Canada-Saskatchewan Irrigation Diversification Centre

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Annual Review

April 1, 2000 to March 31, 2001

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

Introduction

Manager's Report

It is my pleasure to present the annual progress report of the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC). This report summarizes the wide range of activities conducted, funded or facilitated by the Centre in 2000. CSIDC is a federal, provincial, and industry partnership. Industry is represented by the Saskatchewan Irrigation Projects Association (SIPA) and the Irrigation Crop Diversification Corporation (ICDC), the Federal Government by Agriculture and Agri-Food Canada, PFRA and the Provincial Government by Sask Water. Representatives from each group are members of the CSIDC Executive Management Committee (EMC). I would like to extend special thanks to the members of this committee for their input, direction and support of the Centre.

Executive Management Committee
(EMC)

Don Fox, SIPA
John Linsley, ICDC
Gerry Luciuk, PFRA
Carl Siemens/John Konst, ICDC
Wayne Dybvig, Sask Water
Laurie Tollefson, CSIDC

The year 2000 was a busy year of activity and planning at the Centre. Major accomplishments included the finalization of the CSIDC Strategic Framework (see insert). This framework clearly outlines the future vision for the Centre and the outputs and activities needed to achieve it. It is the final product of consultations and discussions with our partners and clients. Using this framework a detailed workplan was developed. Major emphasis has been placed on aligning the Centre with the vision and business lines of the federal and provincial governments and to meet the needs of our industry partners and clients. In addition to the strategic framework and workplan a detailed business plan was developed for the Centre.

Securing adequate funding to conduct the work outlined in the workplan is a priority at CSIDC. Traditionally the Centre has relied on federal and provincial A-base dollars along with agreement funding to facilitate its program. With the conclusion of the Partnership Agreement on Water Based Economic Development (PAWBED) and the final year of the Agri-Food Innovation Fund (AFIF) being 2001, additional funding will be required to meet the goals outlined in our framework.

Many activities occurred at the Centre in 2000. Crop diversification and value added continue to be key to the work at the Centre. Depressed commodity prices have accentuated the search for new alternatives. A highlight of this work was Herbfest 2000 held at CSIDC July 22-23, 2000. This event was hosted by the Saskatchewan Herb and Spice Association, CSIDC and the University of Saskatchewan. It was the *grande finale* to a week that started with a scientific conference on medicinal herbs held at the University of Saskatchewan in Saskatoon and which moved to CSIDC at Outlook for the Herbfest portion. Both events were a huge success and were firsts for Western Canada.

The scientific conference profiled many facets of the medicinal herb industry from research and production of herbs and spices to processing and marketing. Featured speakers from around the world were present. Herbfest at CSIDC showcased agronomic production, post harvest handling and processed products. In excess of 1000 visitors attended the two-day event with people coming from across Canada, USA and Europe to view production on the prairies.

In addition to Herbfest, the annual CSIDC field day and commodity group tours (potato, vegetable, etc.) were popular and well attended events. Visitor attendance at CSIDC was at an all time high in 2000 reflecting the desire for information by producers and consumers.

International interest in the Centre continues to increase. Numerous groups from around the world visit the Centre each year and are interested in the work being conducted. A world class facility and staff make this type of interaction possible. CSIDC staff are involved nationally and internationally through membership and participation on National and International Committees. In addition they provide technical and management expertise to projects in China (Sustainable Agriculture Development Project in Inner Mongolia), the National Water Quality and Availability Management Project (NAWQAM) in Egypt, and the Hebei Dryland Project in China. This interaction keeps staff current and allows networking and new ideas to be continually brought forward to our Centre.

Objectives

1. Identify higher value cropping opportunities through market research to help target research and demonstration programs.

2. Conduct, fund and provide support for 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 outside research agencies.

4. Demonstrate sustainable irrigated crop production practices at CSIDC.

5. Promote and extend sustainable irrigated crop production methods.

6. Evaluate the environmental sustainability of irrigation, and evaluate the impact of irrigation on natural and physical resources.

7. Promote a Western Canadian approach to irrigation sustainability by interacting with staff from similar institutions and industry across Western Canada, and by transferring this technology to the industry. This will increase levels of co-operation in marketing, research and demonstration in support of diversification and value added processing.

Staff

Manager:	L. Tollefson	ICDC Agrologists:	J. Linsley
Administration:	M. Martinson		L. Bohrson
Secretarial:	J. Clark		I. Bristow
Clerical:	D. Greig		K. Olfert
Market Analyst:	H. Clark	Field Operations:	B. Vestre
Irrigation Sustainability:	T. Hogg	Irrigation:	D. David
Specialty Crops Agronomist:	J. Wahab	Maintenance:	A. MacDonald
Technician	G. Larson	Technology Transfer:	J. Harrington
Technician	S. Avis		

CSIDC STRATEGIC FRAMEWORK 1999 - 2006

ACTIVITIES → OUTPUTS → REACH → OUTCOMES → IMPACT

ACTIVITIES

CROP DIVERSIFICATION & PROCESSING

- Develop a market-driven approach to evaluating new crop species and varieties with economic potential for production of food or consumer demand products (bio-medical, bio-energy, bio-product)
- Development of production packages to promote the production of promising material
- Demonstration of varieties and technology on a field scale basis
- Technology transfer

IRRIGATED CROP INTENSIFICATION

- Evaluation of new and/or existing genetic material for selected irrigated crops to test their response under irrigation
- Evaluation of agronomic practice and development of production practices
- Demonstration on a field scale basis with appropriate varieties and technology
- Technology transfer

OUTPUTS

NEW TECHNOLOGIES

- Vegetable tunnels and use of plastic mulch
- Extended storage for potatoes and vegetables
- Use of transplants in production of medicinal herbs
- Spearmint production

INFORMATION PRODUCTS/EVENTS

- Agronomic production practices
- Scientific papers and reports
- Annual report
- Variety guide
- Annual field day
- Commodity tours
- Presentations at extension events
- Fact sheets and brochures
- Website information

SERVICES

- Agronomic advice about irrigated production
- Identification of market trends

REACH

PRIMARY CLIENTS

- Irrigation farmers
- Agriculture industry

SECONDARY CLIENTS

- Agribusinesses
- Agriculture extension staff
- Researchers
- Commodity groups

OUTCOMES

- Increased crop diversification and value added opportunities on Saskatchewan's irrigated land base
- Increased production efficiencies under irrigated conditions to optimize economic net return

IMPACT

RURAL ECONOMIC DEVELOPMENT

Long-term rural economic growth through irrigated crop production

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ACTIVITIES

WATER USE EFFICIENCY

- Investigate and demonstrate low energy and drip irrigation technologies.
- Develop and demonstrate irrigation scheduling methods for irrigated crops.

PROTECTION OF LAND AND WATER

- Evaluate agro-chemical movement in the soil and to the surface and groundwater under irrigated conditions.
- Develop Best Management Practices for agro-chemical use under irrigated conditions.
- Reclaim and maintain saline crop lands using sub-surface drainage and appropriate water management practices.
- Evaluate the impact of irrigation on greenhouse gas production

OUTPUTS

NEW TECHNOLOGIES

- Low energy and drip irrigation technologies
- Irrigation scheduling methods
- BMP's for agro-chemical use

INFORMATION PRODUCTS/EVENTS

- Agronomic production practices
- Scientific papers and reports
- Annual report
- Annual field day
- Presentations at extension events
- Fact sheets and brochures
- Website information
- Water management advice

SERVICES

- Agronomic advice about irrigated production

REACH

PRIMARY CLIENTS

- Irrigation farmers
- Canadian public

SECONDARY CLIENTS

- Agribusinesses
- Agriculture extension staff
- Researchers

OUTCOMES

- Increased water use efficiencies for irrigated production systems
- Protection of land and water resources through environmentally sustainable irrigation production practices

IMPACT

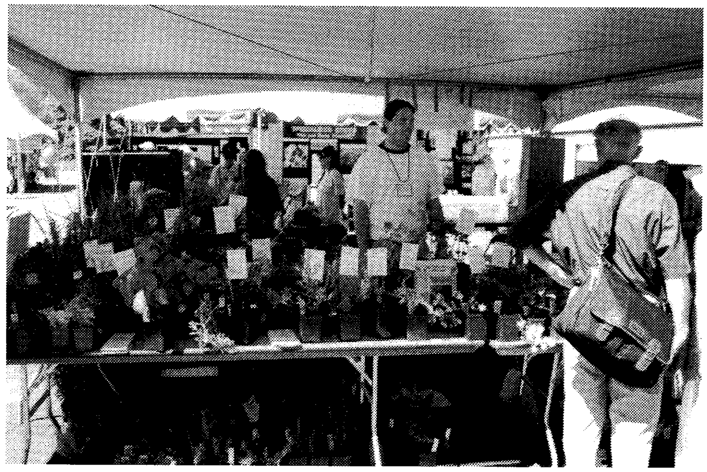
SUSTAINABLE IRRIGATION MANAGEMENT

Sustainable management of land and water resources under irrigation production systems

Herbfest 2000

Herbfest 2000 held at Canada-Saskatchewan Irrigation Diversification Centre

More than a thousand people attended Herbfest 2000 during the July 22-23 weekend, getting an opportunity to taste, smell or apply herb and spice products.



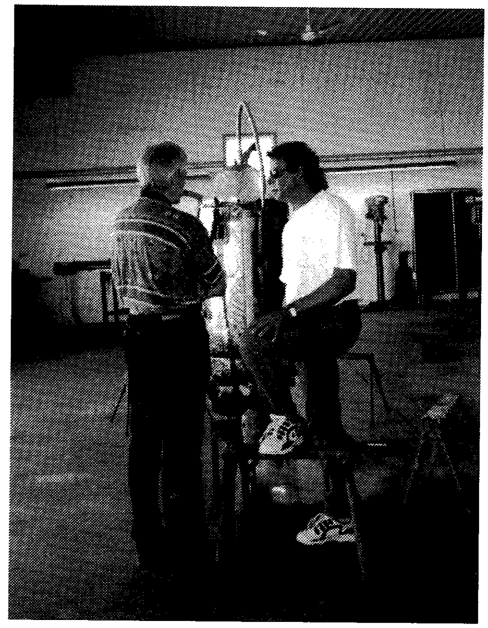
It was billed as two days of entertainment and education. And so it was, with 64 booths offering a wide variety of herb and spice products, actors battling in medieval garb, new Saskatchewan artists performing their music, demonstrations of teepee raising, face-painting, guided tours of herb and spice test plots, and seminars on botanicals.

The festival was hosted by the Saskatchewan Herb and Spice Association, the University of Saskatchewan Extension Division and the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC), and was the grand finale to a week that also included a four-day conference on herbs and spices in Saskatoon. Both events were firsts for Western Canada. It was also the first International Herb Association annual conference held outside the United States.

The conference profiled every facet of the industry, from research and production of herbs and spices to processing and marketing, and featured speakers from around the world. Herbfest showcased herbs and spices and a variety of processed products. CSIDC played a key role in the success of Herbfest 2000, helping organize the event and allowing the festival to be held on its grounds. For manager Laurie Tollefson it was an excellent opportunity to expose producers, researchers and the general public to the Centre and the work it is doing with herbs and spices. "This was a very public event, attracting hundreds of people from across Western Canada, the United States, and various parts of the world," Laurie explained. "You couldn't get a better showcase for your work."

Connie Kehler of the Saskatchewan Herb and Spice Association said they were very pleased with the way the festival turned out. "It was really gratifying to see people at so many different levels connecting with one another," Connie said. "We had scientists talking to producers, producers talking to consumers, researchers talking to processors. They were all casual conversations, the kind that can lead to valuable information."

CSIDC, which recently expanded its herb research activities to meet the needs of the rapidly expanding botanical industry, is in the third year of a new five-year botanical research program. Harvested material is being supplied to the University of Saskatchewan for post-harvest handling studies and chemical analysis.



The work is being undertaken with the assistance of the Saskatchewan Herb and Spice Association and with funding from the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF). AFIF support has allowed CSIDC to fully develop its herb agronomy program, making the Centre the natural venue for an international event such as Herbfest 2000.

Jazeem Wahab, Specialty Crops Agronomist, is heading up the herb and spice field work at CSIDC: "We're looking at six plant species— echinacea, milk thistle, German chamomile, stinging nettle, St. John's wort, and feverfew. Because many of the herb species are difficult to direct-seed due to the extremely small size of the seeds and seed dormancy, we've had to use transplants in most of our trials." Jazeem said there are six major objectives of the research:

- evaluate the adaptability of the promising medicinal and culinary herbs for Saskatchewan conditions
- develop management practices for mechanized commercial production
- develop labour-saving agronomic practices
- compare yield and quality under dryland and irrigated production
- assess the feasibility of direct-seeding and transplanting under dryland and irrigated conditions
- determine stage and method of harvesting to increase recovery and maintain quality.

According to Jazeem, "early results indicate that many herb species can be grown on a commercial scale through mechanization and minimal manual labour. Echinacea can be established through direct seeding or transplanting. Milk thistle can be grown successfully in our relatively cool, short growing season and harvested by machines producing promising seed yields. Production practices, stage and method of harvest can affect both yield and quality characteristics of feverfew. Agronomic studies are being carried out to develop cost-effective management practices for commerical scale production of several herb species for dryland and irrigated production."

Reprinted courtesy of PFRA Communicator, August 2000

Programs

Specialty/Horticultural Crops

A specialty crops development program was initiated at the CSIDC 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. It involves a broad range of varietal evaluation, irrigation and agronomic adaptation studies. A major effort has been made to identify the most promising market opportunities and to act accordingly. Examples of projects include: varietal and agronomic evaluation of dry bean, pea, lentil, faba bean, mint, coriander, fenugreek, medicinal herbs, etc.

In 1992, emphasis was placed on potato and vegetable crop production. This was in response to industry demand. The potato studies involve a wide range of agronomic research to produce high quality 'seed', 'processing' and 'table' potato. The tests include germplasm evaluation, fertility management, irrigation scheduling, plant population studies and harvest management. The vegetable work is designed to raise awareness of the opportunities that exist in the vegetable industry. This is accomplished by developing cost of production information suited for Saskatchewan and by demonstrating improved production techniques to increase yield and improve quality, thereby improving economic returns.

Field Crops (Cereals, Oilseeds and Forages)

Field crops (cereals, oilseeds and forages) are a major part of any irrigated rotation. In 1996, more than 90% of the irrigated acreage in Saskatchewan was planted to field crops. While desirable to introduce new and specialty crops, a priority must also be placed on improving the profitability of the more conventional field crops. This includes examining new and/or existing genetic material with improved disease and lodging tolerance suited to irrigated conditions or with novel quality traits which 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, increased production or lower input costs must also be determined.

Environmental Sustainability

This program was designed to evaluate the effect of irrigation on the environment. It was initiated in 1991 with funding from the Environmental Sustainability Initiative. It was intensified in 1993 as the irrigation sustainability program using funding from the Canada/Saskatchewan Agriculture Green Plan. More recently the National Soil and Water Conservation Program has provided resources to evaluate the environmental effects under intensively irrigated crop production.

Market Analysis

This program was initiated to identify and evaluate potential markets for irrigated crops and to determine opportunities for value-added processing with the goal of promoting economic security and rural development in the irrigated areas.

Technology Transfer

This activity ensures that information developed at CSIDC is made available to farmers, extension personnel, private industry and the general public. It includes the annual field day, tours, participation in extension meetings, and report writing.

Field Demonstrations

ICDC agrologists conduct field demonstrations of applied research developed at CSIDC and other institutions. The Crop Manager project examines crop management practices of dry bean and cereals. The Forage Manager project evaluates alfalfa management for southern Saskatchewan irrigators.

