates. Standard production and irrigation practices were employed. The crop was harvested and graded for yields. 100 tubers were evaluated for scab damage.

The pH treatments tested ranged from 6.5 to 9.0. Yields of marketable size tubers were similar at all pH levels at both sites in both years. There was only scattered scab on any of the treatments at the Outlook site, despite the fact that the seed was heavily infested. At the Saskatoon site in 1995 and 1996, the highest pH levels tested (pH 8.5 and 9.0) greatly reduced the incidence and severity of scab on the crop. There were few differences between the other levels tested (Table 1). In 1997 shifting the pH to 7.5 or 8.0 resulted in a substantial reduction in scab levels relative to the control (pH 8.5). Shifting the pH to higher levels by the application of lime worsened the scab situation.

Table 1. Influence of soil pH on grade out to excessive scab for Norland potatoes (Saskatoon 1995-1997).

pH	1995	1996	1997	x̄
	% Grade Out to Scab			
6.5	33	37	-	35
7.0	31	34	-	32
7.5	38	33	20	30
8.0	41	29	20	30
8.5	15	20	29	21
9.0	-	-	36	
9.5	-	-	36	

In summary, adjusting the pH to 8.5 or 9.0 will reduce losses to scab without adversely affecting yields on Saskatchewan soils with a history of scab problems. Growers are cautioned that the availability of some soil nutrients begins to decline at these high pH levels and that all cultivars may not respond similarly to high pH levels.

Time of Planting

Planting time can influence soil temperatures and evaporation rates during tuber set. If early planting results in tuber set during the relatively cool weather of early summer there should be relatively fewer problems with scab than if tubers were set during more drought-prone weather. This trial examined the relationship between time of planting and the incidence of common scab in potatoes.

Trials were conducted from 1995 to 1997 in Saskatoon using Norland and Shepody potatoes. The early crop was seeded in the second week of May while the late crop was seeded four weeks later. Standard management practices were employed. Each plot consisted of three 8 m (26') long rows, arranged in a randomized complete block design with four replicates. The trial was laid out to allow for three harvest dates (early August, late August and mid-September). The crop was graded and evaluated for scab as previously described.

The yield and scab level responses for the Norland and Shepody potatoes were similar in both years and consequently only the Norland data is presented.

1995 Trial

Delaying planting by four weeks had relatively little effect on yields, unless the crop was also harvested early (Table 2). Grade-out to scab was high in this trial. The combination of early planting and delaying the harvest resulted in a substantial increase in grade-out to excessive scab. As a consequence, planting late and harvesting relatively early produced the highest yields of scab free Norland tubers in 1995.

1996 Trial

Delaying planting by four weeks resulted in a substantial reduction in yields in 1996 (Table 2). In the early planted crop, delaying the harvest until late September was not necessary to produce maximum yields. The late planted crop benefited from delaying the harvest as long as possible. Severity of grade-out to scab increased as harvest was delayed, although the impact of the delay on scab severity was more pronounced in the late planted crop. The early planted crop, harvested in early September, produced the highest yields after grade-out to scab.

Table 2. Influence of planting and harvest time on yields, grade-out to excessive scab and marketable yields of Norland potatoes (Saskatoon 1995-1997).

	1995					1996				
	Marketable Size		Grade Out	Marketable		Marketable Size		Grade Out	Marketable	
	(t/ha)	(cwt/ac)	(%)	(t/ha)	(cwt/ac)	(t/ha)	(cwt/ac)	(%)	(t/ha)	(cwt/ac)
Planting 1										
Harvest 1	42.6 c	394	38 b	26.4 c	248	43.6 b	409	18 bc	36.8 b	346
2	49.9 b	466	50 a	24.9 c	234	49.2 ab	463	15 cd	42.4 a	398
3	62.3 a	586	49 a	31.8 bc	298	51.8 a	486	24 b	39.6 ab	372
Planting 2										
Harvest 1	21.9 d	203	20 d	17.5 d	164	15.2 d	143	5 e	14.5 e	136
2	51.9 b	539	20 d	41.5 a	390	23.8 c	223	10 de	21.5 d	202
3	48.6 b	457	30 c	34.0 b	320	45.9 ab	431	44 a	26.0 c	244

1997 Trial

Yield and scab responses to the planting and harvesting variables in 1997 were very similar to the 1996 trial (Table 3). Delaying planting by four weeks had a negative effect on yields, particularly if the crop was harvested early. Severity of grade-out to scab was not influenced by the planting date, but increased as harvest was delayed. The early planted crop, harvested in early September produced the highest yields after grade-out to scab.

Table 3. Influence of planting and harvest time on yields, grade-out to excessive scab and marketable yields of Norland potatoes (Saskatoon 1995-1997).

	1997				
	Marketable Size		Grade Out	Marketable	
	(t/ha)	(cwt/ac)	(%)	(t/ha)	(cwt/ac)
Planting 1					
Harvest 1	40.2 b	377	12 c	35.4 b	333
2	51.9 a	488	15 bc	43.9 a	413
3	52.5 a	493	33 a	35.2 b	331
Planting 2					
Harvest 1	15.5 d	146	10 c	14.1 d	133
2	27.0 c	254	23 bc	21.0 c	197
3	31.5 c	296	29 ab	21.9 c	206

In summary, delaying planting slowed crop development, resulting in some loss in yield potential in most cases. Delaying the harvest rarely was beneficial in the early maturing Norlands. Grade-out to scab increased with the duration of time the crop was in the field. This is to be expected as the scab lesions increase with size over time. Once the lesions cover more than 10% of the surface of the tuber it is no longer marketable. Extending the duration of the growing season by delaying the harvest resulted in more scab problems than did early planting. This suggests that environmental conditions in the fall may be more conducive to development of scab than earlier in the season. The optimal time to harvest represented a balance between the anticipated increase in yields obtained by delaying the harvest relative to the associated increase in grade-out to excessive scab. For Norland potato, which senesces relatively early, the balance favoured minimizing the period that the crop was in the field.

Canopy Management

The onset of scab in potatoes is thought to be triggered by drought stress early in the development of the tubers. Although growers may strive to minimize this stress through careful moisture management, problems with scab are still common. This study examined the relationship between moisture stress and the incidence of scab by using plant growth regulators or other treatments to artificially manipulate crop moisture use and to manipulate the relationship between root area and leaf area.

In 1995, the growth regulating treatments tested had no effect on pre-grading yields. The growth retardant Daminozide had a strong inhibitory effect on scab, while the other treatments were no better than the control. The final marketable yields for the Daminozide treated crop were significantly greater than all the other treatments.

In a 1996 trial, partial defoliation or foliar application of growth regulators like Daminozide and ABA at the time of tuber set reduced the incidence of scab in heavily infested soils. Treatment effects likely stemmed from a reduction in water use triggered by the treatments; the incidence of scab is known to be inversely related to soil moisture availability at tuber set. While these treatments provided a degree of scab control, they did so at the expense of overall yields.

The 1997 trial used Norland and Shepody potatoes at the Saskatoon test site. The treatments were:

1) Control,
2) Daminozide (5g/l) applied to run off at stolon initiation. Daminozide is a growth retardant, that shifts root/shoot ratios in favour of the roots,
3) Partial defoliation at tuber set - the top 40% of the canopy was removed using a "weed-eater" to reduct transpiration, thereby maintaining a favourable moisture balance for the developing tubers,
4) Abscisic acid (ABA) at tuber set (15% s-ABA applied at 55 ml/a). ABA slows growth and reduces water use by temporarily closing the stomata,
5) Antitranspirant (Vapor-Lok) - temporarily closes the leaf stomata, thereby reducing moisture loss.

Each treatment plot consisted of two adjacent 8 m (26') long rows arranged in a randomized complete block design with four replicates. The crop was managed, harvested, and evaluated for scab levels in the usual manner.

Table 4. Yields and scab losses for Norland and Shepody potatoes given various growth regulator treatments (Saskatoon 1997).

	Total Yield		Marketable Size		% Marketable	Marketable Yields	
	(t/ha)	(Cwt/ac)	(t/ha)	(Cwt/ac)		(t/ha)	(Cwt/ac)
Norland							
Control	52.8 a*	496	48.5 a	456	90 a	43.6 a	404
ABA	54.9 a	516	49.8 a	468	84 a	41.9 a	393
Daminozide	58.6 a	550	54.8 a	515	92 a	50.2 a	472
Defoliation	53.1 a	499	48.9 a	460	88 a	42.0 a	395
Vapor-Lok	58.9 a	553	56.0 a	526	87 a	49.1 a	461
Shepody							
Control	49.5 a	465	45.0 a	376	80 a	35.6 a	334
ABA	44.5 ab	418	41.6 a	391	76 a	31.5 a	296
Daminozide	45.4 a	426	42.6 ab	400	77 a	32.6 a	306
Defoliation	34.5 b	324	32.3 b	303	86 a	28.0 a	263
Vapor-Lok	45.7 a	429	42.8 ab	402	83 a	35.1 a	330

* Values within the same columns followed by the same letter are not significantly different.

The two cultivars responded similarly to the treatments (Table 4). None of the treatments produced any noticeable change in crop appearance. The defoliated plots recovered very quickly and were indistinguishable from the rest of the trial at harvest. Total yields for Norland were not affected by any of the treatments. For Shepody, the ABA and defoliation treatments reduced yields relative to the control. Similar growth responses were found in 1996. In contrast to results from previous years, none of the treatments influenced the grade-out to excessive scab. Grade-out to scab for all treatments in the 1997 trial was substantially lower than in previous years, i.e. the least effective treatment in 1997 had a higher percentage of marketable tubers than the most effective treatment in previous years. It appears that conditions in 1997 at tuber set were simply not conducive to scab formation. After grade-out to scab, there were no significant differences in yields for any of the treatments.

In summary, it appears that partial defoliation or foliar application of growth regulators like Daminozide and ABA at the time of tuber set has the potential to reduce the incidence of common scab in heavily infested soils. Treatment effects likely stem from a reduction in water use triggered by the treatments; the incidence of scab is known to be inversely related to soil moisture availability at tuber set. If conditions at the time of application are not conducive to the development of scab, the treatments cannot be recommended as they tend to reduce overall yields.

Plastics to Enhance Vegetable Crop Production

Principal: D. Waterer, Department of Horticulture Science
University of Saskatchewan
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Location: Saskatoon and Saskatchewan Irrigation Development Centre, Outlook
Progress: Project completed
Objectives: To develop and test plasticulture technology to enhance vegetable production.

Mulch/Herbicide Trials

Soil mulches can increase yields and profitability of vegetable production if they are used in an appropriate and efficient manner. The limited information on herbicide use under plastics suggests that significant modifications in herbicide efficacy (+ and -), together with the shift in weed populations under plastic towards heat tolerant weed species (ie; pigweed, portulaca) must be considered in developing an appropriate herbicide program. This project examined the relative effectiveness of various mulches used with or without herbicides for enhancing productivity of several warm season vegetable crops.

Trials were conducted from 1994 through 1997 in Outlook, SK on a sandy loam soil and on a heavy clay soil in Saskatoon. The test crops were muskmelons, peppers and sweet corn, all representing high value, warm season crops which respond favourably to the soil warming provided by clear mulch. The treatments were: a) Black mulch - provides inexpensive weed control but limited soil warming, b) IRT (wavelength selective) mulch - provides weed control and soil warming, but is quite expensive, c) Clear mulch - inexpensive materials provide soil warming but severe weed growth, d) Clear mulch and herbicide - soil warming and weed control but with added expense and uncertain efficacy, e) No mulch + herbicide - control treatment.

The herbicides were all preplant incorporated, with the clear plastic applied immediately after. The products used were: Eradicane for corn (1 L a.i./ha), Alanap (3 L a.i./ha) or Dacthal (surface applied at 1.5 kg a.i./ha) for muskmelons and Treflan for the peppers (0.5 L a.i./ha). The trial was laid out in a split plot design, with mulch types as the main plots and crops as the sub-plots. Each sub-plot was 4 m (13 ft) long and there were four replicates. The peppers and melons were transplanted while the corn was direct seeded. The melons and peppers were protected with crop covers for the first six weeks of the growing season.

Applying herbicide under the clear plastic mulch provided a degree of weed control equivalent to the black and IRT mulches in all three crops. No single weed species dominated the population that developed in the herbicide treated areas.

The mulch and herbicide treatments represented a relatively minor component of the total production cost for the pepper and melon crops, but added considerably to the cost of producing the corn crop (Table 1). All mulch treatments reduced the break-even price required for the pepper crop relative to producing the crop without mulches. Based on the average for the six site-year combinations, the clear mulch with no added herbicide had the lowest cost per unit fruit production.

Table 1. Crop cost, average yield and break even price for peppers, corn and melons as influenced by differing soil mulch and herbicide combinations.

Mulch Treatments	Pepper			Corn					Muskmelon		
	Crop Cost ($/m)	Yield[y] (kg/m)	Break Even[x] ($/kg)	Crop Cost ($/m)	Yield (kg/m)		Break Even ($/kg)		Crop Cost ($/m)	Yield (kg/m)	Break Even[x] ($/kg)
					Early	Total	Early	Total			
Clear	1.16	4.4	0.26	0.28	2.4	4.2	0.12	0.07	0.94	15.5	0.06
Clear + Herbicide	1.17	4.2	0.27	0.29	2.2	3.8	0.13	0.08	0.95	15.0	0.06
Wavelength Selective	1.25	4.3	0.29	0.37	1.2	3.0	0.31	0.12	1.02	13.7	0.07
Black	1.16	4.1	0.28	0.28	1.3	3.2	0.21	0.09	0.94	12.0	0.08
Herbicide only	1.12	2.5	0.45	0.24	0.9	2.8	0.27	0.09	0.89	8.1	0.11

[y] Average over all site year combinations; [x] Crop Cost/Yield.

Based on the six site year combinations, mulches of all types generally improved corn yields and earliness relative to the non-mulched control. The clear plastic mulch with or without herbicide usually produced superior early and total yields and represented the most cost effective production option. The clear mulch was particularly cost effective when the objective was early production.

Mulches increased melon yields by an average of 73% relative to the non-mulched controls. There was no consistent difference in melon yields between the various mulch treatments. All mulches reduced cost per unit fruit produced relative to the non-mulched controls, with the clear mulch with or without herbicide having the lowest cost per unit of fruit yield.

This study demonstrated that clear plastic mulches generally represented the most effective means for enhancing yields and profitability of production of warm season vegetable crops under Saskatchewan growing conditions. The enhancement in yields is likely due to the higher soil temperatures produced by the clear mulches. This study showed that herbicides applied under the clear mulch at standard recommended rates provided effective weed control with no observable changes in herbicide efficacy or crop toxicity relative to non-mulched areas.

Effect of Mulch Colour on Yields of Warm Season Vegetable Crops

Although black and clear are the most popular types of mulch, there is some evidence that mulch colour may influence specific stages in development of the crop, thereby potentially influencing yields. It is thought that this activity stems from the changes in the spectral characteristics of the light reflecting from the various colours of mulch into the crop canopy. This trial examined the influence of several mulch colours on yields of two valuable warm season crops (peppers and tomatoes).

The trial was conducted in 1997 at the Horticulture Science Field Research Station in Saskatoon (previously described above). Peppers and tomatoes were transplanted into the field in late May. Mulches were laid according to common practice about one week prior to transplanting of the crop. The mulch treatments were: a) Black (1.0 mil) - standard mulching treatment - provides weed control but no soil warming, b) Clear (1.0 mil) - standard mulching treatment -provides soil warming but no weed control, c) Wavelength Selective (IRT 1.0 mil) - provides soil warming comparable with clear but with added weed control, d)Green (1.0 mil), and e) Red (1.0 mil).

Each treatment was replicated four times in a randomized complete block design. Each plot consisted of 10 plants (30 and 45 cm; 12 and 18 in apart for peppers and tomatoes, respectively). The peppers were protected with a row cover for six weeks after transplanting. The pepper crop was harvested in a once-over picking just prior to the first killing frost (early October). The tomato crop was harvested once weekly until the crop was killed by frost at which time all remaining fruit were harvested. The peppers were also rated for proportion of the fruit turning red.

A non-replicated demonstration trial involving the same mulch colours and test crops was conducted at the SIDC in Outlook. This trial was overhead irrigated but otherwise all management and data collection variables were similar to the Saskatoon trial.

The mulches had no visible effect on vegetative growth or flowering characteristics of either crop at either site. By mid-July the leaves of the tomato crop had completely obscured the mulch. It is doubtful whether significant light struck the mulches from this point onwards. The peppers produced a much smaller canopy than the tomatoes and the mulch remained unobscured for the duration of the trial.

Tomatoes

Early yields with the IRT and green mulches were higher than with the red. Overall, the marketable yields for the green and clear mulches were superior to the red (Table 3). The red mulch also produced a lower total weight of tomatoes than the other treatments. Irrespective of the mulch treatment, a significant portion of the crop was still immature by the time of the first killing frost. Mulch type had no effect on the weight of the immature fruit but a greater portion of the crop on the clear mulch matured before frost than when IRT plastic was used. Mulch type had no impact on either the total amount of fruit lost to decay or the proportion of the crop lost to rots.

Table 3. Fruit yields for tomatoes grown using various colours of plastic soil mulch - Saskatoon, 1997.

Mulch Type	Marketable (kg/m row)		Green (kg/m row)	Rots (kg/m row)	Total (kg/m row)
	Early	Total			
Black	2.2 ab	19.1 ab	17.6 a	8.9 a	45.6 ab
IRT	2.7 a	17.5 ab	17.4 a	8.7 a	43.7 ab
Green	3.0 a	21.1 a	16.1 a	9.0 a	46.1 a
Red	1.3 b	15.6 b	15.0 a	9.4 a	40.0 b
Clear	2.5 ab	20.1 a	14.6 a	11.3 a	45.6 ab

Values within columns followed by the same letter are not significantly different (p=0.05).

The results for the Outlook tomato trial are presented in Table 4. No statistically valid comparisons can be made of mulch effects on yields, but the following observations can be made;

1) the green mulch produced higher early yields than all other treatments,
2) total marketable yields for the black, clear and wavelength selective mulches were substantially higher than the other treatments,

3) an unusually large proportion of the crop rotted when grown on the green mulch,
4) the wavelength selective and clear mulches produced large numbers of fruit which did not mature prior to the first frost, and
5) total fruit yields for the wavelength selective and clear mulches were substantially higher than the other treatments.

Table 4. Fruit yields for tomatoes grown using various colours of plastic mulch - Outlook, 1997.

Mulch Type	Marketable (kg/m row)		Green (kg/m row)	Rots (kg/m row)	Total (kg/m row)
	Early	Total			
Black	0.3	9.9	13.8	3.8	27.5
IRT	0.4	10.1	26.0	1.1	37.2
Green	2.1	5.3	8.5	3.6	17.4
Red	0.9	6.1	9.9	2.3	18.3
Clear	0.8	10.3	24.5	2.6	37.4

Peppers

There were no significant differences between the mulch treatments in terms of total yields, yields of red fruit, or the proportion of the crop turning red for the peppers grown at the Saskatoon site (Table 5). The red and clear mulches produced almost twice as many red fruit as the other treatments but this difference was obscured by variability from plot to plot.

Table 5. Yields of pepper fruit grown with various colours of plastic mulch - Saskatoon, 1997.

Mulch Types	YIELD (kg/m of row)		Red (%)
	Total	Red	
Black	6.0	0.3 b*	5
IRT	6.4	0.3 b	4
Green	6.0	0.2 b	3
Red	6.2	0.6 a	10
Clear	7.3	0.6 a	8
	NS		NS

* Values within each column followed by the same letter are not significantly different (p=0.05).

In the trial conducted in Outlook (Figure 1), the clear mulch produced the highest yields of both green and red fruit.

Mulch colour had no beneficial impact on vegetative or reproductive growth of either peppers or tomatoes grown in Saskatchewan. In tomatoes, the lack of response may reflect the fact that the mulches were covered by the vegetative portions of the plant prior to any fruit development. More significant effects could be expected if a less vigorous cultivar with a smaller canopy was used or if the plants were staked. Given the fact that the coloured mulches are considerably more expensive than standard types, this trial suggests that Saskatchewan's growers are unlikely to experience a significant benefit from their use.

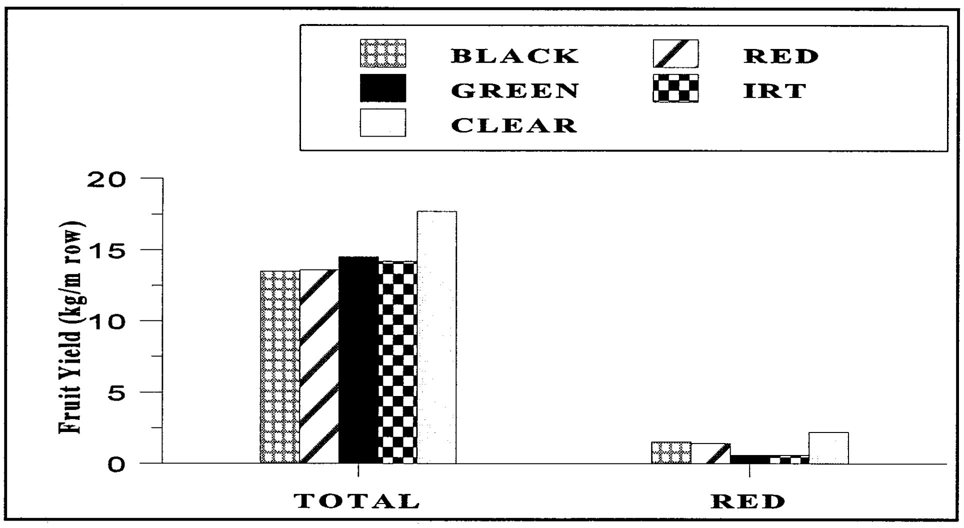


Figure 1. Yields of pepper fruit grown on various colours of plastic mulch - Outlook, 1997.

Bio/Photodegradable Mulches for Production of Warm Season Vegetable Crops

Removal and disposal of the plastics at the end of the growing season represents a significant portion of the total cost and effort involved in utilizing mulches to enhance productivity of vegetable crops. One potential solution to this problem is the use of bio or photodegradable mulches. This trial examined the potential for utilizing some of the bio and photodegradable mulches to enhance productivity of warm season vegetable crops under Saskatchewan growing conditions.

The trial was conducted at the Horticulture Department Field Research Station in Saskatoon. Six week old pepper seedlings were transplanted into the field in late May. Cucumbers and corn were direct seeded in late May. The pepper and cucumber plots consisted of 10 plants spaced 30 cm (12 in) apart. The corn was planted in twin 2 m (6.6 ft) long rows spaced 30 cm (12 in) apart with an in-row spacing of 15 cm (6 in). The mulch treatments had been laid approximately one week prior to planting, to allow for some soil warming to occur.

The mulch treatments were: a) standard black polyethylene (1.0 mil), b) standard clear polyethylene (1.0 mil), c) photodegradable black (90 day breakdown), d) photodegradable clear (90 day breakdown), and e) biodegradable paper.

The trial was arranged in a randomized complete block design with four replicates. The trial was drip irrigated. The cucumbers and corn were harvested twice weekly until the plants ceased production. Yields for the cucumbers and corn were classified as early if they were taken prior to mid-August or late August, respectively. The peppers were taken in a once over harvest just prior to the first killing frost (late September).

The paper mulch broke down within four weeks of application. The initial point of breakdown was usually at the junction between the above and below ground portions of the mulch. The four week lifespan was not sufficient to protect any of the crops from weed competition. The photodegradable clear mulch began to tear within six weeks of installation, but the black formulation remained intact until very late in the growing season. Both photodegradable mulches were formulated to last 90 days. Breakdown of the photodegradable mulches was most rapid in areas of the mulch exposed to full sunlight. The prostrate canopy produced by the cucumbers effectively protected the underlying mulch, whereas the more limited and upright canopy produced by the pepper plants provided limited protection to the photodegradable mulch.

In the cucumbers, standard clear plastic produced the best early and total yields (Table 6). The two types of black plastic produced yields comparable to the photodegradable clear mulch. The more limited soil warming provided by the photodegrable clear was balanced by the long-term weed control provided by both types of black plastic. Yields for the paper mulch treatments lagged well behind the others. This reflects the problems with early breakdown of the paper mulch.

Table 6. Yields of corn, cucumbers and peppers on various standard and bio/photodegradable mulches.

Mulch Type	Cucumber		Corn		Peppers	
	Fruit Yield (kg/m)		Cob Yield (kg/m)		Fruit Yield (kg/m row)	
	Early	Total	Early	Total	Number	kg
Standard Clear	9.2 a*	25.1 a	5.7 a	7.1 a	43 a	7.3 a
Standard Black	6.1 b	20.1 bc	3.6 bc	5.3 b	41 a	6.6 a
Photodegradable Clear	5.6 b	16.8 dc	4.4 ab	6.3 ab	40 a	6.8 a
Photodegradable Black	6.8 b	22.7 ab	3.6 bc	5.6 b	36 a	6.2 ab
Paper	3.7 c	14.8 d	2.7 c	5.3 b	34 a	5.2 b

*Values within columns followed by the same letter are not significantly different (P=0.05)

In the corn, use of either the standard or the photodegradable clear mulch enhanced early and final yields. This again reflects the positive effect that elevated soil temperatures have on the development of warm season vegetable crops.

Mulch type had no impact on the number of fruit produced by the pepper plants but did influence fruit weight. The two clear mulches and the standard black produced a heavier fruit yield than the paper mulched plots.

In summary, paper mulch did not perform satisfactorily as it broke down too quickly. The photodegradable plastics enhanced growth of the test crops to an acceptable degree and were easier to remove from the field than the standard plastics. As the photodegradable plastics are considerably more expensive than the standard type, growers should do a careful cost/benefit analysis when considering their use.

Vegetable Cultivar Testing Program

Principal: D. Waterer, Department of Horticulture Science
University of Saskatchewan, Saskatoon, Saskatchewan
Funding: Agriculture Development Fund
Location: Nipawin, Saskatoon, and SIDC
Progress: 1997 trials completed. Storage trials ongoing.
Objective: To evaluate new vegetable crops and cultivars for their adaptation to Saskatchewan growing conditions and market requirements.

Vegetable cultivar evaluations are conducted to provide Saskatchewan's vegetable growers with information on cultivar performance under local growing conditions. The trials are partly underwritten by grower co-operatives and suppliers of seed and horticultural products. Cultivars are selected for testing based on performance in previous trials, industry sources and seed companies. The data presented is specific to growing conditions and production practices and may not be applicable to all farm sites.

The 1997 trials were conducted at three sites (Saskatoon, Outlook and Nipawin) representative of vegetable production conditions in Saskatchewan. Crop production and pest control measures generally followed recommended practices. Irrigation was used to maintain adequate soil moisture levels throughout the growing season at the Outlook and Saskatoon sites. A portion of the Nipawin trial relied on rainfall only.

Broccoli, cabbage, cauliflower, sweet corn, leeks, onions and romaine lettuce were planted in twin rows using recommended in and between row spacings. Rows were 4-8 m (12-26 ft) in length. Carrots and parsnips were planted in twin, 4-8 m (12-26 ft) long rows on raised beds in Saskatoon. The lighter soils in Outlook did not require bed establishment for parsnip production. Radishes, cantaloupe, winter squash and zucchini were planted in single rows 3-10 m (10-33 ft) long using recommended in and between row spacings. Broccoli, cabbage, carrots, cauliflower, sweet corn, romaine lettuce, onions, parsnips and radishes were direct seeded using a Planet Jr. type seeder. Zucchini was seeded into black plastic mulch. Transplants were used to produce the cantaloupe, leeks and winter squash. Cantaloupe was grown on IRT soil mulch. Winter squash was grown on black mulch. The cantaloupe was covered with clear perforated plastic tunnels. Winter squash was protected with P-17 floating row cover. Tunnels and covers were removed in mid-July.

The 1997 growing season was excellent for irrigated vegetable production. After a cool period in mid-May with the final spring snowfall on May 17, temperatures increased and a typical hot dry prairie summer ensued. A relatively dry late May and June limited germination in Nipawin. Rainfall in Nipawin in July and August was ample. A hailstorm in Nipawin in mid-June damaged plants however, growing points were not destroyed and most crops completely recovered. A long, dry fall ensured that all crops were completely harvested prior to a killing frost.

Excellent growing conditions enabled nearly all cultivars to fully mature prior to harvest. Smaller in-row spacing in the lettuce plots may have limited head size in some cultivars. Many cultivars tended to bolt and/or yellow prematurely, possibly due to the hot weather. Parsnips were typically undersized despite the long growing season. Radishes were planted at three times in Saskatoon. The overall best taste and yields were at the second harvest. Roots were of good quality with little maggot damage.

Although the crop was seeded early and growing conditions were favourable, the corn crop in Saskatoon was slow to develop and mature. This slow maturity was probably due to insufficient nitrogen early in the season. Most cultivars completely matured prior to fall frost. The Outlook corn matured in the expected time frame.

Broccoli

Cultivars were evaluated for earliness, yield, bead uniformity and quality. 'Early Dividend' was the earliest cultivar, however yields were poor. The best cultivar in terms of appearance and yields was 'Emerald City'. 'Marathon' had the best yields at all irrigated sites, but uneven beads resulted in unattractive heads.

Cabbage

Cultivars recommended for their earliness include 'Elisa' (slightly below-average yields) and 'Greenstart' (slightly later but better yields).

Mid-season cultivars recommended for their yields and quality include 'Almanac', 'Dynamo', 'Headstart', 'Hercules' and 'HMX 7270'. 'Dynamo' had very small, extremely dense heads of excellent quality. Late cultivars recommended for their yields and quality are 'Little Rock', 'Panther' and 'Rio Verde'.

Cantaloupe

Cultivars recommended for their taste, yields and earliness include 'Athena', 'Earligold', 'Superstar' and 'Sweet n Early'. 'Grido' and 'Venice' also had good yields and taste but were later maturing. 'Albers' is recommended as an early cantaloupe with excellent yields and taste however texture was mushy, exterior skin was yellow-green and flesh was white. 'Alaska' was early with excellent yields but taste was poor.

Carrots

Carrots were harvested on August 22 and September 27. Overall ratings were based on marketable yields, total yields and taste. At the early harvest, 'Chantenay Red Cored' had the best marketable yields and good flavour of the danvers types. For a late harvest, 'Kuroda Improved' and 'Royal Chantenay' are recommended danvers types for their yields and taste.

Of the imperator type, 'Eagle', 'Nandrin' and 'Heritage' had excellent yields and good taste at both harvests. 'Artist', 'Crusader', 'Ivanhoe' and 'Eclipse' also had excellent yields at both harvests.. Taste was inconsistent. 'First Class' demonstrated consistent good flavour throughout the season with slightly above average yields. 'Prelude' had good consistent taste throughout the season and was one of the best tasting cultivars at the late harvest. Yields at the early harvest were above average. 'Kamaran' and 'Primecut' had the best taste and yields of the imperator-nantes type.

Nantes type carrot cultivars recommended for combined taste and yield include 'Mokum' and 'Presto'. 'Earlibird Nantes', 'Favor' and 'Touchon' had good to excellent taste at all harvests as well as good yields. 'CXC 7105', 'Nantes Half Long', 'Napoli' and 'Sytan' are recommended for their yields, however taste was inconsistent.

Cauliflower

Heads were graded for yield, interleafing, hollow stem and quality. 'Minuteman' is recommended for its earliness and yields. 'Rushmore' had average yields and good head quality. 'Incline' was a late cultivar with good yields and attractive heads.

Sweet Corn

Of the standard types, 'Seneca Horizon' was the best yielding early cultivar with acceptable taste. 'Beretta' and 'Harmony' had excellent yields at mid-season however their taste ratings were poor. 'Early Sunglow', 'Sweet Rhythm' and 'Yukon' are all mid-season standard cultivars with good taste and yields.

Sugar enhanced cultivars recommended for earliness include 'Seneca Pronto' (good yields and taste), 'Advantage' (excellent yields but average taste), 'Seneca Explorer' (good yields and average taste) and 'Native Gem' (good taste but average yields). Of the mid-season sugar enhanced varieties, 'RXB 6401' had excellent yields and taste. 'Ambrosia', 'Lyric' and 'Polo' had good taste and yields. '4G0007' had good taste but only average yields. 'Precious Gem' and 'Tecumseh II' are recommended as late sugar enhanced cultivars with good yields and taste.