Activities

Presentations

CSIDC staff gave presentations at numerous meetings, conferences, and events. Among those were:

United States Commission on Irrigation and Drainage (USCID) Participatory Irrigation Research and Demonstration Conference, Fort Collins, Colorado

Canadian Water Resources Association (CWRA) Meetings [Egypt (NAWQAM) and Irrigation Crop Diversification Opportunities], Saskatoon

Presentations on Water Savings Technology to groups in Jilin and Inner Mongolia, China

Presentations on the CSIDC - Technical Service Retreat, Kenosee Lake

Presentations to PFRA Senior Management Committee, Regina

Egyptian Study Group presentation (Irrigation in Western Canada), Outlook

Mexican Rural Development (Irrigation in Western Canada), Outlook

Soils and Crops Workshop 2001, Saskatoon

Presentation on the CSIDC to Xinjiang, Chinese group, Moose Jaw

Presentation on the CSIDC to senior officials of the Aral Sea Project, Outlook

Saskatchewan Vegetable Growers' Association Annual Meeting and Workshop, Outlook

Vegetable Growers' Meeting, Humboldt

Vegetable Growers' Meeting, Nipawin

New Crop Work at the CSIDC. CWRA Annual Conference, Regina

Advances in Herb Agronomy: The Saskatchewan Experience. International Herb Conference, Saskatoon

Management Practices for High Quality Processing Potato Production in Saskatchewan. Agri-Food Innovation Fund (AFIF) Conference, Regina

Advances in Herb Agronomy. AFIF Conference, Regina

Crop Diversification Research and Development at the CSIDC. Parkland Crop Diversification Working Group Meeting, Dauphin

Production and Utilization of Medicinal Plants. Rosetown High School, Rosetown

Field Studies on Commercially Important Herb Crops. Saskatchewan Herb and Spice Association, Annual General Meeting, Saskatoon

Processing Potato Research at the CSIDC. Joint meeting with the Saskatchewan Agriculture and Food, Potato Task Force, Outlook

St. John's Wort: Agronomic Practices for Irrigated and Dryland Production. Soils and Crops Workshop, University of Saskatchewan, Saskatoon

Agronomics for *Echinacea angustifolia* and St. John's Wort. Prairie Medicinal Plant Conference: Growing Global, Edmonton

CSIDC Potato and Herb Research and Development. CSIDC/ICDC Working Group Meeting, Outlook

Herb Production Research Update. Saskatchewan Herb and Spice Association Working Group Meeting, Moose Jaw

Post Harvest Processing of St. John's Wort. CSAE/ASAE North Central Sections Conference, Moorhead

CSIDC Display

CSIDC presented a display at the following events:

Crop Production Show, Saskatoon

Saskatchewan Herb and Spice Association Annual Meeting, Saskatoon

AFIF Technical Meetings, Regina

CSIDC Annual Field Day, Outlook

Saskatchewan Irrigation Projects Association Meetings, Swift Current

Herbfest 2000, Outlook

Canadian Forage and Turf Seed Conference, Saskatoon

Saskatchewan Forage Council Workshop, Weyburn

Markusson New Holland Haying and Forage Day, Regina

Saskatchewan Cattle Feeder Trade Show, Saskatoon

Agribition, AFIF Display, Regina

Tours

A large number of tours of the Centre and of the field programs are conducted each year at the CSIDC. Noteworthy groups touring the Centre in 2000 included:

South Africa instructor and farmer's group	April 12
Egyptian staff, NAWQAM project	April 12-14
PFRA Northern Region	April 25
PAMI Technical staff	April 27
Representatives of the Siksika Tribe Irrigation Project	April 28
Lutheran Collegiate Bible Institute High school science class	May 18
Saskatchewan Governor General tour	May 27
Corporate Services staff	June 5
French exchange students	June 12
Chinese Xin Jiang group	June 23
Montana Special Crop Growers group	June 23
McGill University & CIDA Representatives	June 23
Canadian Water Resources Association	June 24
Chinese Bai Cheng group	June 26
Inner Mongolia Group tour	July 5
Norwegian farm group	July 13
CSIDC Annual Field Day	July 14
Herbfest 2000	July 21, 22 & 23
Variety Plot tour	July 25
NAWQAM project group	July 31
CSIDC Potato Field Day	August 8
PAMI Group tour	August 10
President, Sask Water	August 24
Vegetable Growers Cooperative	August 25
PFRA Inner Mongolia project delegation	September 5
CIDA Egyptian representatives	September 20
Outlook School Division classes	September 7, 13, 18, 19, 27, 28, 29
Egyptian Group tour	September 22
Outlook High School teachers	September 22
Sask Valley Potato group	October 16
Egyptian Group tour	October 19
Mexican Rural Development group	October 23
Senior Officials of the Aral Sea Project	November 16
Triprovince Irrigation Crop Diversification meeting & tour	December 7
Environmental Auditors tour	December 12
Potato Group tour	February 16
IRIS Environmental Group tour	March 22

Additional tours and activities were held for private industry, for members of the media, and for numerous other producers, agriculture professionals, industry groups, association representatives, and visitors who stop in at the CSIDC. Attendance in 2000 was clearly at an all time high level.

Committees

L. Tollefson

- Agriculture and Agri-Food Canada National Potato Research Network
- Agri-Food Innovation Fund Horticulture Committee, Federal Co-chair
- Praire Potato Council Storage and Marketing Committee, Chair
- Canadian Commission on Irrigation and Drainage (CANCID), Executive member
- International Commission on Irrigation and Drainage (ICID) Crops and Water Use subcommittee
- National Water Quality and Availability Management Project, Egypt, Headquarters Co-ordinator; Executive Committee member
- PFRA Senior Management Committee
- Partners for the Saskatchewan River Basin Technical Committee
- Prairie Crop Diversification Task Force
- Prairie Agricultural Landscapes Technical Committee
- Health of Our Rural Water Steering Committee
- Dept. of Agriculture and Bioresource Engineering, Research Associate
- Herbfest 2000 Organizing Committee
- Canadian Water Resources Association Technical Committee, 2000 Conference
- USCID "Irrigation and Drainage in the New Millenium" Organizing Committee
- ICID 18th Congress and 35th International Executive Council, Montreal 2000 Organizing Committee
- Executive Management Committee of CSIDC
- Agriculture and Agri-Food Canada Nutraceutical and Functional Food Task Force
- Agriculture and Agri-Food Canada Development of a Broader Trade Strategy Task Force
- PFRA Capital Planning Committee
- Sustainable Agriculture Development Project, Inner Mongolia

T. Hogg

- Prairie Regional Recommendation Committee on Grains
- Saskatchewan Advisory Council of Grain Crops
- Environmental Management Strategy Planning Committee
- PFRA Pesticide Review Committee
- PFRA Universal Classification System Evaluation team
- Canadian Commission on Irrigation and Drainage (CANCID), Executive member

H. Clark

- Agriculture and Agri-Food Canada Ethanol working group
- CSIDC Field Day Committee

J. Wahab

- Herbfest 2000 Organizing Committee
- Herbs 2000 International Herb Conference Organizing Committee
- Saskatchewan Herb and Spice Association, Herb Production Manual Review
- Saskatchewan Seed Potato Growers Association technical advisor
- Soils and Crops Organizing Committee
- Pesticide Minor Use Registration Committee
- Western Potato Council
- Potato Association of America
- American Horticultural Society
- Saskatchewan Herb and Spice Association
- Saskatchewan Herb and Spice Association - Aster Yellow Research Project

B. Vestre

- Enviromental Management Strategy Planning Committee
- Joint Occupation Safety and Health Committee
- PFRA Pesticide Review Committee
- PFRA Safety Orientation Committee
- Herbfest 2000 Organizing Committee

M. Martinson

- Saturn Implementation Committee
- PFRA Communicator Newsletter working group
- Herbfest 2000 Organizing Committee

Publications

[CSIDC] Canada-Saskatchewan Irrigation Diversification Centre. 2000. Business Plan. 43 pp.

CSIDC] Canada-Saskatchewan Irrigation Diversification Centre. 2000. Agri-Food Innovation Fund Specialized Spoke Sites Annual Report. 225 pp.

[CSIDC] Canada-Saskatchewan Irrigation Diversification Centre. 2000. Canada-Saskatchewan Irrigation Diversification Centre Annual Review. Outlook, Saskatchewan: CSIDC. 159 pp.

[CSIDC] Canada-Saskatchewan Irrigation Diversification Centre. 2001. Crop Varieties for Irrigation. Outlook, Saskatchewan: CSIDC. 16 pp.

G. Luciuk, L. Tollefson, D. Tomasiewicz, and J. Harrington. Participatory Irrigation Research and Demonstration. USCID, Fort Collins, Colorado.

L. Tollefson and B. Wettlaufer. 2000. National Water Quality & Availability Management Project. In: CWRA Conference; June 22; Saskatoon, Saskatchewan.

H. Clark. 2000. Herb and Spice Marketing - North America. In: PFRA Today Symposium; March 1, 2000; Regina, Saskatchewan.

H. Clark. 2001. Opportunities for Vegetable Production in Western Canada. In: Soils and Crops Workshop 2001; February 23; Saskatoon, Saskatchewan.

J. Wahab, T. Hogg, and L. Tollefson. 2000. New Crop Work at the Canada-Saskatchewan Irrigation Diversification Centre. In: CWRA Annual Conference; June 21-22, Regina, Saskatchewan. Abstract.

J. Wahab. 2000. Advances in Herb Agronomy: The Saskatchewan Experience. In: International Herb Conference; July 20-21; Saskatoon, Saskatchewan.

J. Wahab and D. Waterer. 2000. Management Practices for High Quality Processing Potato Production in Saskatchewan. In: AFIF Conference; November 8; Regina, Saskatchewan.

J. Wahab and G. Larson. 2000. Advances in Herb Agronomy. In: AFIF Conference; November 7-8; Regina, Saskatchewan.

J. Wahab. 2001. Agronomics for *Echinacea angustifolia* and St. John's Wort. In: Prairie Medicinal Plant Conference: Growing Global. March 5-7; Edmonton, Alberta.

J. Wahab and G. Larson. 2001. St. John's Wort: Agronomic Practices for Irrigated and Dryland Production. In: Soils and Crops Workshop, University of Saskatchewan. February 22-23; Saskatoon, Sask..

J. Wahab. 2000. Production Practices for Echinacea angustifolia. CSIDC Fact Sheet.

J. Wahab. 2000. Production Practices for Feverfew. CSIDC Fact Sheet.

L. Hill, J. Wahab, and D. Waterer. 2001. Comparison of Alternative Mechanical and Top-kill Methods to Achieve Optimum Quality and Economics of Seed Potato Production. Saskatchewan Agriculture Development Fund, Progress Report.

D.R. Lynch, G. Secor, L.M. Kawchuck, D. Waterer, C.A. Schaupmeyer, J. Holley, D.K. Fujimoto, D. Driedger, J. Wahab, and M.S. Goettel. 2000. AC Peregrine: A High Yielding Red Skinned Fresh Market Cultivar. American Journal of Potato Research.

D.R. Lynch, C. Miller, L.M. Kawchuck, C.A. Schaupmeyer, J. Holley, J. Panford, D.K. Fujimoto, D. Waterer, J. Wahab, B. Rex, and M.S. Goettel. 2000. AC Stampede Russet: A High Yielding Oblong Russet Cultivar for the French Fry and Fresh Market. American Journal of Potato Research.

D.R. Lynch, S.J. Peloquin, L.M. Kawchuck, C.A. Schaupmeyer, J. Holley, D.K. Fujimoto, D. Driedger, D. Waterer, J. Wahab, and M.S. Goettel. 2000. AC Glacier Chip: A High Yielding Chip Cultivar for Long Term Storage. American Journal of Potato Research.

D.R. Lynch, L.M. Kawchuck, C.A. Schaupmeyer, J. Holley, D.K. Fujimoto, D. Driedger, T. R. Tarn, D. Waterer, J. Wahab, and M.S. Goettel. 2000. AC Maple Gold: A High Yielding Yellow Flesh French Fry Variety. American Journal of Potato Research.

J. Elliott, A. Cessna, T. Hogg, J. Wahab, B. Vestre, and L. Tollefson. 2000. Agrochemicals in the Soil and Ground Water Under Intensively Irrigated Crop Production. Final Report. National Soil and Water Conservation Program.

D. J. Carrier, T. Crowe, S. Sokhansanj, A. Katrusiak, B. Barl, and J. Wahab. 2000. Milk thistle (*Sylibum marianum*) flower head development and associated marker compound profile. Journal of Herbs, Spices and Medicinal Plants.

J. Wahab. 2000. St. John's Wort: Agronomic Studies. Saskatchewan Herb and Spice Association Newsletter.

Factsheets

The following factsheets are available from the CSIDC. 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 CSIDC
Alfalfa Establishment under Irrigated Conditions

Herbs and Spices:

Herbs, Spices and Essential Oils Research & Demonstration
Annual Caraway Trials at CSIDC
Coriander Trials at CSIDC
Dill Seed Trials at CSIDC
Irrigated Scotch Spearmint Production in Saskatchewan
Production Practices for *Echinacea angustifolia*
Production Practices for Feverfew

Marketing:

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

Pulse Crops:

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

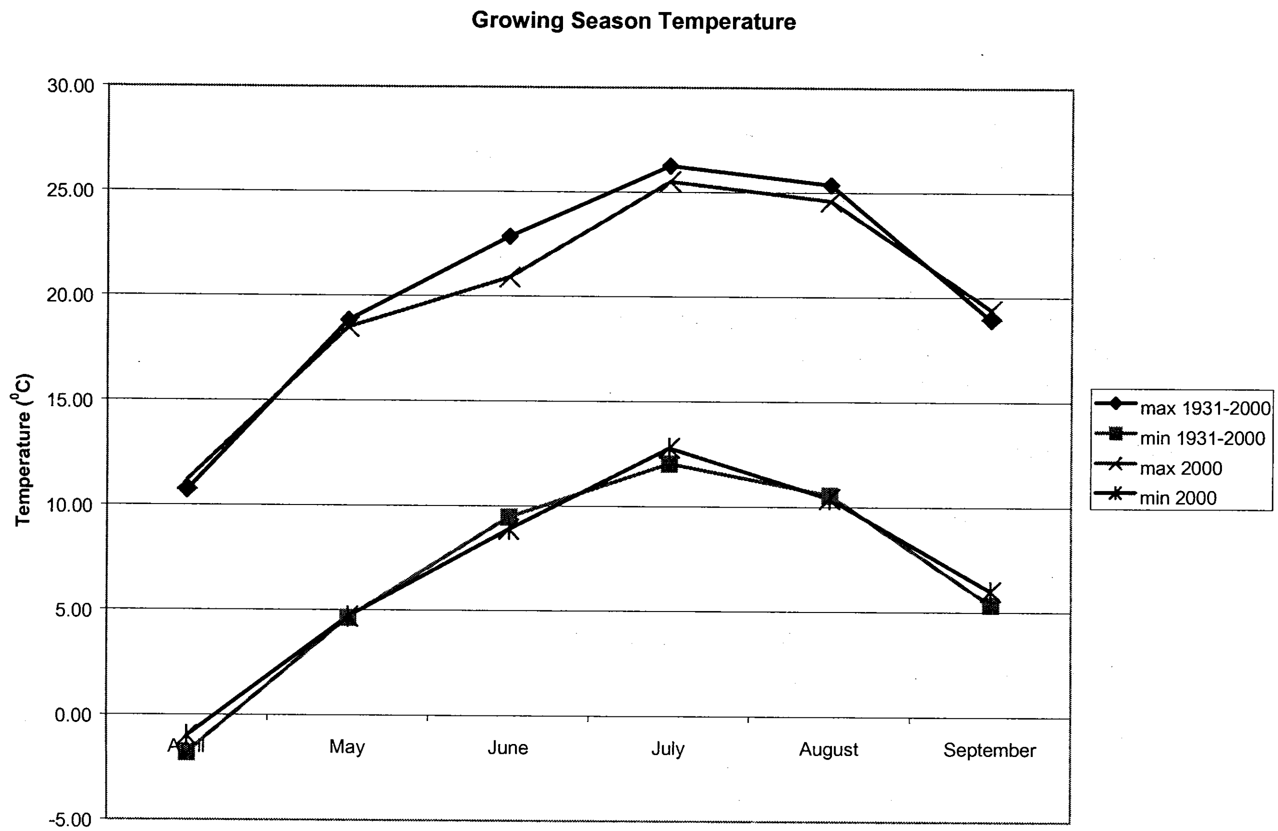
Soils and Fertilizers:

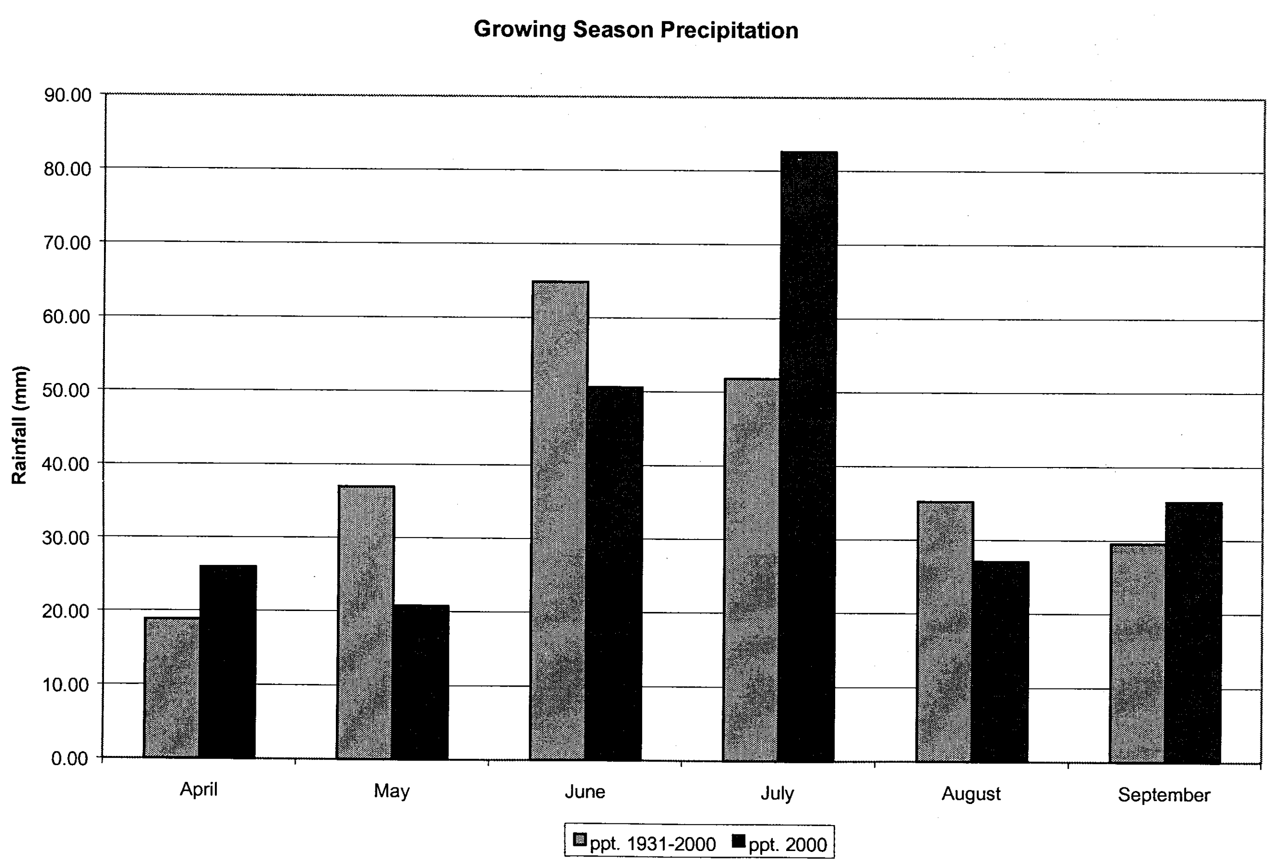
Reclamation of a Saline Field using Subsurface Drains
Rate and Placement Effects of P and K Fertilizer on Peas
Fertility Management of Irrigated Alfalfa
Canola Fertilization Trials at CSIDC

Other:

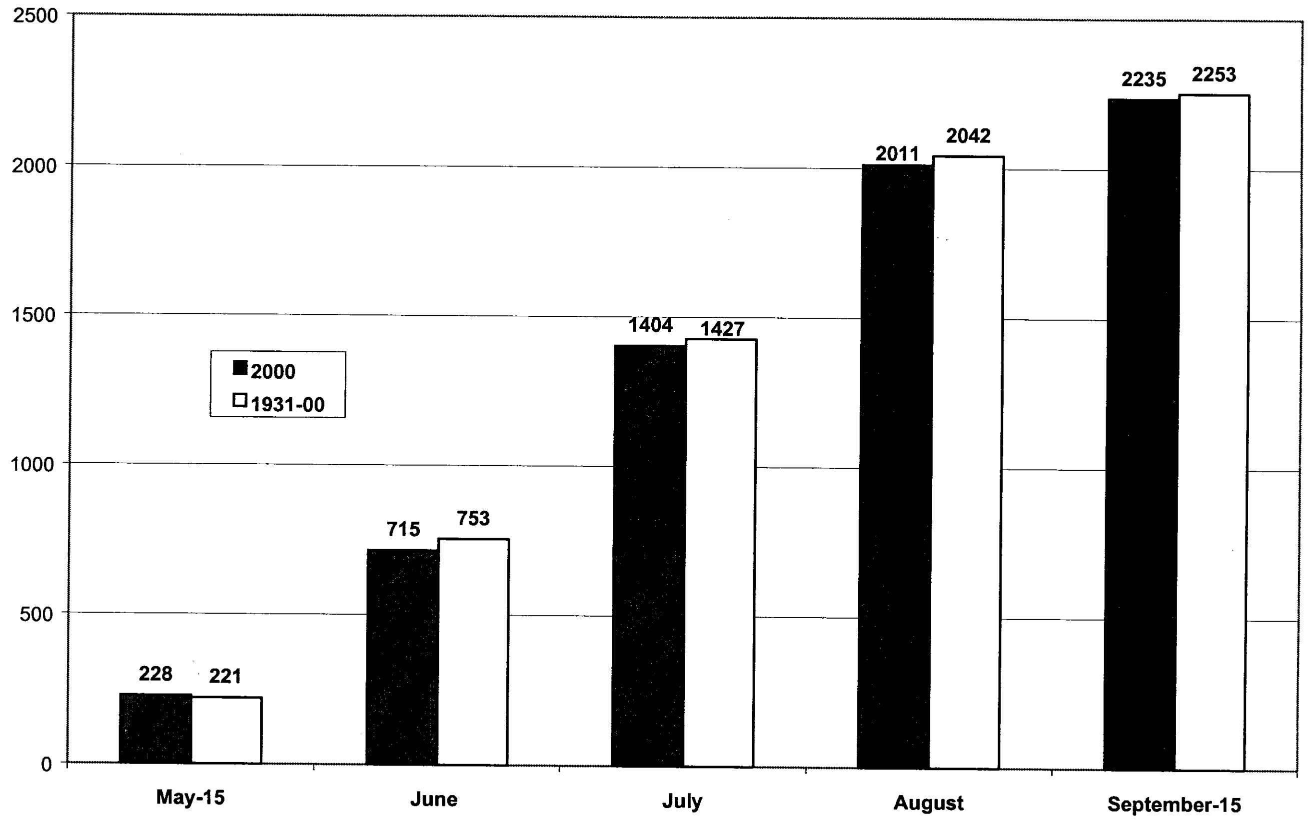
Crop Varieties for Irrigation
Overview of CSIDC
Northern Vigor™ in Seed Potato
Xeriscape Demonstration Project at CSIDC
Plastic Mulches for Commercial Vegetable Production

2000 Weather Summary

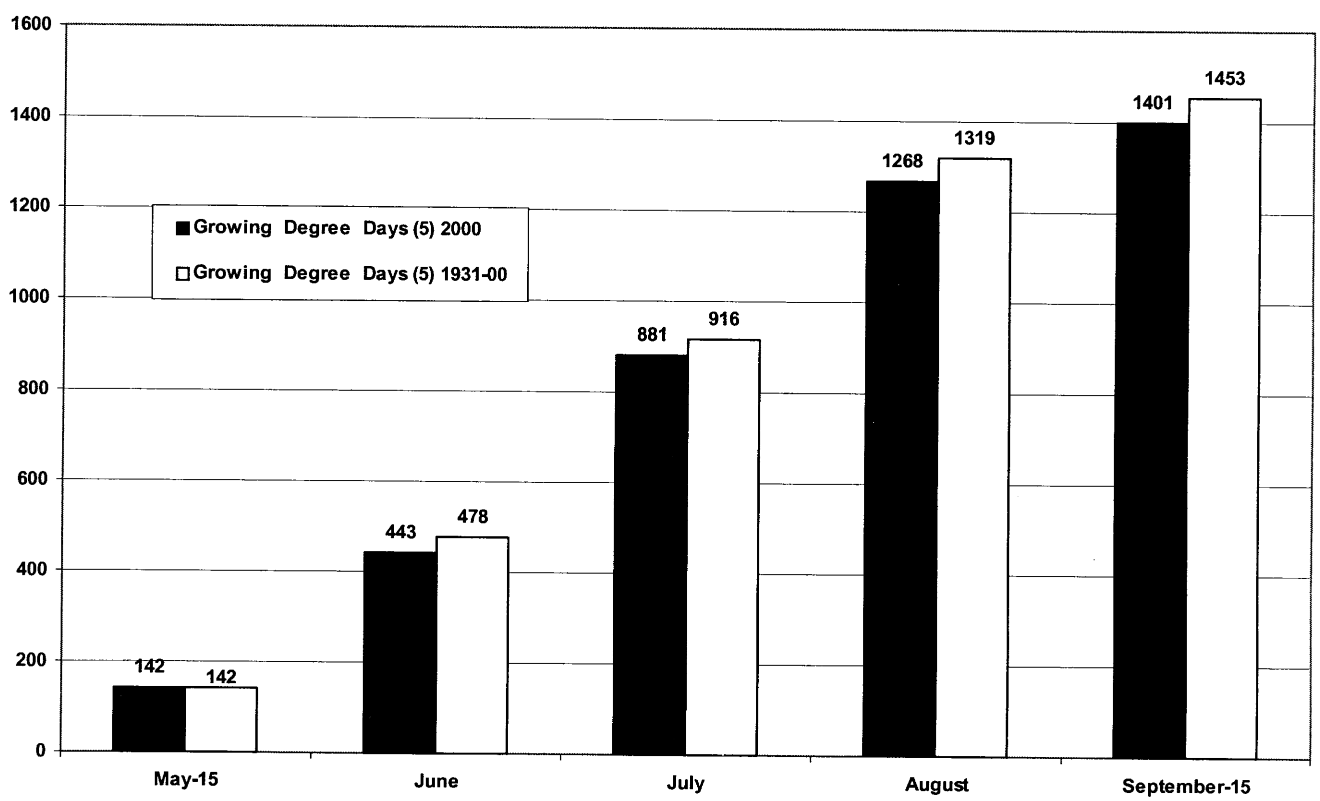




Cumulative Corn Heat Units



Growing Degree Days (Base 5)



2000 Irrigation Data

Field	Crop	Irrigation (mm)					Total irrigation	
		May	June	July	Aug.	Sept.	mm	inches
CSIDC								
1	Canola	65	25	100	0	0	190	7.5
4	Durum wheat	25	25	50	0	0	100	3.9
5	Durum wheat	25	25	80	0	0	130	5.1
6	Chickpea/lentil	50	50	0	0	0	100	3.9
6	Field pea	50	50	100	0	0	200	7.9
6	Dry bean	50	50	100	0	0	200	7.9
7	Canola	55	0	0	0	0	55	2.2
7	Potato	65	25	75	25	0	190	7.5
7	Durum wheat	50	25	50	0	0	125	4.9
8	Dry bean	50	25	75	0	0	150	5.9
8	Durum wheat	15	25	75	0	0	115	4.5
8	Herbs and spices	15	25	75	0	0	115	4.5
8	Crop sequence study	15	25	75	0	0	115	4.5
8	Durum wheat	15	25	75	0	0	115	4.5
9	Hemp trial	15	25	75	0	0	115	4.5
9	ICDC variety trials	15	25	75	0	0	115	4.5
9	Durum wheat	15	25	75	0	0	115	4.5
10	Grasses	15	50	75	0	25	165	6.5
10	Canola	15	50	75	0	0	140	5.5
10	Scotch spearmint	15	50	50	0	25	140	5.5
11	North side	25	25	75	25	0	150	5.9
11	South side	25	25	75	0	0	125	4.9
12	Potato	50	25	75	25	0	175	6.9
12	Vegetables	25	25	100	0	0	150	5.9
12	Durum wheat	25	25	100	0	0	150	5.9
12	Grasses	25	25	100	0	0	150	5.9
12	Canola	25	25	100	0	0	150	5.9
Off-station Site								
	Northwest	30	30	120	45	0	225	8.9
	Northeast	30	15	120	0	0	165	6.5
	Southeast	45	15	120	0	0	180	7.1
	Southwest	30	30	120	45	0	225	8.9

Cereals Program

Variety Evaluations

Cereals Program

Variety Evaluations

Western Canada High Yield Wheat Co-operative Test

C. Ringdal[1], I. Bristow[2]

Progress: *Ongoing*

Objective: *To evaluate potential new Canada Prairie Spring wheat varieties under irrigated conditions in western Canada.*

The High Yield wheat co-operative test was sown May 25 in 1.5 m x 4.0 m (5 ft x 13 ft) plots. 100 kg/ha N (90 lb N/ac) as 46-0-0, and 50 kg/ha P_2O_5 (45 lb P_2O_5/ac) as 11-52-0 were side-banded at seeding. The entire plot was harvested for yield measurements. Results of the test are shown in Table 1. Several lines combine high yield with good lodging resistance and short stature.

Western Canada Soft White Spring Wheat Co-operative Test

C. Ringdal[1], I. Bristow[2]

The Soft White Spring wheat co-operative test was sown May 25 in 1.5 m x 4.0 m (5 ft x 13 ft) plots. 100 kg/ha N (90 lb N/ac) as 46-0-0, and 50 kg/ha P_2O_5 (45 lb P_2O_5/ac) as 11-52-0 were side-banded at seeding. Entire plots were harvested for yield measurement. Results for the test are shown in Table 2.

[1]*CSIDC, Outlook*
[2]*ICDC, Outlook*

Table 1. Yield and agronomic data for the irrigated High Yield Wheat Co-operative test, Outlook.

Line	Yield kg/ha	Yield bu/ac	Height (cm)	Lodging rating[1]
BW661	3909	58.0	77	1.0
HY395	5254	78.0	75	1.5
HY413	6443	95.7	83	1.3
HY417	5958	88.5	72	1.0
HY446	6340	94.1	78	1.3
HY459	5501	81.7	78	1.3
HY461	3945	58.6	65	1.0
HY462	4745	70.5	67	1.0
HY463	5269	78.2	70	1.0
HY464	3009	44.7	59	1.0
HY465	4731	70.3	72	1.5
HY466	6530	97.0	76	1.0
HY528	4720	70.1	74	1.5
HY529	5351	79.5	78	2.0
HY644	3399	50.5	68	1.0
HY650	4558	67.7	74	1.0
HY651	4749	70.5	68	1.0
HY652	4294	63.8	68	1.0
HY653	3726	55.3	71	1.3
HY654	4288	63.7	73	1.3
HY655	3839	57.0	70	1.3
HY656	4553	67.6	68	1.0
HY962	4326	64.2	68	1.0
HY966	5879	87.3	78	1.5
HY967	5754	85.4	78	1.0
Mean	4843	71.9	72	1.2
CV (%)	32.6		10.9	34.7

[1]1 = no lodging; 9 = completely lodged

Table 2. Yield and agronomic data for the irrigated Soft White Spring Wheat Co-operative test, Outlook.