The best early supersweet variety with good taste and yields was 'Northern Xtra Sweet'. 'Princeton' is an early variety with excellent yields. Taste was average. 'Monte Carlo' is recommended as an early supersweet variety with average taste and yields. Midseason supersweet cultivars recommended for good taste and good yields include 'Confection', 'Early Xtra Supersweet', 'Seneca Appaloosa' and 'Uprise'. 'Seneca Sugarburst' had excellent taste however yields were less than average. Two late cultivars recommended for their excellent taste are 'Eagle' and 'Victor'. 'Bandit' is a late cultivar recommended for its good taste and yields.

Leeks

Leeks were graded on yield, size, and length of white stem. 'Albinstar', 'Giant Musselburgh', 'Titan' and 'Varna' are recommended for their excellent yields and quality. 'Autumn Giant', 'Kilma', 'Pancho' and 'Primor' had good yields.

Romaine Lettuce

Cultivars were evaluated for yield, taste and quality. 'Kalura MTO' is recommended as the best overall romaine lettuce with good taste, yields, quality and bolting resistance. 'Romulus' and 'Valmaine' had excellent yields with good taste. 'P.I.C. Special Strain' is recommended for its excellent taste however yields were only average.

Red and Yellow Onions

Outlook had the best overall yields of the three test sites. Dry conditions at germination time and weed pressure severely reduced yields in Nipawin. 'Mercury' was the best yielding red cultivar. 'Red Burgermaster' had good yields. Of the yellow cultivars, 'Copra' had good consistent yields. 'Yula' had good yields as well as the highest percentage of large bulbs.

Storage Onions

Spanish onions grown during the 1996 field season were cured and stored at 0°C and 80% RH for eight months. Weight and quality were assessed at four and eight months after harvest. The white varieties had very poor storage characteristics. Only 'Blizzard' and 'RCS 1001' had any marketable bulbs at four months. None of the white cultivars were marketable at 8 months. Of the yellow cultivars, 'Caesar', 'RCS 1032' and 'Vision' were still in excellent condition after four months. At eight months, 'Vision' had the most marketable bulbs (about 65%). 'Caesar', 'RCS 1032', 'SSC 3359' and 'X 412' had some bulbs that were marketable but are not recommended for large scale commercial storage. It is noteworthy that 'Vision' and 'Caesar' were high yielding cultivars in the 1996 field trials.

<u>*Parsnips*</u>
Parsnips were seeded in Outlook and in Saskatoon early in May and harvested late in October. Despite the length of the growing season and the excellent growing weather, most of the parsnip cultivars had many undersized roots. 'New White Skin' and 'Arrow' are recommended for their yields and small cores. 'Andover Germplus' had good yields, but the roots were very long and thin.

<u>*Radishes*</u>
Radishes were seeded in Saskatoon (three planting dates) and in Outlook (one planting date). The best average yield was at the second harvest. Taste quality diminished as the season progressed. 'SRA 1501' had excellent taste and good yields. 'Cabernet' also had good taste with average yields. 'Sora' is recommended for its good consistent yields and taste, although it tends to have a slight bitter aftertaste. 'Rebel' is attractive with good yields, however taste varies. 'Fireball' is recommended as an attractive cultivar with good marketable yields and good taste at early plantings. 'Altabelle' and 'Red King' are recommended for their good consistent taste, but yields were poor.

<u>*Winter Squash*</u>
Of the acorn squash types, 'Tay Belle' had the best yields. The interior colour was poor and density was only medium. 'Heart of Gold' had an attractive orange flesh colour with average yields. 'Table Ace' and 'XPH 1755' are recommended for their good density and yields. 'Cream of the Crop', an attractive white skinned acorn type, had excellent yields and density.

'Buttercup', a light green skinned buttercup type with bright yellow flesh, is recommended for its excellent yields and quality. The attractive orange skinned buttercup type 'Eastern Rise' is also recommended for its yields and quality. 'Phoenix', a pear-shaped green and white skinned squash, had excellent yields.

All butternut types tested displayed good yields. 'Ultra Butternut', 'Butternut' and 'Early Butternut' are recommended for their excellent yields. Of these three varieties, 'Ultra Butternut' had the largest seed cavity. 'Early Butternut' tended to be rectangular in shape.

Only three delicata type squash were tested. 'Sweet Dumpling', a heart shaped squash with ivory coloured skin and green stripes, had the best yields and the smallest seed cavity. 'Delicata' had long fruit and the biggest average sized fruit, although total yields were poor.

'Pasta Spaghetti' was the highest yielding spaghetti squash. 'Spaghetti Squash' had the largest individual fruit size.

<u>*Zucchini*</u>
Cultivars recommended for their excellent yields include 'El Greco','Tipo Zucchini', 'Spineless Beauty' and 'Dividend'. 'Ambassador', 'Onyx', 'JSS 9601' and 'RXPG 848' had excellent yields however seed germination was poor.

Commercial Vegetable Production

Principals: O. Green and B. Vestre
Saskatchewan Irrigation Development Centre
Location: SIDC, Outlook
Progress: Ongoing
Objective: To observe the crops through the summer and determine their viability for commercial production in Saskatchewan.

Estimates based on vegetable import data indicate that only approximately 7% of the in-season fresh vegetables consumed in Saskatchewan are grown in the province. This compares to a self-sufficiency of 33% in Alberta, and of 57% in Manitoba. The value of vegetable imports into Saskatchewan is $15 million to $20 million annually. Over half of this produce originates in the United States.

In recognition of the market potential for home grown produce, the SIDC began a commercial vegetable demonstration project in 1996. A three year program funded by AFIF began in 1997 to develop and demonstrate commercial production practices for pepper, pumpkin, cucumber, carrot, and cabbage.

Drip irrigation, plastic mulches, tunnels, and floating row covers are being used. These technologies have the potential to lengthen the marketing season, to increase yields, and to improve quality and uniformity of the produce. Costs and returns data are being collected for a cost of production analysis for Saskatchewan. Such analyses are crucial to support private investment and production to replace imports with locally grown vegetables.

1997 Results

Peppers

'Valencia' and 'Ultraset' varieties of pepper were grown in six 135 m (450 ft) rows (approximately 0.2 ha or ½ acre) on Infrared Transmissible (IRT) plastic mulch with surface drip irrigation. Mulch and drip tape were laid in one operation. Transplants were planted with a waterwheel transplanter in a double row with a 30 cm (12 in) row spacing on each mulch row. The time required for transplanting one acre was approximately 2 3/4 hours.

One mulched row of peppers was covered with a perforated tunnel. The remainder of the peppers were grown under floating row covers supported with wire strung on 2 in x 2 in stakes.

An infestation of aphids and some wind damage resulted in some leaf drop and in reduced yields, particularly under the row covers. The aphid damage was less severe on the peppers grown under the tunnel.

The crop was harvested, washed, graded, packed, and marketed to the processing and wholesale trade. Harvesting began August 6 and ended September 18. The overall yield was equivalent to 5740 kg/ha (5110 lb/ac). The yield under the tunnel was estimated as 26,500 kg/ha (23,600 lb/ac). As a result of warm, sunny weather, 20% of the production was harvested as red peppers and sold for a premium at an average price of $1.67/kg ($0.76/lb). Green peppers were sold at $0.97/kg ($0.44/lb) for the retail market, and at $0.72/kg ($0.33/lb) as choppers for processing. At an average price of $1.00/kg ($0.45/lb), the gross return was equal to $1575/ha ($635/ac) under the row covers, and was $26,600/ha ($10,750/ac) under the tunnels.

Pumpkin

Pumpkin was grown in six 135 m (450 ft) rows (approximately 0.2 ha or ½ acre) with IRT mulch and surface drip irrigation. A portion of the trial evaluated four types of subsurface drip irrigation. The variety 'Spirit' was grown from seed in a double row with a 1 m (36 in) in-row spacing. Planting was done using a hand planter, and with the waterwheel transplanter. Some replanting was necessary due to mice digging up the seeds.

The majority of the pumpkins were orange in the field at harvest. The remainder colored well in storage prior to shipping. Quality was excellent with good size and uniform shape.

The pumpkins were cut from the vines on September 25, picked using a picking aid and were placed in bulk bins on a trailer on September 26. There was no further handling until grading and packing. Pumpkins were packed in 385 kg (850 lb) bins or in 22.5 kg (50 lb) bags for shipment to wholesale markets. A yield equivalent to 99,900 kg/ha (44.4 tons/ac) was obtained and was sold at an average selling price of $0.34/kg ($0.16/lb). Gross return was equal to $34,250/ha ($13,800/ac).

Yield from the surface drip irrigation and subsurface drip irrigation were similar.

Cucumber

Approximately a half acre of slicing cucumbers('Jazzer', a hybrid) were planted in the same manner as were the pumpkins on a 60 cm (24 in) in-row spacing. Bees were obtained for pollinating both the pumpkin and the cucumbers.

Mice damage to cucumber seed was less severe than for pumpkin. Two to three seeds per hill were planted to ensure good stand establishment.

Twenty-eight pickings were made between July 25 and October 1. The picking rate ranged from 60 to 250 cucumbers per hour at an overall average of 108 cucumbers per hour. Moving the vines during picking resulted in scarring on the cucumbers at later harvests which reduced the quality of the produce. A spineless variety with suitable yield and quality, a once over harvest, or a means of moving the leaf canopy with a minimum of vine disturbance would appear to be required to improve quality and gain market acceptance.

The average yield under surface drip irrigation was approximately 3480 cases (24 count)/ha (1404 cases/ac). Yield for 5 ml Low Flow (LF) drip tape was 2850 cases/ha (1150 cases/ac), and for 8 ml LF tape was 2965 cases/ha (1196 cases/ac). For 8 ml High Flow (HF) drip tape, which applies water at two time the rate of LF tape, the yield was 3370 cases/ha (1359 cases/ac). Cucumbers left in the field as non-saleable were estimated at 25% of total production.

The produce was initially placed in refrigerated storage, but dehydration occurred after one week. Proper humidity could not be maintained. Subsequent harvests were placed in a root cellar where quality was preserved. A total of 432 cases were either lost or culled.

An equivalent of 4375 cases/ha (1765 cases/ac) were sold at an average selling price of $5.58 per case. The gross return was $24,600/ha ($9950/ac).

Cabbage

'Lennox' cabbage was grown from transplants, and was direct seeded in bare ground on 60 cm (24 in) rows with an in-row spacing of 45 cm (18 in). Transplanting was done with a waterwheel transplanter. A precision Stanhay seeder was used for direct seeding. Total field area was approximately 1/8 ha (1/3 acre).

The use of transplants for cabbage production is more costly than direct seeding. Earlier harvest with higher yields, improved quality, or lower weed control costs would have to be achieved to compensate for the extra cost. In this demonstration, the additional labour cost for transplant (at $6.50/hr) was $630. This is equivalent to $4700/ha ($1890/ac).

The transplanted cabbage matured earlier with an excellent stand and produced uniform heads. The yield was equivalent to 69,100 kg/ha (61,525 lb/ac) compared to 26,200 kg/ha (23,330 lb/ac) for the direct seeded cabbage. The direct seeded plot was near the distribution end of the drip line where excess water reduced yields. Much of the direct seeded cabbage at the distribution end did not attain marketable size.

The crop was harvested, trimmed, graded, packed, and marketed to the processing and wholesale trades. The price received was $0.24/kg ($0.11/lb) resulting in a gross return for the transplanted cabbage of $16,675/ha ($6725/ac). Gross return on the direct seeded cabbage was equivalent to $6325/ha ($2550/ac).

<u>Carrots</u>
Carrots were grown under sprinkler irrigation on a 0.1 ha (1/5 acre) plot. 'Carobest', a long, slender imperator type of carrot, was planted on raised beds with 60 cm (24 in) row spacing and 30 to 36 seeds per foot using a Stanhay precision seeder. Weeds were controlled with Linuron.

Properly punched belts for the Stanhay seeder resolved the planting problem experienced in 1996. A good stand of carrots was achieved using pelletized seed.

A portion of the field was harvested and marketed as bunched carrots (24 count/case). Labour input was ½ hour per case. The price received was $11.85 per case. The gross return was the equivalent of $20,700/ha ($8340/ac).

The main harvest of topped carrots was taken on October 22. The carrots were washed, bulk binned, and stored in the root cellar. The quality of the produce was excellent, with a dark orange color and a sweet taste.

The overall yield was equal to 57,300 kg/ha (25.5 tons/ac). The equivalent on 37,500 kg/ha (16.7 tons/ac) was graded and packed in 2 or 5 pound bags (24 x2 or 5 x 10 baler bags) and sold as Canada #1 carrots at $0.39/kg ($0.176/lb). The remainder was sold for processing at a price of $0.337/kg ($0.153/lb). The gross return for the topped carrot production was equal to $21,800/ha ($8805/ac).

Herb Agronomy

Principal: J. Wahab
Saskatchewan Irrigation Development Centre

Background and Objectives

The use of alternative medicines, health foods, and herbal remedies are increasing rapidly in the western world. The Saskatchewan Herb and Spice Association has identified narrow-leaved purple coneflower (*Echinacea angustifolia*), purple cone flower (*Echinacea purpurea*), seneca snakeroot, milk thistle, valerian, feverfew, mint tea, yarrow, and stinging nettle as important species for commercialization. Currently these herbs are grown in relatively small plots using considerable manual labour for planting, maintenance, and harvesting.

The SIDC herb project, supported by the Agri-Food Innovation Fund, is designed to develop agronomic practices to produce herbs under commercial conditions. The main objectives of this project are to:

a) Identify species suited for dryland and irrigated conditions.
b) Develop agronomic practices to optimize yields and improve quality.
c) Refine harvesting and post-harvest handling practices to maintain quality and improve recovery.
d) Evaluate the effects of production and post-harvest handling practices on quality characteristics.
e) Reduce labour requirement through mechanization.
f) Estimate cost of production for the more important herb species.

Narrow-leaved Purple Coneflower (*Echinacea angustifolia*)

Echinacea spp. are perennial herbs with a strongly developed tap root system. Both the above ground parts and the roots of *E. purpurea* and *E. angustifolia* are used for medicinal purposes. The natives used *Echinacea* to cure a multitude of ailments ranging from tooth ache, sores, snake bites, and cancer. Present medicinal uses include treatment for chronic viral and bacterial infections, skin ailments, as well as colds and flu.

Echinacea can be propagated by seed or by crown division. *Echinacea* seed requires cold stratification and light for successful germination. The requirement of light for germination is a constraint for direct seeding of *Echinacea*. Roots can be harvested 3 to 4 years after planting. Agronomic information for Echinacea production is limited. The following tests are being conducted as preliminary investigation to develop suitable practices for Echinacea production.

Seeding Rate and Row Spacing Study

Treatments in this study included target seeding rates of 60, 90, 120, 150, 180 seed/m^2 and row spacings of 41 and 61 cm (16 in and 24 in).

Tests are conducted under irrigation and under dryland conditions.

The plant stand increased with increasing seeding rate. Approximately one plant was produced for every 19 seeds planted (Table 1).

Table 1. Seeding rate and row spacing effects on Echinacea establishment under irrigated conditions.				
Seeding rate (seeds/m^2)	Plants /m^2			
	Irrigation		Dryland*	
	40 cm row	61 cm row	40 cm row	61 cm row
90	6.2	5.9	5.8	3.9
135	7	9.2	9	7.5
180	10.7	10.5	7.6	10.1
225	16.2	7.5	11.1	12.3
270	16.7	11.8	8.9	9.7
Mean	11.4	6.9	8.5	8.7

*Irrigated in establishment year

Fertility Study

Three nitrogen rates (0, 50, 100 kg N/ha; 0, 45, 90 lb N/ac) and two Phosphorus rates (50, 100 kg P_2O_5/ha; 45, 90 lb P_2O_5/ac) were evaluated. Nitrogen was applied as (i) single application and (ii) two equal splits (spring and fall). Phosphorus was applied during spring only. The crop was seeded at 61 cm (24 in) row spacing with a target seeding rate of 120 seeds/m^2.

The plant stand in plots ranged from 9.4 to 22.9 plants/m^2.

Harvest Timing, Productivity and Quality of Transplanted E. angustifolia

Echinacea seedlings were transplanted at 61 x 30 cm (24 x 12 in) spacing using a water wheel planter. Successful stand establishment was obtained with this method. The crop will be harvested at 2, 3, 4, and 5 years after planting. Yield and quality attributes will be determined at each harvest.

Winter Survival, Growth, Productivity, and Quality Characteristics of Fall transplanted E. angustifolia as influenced by N and P Fertilization

Three rates of nitrogen (50, 100, 200 kg N/ha; 45, 90, 180 lb N/ac; two splits during spring and fall), two rates of phosphorus (50, 100 kg P_2O_5/ha; spring application) were examined.