Line	Yield kg/ha	Yield bu/ac	Lodging rating[1]
AC Nanda	4762	70.7	1.0
AC Phil	5813	86.3	1.0
AC Reed	4606	68.4	1.0
96B-157	4206	62.5	1.0
96B-37	5283	78.5	1.0
96H-812	6361	94.5	1.0
98B-196	4853	72.1	1.0
99DH-127	4410	65.5	1.0
99DH-222	5028	74.7	1.3
99DH-429	4737	70.3	1.0
99DH-616	5005	74.3	1.0
99DH-635	4651	69.1	1.3
99P6-328	4217	62.6	1.0
99PR-1708	5715	84.9	1.0
99PR-1804	5403	80.2	1.0
99PR-3827	4059	60.3	1.0
99PR-3830	4297	63.8	1.3
99PR-4226	5445	80.9	1.0
99PR-4314	4546	67.5	1.3
99PR-618	4912	72.9	1.0
Mean	4915	73.0	1.0
CV (%)	26.7		21.5

[1]1 = no lodging; 9 = completely lodged

Irrigated Wheat Variety Test

C. Ringdal[1], I. Bristow[2]

Funded by the Irrigation Crop Diversification Corporation (ICDC)

Progress: *Ongoing*

Location: *Four soil associations in the Lake Diefenbaker region.*

Objective: *To evaluate registered wheat varieties under irrigation.*

Wheat variety test plots were grown under irrigation at four locations on varying soil types in the Outlook area. Each site and soil association are as follows:

CSIDC: Bradwell very fine loam.
CSIDC offsite: Asquith sandy loam.
H. Jeske: Tuxford clay loam.
R. Pederson: Elstow loam.

The test was replicated four times.

Plots of 1.5 m x 4.0 m (5 ft x 13 ft) size were sown May 16. All plots received 100 kg/ha N (90 lb N/ac) as 46-0-0 and 50 kg/ha P_2O_5 (45 lb P_2O_5/ac) as 11-52-0.

Yields were estimated by harvesting the entire plot. The results are presented in Table 3.

Table 3. Yield and agronomic data for the irrigated wheat variety test.

	Jeske site			Pederson site			CSIDC Off-station site			CSIDC site			Mean yield		
Variety	Yield (kg/ha)	Height (cm)	Lodging rating[1]	Yield (kg/ha)	Height (cm)	Lodging rating[1]	Yield (kg/ha)	Height (cm)	Lodging rating[1]	Yield (kg/ha)	Height (cm)	Lodging rating[1]	kg/ha	bu/ac	% of Katepwa
Katepwa	3887	91	2.0	3904	92	1.0	5751	101	2.3	4755	101	3.0	4574	67.9	100
AC Avonlea	4487	84	1.3	5193	87	1.0	6533	89	1.0	4411	93	3.0	5156	76.6	113
AC Barrie	3927	93	1.5	4503	90	1.8	6218	100	1.0	4821	97	1.0	4867	72.3	106
AC Cadillac	3759	95	2.8	4403	100	1.5	6198	107	2.5	4398	102	5.0	4690	69.6	103
AC Corrine	3085	99	1.3	2138	101	1.0	5700	106	1.5	3856	100	4.3	3695	54.9	81
AC Crystal	5566	80	1.5	5278	77	1.0	6246	81	1.0	5297	86	4.5	5597	83.1	122
AC Domain	3043	87	2.0	3768	87	1.0	5279	92	1.0	3478	94	1.0	3892	57.8	85
AC Foremost	4800	69	1.5	4618	69	1.5	6266	73	1.0	4855	74	2.5	5135	76.3	112
AC Intrepid	4054	94	1.8	4190	89	1.0	6164	104	1.3	5212	102	2.0	4905	72.8	107
AC Morse	5211	83	1.0	5186	85	1.0	6854	86	1.0	5824	91	1.3	5769	85.7	126
AC Nanda	4695	86	1.3	4436	87	1.0	6399	89	1.0	4669	91	5.3	5050	68.2	110
AC Navigator	4489	78	1.5	5126	76	1.8	5637	74	1.0	4530	83	2.5	4946	73.4	108
AC Pathfinder	4454	87	1.8	4857	85	1.8	6319	90	1.8	5253	95	2.8	5221	77.5	114
AC Vista	5895	81	3.0	5571	79	1.8	7176	87	1.3	5346	86	3.3	5997	89.1	131
McKenzie	4901	88	2.3	5163	87	1.5	6848	98	2.0	5487	96	4.3	5600	83.2	122
CV (%)	5.6	4.4	39.7	11.4	3.1	31.1	6.0	3.4	26.7	14.6	5.7	28.9	—	—	—

[1]1 = no lodging; 9 = completely lodged

[1]*CSIDC, Outlook*
[2]*ICDC, Outlook*

Saskatchewan Advisory Council Irrigated Wheat and Barley Regional Tests

C. Ringdal[1]

Progress: *Ongoing*

Objective: *To evaluate crop varieties in various regions of the province.*

The Saskatchewan Advisory Council wheat regional test was sown May 26. The barley test was sown May 18. Plot size was 1.5 m x 4.0 m (5 ft x 13 ft). 100 kg/ha N (90 lb N/ac) as 46-0-0 and 50 kg/ha P_2O_5 (45 lb P_2O_5/ac) as 11-52-0 were side-banded at seeding.

Yield results for the CWRS, CPS, SWS, CWAD, and CWES market classes are shown in Table 4. Yield data for barley varieties under test is shown in Table 5.

This data is part of the information base from which the provincial variety guide is published.

[1]CSIDC, Outlook

Table 4. Saskatchewan Advisory Council irrigated wheat regional test, Outlook.

Variety	Yield kg/ha	Yield bu/ac	Height (cm)	Lodging rating[1]
Hard Red Spring				
AC Barrie	3453	51.3	101	1.3
AC Abbey	3091	45.9	94	2.5
AC Intrepid	3185	47.3	100	1.3
AC Splendor	3194	47.4	99	2.0
Alikat	3051	45.3	96	1.3
McKenzie	3718	55.2	74	1.8
Prodigy	3525	52.3	106	1.5
BW238	2930	43.5	105	1.8
BW243	3425	50.9	98	1.5
BW245	3186	47.3	99	1.5
BW252	3276	48.6	94	1.3
BW256	2944	43.7	102	2.5
BW259	3161	46.9	94	1.5
BW263	2879	42.8	97	1.0
BW264	3175	47.1	103	1.5
BW720	3736	55.5	104	2.8
BW754	2906	43.2	106	2.5
BW755	3169	47.1	102	2.0
Durum				
AC Avonlea	5834	86.6	94	1.8
AC Morse	5845	86.8	88	1.0
AC Navigator	5244	77.9	79	1.5
AC Pathfinder	5625	83.5	91	2.3
AC Napoleon	6855	101.8	97	2.8
Kyle	5317	79.0	110	5.0
Soft White Spring				
AC Nanda	5854	86.9	87	1.0
AC Phil	5550	82.4	79	1.0
AC Reed	5363	79.6	77	1.0
SWS234	5770	85.7	82	1.0
SWS241	6357	94.4	82	1.3
Canada Prairie Spring				
AC Crystal	6765	100.5	91	3.0
AC Karma	6272	93.1	91	3.5
AC Vista	7015	104.2	91	5.8
HY446	6718	99.8	87	1.5
HY639	6688	99.3	97	3.5
HY644	6870	102.0	91	4.3
HY961	7217	107.2	88	1.5
HY962	7098	105.4	91	3.0
Canada Western Extra Strong				
AC Corrine	4926	73.2	103	3.0
AC Glenavon	5376	79.8	103	2.5
Amazon	5312	78.9	99	3.8
Glenlea	4963	73.7	102	3.5
ES21	5762	85.6	99	2.0

[1]1 = no lodging; 9 = completely lodged

Table 5. Saskatchewan Advisory Council irrigated barley regional test, Outlook.

Variety	Yield kg/ha	Yield bu/ac	Height (cm)
2 Row			
AC Bountiful	5944	110.3	84
AC Metcalfe	4387	74.0	94
CDC Bold	6705	124.5	76
CDC Copeland	5762	107.0	100
CDC Dawn	3410	63.3	85
CDC Dolly	4790	88.9	76
CDC Fleet	4910	91.1	83
CDC Freedom	4341	80.6	93
CDC Gainer	5248	97.4	94
CDC Kendall	4848	90.0	76
CDC McGwire	5158	95.7	85
CDC Speedy	3497	64.9	73
CDC Stratus	5370	99.7	74
CDC Thompson	3786	70.3	55
CDC Unity	4324	80.3	89
Harrington	3562	66.1	88
HB805	5468	101.5	79
Merit	4961	92.1	80
Tercel	4172	77.4	87
TR153	5429	100.8	84
TR346	5999	111.4	71
Xena	5729	106.3	80
6 Row			
AC Bacon	3684	68.4	78
AC Hawkeye	4566	84.8	92
AC Harper	5364	99.6	71
AC Rosser	7780	144.4	75
BT456	5819	108.0	74
BT558	6596	122.4	75
CDC Earl	4604	85.5	65
CDC Sisler	6813	126.5	82
CDC Yorkton	6179	114.7	80
Excel	6024	111.8	74
Foster	5192	96.4	74
Jaeger	3841	71.3	59
Mahigan	3927	72.9	68
Niska	4896	90.9	60
Peregrine	3479	64.6	53
SD516	5198	96.5	67
Stander	7474	138.7	74
Stetson	5709	106.0	49

Oilseeds Program

Variety Evaluations

Oilseeds Program

Variety Evaluations

Western Canada Irrigated Canola Co-operative Tests NI1, NI2, and NI3

C. Ringdal[1], I. Bristow[2]

Progress: Ongoing

***Objective:** To evaluate potential new canola varieties under irrigated conditions in western Canada.*

The canola co-operative tests were sown at CSIDC on May 20 in 1.5 m x 6.0 m (5 ft x 20 ft) plots. Nitrogen was applied at 100 kg/ha (90 lb/ac) as 46-0-0, and phosphorus was applied at 50 kg/ha (45 lb/ac) as 11-52-0. All fertilizer was side-banded at the time of seeding. Results are presented in Tables 1, 2, and 3.

Irrigated Canola Variety Test

C. Ringdal[1], I. Bristow[2]

Funded by the Irrigation Crop Diversification Corporation (ICDC)

Progress: Ongoing

***Locations:** Four soil associations in the Lake Diefenbaker area.*

***Objective:** To evaluate registered canola varieties under irrigation.*

The canola variety tests were grown at four locations in the Outlook area. Each site and soil type are as follows:

- CSIDC: Bradwell very fine loam
- CSIDC offsite: Asquith sandy loam
- H. Jeske: Tuxford clay loam
- R. Pederson: Elstow loam

Canola varieties were tested for their agronomic performance under irrigation. Plots were seeded at four sites and with four replicates at each site.

1.5 m x 4.0 m (5 ft x 13 ft) plots were sown mid May. All plots received 100 kg/ha N (90 lb/ac) as 46-0-0 and 50 kg/ha P (45 lb/ac) as 11-52-0. Yields were estimated by harvesting the entire plot. The results are presented in Table 4.

[1]*CSIDC, Outlook*
[2]*ICDC, Outlook*

Table 1. Yield and agronomic data for the irrigated canola co-operative test NI1, Outlook.

Line	Yield (kg/ha)	Days to maturity	Height (cm)	Lodging rating[1]
AC Excel (check)	2863	99	132	7.0
Apollo	2397	98	127	7.5
Defender (check)	3321	99	144	7.0
Legacy (check)	3442	99	132	7.0
AC Excel 1	3162	99	136	7.3
Q2	3280	100	130	7.0
349.97oL	2714	99	139	8.0
46A65	3912	100	130	4.3
561AA	3383	98	132	2.0
A99-12NR	3060	101	139	5.3
A99-13NR	3251	101	132	7.0
A99-2N	3436	100	143	5.0
CN801163	3218	99	136	7.0
CNR2106	3025	99	132	5.5
CNR2173	2932	100	132	7.0
CNS103	3031	99	131	7.8
NL97-0219	3086	100	132	5.8
NS3154	3672	98	129	6.8
NS3213	3478	100	133	6.0
NS3589	2623	98	129	8.5
PHS99-836	3517	99	143	6.8
PHS99-842	3709	100	150	5.0
PR5731	3051	99	134	7.3
RB04-35	3401	100	141	5.0
S8012	2989	100	129	7.0
SW B2674 RR	3034	100	133	5.5
SW C5009	3601	100	144	2.0
SW C5020 BX	3472	101	134	3.0
SW C5048	3336	100	134	4.0
Z9565	2374	98	130	6.8
Check Mean	3209	99	136	7.0
Grand Mean	3197	99	135	6.0
CV (%)	12.9	---	---	---

[1]0 = upright; 9 = flat

Table 2. Yield and agronomic data for the irrigated canola co-operative test NI2, Outlook.

Line	Yield (kg/ha)	Days to maturity	Height (cm)	Lodging rating[1]
AC Excel (check)	3470	100	141	5.8
Defender (check)	3762	100	140	4.8
Legacy (check)	3809	98	130	3.3
AC Excel 1	3501	100	135	5.8
Q2	3900	100	138	2.8
46A65	4271	101	130	3.0
7.99RR	3816	100	135	1.5
9.99RR	3884	101	133	1.8
CN800847	4219	99	132	5.5
CN801167	3652	100	141	3.3
CN801171	4042	100	132	5.5
NL98-0944	4354	100	141	1.8
NS3233	3962	100	128	1.5
NS3585	4536	100	140	2.3
NS3587	4415	98	135	5.8
PHS99-763	4209	100	135	3.0
PR5650	3346	99	128	5.0
PR5703	3634	98	125	4.3
S8010	2541	100	135	8.0
S8013	3700	101	137	3.8
SW C5026	3891	101	142	2.5
SW C5039 BX	3982	100	140	1.8
SW C5063 BX	4146	100	137	3.0
SW-P 98280	4211	101	140	1.5
SWLM C5011	3946	101	138	2.3
Y9043	3768	101	140	2.8
Z9571	3694	99	132	4.5
Z9576	3352	101	133	4.3
Z9582	3632	99	138	7.0
Check Mean	3680	99	137	4.6
Grand Mean	3846	100	136	3.7
CV (%)	10.4	—	—	—

[1]0 = upright; 9 = flat

Table 3. Yield and agronomic data for the irrigated canola co-operative test NI3, Outlook.

Line	Yield (kg/ha)	Days to maturity	Height (cm)	Lodging rating[1]
AC Excel (check)	2686	100	135	7.3
Defender (check)	3174	100	140	7.3
Legacy (check)	3120	100	132	5.0
AC Excel 1	2795	101	133	8.0
Q2	3410	101	135	6.3
1199.98	3314	100	134	5.0
1548.98	3574	101	140	1.8
3.99RR	3738	100	135	2.5
4.99RR	3896	100	135	3.0
449RR	3281	100	126	4.3
46A65	4288	100	130	4.0
96-2393	3455	101	141	5.5
A99-15NR	3485	100	127	6.3
CN801191	3576	100	130	7.0
CT8169	3593	99	131	5.3
CT8184	4125	100	130	4.0
NS3223	3670	100	126	4.3
PHS99-755	3624	101	146	3.3
PHS99-758	3917	100	140	4.3
PHS99-764	3510	99	127	5.3
PR5631	3511	99	120	5.8
PR5638	3460	100	127	5.8
PR5671	3683	101	138	4.5
PR5728	2813	102	136	6.0
S8015	3020	102	135	5.3
SW C5022 BX	3796	100	137	2.5
SW C5034 RR	3724	100	137	5.3
SW C5064 BX	3459	100	132	5.0
SW-P 98843	3630	101	132	4.8
Z9581	3150	100	128	6.5
Check Mean	2993	100	136	6.5
Grand Mean	3482	100	133	5.0
CV (%)	14.1	---	---	---

[1]0 = upright; 9 = flat

Table 4. Yield and agronomic data for the irrigated canola variety trial.

Variety	Pederson site			Off-station site			CSIDC site			Mean yield		
	Yield (kg/ha)	Height (cm)	Lodging rating[1]	Yield (kg/ha)	Height (cm)	Lodging rating[1]	Yield (kg/ha)	Height (cm)	Lodging rating[1]	kg/ha	bu/ac	% of Quantum
Quantum (check)	3485	130	3.0	4646	127	2.5	5377	135	3.3	4503	80.2	100
45A52	2665	117	6.8	3977	130	3.5	3754	125	4.8	3465	61.7	77
46A76	2796	118	2.3	3767	125	2.0	4279	136	2.3	3614	64.4	80
Cartier BX	3087	116	3.8	4330	114	3.5	5329	131	3.0	4249	75.7	94
Hylite 201	3073	107	2.3	4145	104	2.8	4567	124	2.8	3928	70.0	87
Hyola 454	2620	123	5.5	3972	124	2.8	4304	133	4.0	3632	70.1	81
Invigor 2273	3087	130	3.5	4964	126	3.0	4235	136	5.3	4095	73.0	91
Invigor 2573	3523	143	1.8	4863	135	1.0	4821	148	3.0	4402	78.4	98
Invigor 2663	3389	134	2.0	5048	143	2.3	5123	142	3.3	4520	80.5	100
LG3235	3064	108	3.3	4422	113	3.0	4603	123	3.8	4030	71.8	89
LG3311	3290	116	2.5	4308	119	2.3	4143	127	2.8	3914	69.7	87
LG3366	2962	115	1.8	4111	119	2.5	4953	132	3.0	4009	71.4	89
LG3455	2944	121	1.8	4278	123	1.5	5123	136	2.3	4115	73.3	91
Magellan	3794	129	4.0	3688	123	2.8	4404	140	3.8	3962	70.6	88
OAC Dynamite	3139	111	3.8	3258	106	4.3	3729	120	4.8	3709	66.1	82
Q2	2615	112	2.3	4800	122	2.5	4280	135	5.0	3898	69.5	87
Synbrid 220	2742	121	3.0	3540	117	2.3	3577	130	3.3	3286	58.6	73
CV (%)	16.6	5.2	36.6	10.6	7.7	42.9	13.1	6.7	37.2	---	---	---

[1]0 = upright; 9 = flat

Irrigated Flax and Solin Variety Test

C. Ringdal[1], I. Bristow[2]

Funded by the Irrigation Crop Diversification Corporation (ICDC)

Progress: *Ongoing*

Locations: *Four soil associations in the Lake Diefenbaker area.*

Objective: *To evaluate registered flax and solin varieties under irrigation.*

Flax and solin varieties were tested for their agronomic performance under irrigation at four locations in the Outlook area. Each site and soil type are as follows:

CSIDC: Bradwell very fine loam
CSIDC offsite: Asquith sandy loam
H. Jeske: Tuxford clay loam
R. Pederson: Elstow loam

Plots were seeded with four replicates at each site. 1.5 m x 4.0 m (5 ft x 13 ft) plots were sown in mid May. All plots received 100 kg/ha N (90 lb/ac) as 46-0-0 and 50 kg/ha P (45 lb/ac) as 11-52-0. Yields were estimated by harvesting the entire plot. The results are presented in Table 5.

Table 5. Yield and agronomic data for the irrigated flax and solin variety test.

	Jeske site			Pederson site			Off-station site			CSIDC			Mean yield		
Variety	Yield (kg/ha)	Height (cm)	Lodging rating[1]	Yield (kg/ha)	Height (cm)	Lodging rating[1]	Yield (kg/ha)	Height (cm)	Lodging rating[1]	Yield (kg/ha)	Height (cm)	Lodging rating[1]	kg/ha	bu/ac	% of AC McDuff
Oilseed flax															
AC McDuff	2435	60	1.0	2010	57	1.0	3636	61	1.3	3016	60	1.0	2774	44.1	100
AC Carnduff	2287	58	1.3	1999	55	1.0	2104	63	1.0	3223	59	1.3	2403	38.2	87
AC Emerson	2158	58	1.3	2403	57	1.0	3059	60	1.3	2968	55	1.3	2647	42.1	95
AC Watson	2241	55	1.5	1883	52	1.0	3068	55	1.0	3036	50	1.0	2557	40.7	92
CDC Arras	2140	59	1.5	1778	55	1.0	3402	59	1.3	2775	59	2.5	2524	40.2	91
CDC Bethune	2529	61	1.0	2366	55	1.0	3608	63	1.3	3620	60	1.0	3031	48.2	109
CDC Normandy	2213	57	1.3	2115	57	1.0	3243	60	1.3	2830	56	1.5	2600	41.4	94
CDC Valour	1791	58	1.0	2173	56	1.0	2528	59	1.8	2739	55	1.3	2308	36.7	83
FP1048	2543	58	1.3	1906	55	1.0	3503	59	1.0	3130	61	1.0	2771	44.1	100
FP1069	2325	59	1.0	1970	57	1.0	3451	62	1.5	3327	57	1.5	2768	44.0	100
FP1082	1952	54	1.3	1753	50	1.0	2941	52	1.0	2695	50	1.0	2335	37.2	84
FP2016	2004	55	1.0	1905	53	1.0	3472	57	1.0	2935	52	1.3	2579	41.0	93
Somme	1985	57	1.0	1783	57	1.0	3145	63	1.3	2644	59	1.8	2389	38.0	86
Taurus	2122	61	1.8	2054	59	1.0	3869	65	1.5	3042	59	1.0	2772	44.1	100
Vimy	2117	59	1.8	1700	55	1.0	3286	60	1.5	2954	57	1.3	2514	40.0	91
Solin															
Linola 1084	2163	64	1.5	1531	55	1.0	3165	67	1.5	3280	59	1.0	2535	40.3	91
Linola 989	2371	64	1.0	2054	57	1.0	2903	65	1.0	3234	61	1.0	2641	42.0	95
SP2022	2137	60	1.8	1835	57	1.0	2776	63	1.3	2777	58	1.5	2381	27.9	86
CV (%)	10.3	3.4	36.2	20.4	6.6	—	14.7	5.1	37.2	6.6	3.4	55.2	—	—	—

[1]0 = upright; 9 = flat

[1]*CSIDC, Outlook*
[2]*ICDC, Outlook*

Sunflower Regional Trial

C. Ringdal[1], T. Hogg[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Ongoing*

Location: *Outlook*

Objective: *This trial is part of a multi-site regional effort to determine the yield of conventional height oilseed sunflowers.*

Producers require information on the relative performance of sunflower to aid them in planting decisions. CSIDC has been running this irrigated sunflower trial for four years and in this time new genetic material has been developed that needs to be tested. This trial provides information for recommendations made to producers.

Sunflowers were planted on May 9 in two row plots 60 cm (24 in) apart and 6 m (20 ft) long. Soil testing indicated there was good fertility, therefore 20 kg P_2O_5/ha (18 lb P_2O_5/ac) and 60 kg N/ha (53 lb N/ac) were side-banded at seeding. Plant numbers were adjusted to one plant/25 cm (one plant/10 in) by hand thinning. Poast was applied to all plots on June 7. All heads were bagged after flowering to prevent bird damage. Plots were harvested November 17.

One confectionary cultivar (IS 8048) was included in the trial and its yield was significantly lower than all cultivars except 63A81 (Table 6). SF 125NL was the only other cultivar significantly lower than the remaining cultivars. Samples of the oilseed cultivars were submitted for oil content analysis. The confectionary cultivar was submitted for seed size, seed weight and test weight analyses.

Table 6. Irrigated Sunflower Regional Variety Trial agronomic data.

Variety	# Days to first flower	Plant height (cm)	1000 Seed weight (g)	Yield (kg/ha)	Yield (lb/ac)
IS 6111	75	160	67	3939	3510
IS 8048	78	182	132	2355	2098
63A81	84	190	56	2744	2445
63A30	84	195	57	3948	3518
63A70	82	196	65	4504	4013
SF 125NL	82	197	74	3090	2753
SF 270	79	183	66	4209	3750
SF 187	84	189	50	4062	3619
SF 260	83	184	52	3622	3227
SF 120	81	187	78	4089	3643
SF 290NL	85	183	54	4214	3755
LSD (0.05)				721	642

[1]CSIDC, Outlook

Forage Program

Forage Program

Turf Grass Seed Program

There is a large turf grass seed market both in North America and Europe. Western Canada can become the low cost supplier of seed if production packages can be developed that result in yields similar to traditional growing areas.

This program seeks to develop information on establishment, weed control and post-harvest management which will allow producers to obtain high seed yields for turf grass species.

Production Package for Bluegrass

B. Coulman[1], S. Brown[2], T. Nelson[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Post Harvest Residue Management, N-Fertility and Application of Chemicals for Insect Control

***Progress**: Year two of three*

***Objective:** To refine a seed production package for bluegrass seed to ascertain the potential effectiveness of weed, insect and residue management.*

A trial was set up in August of 1999 on an established bluegrass stand (seeded 1997) which had previously been used for herbicide trials. This stand was in good condition, having yielded close to 700 kg/ha (624 lb/ac) in 1999.

Treatments:

- N fertility (mid-September, 1999) - 0, 75 and 150 kg/ha
  - 0, 67 and 134 lb/ac
- Residue management (late-August, 1999) - none; mow close and remove; burn
- Silvertop control (late May, 2000) - cygon; no cygon

Treatments were applied in a factorial randomized complete block design with four replications.

[1]*Agriculture & Agri-Food Canada Research Centre, Saskatoon*
[2]*CSIDC, Outlook*

In 2000, the following data were collected: percentage spring vegetative cover, number of days to heading, mean number of heads/m^2, mean number of silvertopped heads/m^2, disease incidence and seed yield.

The data collected in 2000 are reported in Table 1. Seed yields ranged from 233-577 kg/ha (208-514 lb/ac) depending on treatment. Yields such as this would be considered to be low to moderate. The mow and removal treatment produced the highest seed yields, followed by no removal. Burning the residue resulted in poorer stands, fewer heads and lower seed yields than other residue treatments. This was surprising as residue burning is a common, recommended practice in areas producing Kentucky bluegrass.

Nitrogen fertilization has a relatively minor positive effect on yield. It is possible that there was residual nitrogen from previous treatment; however, soil samples were not taken to assess this. Seed yields were higher for plots treated with cygon, than for those which did not receive cygon. Silvertop incidence, although not high in 2000, was less with cygon application, which may partially explain the yield advantage. Cygon provides some control of insects associated with silvertop.

Treatments were applied again in the fall of 2000, and data will be collected in 2001.

Production Package for Annual and Perennial Ryegrass and Tall Fescue

B. Coulman[1], S. Brown[2], T. Nelson[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Establishment and Crop Rotation

Progress: *Year four of five*

Objective: *To develop a production system for producing seed of perennial ryegrass and tall fescue as biennial crops and annual ryegrass as an annual crop.*

Profitable production of grass seed depends on the establishment of good stands. Most grasses do not produce seed in the year of planting and, thus, 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 with bluegrass has shown that flax was the most suitable companion crop since it is less competitive. 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 can be planted after the harvest of an early maturing crop or is broadcast into a standing crop prior to harvest.

New trials were successfully established in 1999 with spring seedings and companion crops established the first week of June, and grasses broadcast into standing crops the middle of August. Tall fescue and perennial ryegrass were seeded without a companion crop and with AC Taber and AC Barrie wheat. They were broadcast in late summer into standing crops of LG3295 canola and AC Pennant yellow mustard.

[1]*Agriculture & Agri-Food Canada Research Centre, Saskatoon*
[2]*CSIDC, Outlook*

Table 1. 1997 Kentucky bluegrass management trial: 2000 data.

Residue treatment	Nitrogen (kg/ha)	Insecticide	% Vegetative cover 05/23/00	Days to 50% heading from 04/01/00	Heads/m²	Silvertop heads/m²	Disease rating 06/27/00	% Incidence silvertop	Seed yield kg/ha	Seed yield lb/ac
None	0	None	98	67	295	61	0.3	22.2	354	315
	0	Cygon	92	67	383	16	0.5	4.2	424	378
	75	None	93	68	258	46	0.3	18.2	271	241
	75	Cygon	93	66	485	24	1.3	6.2	563	502
	150	None	94	67	390	24	0.8	5.5	480	428
	150	Cygon	93	67	345	19	1.0	7.1	490	437
Mow	0	None	92	64	449	42	0.3	10.6	410	365
	0	Cygon	93	65	448	14	0.5	3.4	487	434
	75	None	83	55	457	39	1.0	8.6	424	377
	75	Cygon	93	63	645	41	0.8	6.1	489	436
	150	None	91	65	578	87	0.8	10.9	499	445
	150	Cygon	90	65	462	26	0.0	4.6	577	514
Burn	0	None	78	66	255	24	1.0	9.8	353	315
	0	Cygon	78	62	309	23	0.8	6.5	233	208
	75	None	68	64	280	15	0.8	5.1	237	211
	75	Cygon	78	62	329	17	0.5	5.2	386	344
	150	None	63	64	228	32	0.8	10.3	268	239
	150	Cygon	74	62	441	25	1.3	6.5	425	379
Mean			86	64	391	32	0.7	8.6	409	
CV (%)			10	7	37	75	113.5	79.0	39	
F value			5	2	2	2	1.3	2.0	2	
LSD (0.05)			12	6	204	34	1.1	9.6	225	

Residue treatments

Treatment	Seed yield kg/ha	Seed yield lb/ac	% Silvertop
Mow	480	425	7
None	430	385	11
Burn	320	285	7

Nitrogen fertilizer

Treatment	Seed yield kg/ha	Seed yield lb/ac	% Silvertop
150	460	410	7
75	400	355	8
0	380	340	9

Insecticide

Treatment	Seed yield kg/ha	Seed yield lb/ac	% Silvertop
Cygon	450	400	6
None	370	330	11

Perennial ryegrass failed to establish when broadcast into standing crops and the spring seedings suffered winterkilling and were not harvested. Tall fescue established and overwintered in all treatments although broadcast seedings were thin. Seed yields of the spring seeding with no companion crop were over twice as high as any of the other treatments (Table 2). This confirms previous data which showed that companion crops and later seedings resulted in a reduction of tall fescue seed yields the following year.

Table 2. 1999 Tall fescue establishment and crop rotation trial: 2000 data.

Treatment	Companion crop	Seed yield kg/ha	Seed yield lb/ac
Direct seeded	None	1164	1035
Broadcast	Canola	568	505
Direct seeded	CPS wheat	505	449
Broadcast	Yellow mustard	385	343
Direct seeded	HRS wheat	138	123
Mean		552	
CV (%)		59	
LSD (0.05)		505	

Residue, Fertility, and Insect Management of Tall Fescue

Objective: *To refine a system of residue management, nitrogen fertilization and insect control for tall fescue seed production fields.*

Two trials were set up in August of 1999 on a 1997 established tall fescue stand which had been previously used for herbicide trials. This stand was in good condition having yielded around 900 kg/ha (802 lb/ac) in 1999.

Treatments were applied in a factorial randomized complete block design with four replications.

In 2000, the following data were collected: percentage spring vegetative cover, number of days to heading, mean number of heads/m^2, mean number of silvertopped heads/m^2, disease incidence and seed yield.

For Trial 1 (Table 3), seed yields were greater than 1 t/ha for the mowed and no residue removal treatments. Yields were substantially depressed in the burned treatment due to reduced vegetative cover and fewer heads. The application of cygon had little effect on yield, likely due to the fact that there was little silvertop present. Tall fescue is less susceptible to silvertop than kentucky bluegrass and the fine fescues.

Trial No. 1 Treatments:

- Residue management (late August, 1999) - none; mow close and remove; burn
- Silvertop control (late May, 2000) - cygon; no cygon

Trial No. 2 Treatments:

- Residue management (late August, 1999) - none; mow close and remove; burn
- N fertility (mid September, 1999) - 0, 75 and 150 kg/ha - (0, 67 and 134 lb/ac)

For Trial 2 (Table 4), seed yields were much lower than Trial 1. The burned residue treatment again produced the lowest seed yields due to poorer stands and fewer heads. Nitrogen fertilization had some effect on yield with 75 kg/ha (67 lb/ac) producing twice the seed yields of the 0 treatment. The highest rate, 150 kg/ha (134 lb/ac), was not superior to 75.

Treatments were applied again in fall of 2000, and data will be collected in 2001.

Table 3. 1997 Tall fescue residue management Trial No. 1: 2000 data.