Field plots were planted in August 1997. Appropriate treatments will be applied. Data collection will commence in the spring of 1998.

Effects of Over-wintering Methods on Growth and Productivity of E. angustifolia

Echinacea transplants were over-wintered in a straw covered pit and were maintained in the greenhouse. Transplants were produced in multi-pots during the summer of 1997. Four thousand transplants were placed in a 60 cm (2 ft) pit. The trays were covered with barley straw to approximately 22 cm (9 in). An equal number of transplants are being maintained in the greenhouse.

The degree of winter-kill will be recorded for the transplants placed outside. Field plots will be established at 30 x 61 cm (12 x 24 in) spacing to study growth and productivity of plants raised from these two sources.

Observational Study of Root Damage and Transplant Survival of E. angustifolia

This observational study examined the effect of root damage while pricking out from the germination flat.

Seedlings were pricked out at the two leaf stage and the following treatments were applied: Root cut to 1, 2 and 3 cm (0.5, 1.0, and 1.5 in) lengths and planted directly, and root cut to 1 cm length and dipped in rooting hormone #3 prior to planting.

Visual observations on the transplanting success and subsequent growth showed no difference for the various root pruning treatments. This indicates that *E. angustifolia* can tolerate considerable amount of transplanting shock.

Milk Thistle

Milk thistle is an annual or grown as an biennial. Milk thistle is a vigorously growing shrub that has a tendency to branch profusely. The plant and seed heads are susceptible to frost. In Europe, preparations of milk thistle are being used to treat liver and gall bladder disorders. It is not widely used in North America. The active ingredient, silymarin, is found predominantly in the seed.

The milk thistle trials are designed to:

a) Reduce frost damage by adjusting harvest date.
b) Control excessive branching to facilitate mechanical harvesting.

Seeding Rate and Row Spacing Study

Two target seeding rates (40,000 and 120,000 seeds/ha; 16,000 and 48,000 seeds/ac) and two row spacings (61 and 82 cm; 24 and 32 in) were examined for milk thistle grown under irrigation.

The higher seed rate (120,000 seeds/ha) produced approximately double the seed yield as compared to the 40,000 seeding rate at all harvest dates. The estimated total yield for the 40,000 and 120,000 seeding rates were 195.1 kg/ha and 378.6 kg/ha respectively (Table 2). Row spacing had no effect on seed yield at any harvest.

Higher seeding rate had a positive effect on seed size only during the second harvest while row spacing had no effect on seed size (Table 3).

Table 2. Seeding rate and row spacing effects on seed yield of milk thistle at different harvests.

Seeding rate (seeds/ha)	Seed yield (kg/ha)							
	Harvest - 1		Harvest - 2		Harvest - 3		Total	
	61 cm	82 cm	61 cm	82 cm	61 cm	82 cm	61 cm	82 cm
40000	41	75.3	32.3	47.1	93.7	72.7	167.1	195.1
120000	95	136.5	77.9	95	177.2	147.1	350.1	378.6
ANOVA	**Significance**							
Source								
Seed. rate (R)	0.05		0.01		0.001		0.01	
Row spacing (s)	NS		NS		NS		NS	
R x S	NS		NS		NS		NS	
C.V. (%)	72.6		75.4		50.5		28.6	

Table 3. Seeding rate and row spacing effects on seed weight of milk thistle at different harvests.						
Seeding rate (seed/ha)	1000 seed weight (g)					
	Harvest - 1		Harvest - 2		Harvest - 3	
	61 cm	82 cm	61 cm	82 cm	61 cm	82 cm
40000	18.9	17.5	13.6	14.9	20.3	20.9
120000	20.2	20.4	16.2	16.5	20.7	20.7
ANOVA	**Significance**					
Source						
Seed. rate (R)	NS		0.01		NS	
Row spacing (S)	NS		NS		NS	
R x S	NS		NS		NS	
C.V. (%)	21.9		14.3		7.6	

Feverfew

Feverfew is a bushy perennial. The flowers are used for medicinal purposes. Historically, feverfew was used for various ailments including colds, fever, arthritis, and rheumatism. It has also been used as a sedative. In Europe, feverfew is widely used to treat migraine headaches and arthritis.

Establishment of feverfew is difficult through direct seeding. Proper cultural and harvesting practices are required to produce high quality material. This project is designed to develop methods (i) to overcome constraints for direct seeding, and (ii) to increase yields and improve quality.

Spacing Effects on Maturity, Productivity and Quality for Transplanted Feverfew

Feverfew was transplanted at 30 x 61 cm (12 x 24 in) spacing using a water wheel planter. The crop will be harvested at 1, 2, 3, and 4 years after planting.

The test was planted in July 1997. The crop will be harvested and observations will be taken at the appropriate intervals.

Seeding Rate and Row Spacing, Harvest Date, and Fertilizer Response Studies for Direct Seeded Feverfew

Feverfew was direct seeded in 41 and 61 cm (16 and 24 in) rows at different seeding rates. Seeding rate varied from 100-600 seeds/m^2. The crop was maintained under irrigation.

The crop was seeded twice. The first seeding was done at 0.6 cm (1/4 in) seeding depth. At the second seeding the seeds were placed on the soil surface. The seed bed was kept moist with light irrigation using a linear move system.

Establishment was poor at both plantings.

Valerian

Valerian is a perennial herb. Roots and rhizomes are used for medicinal purposes. Valerian is claimed to have a variety of pharmaceutical uses. Currently, it is being used to treat many conditions including hysteria, insomnia, rheumatic pains, cramps, and migraines.

Delayed germination and the requirement of light and moisture for germination is a major constraint for direct seeding valerian particularly under dryland conditions. The following tests were initiated in 1997 to develop methods to improve stand establishment aimed at increasing yields and improving quality.

Fertility Study

Three rates of nitrogen (0, 50, 100 kg N/ha; 0, 45, 90 lb N/ac) applied as single application, also two equal splits during spring and fall and two rates of phosphorus (50, 100 kg P_2O_5/ha, spring applied) were examined for direct seeded valerian grown under irrigation.

Plant stands were recorded in the fall of 1997. Establishment ranged from 0-6 plants/m^2 with an overall average of two plants/m^2. That's one plant for every 24 seeds. No identifiable trends were observed in relation to nitrogen and phosphorus application treatments (Table 4). Yield and growth characteristics will be monitored in subsequent years.

Table 4. Initial plant stand of Valerian in the fertility test.

kg N/ha	Plant stand/m^2		
	0 kg P_2O_5/ha	50 kg P_2O_5/ha	100 kg P_2O_5/ha
0	-	2.0	1.9
25	-	1.3	1.9
50	1.8	1.7	1.6
50	-	2.5	2.8
100	3.6	2.8	3.1

Seeding Rate and Row Spacing Study of Valerian

Valerian was seeded at a seeding rate of 16, 32, 48, 64, 80 seed/m^2 to obtain a target plant stand of 4, 8, 12, 16, 20 plants/m^2. Two row spacings (40, 61 cm; 16, 24 in) were utilized in this study. This test was conducted under irrigated conditions.

Approximately one seedling was produced for every 5-9 seeds planted. Higher seeding rates produced higher plant stands. Row spacing did not affect stand establishment (Table 5). This test had noticeably higher plant establishment than the Fertility Study at the same seeding rate. This is likely due to lower weed competition at this site.

Table 5. Seeding rate and row spacing effects on valerian establishment under irrigation.

Seeding rate (seeds/m^2)	Plants /m^2	
	40 cm row	61 cm row
16	1.7	1.8
32	6.5	5.5
48	9.8	6.4
64	8	9.3
80	15	12
Mean	8.2	7

Stinging Nettle

Stinging nettle is a perennial herb. Leaves, flowers, and roots are used for medicinal purposes. Stinging nettle is used as a blood purifier and for several skin conditions. The fibrous nature of the mature plant can pose problems at harvesting and while curing. This study examines methods for direct seeding stinging nettle and for improved quality of the harvested product.

Seeding Rate and Row Spacing Study of Stinging Nettle

Stinging nettle was seeded at a seeding rate of 16, 32, 48, 64, and 80 seed/m^2 to obtain a target plant stand of 4, 8, 12, 16, and 20 plants/m^2. Two row spacings (40, 61 cm) were utilized in this study. This test was conducted under irrigated conditions.

Germination was poor. This test was abandoned and transplants are being raised to conduct this test using transplants.

Effects of Over-wintering Methods on Growth and Productivity of Stinging Nettle

Stinging nettle transplants were over-wintered in the greenhouse, and in a straw covered pit. Growth and productivity will be monitored for these two methods of over wintering.

Yarrow

Yarrow is a perennial herb. The above ground portion at the flowering stage is generally used for medicinal purposes. Yarrow is difficult to propagate by seed. The essential oil content in yarrow is believed to be the highest during bud formation or early flowering. The current project is designed to examine the effect of harvest stage on essential oil concentration in different plant parts.

Harvest Timing Effects on Maturity, Productivity and Quality of Transplanted Yarrow

Yarrow was transplanted at 30 x 61 cm (12 x 24 in) spacing. Growth, yield and quality will be determined at 2, 3, 4, and 5 years after planting.

The test was planted in July 1997 using a water-wheel transplanter. The crop will be harvested and observations will be taken at the appropriate intervals.

German and Roman Chamomile

Chamomile is an annual herb. Fresh or dried flower heads are used in the medicinal industry. Chamomile is being used as a nutritional supplement and to treat a wide range of ailments. Its being used as a carminative, a mild sedative, and as an anti-inflammatory agent. This project is designed to develop appropriate management practices for producing German chamomile from transplants.

Effect of Cutting Height on Yield of Transplanted German Chamomile

German chamomile was harvested (i) with Flower + 2.5 cm (1 in) of the top shoot, and (ii) Flower + 10 cm (4 in) of the top shoot. The crop was planted on July 8, 1997 using water wheel planter. Harvests were taken on August 26, and September 11, 1997.

Harvesting German chamomile with 10 cm of the top shoot produced approximately double the yield during the early harvest, and a three-fold yield increase at the late harvest than harvesting the flowers with 2.5 cm of the shoot (Table 6). Quality characteristics of the material obtained from these harvest methods will be analysed in future studies.

Table 6. Cutting height effects on fresh weight of German chamomile.

Cutting height	Yield of fresh flower and shoot (kg/ha)	
	Harvest-1	Harvest-2
Flower + 2.5 cm stem	2473	2356
Flower + 10 cm stem	4932	6328

Fall Seeding of Selected Herbs

Breaking seed dormancy and the light requirement for germination are major limitations to direct seeding of herbs, particularly during spring seeding. It is likely that fall seeding, while satisfying the stratification requirement, will also provide an ideal seed bed for germination in the spring.

Milk thistle, valerian, feverfew, German chamomile, Roman chamomile, stinging nettle (stratified), stinging nettle (not stratified), *E. angustifolia* (stratified), and *E. angustifolia* (not stratified) were seeded in the fall (November 4, 1997).

This test is being conducted under both dryland and irrigated conditions. Seed germination, stand establishment, and subsequent growth and yield characteristics will be monitored.

Observational Plots of Selected Herbs Planted into IRT Mulch

The following herb species were grown in IRT mulch:

Echinacea angustifolia, Echinacea purpurea, seneca root, lovage, inula, chives, sorrel, calendula, summer savoury, wormwood, St. John's wort, horehound, anise hyssop, hyssop, licorice, valerian, German chamomile, Roman camomile, and yarrow.

Cultivar Evaluation Trials And New Cultivar Development For Native Fruit Species

Principal: R. St-Pierre, Department of Horticulture Science
Funding: Canada/Saskatchewan Agri-Food Innovation Agreement (AFIF)
Co-investigators: B. Shroeder, Shelterbelt Centre, Indian Head; L. Tollefson, SIDC
Progress: Ongoing
Location: SIDC, Outlook; Shelterbelt Centre, Indian Head;
M. Neuhoffer, Yorkton

Objective:
c) to collect agronomic and fruit quality data from previously established cultivar trials;
b) to evaluate and select new cultivars suitable for production and processing;
c) to establish new cultivar trials where promising, unnamed selections can be compared to existing, named cultivars.

Native fruit crops, such as black currant, chokecherry, highbush cranberry, pincherry, and sour cherry have substantial potential to contribute to the diversification of Saskatchewan's agricultural economy. However, scientific knowledge regarding many production practices is lacking. Native and traditional fruit cultivar evaluation trials were established previously under the Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED). The following is a summary of the activity continued at the Saskatchewan Irrigation Development Centre (Outlook). All native fruit crops tested at this site were planted in the fall of 1994 and spring of 1995, except the sour cherry trials which were planted in August of 1996. During the 1997 season, survival and growth data were collected from black currant, chokecherry, highbush cranberry, pincherry, and sour cherry cultivar trials. Fruit yield and mean fruit weight data were collected from the black currant trials.

<u>Black Currant</u>

All cultivars performed equally well in terms of growth and survival. This season offered the first significant fruit harvest since these trials were planted. Bush yields and mean berry weight were highest for the cultivar Wellington.

Crop	Cultivar	Survival (%)	Growth (Caliper) mm	(in)	Bush Yield kg	(lbs)	Fruit Wt. g	(oz)
Black Currant	Consort	100	3.7	(0.15)	0.34	(0.75)	0.46	(0.016)
	Wellington	100	4.1	(0.16)	0.63	(1.39)	0.85	(0.03)
	Willoughby	100	4.1	(0.16)	0	(0)	0.61	(0.021)

<u>Chokecherry</u>

Caterpillar damage affected the general vigour of these plants and eliminated any fruit production. These plants are still several seasons away from significant fruit production and the fruit loss that occurred this season was probably very small. Differences in overall cultivar performance are not evident at this point in the trial.

Crop	Cultivar	Survival (%)	Growth (caliper) mm (in)	Sucker Production
Chokecherry	Garrington	100	5.0 (0.2)	0.8
	Lee Red	93.3	7.3 (0.29)	0.4
	Yellow	100	7.7 (0.31)	0.1

Highbush Cranberry

The cultivar Phillips continues to show inferior survival, however those plants that have established appear to be hardy. All cultivars had increased shoot growth during the previous season. The cultivar Wentworth appears to be the most vigorous of the cultivars tested.

Crop	Cultivar	Survival (%)	Shoot growth cm (in)	Sucker Production
Highbush Cranberry	Alaska	86.7	20.4 (8.2)	0
	Phillips	66.7	28.2 (11.3)	0
	Wentworth	100	29.7 (11.9)	0

Pincherry

The pincherry trial has established more quickly than the other crops tested at this site. Most bushes now exceed 1.5 meters in height and the treatment blocks have formed a dense hedge-row. Caliper growth was greatest from the cultivar Mary Liss. Fruit yield from this site was too low to be harvested.

Crop	Cultivar	Survival (%)	Growth (caliper) mm (in)	Sucker Production
Pincherry	Jumping Pound	100	10.7 (0.43)	0.5
	Lee #4	100	13.6 (0.54)	0.2
	Mary Liss	100	16.4 (0.66)	0.2

Sour Cherry

This was the first growing season since the planting of this trial in the fall of last year. No replacements were required at this site.

Crop	Cultivar	Survival (%)	Growth	Sucker Production
Sour Cherry	6-69-11.0	100	na	0
	6-69-2.8	100	na	0
	6-68-25.1	100	na	0

Soils/Fertilizer/Water

Development and Extension of Precision Farming Techniques for Saskatchewan Producers

Principals:	T.J. Hogg and M. Pederson, Saskatchewan Irrigation Development Centre
Funding:	Canada/Saskatchewan Agri-Food Innovation Fund (AFIF)
Co-investigators:	D. Pennock, F. Walley and M. Solohub, Department of Soil Science, University of Saskatchewan, Saskatoon, Saskatchewan

Location:	R. Pederson (SE-20-28-07-W3)
Progress:	Year one
Objective:	To develop an agronomic information package which can be used to tailor management practices to variable soil and moisture conditions within a given field.

The generation of seeding and fertilizer application equipment currently under development by major Saskatchewan equipment manufacturers will allow producers to choose different fertilizer and seeding rates. There is very little basic agronomic information available for producers wanting to implement precision farming technology. The success of precision farming technology ultimately rests on our ability to develop effective management maps to guide producers in choosing appropriate input rates. Thus, an agronomic information package must be developed that can be used to tailor management practices to variable soil and moisture conditions within a given field.

In the spring of 1997, a plot was established at the selected site to determine the effect of variable nitrogen and phosphorus fertilizer and seeding rates on the establishment, harvest index, grain yield, and grain quality of irrigated AC Barrie wheat across different landscape positions. Fertilizer treatments consisted of nitrogen and phosphorus applications based on soil test recommendations (Table 1). The treatments were applied as a side band application utilizing urea (46-0-0) and monoammonium phosphate (12-51-0) as the nitrogen and phosphorus fertilizer sources. Each treatment strip was seeded over the complete range of landscape management units in a strip plot design and replicated six times.

Irrigated AC Barrie wheat showed significant differences among the landscape management units and fertility treatments. Yield and protein content increased with nitrogen application up to 168 kg N/ha (150 lb N/ac) in each landscape management unit and was of the order lower>mid>upper (Table 2 and 3). Differences were greatest at the low nitrogen application rates indicating the greater inherent soil fertility of the lower slope position. There was no consistent response to increasing phosphorus application or seeding rate within each landscape management unit. More straw was produced at the lower slope position as indicated by the lower harvest index values (Table 4). Yield increases were due to an increase in the number of seeds produced since seed size decreased with increased nitrogen application.

These results are considered preliminary. Data from several site years is required before an agronomic information package can be developed to tailor management practices to variable soil and moisture conditions within a given field.

Table 1. Treatments for the precision farming trial.				
Treatment #	Seeding Rate		Nitrogen Rate[1]	Phosphorus Rate[1]
	kg/ha	bu/ac		
1	100	1.5	0	0
2	100	1.5	1x	0
3	100	1.5	0	1x
4	100	1.5	0.5x	1x
5	100	1.5	1x	1x
6	100	1.5	1.5x	1x
7	100	1.5	2x	1x
8	67	1.0	1x	1x
9	134	2.0	1x	1x
10	100	1.5	1x	2x

[1] recommended rates based on standard soil testing procedures

Table 2. Landscape position and fertilizer effects on irrigated AC Barrie wheat yield.											
N Rate[1]	P_2O_5 Rate[2]	Seeding Rate		Yield						Treatment Mean	
				Upper		Mid		Lower			
		kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	bu/ac
0	0	100	1.5	2893	43.0	3229	48.0	3720	55.2	3280	48.7
1x	0	100	1.5	4349	64.6	4479	66.5	4541	67.4	4456	66.2
0	1.0x	100	1.5	3111	46.2	3384	50.3	3774	56.0	3423	50.8
0.5x	1.0x	100	1.5	3617	53.7	3941	58.5	4309	64.0	3956	58.7
1.0x	1.0x	100	1.5	4006	59.5	4313	64.0	4362	64.8	4227	62.8
1.5x	1.0x	100	1.5	4632	68.8	4703	69.8	4793	71.2	4709	69.9
2.0x	1.0x	100	1.5	4611	68.5	4492	66.7	4657	69.2	4587	68.1
1.0x	1.0x	67	1.0	4204	62.4	4281	63.6	4630	68.8	4372	64.9
1.0x	1.0x	134	2.0	4308	64.0	4435	65.9	4639	68.9	4461	66.2
1.0x	2.0x	100	1.5	4286	63.6	4495	66.8	4692	69.7	4491	66.7
Landscape Position Mean				4002	59.4	4175	62.0	4412	65.5		

ANOVA LSD(0.05)	kg/ha	bu/ac
Landscape Position (LP)	193	2.9
Treatment (T)	196	2.9
LP x T	195	2.9

[1] 1x = 112 kg N/ha (100 lb N/ac)
[2] 1x = 28 kg P_2O_5/ha (25 lb P_2O_5/ac)

Table 3. Landscape position and fertilizer effects on irrigated AC Barrie wheat protein.

N Rate[1]	P_2O_5 Rate[2]	Seeding Rate		% Protein			Treatment Mean
		kg/ha	bu/ac	Upper	Mid	Lower	
0	0	100	1.5	12.1	12.3	13.5	12.6
1x	0	100	1.5	12.9	13.5	14.2	13.5
0	1.0x	100	1.5	12.1	12.3	13.1	12.5
0.5x	1.0x	100	1.5	12.0	12.3	13.6	12.6
1.0x	1.0x	100	1.5	12.8	13.3	14.1	13.4
1.5x	1.0x	100	1.5	14.1	14.3	14.7	14.4
2.0x	1.0x	100	1.5	15.0	14.9	15.1	15.0
1.0x	1.0x	67	1.0	12.6	13.2	13.9	13.2
1.0x	1.0x	134	2.0	12.8	13.3	14.1	13.4
1.0x	2.0x	100	1.5	12.9	13.2	14.0	13.4
Landscape Position Mean				12.9	13.3	14.0	

ANOVA LSD(0.05)	
Landscape Position (LP)	0.3
Treatment (T)	0.3
LP x T	0.3

[1] 1x = 112 kg N/ha (100 lb N/ac)
[2] 1x = 28 kg P_2O_5/ha (25 lb P_2O_5/ac)

Table 4. Landscape position and fertilizer effects on irrigated AC Barrie wheat harvest index.

N Rate[1]	P_2O_5 Rate[2]	Seeding Rate		Harvest Index[3]			Treatment Mean
		kg/ha	bu/ac	Upper	Mid	Lower	
0	0	100	1.5	0.51	0.47	0.42	0.47
1x	0	100	1.5	0.43	0.43	0.36	0.41
0	1.0x	100	1.5	0.50	0.46	0.41	0.45
0.5x	1.0x	100	1.5	0.44	0.45	0.37	0.42
1.0x	1.0x	100	1.5	0.41	0.42	0.33	0.39
1.5x	1.0x	100	1.5	0.46	0.44	0.37	0.42
2.0x	1.0x	100	1.5	0.43	0.38	0.36	0.39
1.0x	1.0x	67	1.0	0.43	0.41	0.39	0.41
1.0x	1.0x	134	2.0	0.46	0.45	0.37	0.42
1.0x	2.0x	100	1.5	0.44	0.44	0.35	0.41
Landscape Position Mean				0.45	0.43	0.37	

ANOVA LSD(0.05)	
Landscape Position (LP)	0.04
Treatment (T)	0.03
LP x T	NS[4]

[1] 1x = 112 kg N/ha (100 lb N/ac)
[2] 1x = 28 kg P_2O_5/ha (25 lb P_2O_5/ac)
[3] Grain weight/total weight
[4] not significant

Drainage Investigations at SIDC

Principals: T. Hogg, L. Tollefson and B. Vestre, Saskatchewan Irrigation Development Centre
Location: SIDC (SW-15-29-08-W3)
Progress: Field 11 - Year 12; Fields 4 and 5 - Year four
Objective: To determine the effect of subsurface drainage installation on soil salinity reclamation.

Two areas at the SIDC have had subsurface drainage installed to lower the water table and provide a means for leaching the excess soluble salts. In 1986, subsurface drainage was installed on Field 11, and in 1994, on Fields 4 and 5. Leaching to reduce the salt load in the soil was achieved using large applications of irrigation water after the crop was harvested each fall starting in 1988 for Field 11 and in 1994 for Fields 4 and 5 (Table 1). Once the leaching was completed each fall, the drainage areas were monitored on a 15 metre grid using an EM 38 non-contacting terrain conductivity meter. The EM 38 data was gridded and contoured using geostatistical software which allowed the calculation of the areal extent of salinity at contour intervals to represent non, slight, moderate, and severe salinity classes. Soil samples were collected at specific grid points and analysed for electrical conductivity and for major anion and cation content on the saturation extract.

Table 1. Total fall leaching water applied.

Year	Leaching Water (mm)
Field 11	
1988	475
1989	355
1990	270
1991	297
1992	222
1993	135
1994	50
1995	0
1996	0
1997	0
Fields 4 and 5	
1994	350
1995	300
1996	225
1997	425

Field 11

Results based on the EM 38 horizontal readings, representing salinity in the top 0.6 metre of the soil profile, indicate a reduction in the area classified as moderate and severely saline from 62% in 1986 to 29% in 1988 after the first fall leaching period (Table 2). This was reduced to 0% by the fall of 1991 with little change thereafter. Clearly a dramatic change in salinity class has occurred.

Mean soil electrical conductivity (ECe)of samples collected after leaching also indicates a dramatic reduction in the salt content of the soil profile (Figure 1). A small increase in soil Ece has occurred since fall leaching was discontinued.

Significant improvement in barley yield has occurred since drain installation and fall leaching (Table 3). In 1995, dry bean, a salt sensitive crop, grown on this area yielded in excess of 2400 kg/ha (2150 lb/ac).

This field has been reclaimed using subsurface drainage. Monitoring will continue to ensure the reduced salinity levels are maintained.

Table 2. Changes in salinity class from EM 38 horizontal readings on Field 11 (1986 - 1997).										
Salinity Class	% Area									
	1986	1988	1989	1990	1991	1992	1993	1994	1995	1997
Non (0-2 dS/m)	20	17	69	46	89	81	93	74	70	83
Slight (2-4 dS/m)	18	54	28	47	11	17	8	24	28	16
Moderate (4-8 dS/m)	34	26	3	8	0	2	0	2	2	1
Severe (8-16 dS/m)	28	3	0	0	0	0	0	0	0	0

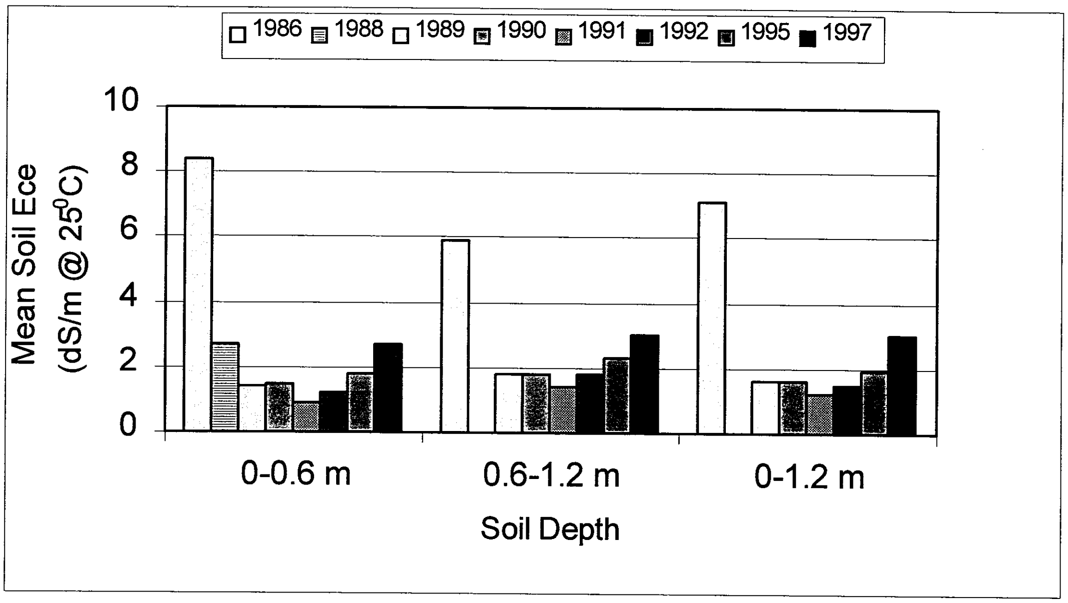


Figure 1. Mean soil Ece for 15 sites of Field 11.

Table 3. Crop yield after subsurface installation and leaching on Field 11.			
Year	Crop	Yield	
		kg/ha	bu/ac
1988	Heartland barley	3225	60
1989	Bonanza barley	4470	83
1990	Duke barley	6990	130
1991	Duke barley	5900	110
1992	Duke barley	6505	121
1993	Manley barley	4838	90
1994	Duke barley	5240	96
1995	Othello pinto bean/Seaforth navy bean	2477	2205*
1996	AC Reed Soft White Spring Wheat	---	---
1997	Sceptre Durum Wheat	4720	70

*lb/ac

Fields 4 and 5

Results based on the EM 38 horizontal readings, representing salinity in the top 0.5 metre of the soil profile, indicate a reduction in the area classified as moderate and severely saline from 28% in 1993 to 9% in 1994 for Field 4,and from 72% in 1993 to 45% in 1994 after the first fall leaching period (Table 4). The total area in the non and slightly saline classes increased to 95% for Field 4 and to 83% for Field 5 by the fall of 1997.

Soil samples collected prior to leaching in 1994 and 1995 indicate a reduction in the salt content of the soil profile on both Field 4 (Figure 2) and Field 5 (Figure 3) after four fall leaching periods.

Future activity at this site will monitor salinity changes. This site will be used to conduct replicated herbicide and nutrient leaching studies.

Table 4. Changes in salinity class from EM 38 horizontal readings on Fields 4 and 5 (1993-1997).

Salinity Class	% of Field Area							
	Field 4				Field 5			
	1993	1994	1995	1997	1993	1994	1995	1997
Non (0-2 dS/m)	43	57	52	76	11	26	18	57
Slight (2-4 dS/m)	29	34	41	19	17	29	40	26
Moderate (4-8 dS/m)	25	9	7	5	58	42	29	13
Severe (8-16 dS/m)	3	0	0	0	14	3	13	4

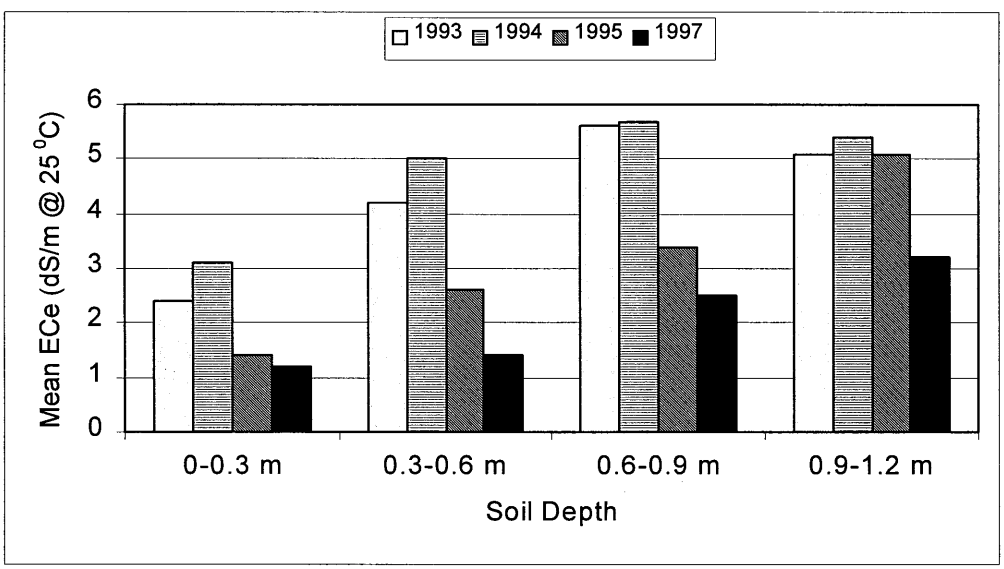


Figure 2. Mean soil Ece for eight sites on Field 4.

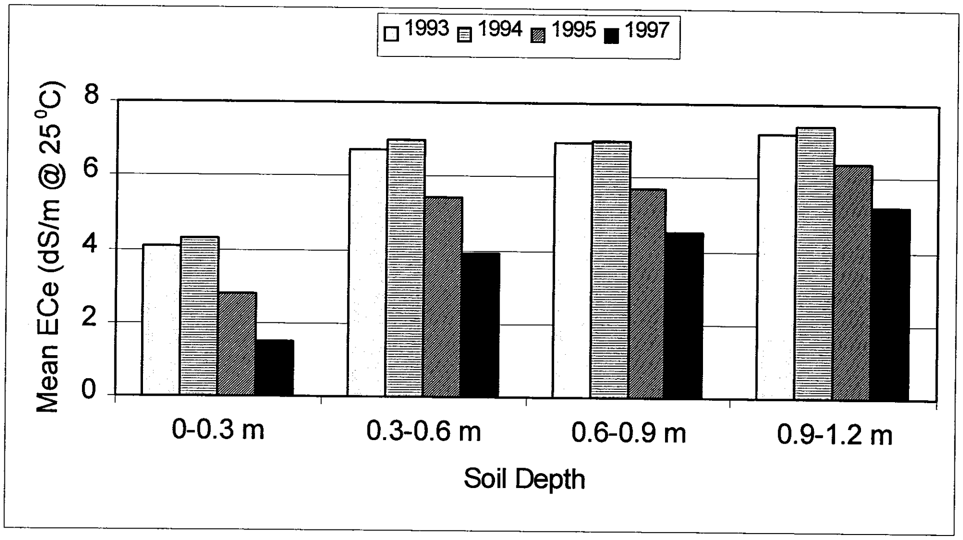


Figure 3. Mean soil Ece for eight sites on Field 5.