Residue treatment	Insecticide	% Vegetative cover 05/23/00	Days to 50% heading from 04/01/00	Heads/m²	Silvertop heads/m²	Disease rating 06/27/00	% Incidence silvertop	Seed yield kg/ha	Seed yield lb/ac
None	None	90	80	200	0.5	1.7	0.23	1345	1197
	Cygon	86	80	199	0.5	2.5	0.23	1006	985
Mow	None	95	73	184	10	1.2	5.9	1300	1157
	Cygon	83	73	171	7	1.5	3.9	1367	1216
Burn	None	74	74	136	4.5	1.2	3.2	659	586
	Cygon	88	73	131	4	1.2	3.4	795	708
Mean		86	75	169	4	2	3	1078	
CV (%)		9	1	25	140	47	147	24	
F value		3	190	2	0.9	2.2	0.8	3.6	
LSD (0.05)		12	1	63	9.3	1.1	6.2	389	

Residue treatments

Treatment	Seed yield kg/ha	Seed yield lb/ac
Mow	1330	1185
None	1180	1050
Burn	730	650

Insecticide

Treatment	Seed yield kg/ha	Seed yield lb/ac
Cygon	1060	940
None	1100	980

Table 4. 1997 Tall fescue residue management Trial No. 2: 2000 data.

Residue treatment	Nitrogen (kg/ha)	% Vegetative cover 05/23/00	Days to 50% heading from 04/01/00	Heads/m²	Silvertop heads/m²	Disease rating 06/28/00	% Incidence silvertop	Seed yield kg/ha	Seed yield lb/ac
None	0	94	74	111	1	1.7	0.75	200	178
	75	85	80	188	2.6	1.6	1.7	209	186
	150	87	77	148	0.5	1.2	0.3	422	376
Mow	0	89	77	134	4.5	1	3.3	320	285
	75	84	75	205	2	1.5	1.6	567	505
	150	92	73	208	8	1	4	438	390
Burn	0	79	73	47	3.5	1	7.5	28	25
	75	82	73	98	1	0	0.9	293	261
	150	72	73	84	4	1.3	5.8	22	20S
Mean		85	75	136	3	1.1	3	955	
CV (%)		12.7	3.6	29.1	141	71	180	33.2	
F value		3.2	1.9	6.3	1	1.6	0.8	3.6	
LSD (0.05)		15.7	4.1	58.1	6.2	1.2	7.5	463.5	

Residue treatments

Treatment	Seed yield kg/ha	Seed yield lb/ac
Mow	440	390
None	280	250
Burn	110	100

Nitrogen fertilizer

Treatment	Seed yield kg/ha	Seed yield lb/ac
75	360	320
150	290	260
0	180	160

Seeding Date Trials for Perennial, Italian and Westerwolds Ryegrass

Objectives:
- To determine whether fall dormant seeding will promote seed production in Italian and perennial ryegrass.
- To determine whether fall dormant seeding will promote early spring growth and earlier seed production in Westerwolds ryegrass compared to spring seedings.

Late fall (dormant) seedings have worked well with canola. They also show potential for ryegrass seed crops. Annual (westerwolds) ryegrass has produced fairly high yields from spring seedings, but yields could perhaps be increased by dormant seedings. Italian and perennial ryegrass do not produce any heads in the year of seeding and must overwinter to become vernalized and produce seed the following year. Italian ryegrass will not survive our winters and perennial ryegrass is only moderately winter hardy. For dormant seedings of these latter two species, seedlings germinating early in the spring may become vernalized and subsequently produce heads and seed. This would eliminate the need to overwinter plants and create an effective annual production system for these grasses. The objectives are: 1) to determine whether fall dormant seeding will promote seed production in Italian and perennial ryegrass; and 2) to determine whether all dormant seeding will promote early spring growth and earlier seed production in Westerwolds ryegrass compared to spring seedings.

Data collected in 2000 were: number of days to heading, mean number of tillers/0.25 m^2, mean number of heads/0.25 m^2, and seed yield.

Stands of fall seedings were poor in the spring, but most thickened up as the season progressed through rapid tillering. All dormant seedings headed earlier than spring seedings, but seed maturity occurred within the same week for all seedings within a ryegrass type.

Seeding Dates:
- Water-insoluble seed coat - early November, 1999
- Water-soluble seed coat - early November, 1999
- Water-soluble seed coat - May, 2000

Varieties:
- Westerwolds - Barspectra
- Italian - Bardelta, Maris Ledger, Bartali, Bartissimo
- Perennial - Yatsyn

Yatsyn perennial ryegrass produced low seed yields (less than 100 kg/ha) (89 lb/ac) for the dormant seedings and as expected, no seed for the spring seeding (Table 5). As in previous years, dormant seeding shows little promise for economic seed production in perennial ryegrass.

Barspectra westerwolds ryegrass yielded 1 t/ha or more in all seedings. Dormant seedings were lower yielding than spring seedings, with the lowest yields for the water-insoluble seed coated treatment. In previous years, there was a considerable advantage for dormant seedings over spring seedings.

Seed yields of Italian ryegrass varieties were highly variable. All spring seedings, as expected, produced little or no seed. Yields of dormant seeded Bardelta were the highest followed by Bartali. These two varieties are known to have a lower vernalization requirement. These yields (550-750 kg/ha) (490-668 lb/ac) may be economic for ryegrasses, depending on price in a given year. Yields of Bartissimo and especially Maris Ledger, were lower and would likely not be economical. These latter varieties are known to have a high vernalization requirement for flowering.

Dormant seedings were repeated in early November, 2000 and data will be collected in 2001.

Table 5. 1999 Ryegrass dormant seeding trial - Growtec seed coatings: 2000 data.

Variety	Ryegrass species	Impermeable seed coat	Date of seeding	Days to 50% heading from 04/01/00	Mean # tillers per 1/4 m²	Mean # heads per 1/4 m²	Seed yield	
							kg/ha	lb/ac
Yatsyn	Perennial	Yes	Fall 1999	109	45	74	93	83
		No	Fall 1999	102	35	54	79	70
		No	Spring 2000	0	27	0	0	0
Maris Ledger	Italian	Yes	Fall 1999	108	61	66	185	165
		No	Fall 1999	105	28	32	221	197
		No	Spring 2000	0	45	0	0	0
Bartali	Italian	Yes	Fall 1999	94	52	106	550	490
		No	Fall 1999	96	47	112	634	564
		No	Spring 2000	113	44	16	7	6
Bartissimo	Italian	Yes	Fall 1999	93	55	113	379	337
		No	Fall 1999	93	50	112	510	454
		No	Spring 2000	108	57	3	11	10
Bardelta	Italian	Yes	Fall 1999	97	55	147	758	675
		No	Fall 1999	95	59	81	659	587
		No	Spring 2000	103	68	0	4	3
Barspectra	Westerwolds	Yes	Fall 1999	90	42	137	849	756
		No	Fall 1999	86	44	141	1119	996
		No	Spring 2000	98	59	133	1428	1271
Mean	---	---	---	---	48	74	416	
CV (%)	---	---	---	---	31	53	42	
F value	---	---	---	---	2	7	20	
LSD (0.05)	---	---	---	---	21	56	250	

Production Package for Slender Creeping Fescue and Chewings Fescue

B. Coulman[1], S. Brown[2], T. Nelson[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Residue Management, Nitrogen Fertility and Insect Control in Chewings and Slender Creeping Fescue

Progress: *Year two of three*

Objective: *To develop a cost effective method of establishing and managing slender creeping fescue and chewings fescue.*

A trial was set up in August of 1999 on 1997 established stands of chewings and slender creeping fescue which had previously been used for herbicide trials. The chewings fescue stand was in good condition having yielded close to 400 kg/ha (356 lb/ac) in 1999. The slender creeping fescue stand was not as thick, so no seed was harvested in 1999.

Treatments were applied in a factorial randomized complete block design with four replications.

[1]*Agriculture & Agri-Food Canada Research Centre, Saskatoon*
[2]*CSIDC, Outlook*

Treatments:

- N fertility (mid-September, 1999) - 0, 75 and 150 kg/ha - (0,67 and 134 lb/ac)
- Residue management (late-August, 1999) - none; mow close and remove; burn
- Silvertop control (late May, 2000) - cygon; no cygon

In 2000, the following data were collected: percentage spring vegetative cover, number of days to heading, mean number of heads/m^2, mean number of silvertopped heads/m^2, disease incidence and seed yield.

Chewings Fescue:

Yields of chewings fescue ranged from 76 to 859 kg/ha (68 to 765 lb/ac) depending on treatment (Table 6). Removal of residue produced higher yields than no removal. Burning drastically reduced seed yields because of thin stands and low production of heads. Burning significantly reduced the incidence of silvertop and disease incidence, but this was no advantage due to the poor stands and head production.

Nitrogen fertilization had no effect on seed yields; it may have even slightly reduced yields. An application of cygon had a positive effect on seed yield, perhaps due to somewhat lower silvertop incidence.

Slender Creeping Fescue:

Slender creeping fescue is a high quality turf species used in Europe. Attempts to produce seed in Canada have not been very successful. Yields in this trial ranged from 170 to 838 kg/ha (151 to 747 lb/ac), which would be considered excellent for this species (Table 7). Removing residue by mowing resulted in the highest yields, while burning produced the least. Cygon application produced a slight advantage in yield and reduced silvertop incidence. Nitrogen fertilization had a moderate positive effect on seed yield.

Treatments were applied again in the fall of 2000, and data will be collected in 2001.

Table 6. 1997 Chewings fescue residue management trial: 2000 data.

Residue treatment	Nitrogen (kg/ha)	Insecticide	% Vegetative cover 05/23/00	Days to 50% heading from 04/01/00	Heads/m²	Silvertop heads/m²	Disease rating 06/27/00	% Incidence silvertop	Seed yield kg/ha	Seed yield lb/ac
None	0	None	76	71	307	38	1	12.3	450	401
	0	Cygon	64	71	242	25	1.25	7.0	430	383
	75	None	92	72	362	57	1	17.8	336	299
	75	Cygon	75	72	234	4	0.5	1.3	422	376
	150	None	85	74	357	29	0.8	11.8	167	149
	150	Cygon	76	71	228	14	0.5	7.5	396	352
Mow	0	None	66	67	499	31	1.0	5.0	487	433
	0	Cygon	75	67	831	58	1.0	7.8	724	644
	75	None	81	66	624	46	1.3	7.8	430	383
	75	Cygon	71	66	783	44	0.8	5.8	859	765
	150	None	79	66	557	52	1.3	9.0	463	412
	150	Cygon	80	67	745	40	1.5	7.3	752	669
Burn	0	None	31	0	33	1	0.0	1.5	169	150
	0	Cygon	40	42	94	1	0.3	0.3	110	98
	75	None	46	39	109	8	0.0	4.3	103	92
	75	Cygon	40	442	66	3	0.0	2.5	121	108
	150	None	35	20	78	2	0.0	2.0	76	68
	150	Cygon	38	40	129	7	0.0	7.0	139	124
Mean			64	56	348	25	0.6	6.5	368	
CV (%)			20	43	56	102	123.3	101.7	67	
F value			10	3	7	2	1.7	1.7	3	
LSD (0.05)			18	34	275	37	1.1	9.4	348	

Residue treatments

Treatment	Seed yield kg/ha	Seed yield lb/ac
Mow	538	479
None	367	327
Burn	119	106

Nitrogen fertilizer

Treatment	Seed yield kg/ha	Seed yield lb/ac	% Silvertop
150	332	295	7.4
75	379	337	6.6
0	395	352	5.7

Insecticide

Treatment	Seed yield kg/ha	Seed yield lb/ac	% Silvertop
Cygon	439	391	5
None	298	265	7.9

Table 7. 1997 Slender creeping fescue residue management trial: 2000 data.

Residue treatment	Nitrogen (kg/ha)	Insecticide	% Vegetative cover 05/23/00	Days to 50% heading from 04/01/00	Heads/m²	Silvertop heads/m²	Disease rating 06/27/00	% Incidence silvertop	Seed yield kg/ha	Seed yield lb/ac
None	0	None	90	73	239	18	1.5	8	475	423
	0	Cygon	80	71	199	5	1.3	2	367	327
	75	None	89	73	200	23	1.3	10	384	342
	75	Cygon	90	67	318	14	0.3	6	587	522
	150	None	84	73	254	19	0.3	7	381	339
	150	Cygon	80	74	254	7	0.8	5	472	420
Mow	0	None	69	69	292	19	0	8	300	267
	0	Cygon	71	69	430	3	1.8	1	623	554
	75	None	73	67	370	6	0.5	2	416	370
	75	Cygon	80	66	405	9	0.3	2	646	575
	150	None	80	67	450	22	0.5	4	838	746
	150	Cygon	69	67	498	4	0.5	1	437	389
Burn	0	None	26	late	0	0	0	0	327	291
	0	Cygon	29	late	376	0	0.3	0	233	208
	75	None	40	late	66	1	0.3	2	421	375
	75	Cygon	28	late	388	12	0.3	3	277	246
	150	None	30	late	22	0	0.3	0	170	151
	150	Cygon	28	68	270	4	0.5	6	458	408
Mean			63	69	304.0	10.2	0.6	4	434	
CV (%)			18.9	2.1	53.3	123.0	105.9	114.6	57.1	
F value			15.8	2.2	1.8	1.3	2.9	1.2	1.5	
LSD (0.05)			16.9	5.1	233.0	18.1	0.9	6.7	351.8	

Residue treatments

Treatment	Seed yield kg/ha	Seed yield lb/ac	% Silvertop
Mow	543	483	3
None	444	395	6.3
Burn	314	279	1.8

Nitrogen fertilizer

Treatment	Seed yield kg/ha	Seed yield lb/ac	% Silvertop
150	459	409	3.8
75	455	405	4.1
0	387	344	3.2

Insecticide

Treatment	Seed yield kg/ha	Seed yield lb/ac	% Silvertop
Cygon	455	405	2.9
None	412	367	4.6

Forage Crop Variety Testing at the CSIDC

B. Coulman[1]

The Western Forage Testing System (WFTest) is responsible for testing forage crops across Alberta, Saskatchewan and Manitoba. Private and public plant breeders submit their new varieties to the system and they are tested at a minimum of 16 sites over a period of three years. This provides enough data for consideration of the variety for registration and recommendation in all three provinces. CSIDC is one of the core testing sites of WFTest. Data collected on the tests includes: 1) spring stand to assess winter survival; and 2) dry matter yield (two cuts). Table 8 lists trials that were evaluated at the CSIDC in 2000.

Table 8. Number of entries in the Western Forage Testing system.

Species	Year established	Number of varieties
Alfalfa	1997 1998 1999	15 14 24
Birdsfoot trefoil	1997	2
Cicer milkvetch	1997	4
Clovers (red)	1998	3
Clovers (red and alsike)	1999	5
Crested wheatgrass	1997 1999	3 3
Orchardgrass	1998	5
Timothy	1998 1999	4 3
Bromegrass	1999	6
Kentucky bluegrass	1999	2
Westerwolds ryegrass	1999	2

In addition, the following new trials were seeded in 2000: Alfalfa (17), westerwolds ryegrass (2), Italian ryegrass (2), and timothy (6).

The numbers of varieties in the trials reflect the amount of breeding activity for the species. Many more new cultivars of alfalfa are being developed than for any other forage crop.

[1]*Agriculture & Agri-Food Canada Research Centre, Saskatoon*

Specialty Crops Program

Pulse Crops

Alternate Crops

Specialty Crops Program

Pulse Crop Program

The pulse crop program at the CSIDC 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

Seeding Rate and Row Spacing Effects on Irrigated Dry Bean

T. Hogg[1], A. MacDonald[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year four of five*

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. High plant density is often associated with low-canopy aeration, high humidity and prolonged periods of dampness which can promote the development of disease. These factors will be affected by both plant architecture and 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 cm to 80 cm. Lower seeding rates would reduce the seeding costs for producers.