Irrigation Application Regime Effects Using Lower Elevation Spray Application (LESA)

Principals: T. Hogg, R.B. Irvine, and M. Pederson, Saskatchewan Irrigation Development Centre

Co-investigators: K. Stonehouse and J. Gillies, Department of Agriculture and Bioresource Engineering, University of Saskatchewan, Saskatoon, Saskatchewan

Location: SIDC (SW15-29-08-W3)

Progress: Year one

Objective: To determine the effect of different irrigation application regimes using LESA under Saskatchewan growing conditions.

LESA irrigation systems can reduce energy use and can increase water application efficiency. More efficient water application may result in runoff. In order to meet crop water requirements yet prevent runoff, smaller more frequent water applications may be required.

A project was initiated in 1997 at the SIDC using a LESA two-tower centre pivot irrigation system to determine the effect of smaller, more frequent water applications on crop yield and soil moisture. Irrigation treatments applied 25 mm (1 in) of water in either one pass or two passes to alternate segments of the field. Both treatments received the same total water application over the growing season. AC Reed softwheat was used as the test crop. Soil moisture was monitored throughout the growing season with a neutron moisture meter in the outside tower area of each treatment segment of the field.

Soil profile moisture change, total water use, and daily water use showed a significant difference only in the second measuring time period (Table 1). Cumulative water use showed no significant difference between the two water application treatments. Soft wheat yield was not significantly affected by the two application treatments (Table 2). Water application was sufficient to meet the requirements of the soft wheat over the growing season for both water application treatments.

Table 1. Profile moisture change, total water use and daily water use at different measurement times throughout the growing season for the LESA irrigation application trial (softwheat).

Time Period	Rainfall (mm)	Irrigation (mm)	Irrigation Treatment	Profile Moisture Change (mm)	Total Water Use (mm)	Daily Water Use (mm)	Cumulative Water Use (mm)
05/30-06/10	14.6	40	2@12.5mm	5.9	60.5	5.0	60.5
			25mm	5.9	60.5	5.0	60.5
			LSD(0.05)	NS	NS	NS	NS
06/11-07/03	65.6	75	2@12.5mm	19.0	159.6	6.9	220.1
			25mm	14.7	155.3	6.8	215.8
			LSD(0.05)	3.5	3.5	0.2	NS
07/04-07/14	2.6	0	2@12.5mm	36.7	39.3	3.6	259.4
			25mm	41.5	44.1	4.0	259.9
			LSD(0.05)	NS	NS	NS	NS
07/15-07/28	3.4	0	2@12.5mm	14.8	18.2	1.3	277.6
			25mm	19.2	22.6	1.6	282.5
			LSD(0.05)	NS	NS	NS	NS
07/29-08/07	1	0	2@12.5mm	32.5	33.5	3.4	311.1
			25mm	42.5	43.5	4.4	326.0
			LSD(0.05)	NS	NS	NS	NS
08/08-08/21	32.8	0	2@12.5mm	-11.6	21.2	1.5	332.2
			25mm	-12.7	20.1	1.4	346.1
			LSD(0.05)	NS	NS	NS	NS

Table 2. Soft wheat yield for the LESA irrigation application trial.

Irrigation treatment	Yield @ 14.5% Moisture	
	kg/ha	bu/ac
2@12.5 m	5489	81.5
25 mm	5777	85.8
LSD (0.05)	NS[1]	NS

[1]not significant

Comparative Salinity Tolerances of Alternate Crops Grown Under Irrigation

Principal:	H. Steppuhn, Semiarid Prairie Agricultural Research Centre (SPARC), Agriculture and Agri-food Canada, Swift Current
Co-investigators:	K.G. Wall, P. Miller (SPARC)
Funding:	Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Location:	Swift Current, Saskatchewan
Progress:	Final year
Objective:	To compare the emergence, growth and seed yield of six alternative crops grown under irrigation and maintained at three levels of root-zone salinity.

The salt sensitivity test was conducted during 1996 under controlled conditions in the Salt Tolerance Testing Laboratory at Swift Current. The lab features control over irrigation, fertility, root zone salinity, and temperature using an electronic programmable controller. Six crops commonly produced under irrigation were grown hydroponically in large sand tank cultures: Cyclone canola, Linola™ 947 flax, Carneval field pea, Radley field pea, Kyle durum wheat, and Othello pinto bean. Three levels of root zone salinity were maintained. Solution electrical conductivies equalled 1.2 dS/m (slightly saline), 11.2 dS/m (moderately saline), and 24.6 dS/m (severely saline).

Field soil which contain saline solutions measuring near 11 dS/m or less rarely exhibit white crusts on the surface. At a conductivity of 11.2dS/m, all grain yields were reduced by 60% or more. Root zone salinity reduced crop production by at least 50% when field salts were not obviously visible.

The ranking of the test crops according to relative grain production in moderate to severely saline soils were: canola>durum wheat>flax>green pea>yellow pea>pinto bean. At 24.6 dS/m (severely saline), all crops except canola failed to manage any significant production. Even canola could only produce 20% of the yield produced in the non-saline rooting media.

If white crusting on the soil surface is apparent, these crops should not be grown.

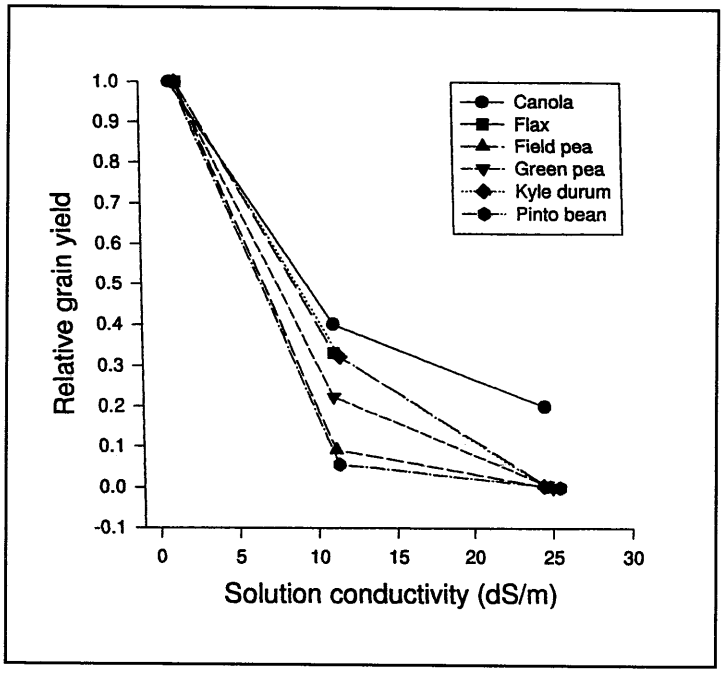


Figure 1. Grain yield of six field crops in moderately and severly saline media relative to yield in non-saline medium.

Energy Conservation and Application Uniformity for Centre Pivot and Linear Move Irrigation Systems When Operating at Varying Pressures

Principals: J.A. Gillies, K. Stonehouse, Agriculture and Bioresource Engineering, University of Saskatchewan
Funding: Canada/Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED)
Co-operators: G. Sommerfeld, Riopka Bros., D. Eliason, J. Eliason, SIDC
Progress: Year two of two
Objective:

a) To determine:
   1) Water distribution efficiency, application uniformity, and application efficiency for centre pivots equipped with spray, spinner, and rotator nozzles;
   2) Energy use at high and low operating pressures;
   3) The effect of wind speed on uniformity of application,

b) To develop a model to predict application efficiency based on wind speed and nozzle operating pressure.

The purpose of the study is to determine the application uniformity and efficiency, energy consumption, and runoff characteristics of irrigation systems equipped with Low Drift Nozzles (LDN) operating in Saskatchewan. The study is in its fourth year of field research. The first two years of data have been analyzed and reported.

The field research for 1997 has been completed. The field scale systems monitored for this study were owned and operated by the co-operators. Minor changes were made to the 1997 monitoring program as compared to the previous three seasons.

The Sommerfeld systems were added to the study in 1995 to evaluate and compare the data from the SIDC modified centre pivot on Field 1 with a field scale pivot. The co-operator owns two centre pivots on adjacent quarter sections. The first system is a low pressure Zimmatic Generation II centre pivot of 395 m (1295 ft) length. This system is equipped with Senninger Low Drift Nozzles on 1.8 m (6 ft) drop tubes with 70 kPa (10 psi) regulators on each nozzle. This quarter grew wheat in 1995, potato in 1996, and alfalfa in 1997.

The adjacent system is a Gifford-Hill centre pivot of 316 m (1035 ft) length. This pivot is equipped with standard impact nozzles of varying size and spacings. The crops grown under this system were alfalfa in 1995, wheat in 1996, and potato in 1997.

Three centre pivot systems added to the study in 1996 were monitored again in 1997. The Riopka system is a Valley pivot of 395 m (1295 ft) length. This machine was originally fitted with standard impact nozzles. In 1996, the outer two spans were converted to Nelson R&S 3000 series nozzles mounted on flexible drop tubes with 100 kPa (15 psi) and 170 kPa (25 psi) Nelson regulators. One span has spinner plates fitted to the nozzles, the other has rotator plates. Wheat was grown in 1996, and canola was grown in 1997.

The D. Eliason system is a Zimmatic Generation I section pivot of 752 m (2470 ft) length. This centre pivot was originally equipped with standard impact nozzles. The system was converted in 1996 to Nelson D 3000 series nozzles on flexible drop tubes with 70 Kpa (10 psi) regulators for each nozzle. The nozzles incorporate spray plates. Wheat was grown in the monitored area in both 1996 and 1997.

The J. Eliason system is a Valley pivot of 798 m (2615 ft) length equipped with low pressure Nelson S 3000 nozzles and spray plates on flexible drop tubes with 100 kPa (15 psi) Senninger regulators. The crops in the monitored area were dry bean in 1996 and wheat in 1997.

A Valley quarter section pivot owned by the SIDC and equipped with LDNs was added to the study in 1997. Two rows of catch cans were installed under the outer two spans. Three data sets were added to the analysis from this system.

The number of catch can rows per pivot was doubled to four in 1997. This allowed the collection of a larger amount of data. Problems encountered during the last two seasons are being addressed. Changes made to the systems in 1997 will mean that additional nozzle tests of flow rates are warranted.

The data is currently under analysis. Analysis is expected to be complete by the end of March 1998.

Agrium Biologicals, 1997 Effect of Inoculant Formulation on Root Nodulation and Grain Yield of Pulse Crops

Principals:	R.K. Hynes and N. Nyssen, Agrium Inc., Biologicals, Saskatoon, Saskatchewan
Location:	Saskatchewan Irrigation Development Centre
Co-investigator:	R.B. Irvine, SIDC
Progress:	One year only
Objective:	To examine the effect of formulation on the performance of rhizobial inoculants.

Rhizobium strains that effectively nodulate field pea, lentil, and dry bean were formulated in liquid, sterile peat, and a granular peat. The experimental design was a four-replicate RCBD. Inoculants were applied at rates indicated by the manufacturer.

Plants from each plot were carefully removed and nodule count per root was determined. Grain yield was also determined. Liquid, peat, and granular inoculants performed equally well.

Irrigation Management Practices to Prevent or Minimize Leaching and/or Preferential Flow of Pesticides and Plant Nutrients to Ground Water

Principal:	A.J. Cessna, Agriculture and Agri-Food Canada, Saskatoon Research Centre
Funding:	Canada/Saskatchewan Agriculture Green Plan Agreement (CSAGPA), Irrigation Sustainability and Water Quality Program
Location:	Saskatchewan Irrigation Development Centre
Co-investigators:	J.A. Elliott, L. Tollefson, R. McKay, B. Vestre, and W. Nicholaichuk
Progress:	Fourth year of a four-year study on Fields 4 and 5
Objective:	To improve irrigation sustainability through development and validation of irrigation management options for producers which will prevent or minimize leaching and/or preferential flow of pesticides and nutrients through the vadose zone.

CSAGPA funding was used to establish a "field laboratory" on the SIDC consisting of a tile-drained field irrigated by a centre pivot. The tile drains were installed in the spring of 1994 and are arranged so that effluent from the four quadrants of the field can be monitored separately. In order to monitor the chemical equilibration of the site, the site has been instrumented with automated water samplers to collect water samples and to measure flow rates from the tile drains, with suction lysimeters to sample soil water from several depths, and with time domain reflectometry (TDR) waveguides to monitor soil water content.

The site is saline and each year receives a fall irrigation to remove salts from the root zone via the tile drains. During the 1994 to 1996 growing seasons, water infiltration rates and soil densities were measured to assess physical equilibration of the site. Tile drain effluent was monitored for herbicide, nutrient, and major inorganic ion content to assess chemical equilibration of the site. These measurements indicated that by the end of the 1996 growing season, the site was essentially equilibrated both physically and chemically.

In 1997 prior to the fall irrigation, the herbicides triallate and metribuzin were applied to the site. The west half of the field was cultivated between the application of triallate and metribuzin. There was no post-harvest cultivation on the east half of the field. During the irrigation, tile-drain effluent flow rates were measured. Effluent and lysimeter soil water samples were collected for herbicide, nutrient, and major ion analysis. A preliminary summary of the nutrient data is reported here, whereas the herbicide and major ion analyses have not been completed.

Tile-drain effluent flow rates were considerably greater from the tilled portion of the field than the untilled portion. As a result, total fluxes of nutrients in the effluent were also greater where the field had been tilled. Although concentrations of nitrates were consistently greater in effluent from the tilled field, concentrations of phosphorus were greater in effluent from the untilled field. Average nitrate concentrations were 22.5 ppm in effluent from the tilled field and 18.4 ppm from the untilled field. The total P concentration in effluent from the tilled field averaged 0.14 ppm compared to 0.17ppm from the untilled field.

A final report will be submitted to the CSAGPA Water Quality Technical Committee after the herbicide analyses have been completed and the data summarized.

Marketing and Economics

Marketing and Economics

Principal: H. Clark
Saskatchewan Irrigation Development Centre

Objectives:

a) To assist producers to diversify through identification of higher value market opportunities;
b) To help direct the research and demonstration program at SIDC by evaluating the market potential for irrigated crops;
c) To assist entrepreneurs in establishing value added processing through market identification;
d) To assist in evaluating other crop diversification and processing opportunities for rural development.

Methodology

1) Gathering supply/demand information on specialty crops and analysing information on major irrigation crops.
2) Maintaining price information on irrigated and specialty crops. A monthly summary is prepared in the spring with the expected prices and returns for the major irrigation crops in the coming year. This is available either directly from the Centre, or at the SIDC/PFRA website: http://www.agr.ca/pfra/sidcpub/icrop98.htm
3) Preparing periodic newsletters and reports. These updates are circulated to internal and external clients on a regular basis.

Projects

- Assisted in determining markets, prices, and cost of production information for medicinal and other herbs.
- Represented SIDC with J. Wahab in the planning for the 1998 Prairie Medicinal and Aromatic Plants Conference to be held in Saskatoon in March of 1998.
- Participated in industry sponsored production meetings on medicinal herbs in Prince Albert, Humboldt and Arborfield. Presented information on marketing.
- Assisted in determining the costs of production for various vegetables in Saskatchewan.
- Assisted in reviewing the SIDC R & D activities using the study management system of Agriculture and Agri-Food Canada.
- Prepared a supply/demand for potatoes in Western Canada which was distributed for review.
- Assisted Saskatchewan Agriculture and Food in their efforts to develop cost of production information on specialized crops.
- Assisted in the development of a Human Resources strategic plan for PFRA in November and December of 1997.
- Represented SIDC at numerous trade shows including the crop production show in Saskatoon, the SIDC field day, Prairie Ventures, the PMAP conference, and the PFRA field day at the Shelterbelt Centre.

Demonstrations

Irrigation Crop Diversification Corporation Demonstrations

Introduction

The Irrigation Crop Diversification Corporation (ICDC) is the provincial organization responsible for irrigation research, demonstration and extension. It was formed under the *Irrigation Act 1996*.

ICDC contracted Footprint Field Consulting to carry out seven crop demonstrations in central Saskatchewan. The mandate was to monitor and collect data from the fields on a weekly basis, and to present summary reports for the demonstrations. A minimum of five sites were arranged for each demonstration as a means of replicating the trials. Thirty-seven sites were located by mid-May.

Demonstration co-operators pay a $2/ac fee to ICDC for the crop monitoring service. In return each co-operator is kept up to date of any production problems in the field. An on-going database of field agronomic information will be assembled and maintained over the course of the project. This information will be used to direct and to influence irrigated crop production in the province.

The demonstration projects conducted in 1997 were as follows:

Project	No. of fields	Objective
Fungicide on Beans	5	To determine if two applications of fungicide enhance yield in dry bean.
Foliar Feed on Beans	5	To determine if two applications of foliar feed (15-20-20) enhance yield in dry bean.
Nitrogen Rate on Beans	5	To determine if additional nitrogen increases yield in dry bean.
Fungicide in Cereals	7	To determine if a fungicide application enhances yield or quality in cereals.
Pulses in Rotation	5	To determine crop differences when grown on a pulse stubble versus a non-pulse stubble.
Increased Protein in Durum	5	To determine if an additional 30 lb/ac of nitrogen at flag leaf emergence increases protein content in Durum.
N/S Ratio in Canola	5	To determine in canola yield can be enhanced by increasing the nitrogen to 2 or 3 times soil test recommendation (higher N/S ratio).

Dry Bean Fungicide Trial

This project is a continuation of demonstrations done by Sask Water under the PAWBED program and of research done by SIDC. Field demonstrations in each of the past four years have consistently shown economic benefits to both single and double applications of fungicide to control white mold (*Sclerotinia sclerotiorum*).

Five sites were set up for this trial, however three were not continued through to harvest. The yields from the two trials completed are shown in Table 1.

Table 1. Fungicide application results.

Field #	Yield (lb/ac)		
	No Fungicide	One Application	Two Applications
22	---	2,370	2,422
29	1,439	1,611	---

Economics

The cost of a single application of fungicide is about $30.00 per acre. If dry beans are worth $.30 per pound, then a break even point is an extra 100 lb/ac. In the above table, the single application in Field 29 exceeds that level while the second application on Field 22 falls a bit short. Field observations and disease ratings indicate that disease pressure was lower than normal in 1997 so it is of no surprise that the second application did not show as large an advantage as is normal.

Over the last four years these demonstrations have been so successful that growers are increasingly reluctant to leave check strips with no fungicide or with a single application. Two applications of fungicide are now the standard practice for disease control in dry beans. For that reason we are recommending that this project be dropped in 1998.

Dry Bean Foliar Feed Fertilizer Trial

The use of foliar feed micronutrient solutions for dry bean production is fairly controversial in Saskatchewan with local scientists and agricultural advisors suggesting it is of no value while production specialists from other areas are saying it is a necessary input. Research work at the SIDC has not shown an economic return to either soil applied or foliar applied micronutrients. Records from the Bean Production Unit of Alberta Pool indicate the producers who use foliar fertilizer average higher yields than those who do not.

Table 2. Foliar fertilizer vs yield in dry bean.

Field #	Yield (lbs/ac)		
	Zero Foliar Feed	5 lbs/ac	10 lbs/ac
4		1460	1560
15	2300		2310
18	1556	1744	1501
19	2368		2532

To help address this problem we set up five trials where the co-operating farmers applied a foliar feed fertilizer on part of their crop and left part untreated. Four of the five completed the trial. In all four locations the grower used Gainer's High Yield 15-20-20 plus micronutrient soluble fertilizer applied with the fungicide spray via a row crop sprayer. Two applications of five pounds per acre each were applied. The first one was made at about 10% bloom and the second two weeks later.

A zero treatment check was missed on Field 4 but we did leave a strip that only received one application of five pounds of fertilizer. Tissue samples were taken several times on each field to track the levels of nutrients in the plants. The results from those samples are as follows:

Table 3. Field 4 foliar feed on dry bean tissue sample analysis.

Date	Trmt	% N	% P	% K	% S	%Ca	% Mg	Cu ppm	Fe ppm	Mn ppm	Zn ppm	B ppm
July 31	5 lb	2.86	0.40	2.59	0.33	1.54	0.51	8.93	207	63	30	36
	10 lb	3.52	0.46	3.14	0.31	1.40	0.45	9.96	153	58	47	33
Aug 8	5 lb	2.42	0.49	2.46	0.23	0.35 D	0.29	7.95	93	22	34	30
	10 lb	2.36	0.43	2.31	0.20	0.43 D	0.30	6.98	97	26	32	30

D=deficient ; M=marginal

Table 4. Field 15 foliar feed on dry bean tissue sample analysis.

Date	Trmt	% N	% P	% K	% S	%Ca	% Mg	Cu ppm	Fe ppm	Mn ppm	Zn ppm	B ppm
July 3		4.77	0.64	3.34	0.29	1.65 D	0.46	25	796	129	34	27
July 25	none	3.65	0.48	3.82	0.28	1.33	0.39	4.99 M	162	59	29	26
	5 lb	3.15	0.42	3.39	0.27	1.28	0.37	5.97	124	55	28	29
July 30	none	2.70 M	0.38	3.15	0.22	1.36	0.36	6.92	109	63	27	24
	10 lb	2.68 M	0.37	3.01	0.25	1.47	0.39	8.91	128	77	38	33
Aug 10	none	3.41	0.43	2.43	0.27	1.71	0.44	7.99	464	94	32	33
	10 lb	3.6	0.39	2.34	0.26	1.41	0.41	7.97	107	74	30	42

D=Deficient; M=Marginal

Table 5. Field 18 foliar feed on dry bean tissue sample analysis.												
Date	Trmt	% N	% P	% K	% S	%Ca	% Mg	Cu ppm	Fe ppm	Mn ppm	Zn ppm	B ppm
July 25	none	3.59	0.42	2.57	0.27	2.03	0.49	9.93	240	53	33	27
	5 lb	3.59	0.49	2.79	0.32	2.04	0.51	15	275	53	65	41
	10 lb	3.40	0.43	2.57	0.35	2.46	0.59	19.9	295	76	108	45
Aug 1	none	3.3	0.36	2.23	0.31	2.96	0.59	10.9	290	70	30	35
	5 lb	3.18	0.37	2.36	0.33	2.72	0.63	10.9	217	60	40	33
	10 lb	3.21	0.35	2.1	0.30	2.68	0.63	10.9	212	68	48	39
Aug 10	none	2.35	0.34	1.69	0.28	2.67	0.68	7.96	145	64	22M	36
	5 lb	2.56	0.34	1.77	0.35	2.87	0.74	10.9	415	83	31	33
	10 lb	2.52	0.37	1.93	0.34	2.62	0.65	10.9	786	84	38	37

D=Deficient; M=Marginal

Table 6. Field 19 foliar feed on dry bean tissue sample analysis.												
Date	Trmt	% N	% P	% K	% S	%Ca	% Mg	Cu ppm	Fe ppm	Mn ppm	Zn ppm	B ppm
July 17	none	4.36	0.48	2.91	0.32	1.58 D	0.52	8.9	330	64	49	41
July 24	none	4.45	0.49	2.95	0.32	1.57	0.60	8.93	757	72	37	37
	5 lb	4.14	0.46	3.31	0.32	1.5	0.42	8.93	500	71	44	30
July 30	none	2.81 M	0.40	2.71	0.27	1.6	0.54	9.00	276	49	31	34
	10 lb	3.34	0.42	9.01	0.27	1.49	0.47	13.9	262	50	49	39
Aug 10	none	2.61	0.40	2.09	0.30	1.87	0.55	8.98	194	60	34	39
	10 lbs	2.51	0.37	1.96	0.33	1.68	0.44	9.93	207	57	37	36

D=Deficient; M=Marginal

The above tables are difficult to interpret since the level of each nutrient that is sufficient, marginal or deficient changes as the plants mature (Table 6). There is little value in comparing nutrient levels between two dates or two growth stages. The best comparison is between the treatments of a given trial on a single date. For example, Field 15 was sampled four times, once on July 3 prior to flowering, again on July 25 after one nutrient application at full flowering, a third sample on July 30 at the end of flowering, and finally on August 10 during the pod fill stage. For the first sample the entire above ground portion of the plant was taken. On the other dates, we sampled the top half of the plant. The final sample containing a high percentage of pods. While the nitrogen levels were lower than optimum in the second and third sample there was not really any significant difference between the treatments.

Table 7. Field bean nutrient concentration data.													
Growth Stage	Nutrient	N	P	K	S	Ca	Mg	Cu	Fe	Mn	Zn	B
		%						ppm				
Early	Deficient	3.6	0.2	1.3	0.18	1.8	0.25	6	45	25	20	20
Flowering	Marginal	3.8-4.0	0.2-0.25	1.3-1.5	0.18-0.2	1.8-2.0	0.25-0.3	6-7	45-50	25-30	20-25	20-25
(Whole Shoot)	Sufficient	4.0	0.25	1.5	0.2	2.0	0.3	7	50	30	25	25
Late	Deficient	2.5	0.25	1.5	0.15	1.0	0.2	3	25	25	20	10
Flowering	Marginal	2.5-3.1	0.25-0.3	1.5-2.0	0.15-0.2	1.0-1.2	0.2-0.25	3-5	25-30	25-30	20-25	10-15
(Whole Shoot)	Sufficient	3.1	0.3	2.0	0.2	1.2	0.25	5	30	30	25	15
Peak	Deficient	1.5	0.2	0.7	0.12	1.0	0.2	3	25	10	20	10
Harvest	Marginal	1.5-1.8	0.2-0.25	0.7-1.1	0.12-0.15	1.0-1.2	0.2-0.25	3-4	25-30	10-12	20-25	10-15
(Leaves)	Sufficient	1.8	0.25	1.1	0.15	1.2	0.25	4	30	12	25	15

Some nutrients, for example, phosphorus, are quite stable with little change among samples. Others, most notably iron, varied considerably with no identifiable pattern, although even the lowest value was three times the sufficient level. Of the major nutrients only nitrogen showed any reports below sufficient. On Field 15, three samples were marginal and one was deficient. On both sample dates the fertilized sample showed a lower analysis than the unfertilized sample. On Field 19, one unfertilized sample was marginal. Both of those fields were high yielding, which may actually have been the reason their tissue nitrogen levels were low.

Calcium showed up as deficient on two fields in the pre-application sample and one field on the post-flowering sample. It is unusual to see a calcium deficiency on our soils and foliar application is not recommended when a deficiency does show. The foliar fertilizer used in this project does not contain calcium. Copper was the only other nutrient to show a marginal level on any of the samples. Field 15 had a copper level just into the marginal zone on the unfertilized sample taken July 25. It is unlikely that any yield loss occurred as a result.

Economics

The cost of the foliar fertilizer is currently $1.44 per pound. The application cost is very close to zero as the fertilizer is mixed with the fungicide. If the bean price is $.25/lb the grower will need a yield increase of only 58 lbs/ac to break even. Two of the four fields had a yield increase above that level and two did not.

Conclusion

Even with four sites it would be premature to arrive at any conclusion on the basis of one year's results. One half of the fields showed a yield increase due to added foliar fertilizer. The other half did not. Is this result significant or random? Do higher yielding crops respond more to the extra fertilizer than low yielding crops? Is there a non-yield advantage to applying foliar fertilizer?

Hopefully we can answer those questions with additional field work over the next two or three years.

Dry Bean Nitrogen Application Trial

Another question that has been frequently asked by bean growers is "How much nitrogen fertilizer should be applied on a bean crop?" The normal recommendation for this crop is between ten and forty pounds actual nitrogen per acre or enough to bring the soil level up to fifty pounds per acre. There have been fields in the past ten years that had a high residual nitrogen content or that had been heavily fertilized, and that yielded above average. Should we be applying more nitrogen?

To address this question SIDC initiated a small plot research trial and ICDC began a field demonstration trial. Five field plots were initiated and four were completed. On each field there were three rates of nitrogen fertilizer applied: 0, 35 lb/ac and 70 lb/ac. Soil residual nitrogen averaged 32 lb/ac. The extra fertilizer was either applied at planting time or broadcast and irrigated in, shortly after planting. Field observations were noted during the growing season and yield measurements were taken at harvest.

Results

On two of the four fields the highest yielding treatment was the 70 lb/ac fertilizer rate. On the other two fields the 35 lb/ac rate was the highest yielding treatment. When all four are averaged the high nitrogen rate had the largest yield (Figure 1). On average, the first 35 pounds increased yield by 129 lb/ac and the second 35 pounds by an additional 206 lb/ac. On the highest yielding field, those increases were 397 and 836 lb/ac, respectively. On the lowest yielding field, the first 35 pounds nitrogen increased yield by 15 lb/ac, but 70 pounds nitrogen decreased yield by 35 lb/ac.

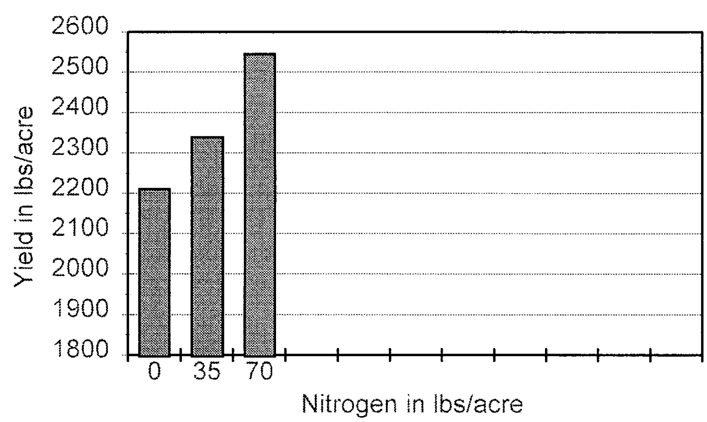


Figure 1 Nitrogen Fertilizer on Beans

Observations during the summer indicate that the high nitrogen treatment had more vegetative growth. In at least one of the fields, combine speed had to be reduced on the high nitrogen treatment due to the heavy plant material. Yields on that field were not significantly higher for the high nitrogen treatment. The extra growth does not always result in increased yield.

Economics

If we use $.30/lb as the cost of nitrogen fertilizer, the 35 lb/ac treatment cost $10.50 and the 70 lb/ac treatment $21.00. Application cost is about $3.50/ac. If the bean price is also $.30/lb, we need to increase yield by 39 and 78 lb/ac, respectively, to break even. On average, this trial returned 4.78 lbs of beans for every extra pound of nitrogen fertilizer.

Table 8. Return to nitrogen fertilizer.				
Nitrogen	Yield Increase	Cost ($)	Return ($)	Increased Profit ($)
Check	0	0	0	0
35 lb/ac	129 lb/ac	14.00	38.70	24.70
70 lb/ac	335 lb/ac	24.50	100.50	76.00

Conclusion

There are unanswered questions arising from this trial. What was the relative level of nodulation in each treatment on each field? What will be the effect of the extra nitrogen on disease development in years when disease is a factor? Will the added nitrogen delay maturity in some years?

This year we did not do a nodulation or nitrogen fixation rating on the treatments or fields. That is a deficiency in our procedures that will be corrected next year. Disease was not a significant factor this year nor was there any evidence that the high fertilized treatment delayed maturity. Both of those concerns may become a factor in subsequent years.

Preliminary results indicate an advantage from the application of extra nitrogen fertilizer on some fields and on average. The small plot work at SIDC will shed more light on this subject since they are using multiple plots and five levels of nitrogen. The results of their work will be reviewed prior to further field demonstrations.

Pulse Rotation Trial

The percentage of acres seeded to annual pulse crops under irrigation in Central Saskatchewan has been increasing every year in the 1990s. The increase has mainly been field peas and field beans. Lentil, chickpeas, and faba beans are also grown under irrigation. Previous research has shown benefits to recropping on a pulse stubble.

The objective of this project was to monitor a single crop grown side by side on a pulse stubble and a non-pulse stubble to observe any differences such as weed pressure, disease incidence, insect incidence, crop growth and yield. Growers would benefit from learning more about the effects of pulse stubble on the following crop.

Five sites were originally set up but changes in seeding plans eliminated one. Another one was monitored this year and will be included in the data next year. The observations from the remaining three sites are presented in Table 9.