A dry bean seeding rate x row spacing trial was established in the spring of 2000 at the CSIDC. A separate trial was established for each of the selected dry bean cultivars representing pinto, black, navy, great northern and small red dry bean market classes. Treatments consisted of five seeding rates/targetted plant populations (20, 25, 30, 35 and 40 seeds/m^2) and three row spacings (20, 60 and 80 cm; 8, 24 and 32 in). Selected cultivars for each dry bean market class were Pinto: Othello - Type III indeterminate sprawling vine and CDC Camino - Type I upright determinate; Black: CDC Expresso - Type I upright determinate; Navy: Skipper - Type I upright determinate; Great Northern: CDC Crocus - Type III indeterminate; Small Red: NW 63 - Type II indeterminate. Normal fertilizer, weed control and irrigation practices for irrigated dry bean production were followed. The treatments were arranged in a strip-plot design. Seeding rate treatments were

[1]*CSIDC, Outlook*

randomized within row spacing strips. All treatments were replicated four times. Each treatment consisted of two passes with the drill and measured 2.4 m x 8 m (8 ft x 24 ft).

Plant stand increased as the seeding rate was increased (Figure 1) and decreased as the row spacing increased from 20 cm to 60 cm and 80 cm for all market classes of dry bean (Figure 2). This probably occurred due to closer spacing between plants within the row causing increased plant competition.

Dry bean yield tended to increase as seeding rate increased for all six cultivars tested (Figure 3). There was a significant yield increase up to a seeding rate of 25 seeds/m^2 for Othello and CDC Camino, 30 seeds/m^2 for CDC Expresso, Skipper and NW 63 and 35 seeds/m^2 for Crocus. The rate of yield increase with an increase in seeding rate was greater for CDC Expresso and Skipper (Type I determinate upright cultivars) in comparison to the other cultivars. These results agree with the current recommended seeding rate of 25-30 seeds/m^2 for irrigated dry bean. As well, yield decreased as row spacing increased from 20 cm to either 60 cm or 80 cm for all dry bean market classes tested except for CDC Crocus great northern and NW 63 small red (Figure 4). This can be attributed to inter-row plant competition resulting in reduced plant stands and inefficient utilization of the growing area at the higher row spacings.

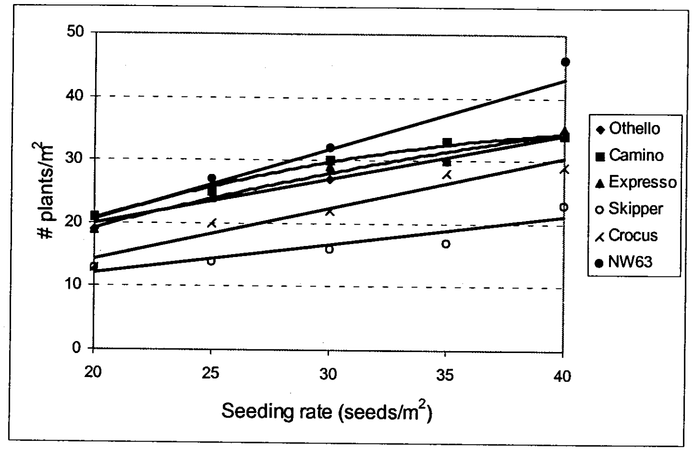


Figure 1. Effect of seeding rate on plant stand of selected dry bean cultivars.

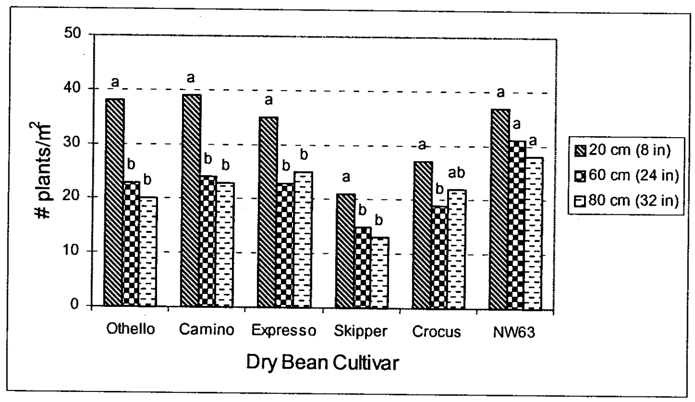


Figure 2. Effect of row spacing on plant stand of selected dry bean cultivars (Row spacings within a cultivar with the same letter are not significantly different at P = 0.05).

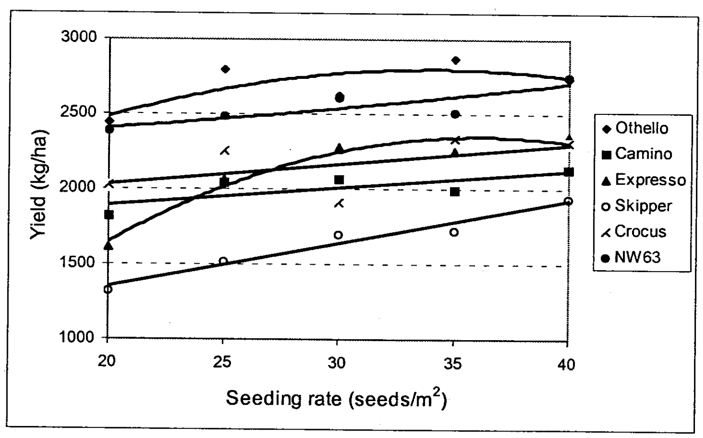


Figure 3. Effect of seeding rate on yield of selected dry bean cultivars.

There was no consistent effect of seeding rate on seed weight of the dry bean cultivars tested (Figure 5). Row spacing effects on seed weight indicated that seed weight was increased for the wide row spacings (60 cm and 80 cm; 24 and 32 in) compared to the narrow row spacing (20 cm; 8 in) for all cultivars tested except CDC Expresso and Skipper (Figure 6). The 80 cm (32 in) row spacing produced the highest seed weight for NW63 small red bean and CDC Crocus Great Northern bean.

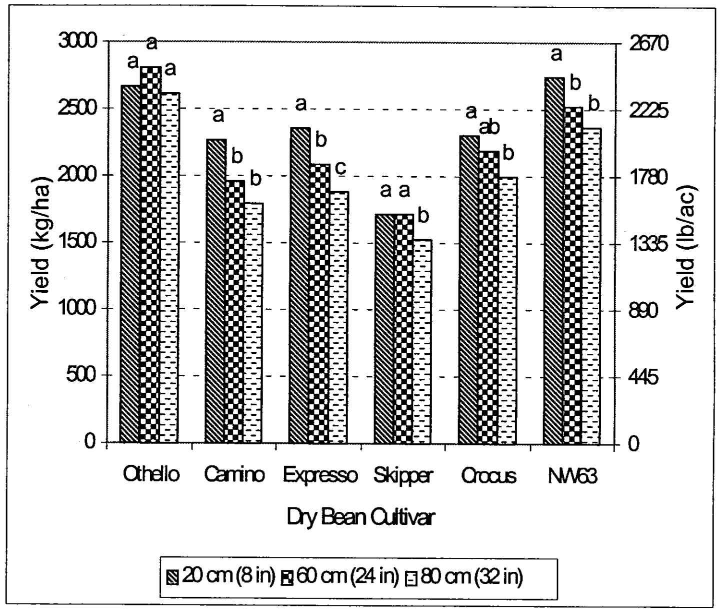


Figure 4. Effect of row spacing on yield of selected dry bean cultivars (Row spacings within a cultivar with the same letter are not significantly different at P = 0.05).

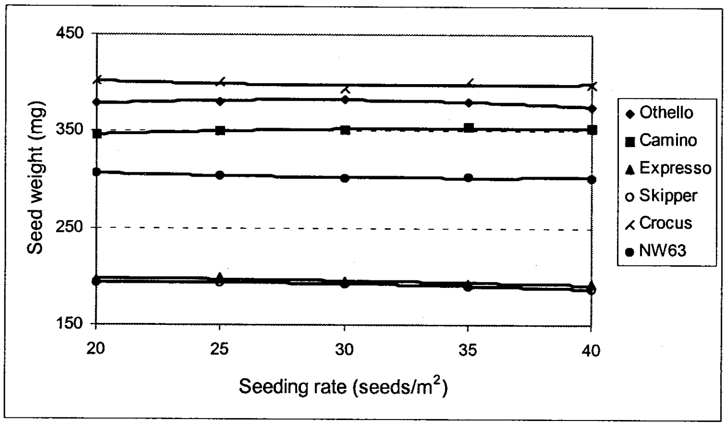


Figure 5. Effect of seeding rate on seed weight of selected dry bean cultivars.

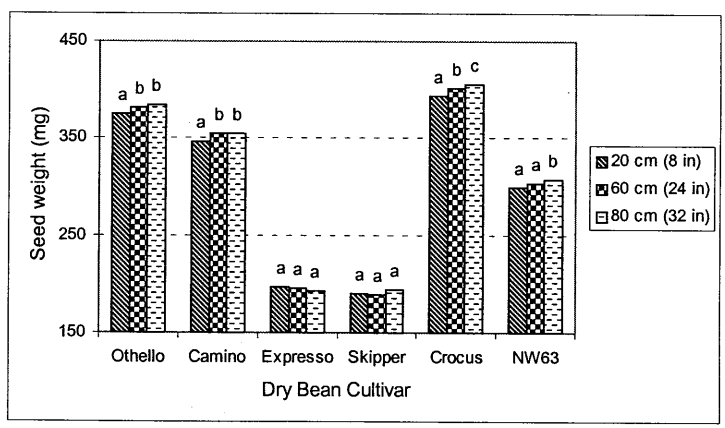


Figure 6. Effect of row spacing on seed weight of selected dry bean cultivars (Row spacings within a cultivar with the same letter are not significantly different at P = 0.05).

Direct Cut Dry Bean Harvest Demonstration

T. Hogg[1], A. MacDonald[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress:** Year one of two*

***Objective:** To demonstrate the Keho Bean Sweep direct cut harvest system for dry bean.*

Direct cutting of solid seeded dry bean using conventional harvest equipment can result in high harvest losses for some dry bean varieties. These high losses are due to pods set low on the bean plant. The development of direct cut combine headers specifically designed for dry bean harvest should help eliminate this problem. The Keho Bean Sweep system is one such commercial direct cut harvest system that offers potential to lower harvest losses with solid seeded dry bean.

A dry bean direct cut demonstration was established in the spring of 2000 at the CSIDC. Treatments included two pinto bean cultivars with differing growth habit (Othello - Type III indeterminate sprawling vine growth habit; CDC Camino - Type I determinate upright tall growth habit) grown under narrow row (20 cm; 8 in) and wide row (60 cm; 24 in) conditions. Each treatment was block seeded in an area that measured 8.5 m x 38 m (30 ft x 125 ft). Normal fertilizer, weed control and irrigation practices for irrigated dry bean production were followed.

At harvest one half of each treatment block was direct cut using a small plot combine modified by the addition of Keho Bean Sweep brushes on the cutter bar, while the other half of each treatment block was direct cut without the brushes. The seed from each treatment was weighed to determine yield.

Harvest losses were measured by weighing the amount of bean seed left on the ground and the amount left in pods in an area 1.2 m x 1.2 m (4 ft x 4 ft) at five locations for each treatment. A width of 1.2 m (4 ft) was chosen since this equals the width of the cutter bar on the small plot combine.

Results indicated that yield was greater where the Keho Bean Sweep brushes were used regardless of plant growth habit. Comparison of harvest losses indicated that highest losses were observed for Othello. Within each cultivar harvest loss was greater for the 20 cm (8 in) row spacing compared to the 60 cm (24 in) row spacing (Figures 7 and 8). As well, shattering losses during the harvest operation were greater than losses due to unharvested pods. The dry bean plants were quite dry at the time of harvest which may have resulted in the high shattering losses observed for this demonstration. Losses due to unharvested pods were generally greater where no brushes were used compared to where brushes were used. Unharvested pod loss was also greater for Othello than for CDC Camino.

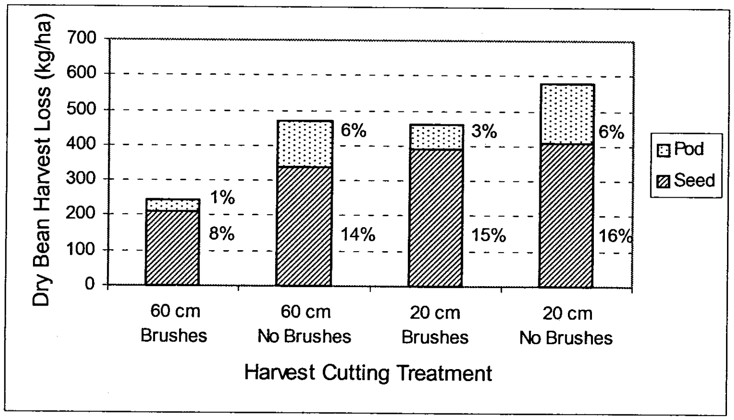


Figure 7. Effect of cutting treatment on irrigated CDC Camino pinto bean harvest losses. (Numbers represent % loss).

[1]*CSIDC, Outlook*

This is probably do to the difference in growth habit for the two cultivars. Othello has a sprawling vine growth habit that results in a large portion of the pods growing low on the plant while CDC Camino has an upright growth habit with the pods higher up on the plant. As a result more pods are lost during the direct cut harvest operation when Othello is grown.

The results from this work would suggest that the Keho Bean Sweep system does improve direct cut harvest ability of dry bean, however, dry bean growth habit is also an important consideration. Further testing of this technology needs to be done using field scale equipment.

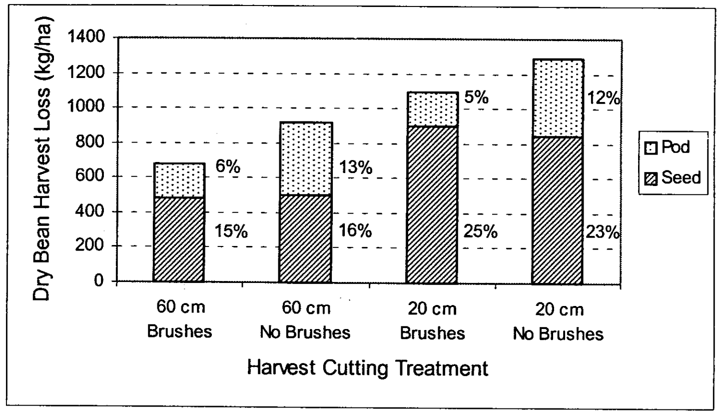


Figure 8. Effect of cutting treatment on irrigated Othello pinto bean harvest losses. (Numbers repıesent % loss).

Response of Irrigated Dry Bean to Zinc Fertilization

T. Hogg[1], A. MacDonald[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress:** Year four of five*

***Objective:** To demonstrate the effect of soil and foliar applied zinc micronutrient fertilizer on irrigated dry bean production.*

Micronutrients are just as essential for optimum growth and yield as the macronutrients although they are required in much smaller quantities. For dry bean the most important micronutrient is zinc. Response may occur under certain conditions, such as zinc application to dry bean on high pH soils, or if early season weather is cool and wet.

A dry bean zinc micronutrient fertilizer response trial was established in the spring of 2000 at the CSIDC. Treatments included granular zinc sulfate broadcast at a rate of 10 kg Zn/ha prior to the seeding operation and liquid zinc EDTA foliar applied at a rate of 0.5 kg Zn/ha at initiation, plus a control. Seven dry bean cultivars representing six market classes (Othello and CDC Camino pinto bean, CDC Expresso black bean, Skipper navy bean, CDC Crocus great northern bean, NW63 small red bean and UI537 pink bean) were row crop seeded at a target plant population of 30 seeds/m^2 using a 60 cm (24 in) row spacing. A factorial arrangement of the zinc micronutrient fertilizer sources and dry bean cultivars in a randomized complete block design with four replicates was used. Normal fertilizer, weed control and irrigation practices for irrigated dry bean production were followed. Each treatment measured 2.4 m x 8 m (8 ft x 24 ft).

Current soil test recommendations indicated the requirement for 20-25 lbs P_2O_5/ac and 3.5-5.0 lbs/ac copper and 5-10 lbs/ac zinc for irrigated dry bean (Table 1).