Table 9. Results of pulse rotation study.									
Site	Ref	Yield	Stubble	Crop	TKW	Weed Scale:	Insect (0-4)	Disease (0-4)	Lodging (0-4)
1	2	67 bu/acre 75 bu/acre	Lentil CPS	CPS	42.9 35.4	4 0	0 0	3 4	0 0
2	27	86 bu/acre 64 bu/acre	Pea CPS	CPS	38.8 37.7	1 1	1 1	1 3.2	1 1
3	10	42 bu/acre 44 bu/acre	Beans Wheat	Beans	na na	0 0	0	0 1	0 0

The data from each site has to be looked at carefully and the particulars of the field need to be known before drawing any conclusions.

At Site 1, the lentil stubble yield is lower than the CPS stubble but this outcome can be attributed to severe early weed pressure from wild mustard. The problem was compounded by poor weed control likely due to later than optimum chemical application timing. The weed pressure caused most tillers to die off. The heads that did fill produced plump grain as can be seen in the significantly higher TKW.

At Site 2, the expected yield increase in the CPS crop on the pulse stubble occurred. The disease rating is higher on the cereal stubble. The non-nitrogen and nitrogen effects of the pulse stubble combined to produce a 22 bu/ac increase.

The final site was a bean field grown on bean stubble and a cereal stubble that had considerable volunteer canola from two years previous. Growing beans on beans is risky due to disease concerns but the volunteer canola was causing the same disease threat in the cereal stubble area.

The bean crop was more lush and healthier on the bean stubble until August when rust moved into the crop in that area. This disease rating does not show up in the table because the disease became apparent after the ratings were taken. It may be coincidence that the rust only affected the beans in the bean stubble area. The potential yield looked higher on the bean stubble prior to the rust outbreak. The crop grown on wheat stubble was slightly higher yielding at harvest despite a thinner stand and slightly more pressure from Sclerotinia.

Rust is uncommon, but devastating if it attacks early. The co-operator was careful not to over water the bean crop to prevent ideal conditions for disease. This worked very well in keeping the sclerotinia in check.

This project is an interesting one, both for the agronomist and the co-operator. An obvious recommendation from this year is to check weed concerns early on a pulse stubble crop. The mustard family weeds are likely to be more numerous than expected. The crops we had in this project were not prone to lodging but that should be considered when deciding which crops and which variety to grow on pulse stubble. (A site had to be cancelled in a different project due to a durum crop lodging early that was grown on bean stubble.)

This project should be continued next year with more sites.

Protein Enhancement Trial

Some research at SIDC has shown additional nitrogen applied at Flag leaf will increase protein in Durum and wheat. With this objective in mind five sites were established, all on Durum. The trial was not completed at two sites. At Field 26, a 2 inch rain coincided with a .5 inch irrigation and made the field too wet to enter with a fertilizer applicator. Field 20, (Kyle variety) began to lodge before the flag leaf stage and it was felt that the additional N would worsen the problem.

Table 10 compares the results of the treated areas versus the untreated areas at the three sites that received the additional nitrogen.

Table 10. Results of protein enhancement trials.

Site	Ref	Yield Difference (%yield diff)	Crop (stbl)	TKW Diff (%)	Protein Difference (actual)	Grade	Cost Benefit ($/acre)
1	31	-4 bu/acre (-5.6%)	Durum (Dur)	-2.6%	+1.3%	Tr -4 Untrt -3	-$36.50
2	17	-4 bu/acre (-6.4%)	Durum (Can)	+6.7%	+1.1%	Same	-$31.00
3	13	+11 bu/acre (+19.6%)	Durum (Dur)	-6.8%	-0.5%	Same	+$29.00

Site 1 was also very wet when the nitrogen application was made with a floater applicator. Crop in the wheeltracks (3' wide) only produced late tillers which resulted in the yield loss and lower grade due to the shrivelled kernels that developed from the late tillers.

Site 2 began to lodge and irrigation was shut down in early August. The yield loss could be attributed to the tracking damage.

The nitrogen in Site 3 was applied through the pivot and the trampling loss did not occur.

The protein was enhanced in two out of three trials. The percentage increase is similar to work done at SIDC. However, this years results indicate that to be economical the nitrogen should be applied through the pivot or by air. The yield losses caused by the ground application negate any economic benefit of higher protein.

Our recommendation is to continue this project with more sites next year.

Fungicide Trial

Many co-operators were interested in doing a fungicide trial on a cereal crop. This probably can be attributed to the wetter summers of the 1990's and more focus on diseases at the grower and extension level. Seven trials were conducted and completed.

The goal of this project was to test the Disease Decision Guide developed by SIDC. The lower price of HRS wheat in 1997 ($2.75) compared to the price used in the guide ($4.50) made the cost benefit doubtful in the HRS sites. Using the 1997 prices, HRS needed a yield potential of 71 bu/ac to warrant spraying. This compares to 44 bu/ac in 1996. SWS/CPS yield potential had to be 52 bu/ac to warrant spraying (compared to 31 bu/ac in 1996).

It was decided to proceed with each trial because there was disease present, prices may change, and further insight may be gained in the effect of diseases on yield and other grain properties such as protein, kernel weight, and final grade.

The results are presented as treated area versus untreated area in Table 11.

Table 11. Results of fungicide trials.

Site	Ref	Yield Difference (bu/ac & %)	Crop (stbl)	TKW Diff (%)	Protein Difference (actual)	Grade	Cost Benefit ($/acre)
1	27	+9 (+14%)	CPS (CPS)	+7.4%	-0.7	Same	+ $6.60
2	25	0 (0%)	Durum (Dur)	+9.4%	0	Same	- $15.00
3	21	-1 (-1.5%)	HRS (Peas)	+2.0%	+0.4	Same	- $17.75
4	11	0 (0%)	HRS (Oats)	+12.9%	+0.2	Same	- $15.00
5	8	-10 (-17.5%)	HRS (Peas)	+12.1%	-0.1	Same	- $42.50
6	6	+6 (+10.2%)	SW (Can)	+4.7%	+0.1	Same	- $0.60
7	2	+8 (+10.7%)	CPS (Cps)	+8.9%	-0.3	Same	+ $4.20

The comparison table shows that in all cases HRS and Durum did not respond to a fungicide treatment. One site actually showed a 17.5% yield loss. It should be noted that field variability may have contributed to this difference.

The SIDC Disease Decision Guide estimates the yield loss to disease in HRS wheat is on average 7.5%. In 1997, the progression of disease to the penultimate and flag leaf stage was slowed by the weather and yield loss was minimal. Given the current low price for wheat, the guide predicted correctly that a fungicide treatment was unlikely to be economical.

The SIDC Disease Decision Guide estimates the yield loss to disease in CPS/SWS wheat is on average 12.0%. Our trials in CPS/SWS support this estimate averaging an 11.6% yield increase to fungicide application. All sites showed a positive yield response to the fungicide treatment. The criteria of the guide indicated an economical benefit could be expected because potential yields in the CPS/SWS were all predicted to be above 50 bu/ac and the disease on the third leaves in all cases was more than 50%.

The data suggests that CPS/SWS will respond economically to a fungicide even during years of depressed prices and dry summers. A fungicide application on HRS wheat, on the other hand, must be carefully examined. The SIDC Disease Decision Guide is helpful in determining the possibility of economical benefit.

Canola Nitrogen/Sulphur Ratio

In the past few years, canola yields across Saskatchewan have been lower than expected. The University of Saskatchewan Department of Soil Science and Enviro-Test soil analysis laboratory suspected the ratio between nitrogen and sulphur in the soil was out of balance in many cases. Under irrigated conditions the sulphur level in the soil increases, resulting in an N/S ratio on the order of 1:1 or 1.5:1. The recommended range is between 5 and 7 to 1, with yield depression expected either above or below that level.

Table 12. Nitrogen / sulphur ratios.

Field #	Treatment	Soil N/S Ratio	Fert. N/S Ratio	Tissue N/S Ratio	Yield (bu/ac)
01	check	>1:3	1.4:1	4.8 : 1	51
01	2 times	>1:3	2.4:1	6.3 : 1	53
01	3 times	>1:3	3.4:1	7.2 : 1	56
03	check	1:1	2.3:1	5.7 : 1	42
03	2 times	1:1	3.7:1	5.9 : 1	39
03	3 times	1:1	5:1	8.1 : 1	38
05	check	2.3:1	5:1	7.3 : 1	43
05	2 times	2.3:1	7:1	6.0 : 1	43
05	3 times	2.3:1	8:1	7.1 : 1	44
07	check			5.3 : 1	36
07	2 times				32
07	3 times			7.0 : 1	29
31	check	1:1.33	4:1	5.5 : 1	41
31	2 times	1:1.33	7.25:1	4.6 : 1	43
31	3 times	1:1.33	10.5:1	4.9 : 1	38

To see if this theory could be proven in large acreage testing, ICDC set up five field demonstrations where three rates of nitrogen fertilizer were applied: soil test recommendation, twice soil test recommendation and three times the normal nitrogen recommendation.

Conclusion

The most likely conclusion that can be arrived at after reviewing the above data is that there is no affect on yield by varying the N/S ratio in the soil. In three of the five fields yields were depressed on the high nitrogen treatments. One field had a ten percent increase in yield on the high fertilizer treatment and one had a twenty percent decrease.

This was the only project that wasn't supported by fairly extensive small plot research work or on farm observations from previous years. In hindsight we should not have conducted this work without more background information. We are not recommending the continuation of this particular project.

Table 13. Nitrogen vs yield in canola.

Fertilizer Treatment	Yield (bu/ac)
Soil test recommendation	42.7
2 times recommendation	42.0
3 times recommendation	41.0

Forage Manager Highlights

Principal: L. Bohrson, Saskatchewan Water Corporation
Swift Current, Saskatchewan

An appreciation for the 60+ year history of irrigation cropping on Southwest projects was applied to new approaches in forage renovation, establishment and selection, weed and pest control, and fertility and soil quality management.

A high priority was also placed on featuring demonstration sites at irrigation field days, and at group activities with irrigation district directors and agronomists.

The 1997 irrigation demonstrations saw a large increase in "objective partnering" with agribusiness and the use of custom applicators for timely placement of inputs. Water use efficiency and the optimization of crop quality showed the greatest potential rewards to improved ranch and farm management.

Large irrigation field days were hosted at Swift Current, Consul, Cadillac, and Maple Creek. Smaller group tours were delivered at Rush Lake ID (2), Swift Current Creek ID(2), Swift Current Effluent ID, Russell Creek ID, and Miry Creek ID. The ground work for 1998 irrigation field days has been laid at Eastend ID, Spangler ID, Consul ID, Miry Creek ID, Swift Current ID and Waldeck North ID.

A few 1997 highlights and issues to be aware of:

- Harold Gold, Maple Creek, produced between 5.5 and 6.0 tons per acre of dairy quality alfalfa, for the third year in a row with optimum sprinkler management. PAWBED funding assistance is now available to convert flood irrigation to suitable sprinkler sites near Junction Reservoir.
- Seven forage fertility demonstration sites produced an average 9 per cent increase feed quality value, while the highest fertilized forages yielded a 15 per cent quality advantage.
- New soil inoculation, special use herbicides, streamlining renovation with direct seeding technology, and winter cereals are improved management tools for alfalfa production.
- The flood tolerance of several Brome grasses and many of the wetland grasses received more than two months spring flooding. Garrison Creeping Foxtail's early vigour, salt tolerance, and response to management was observed.
- Two glyphosate formulations (Roundup & Touchdown) were fall applied in early September to achieve faster root system breakdown of the forage and perennial weeds. Application rates were also compared before and after the second cut. Roundup at 4, 9, 10, and 12 days prior to alfalfa harvest confirmed the recommendation that reduction in hay quality appears to begin at day 8.
- All irrigated grass hay fields ended the year highly deficient in nitrogen. In grass dominated irrigated alfalfa fields, the most direct boost in yield and quality is achieved by meeting the nitrogen requirement of the grass. Upgrading the phosphorous, potassium and/or micronutrients with larger applications before establishment must be assessed on a case by case basis.
- Always consult the current grazing and feeding restrictions of herbicides and pesticides before application to any irrigated crop you may use for forage this year.

A series of local Forage Manager Seminars is planned for February, 1998.

Quality Response to Fertilizer

The reference feed costs are: barley at $110.00/t, canola meal at $330.00/t, mineral (phosphorus) at $728.00/t, and limestone (calcium) at $115.00/t. Average fertilizer treatment produced an advantage of 9%, while the highest fertilized forage quality yielded a 15% advantage over the seven irrigated forage demonstrations.

Table 1. 1997 irrigated forage demonstrations.

Cient	Forage value, $/t dry matter		
	No Fertilizer	Average Fertilizer	High Fertilizer
Lynn Grant	128.63	137.43	140.33
Lance Weiss	72.76	72.06	83.20
Lawrence Schmidt	112.74	125.58	132.96
Darryl McGregor	108.32	116.50	120.12
Jim Feil	73.73	93.01	96.45
Ian Bowie	64.64	66.69	72.12
Scott Sanderson	93.40	102.93	108.I9
$ AVERAGE	**93.46**	**102.03**	**107.62**

ICDC Demonstration Sponsors and Objective Partners

- Tom Staples, Enviro-Test Laboratories, Saskatoon
- Jim Downey, Secan Assoc., Saskatoon
- Justin Watson, Proven Seed, Regina
- Graham Ogilvie, Progressive Seed, Red Deer
- Albert Janzen, Janzen Agro, Swift Current
- Don Strauch, Rhone-Poulenc Canada, Regina
- Brian Klassen, Action Custom Applicators, Swift Current
- Lyle Drew, Cyanamid Canada, Regina
- Scott Leppa, Zenica Agro, Swift Current
- Bert Legault, Legault Holdings, Swift Current
- Bernard Green, Monsanto Canada, Tompkins
- Todd Friday, Paterson Grain, Swift Current
- Brian Nybo, Wheatland Conservation, Swift Current

Saskatchewan Soil Conservation Association Irrigated Direct Seeding Demonstration

Principal: K. Sapsford, Saskatchewan Soil Conservation Association
Support: Saskatchewan Irrigation Development Centre; Flexi-Coil Ltd.
Location: SIDC, Outlook
Objective: To demonstrate the effects of errors commonly made by producers adopting a direct seeding system including improper seeding depth and over-application of seed placed fertilizer on canola and on peas.

Canola was surface seeded with side-banded nitrogen, and was sown at 13 mm (0.5 in) depth with side-banded and seed placed nitrogen. The nitrogen was applied at 90 kg/ha (80 lb/ac) as urea (46-0-0) in all cases. A fourth plot was sown at 13 mm depth with 90 kg/ha of seed placed urea fertilizer that was treated with Agrotain. Agrotain is a chemical product which delays the conversion of urea to ammonium. When this reaction is inhibited, seedling damage is reduced, possibly allowing the use of higher seed placed nitrogen.

Peas were sown at 25 mm (1 in) depth with 90 kg/ha (80 lb/ac) of 12-51-0 side-banded and seed placed. The fertilizer treatments were also applied to peas sown at 50 mm (2 in) depth. A control treatment was included using uninoculated peas sown at 50 mm depth with the fertilizer side-banded.

The plots were sown May 6 into wet soil using a Flexi-Coil 5000 air drill equipped with Stealth openers. The site was sprayed with Roundup at 1.25 l/ha (0.5 l/ac) after seeding. Plant stand counts and yields were recorded for the plots. Yield data was unavailable at the time of writing.

The 13 mm seeding depth with side-band fertilizer gave the best emergence of any canola plots. Seed placing gave the poorest emergence. The seed placed Agrotrain treated urea resulted in increased plant counts, but the plant count was less than half that of the side-band placement (Table 1).

There was little difference in emergence between treatments for the pea trial (Table 1).

Table 1. Date of crop emergence and plant stand counts for canola and pea on the irrigated direct seeding demonstration, Outlook, 1997

Crop	Seed depth mm	Seed depth in.	Fertilizer Placement	Date of Emergence	Plant Count*
Canola	13	0.5	SB	May 21	33.0
	sfc		SB	May 21	21.0
	13	0.5	SP	May 25	4.4
	13	0.5	SP+Agrotain	May 25	14.0
Field pea	50	2.0	SB	May 21	10.0
	50	2.0	SP	May 25	11.4
	25	1.0	SB	May 21	11.6
	25	1.0	SP	May 21	12.2
	50	2.0	uninoculated	May 21	10.0

SB = side-band; SP = seed placed; sfc = surface seeded
* Number of plants per 1 m (3 ft) of row on a 23 cm (9 in.) spacing