[1]*CSIDC, Outlook*

Table 1. Spring soil analysis for the irrigated dry bean zinc fertilizer response trial.

Rep	Depth (in)	pH	1:2 E.C. dS/m	NO_3-N	P	K	SO_4-S	Cu	Mn	Zn	B	Fe
				lb/ac								
1	0 - 12	7.6	0.5	46	101	972	56	2.0	45	3.4	4.0	53
	12 - 24	8.1	0.5	88			42					
2	0 - 12	7.8	0.2	40	62	928	36	1.8	44	3.4	3.8	38
	12 - 24	8.1	0.5	78			36					

There was no significant effect of the zinc micronutrient applications on irrigated dry bean yield (Table 2) or on seed weight (Figure 9). Yield and seed weight differences among the selected cultivars were in line with differences observed in variety evaluation trials. Othello pinto bean, CDC Expresso black bean and UI 537 pink bean showed a trend of higher yield for the zinc application treatments compared to the control. A similar trend was observed for CDC Crocus great northern bean and NW63 small red bean seed weight. There was no observed effect on days to 10% flowering or to maturity.

Table 2. Zinc micronutrient application effects on yield of selected dry bean cultivars grown under irrigation.

Cultivar	Seed yield							
	kg/ha				lb/ac			
	Control	Soil	Foliar	Mean	Control	Soil	Foliar	Mean
Othello	2455	2812	2790	2686	2187	2505	2486	2393
CDC Camino	2453	1981	2278	2237	2186	1765	2030	1993
CDC Expresso	1945	2014	2024	1994	1733	1794	1803	1777
Skipper	1915	2017	1954	1962	1706	1797	1741	1748
CDC Crocus	2577	2400	2504	2494	2296	2138	2231	2222
NW63	2712	2387	2822	2640	2416	2127	2514	2352
UI537	2946	3053	3130	3043	2625	2720	2789	2711
Mean	2429	2381	2500		2164	2121	2228	
CV (%)	14.6							
Factorial ANOVA	LSD (0.05)				LSD (0.05)			
Cultivar (C)	291				259			
Treatment (T)	NS[1]				NS			
C x T	NS				NS			

[1]not significant

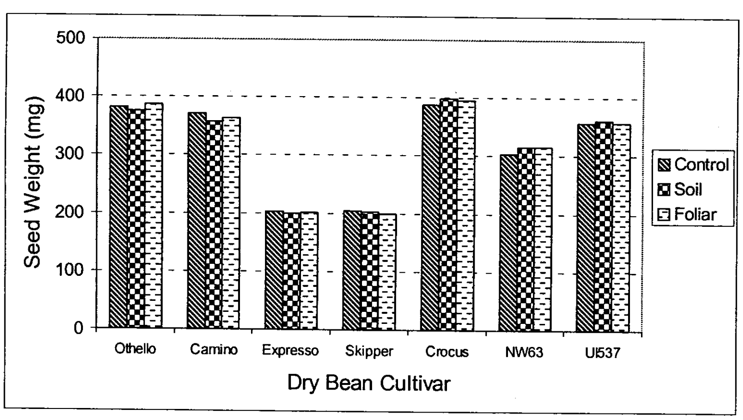


Figure 9. Effect of zinc application on the seed weight of selected dry bean cultivars.

Current soil test guidelines indicated that both zinc and copper were low on this particular site for irrigated dry bean production. Growing season environmental conditions may play as important a role as soil available levels of the micronutrients when deciding when to apply micronutrient fertilizer. Monitoring of soil fertility through an adequate soil testing program is the best way to determine micronutrient fertilizer requirements.

Evaluation of Inoculant Formulations in Irrigated Dry Bean Production

T. Hogg[1], A. MacDonald[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year four of five*

Objective: *To evaluate the efficacy of granular legume inoculants compared to the more traditional peat and liquid formulations.*

The requirement for nitrogen fertilization depends on the level of soil available nitrogen and the ability of the pulse crop to fix nitrogen. Generally, dry bean is considered to fix less nitrogen than other pulses. Inoculants are typically applied as peat based powders or liquid formulations. Recently, manufacturers have begun to develop and formulate *Rhizobium* inoculants as granules which can be applied to the soil in a manner similar to fertilizer application. Implanting the inoculant in the soil may provide more effective infection of the seed and thus better nodulation.

An inoculant evaluation trial was established in the spring of 2000 at the CSIDC. Treatments included liquid, peat and granular based inoculants and an uninoculated control in combination with six dry bean cultivars representing five market classes (Othello and CDC Camino pinto bean, CDC Expresso black bean, CDC Crocus great northern bean, NW63 small red bean and UI 537 pink bean). Liphatec was the inoculant source used in the study. The liquid and peat based inoculants were applied to the seed just prior to seeding. The granular inoculant was seed placed. The dry bean varieties were row crop seeded at a target plant population of 30 seeds/m^2 using a 60 cm (24 in) row spacing. A factorial arrangement of the inoculant formulation and dry bean variety treatments in a randomized complete block design with four replicates was used for the trial. Normal fertilizer, weed control and irrigation practices for irrigated dry bean production were followed. Each treatment measured 2.4 m x 8 m (8 ft x 24 ft).

Table 3. Inoculant formulation effects on yield and of selected irrigated dry bean cultivars.

Dry bean cultivar	Seed yield									
	kg/ha					lb/ac				
	Control	Liquid	Peat	Granular	Mean	Control	Liquid	Peat	Granular	Mean
Othello	2559	2634	2748	2548	2622	2280	2347	2448	2270	2336
CDC Camino	1794	1875	1957	2257	1971	1598	1671	1744	2011	1756
CDC Expresso	1579	1617	1753	1670	1655	1407	1441	1562	1488	1475
CDC Crocus	2522	2057	2487	2278	2336	2247	1833	2216	2030	2081
NW63	2629	2636	2694	2539	2625	2342	2349	2400	2262	2339
UI537	2913	3095	2878	3125	3003	2595	2758	2564	2781	2676
Mean	2333	2319	2420	2403		2079	2066	2156	2141	
CV (%)	9.5									
ANOVA	LSD (0.05)					LSD (0.05)				
Cultivar (C)	159					142				
Inoculant (I)	NS[1]					NS				
C x I	NS					NS				

[1]not significant

[1]*CSIDC, Outlook*

There was no significant effect of inoculant formulation on yield (Table 3) or seed weight (Figure 10) for any of the selected irrigated dry bean cultivars tested. Yield and seed weight differences among the selected cultivars were in line with differences observed in variety evaluation trials. CDC Camino pinto bean and CDC Expresso black bean showed a trend of higher yield for the inoculant treatments compared to the control. A similar trend was observed for CDC Camino pinto bean seed weight. The lack of response to inoculant application could be due in part to the initial level of soil available nitrogen and the high nitrogen mineralization rate of fertile irrigated soils. There was no observed effect on days to 10% flowering or to maturity.

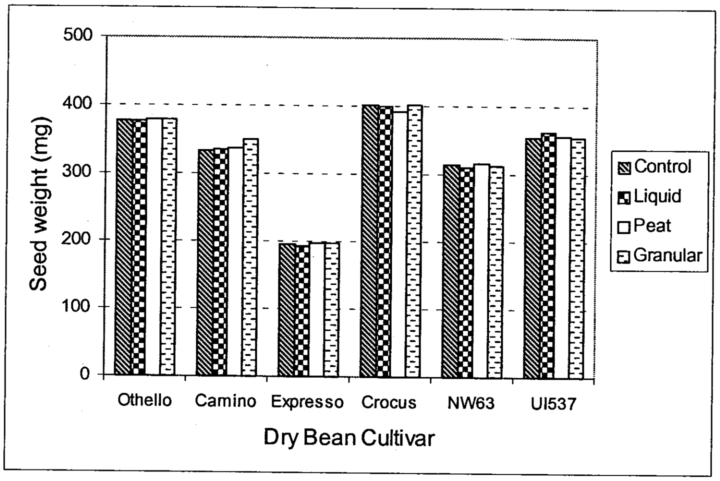


Figure 10. Effect of inoculant formulation on the seed weight of selected dry bean cultivars.

Dry Bean Nitrogen Management

T. Hogg[1], A. MacDonald[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress**: Year one of two*

***Objective:** To determine the merits of using starter nitrogen with granular inoculant in black and pinto bean production.*

Dry bean is generally considered a poor nitrogen fixing species and as such requires the application of starter nitrogen fertilizer in order to produce optimum yield. Large nitrogen applications may reduce the nitrogen fixing capacity. Thus, optimizing dry bean yield requires the proper balance between nitrogen fertilizer applications and nitrogen fixation through inoculation with the appropriate *Rhizobium* inoculant.

A dry bean nitrogen management trial was established in the spring of 2000 at the CSIDC. Treatments included two dry bean cultivars (CDC Expresso black bean and CDC Camino pinto bean) and four starter nitrogen rates (0,25,50 and 75 kg N/ha; 0, 22, 45 and 67 lb N/ac) applied as granular urea (46-0-0) in combination with or without granular inoculant. The nitrogen was sidebanded while the granular inoculant was seedplaced during the seeding operation. The dry bean cultivars were row crop seeded at a target plant population of 30 plants/m^2 using a 60 cm (24 in) row spacing. A factorial arrangement of the dry bean cultivars, starter nitrogen rates and inoculant treatments in a randomized complete block design with four replicates was used. Normal fertilizer, weed control and irrigation practices for irrigated dry bean production were followed. Each treatment measured 2.4 m x 8 m (8 ft x 24 ft).

There was a significant yield response to the applied starter nitrogen (Tables 4 and 5). Yield increased with each 25 kg N/ha (22 lb N/ac) increment of applied starter nitrogen fertilizer. The 50 and 75 kg N/ha (45 and 67 lb N/ac) starter nitrogen treatments increased yield significantly above that of the control treatment but were not significantly different from the 25 kg N/ha (22 lb N/ac) starter nitrogen treatment.

[1]*CSIDC, Outlook*

Table 4. Effect of starter nitrogen rate and inoculant treatment on the yield of irrigated CDC Expresso black bean and CDC Camino pinto bean.

N rate (kg/ha)	Seed yield (kg/ha)						Overall mean
	Expresso			Camino			
	Control	Inoculant	Mean	Control	Inoculant	Mean	
0	2261	1966	2114	2103	2050	2076	2095
25	2322	2217	2269	2126	2184	2155	2212
50	2562	2112	2337	2097	2286	2192	2265
75	2380	2333	2357	2164	2391	2277	2317
Mean	2382	2157		2122	2228		
Overall Mean	2269			2175			
CV (%)	9.0						

ANOVA	LSD (0.05)
Cultivar (C)	NS[1]
N Rate (N)	142
Inoculant (I)	NS
C x N	NS
C x I	143
N x I	NS
C x N x I	NS

[1]not significant

CDC Expresso black and CDC Camino pinto bean would appear to require the application of 25-50 kg N/ha (22-45 lb N/ac) starter fertilizer nitrogen even where significant soil available nitrogen is present. There was no significant yield response to the applied granular inoculant.

There was no significant effect of the starter nitrogen or inoculant treatments on seed weight for either cultivar (Figure 11). This would indicate that yield increases obtained with the starter nitrogen treatments was probably due to an increase in the number of seeds produced rather than to an increase in seed size. Cultivar seed weight differences were consistent with varietal evaluation observations.

Table 5. Effect of starter nitrogen rate and inoculant treatment on the yield of irrigated CDC Expresso black bean and CDC Camino pinto bean.

N rate (lb/ac)	Seed yield (lb/ac)						Overall mean
	Expresso			Camino			
	Control	Inoculant	Mean	Control	Inoculant	Mean	
0	2014	1752	1884	1874	1827	1850	1867
22	2069	1975	2022	1894	1946	1920	1971
45	2283	1882	2082	1868	2037	1953	2018
67	2121	2079	2100	1928	2130	2029	2064
Mean	2122	1922		1891	1985		
Overall Mean	2022			1938			
CV (%)	9.0						

ANOVA	LSD (0.05)
Cultivar (C)	NS[1]
N Rate (N)	127
Inoculant (I)	NS
C x N	NS
C x I	127
N x I	NS
C x N x I	NS

[1]not significant

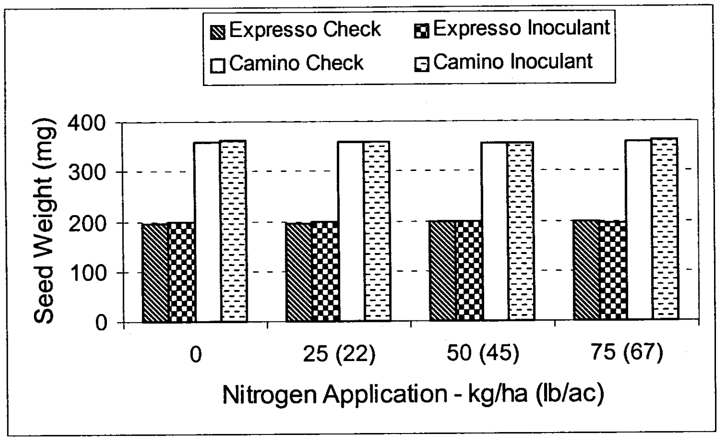


Figure 11. Effect of inoculant and nitrogen application on the seed weight of CDC Expresso black bean and CDC Camino pinto bean grown under irrigated conditions.

Response of Irrigated Dry Bean to Late Nitrogen Application

T. Hogg[1], A. MacDonald[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year one of two*

Objective: *To determine the effect of late nitrogen application on the yield and seed quality of irrigated dry bean.*

Dry bean is generally considered a poor nitrogen fixing species and as such requires the application of some additional nitrogen fertilizer in order to produce optimum yield. Applying all of the additional nitrogen prior to or during the seeding operation may result in a reduction of nitrogen fixing potential. As well, applying all the nitrogen prior to plant emergence may result in excessive vegetative growth resulting in a reduction in seed yield as well as a greater chance of the development of diseases such as white mold (*Sclerotinia*). By delaying the application of the additional nitrogen later in the growth stage a greater proportion of the nitrogen may be utilized in seed production, producing more and/or larger seeds, rather than vegetative growth.

A dry bean late nitrogen fertilizer response trial was established in the spring of 2000 at the CSIDC. Treatments included three late nitrogen application times (early flower, mid-late flower and early pod fill) of 25 kg N/ha applied as granular ammonium nitrate (34-0-0) plus a control. The granular ammonium nitrate late nitrogen applications were applied just prior to an irrigation application that allowed movement of the nitrogen into the soil. Six dry bean cultivars representing five market classes (Othello and CDC Camino pinto bean, CDC Expresso black bean, CDC Crocus great northern bean, NW63 small red bean and UI 537 pink bean) were row crop seeded at a target plant population of 30 seeds/m^2 using a 60 cm (24 in) row spacing. A factorial arrangement of the late nitrogen fertilizer application times and dry bean cultivars in a randomized complete block design with four replicates was used. Normal fertilizer, weed control and irrigation practices for irrigated dry bean production were followed. Each treatment measured 2.4 m x 8 m (8 ft x 24 ft).

[1]*CSIDC, Outlook*

Seed yield for NW 63 small red bean was significantly increased with a late nitrogen application at early pod fill compared to the control treatment (Table 6). There were no yield differences for any of the other cultivar x late nitrogen application time combinations. Seed size, as indicated by seed weight, showed no consistent trend associated with the late nitrogen application (Figure 12).

Table 6. Effect of time of nitrogen fertilizer application on seed yield of selected dry bean cultivars.

Cultivar	Seed Yield (kg/ha)					Seed Yield (lb/ac)				
	Control	Early flower	Mid/late flower	Early pod fill	Mean	Control	Early flower	Mid/late flower	Early pod fill	Mean
Othello	2776	2584	2704	2901	2741	2473	2302	2409	2585	2442
CDC Camino	2298	2242	2643	2440	2406	2048	1998	2355	2174	2144
CDC Expresso	2231	2442	2352	2358	2346	1988	2176	2096	2101	2090
CDC Crocus	2796	2785	2478	2647	2677	2491	2481	2208	2358	2385
NW 63	2564	2645	2820	2935	2741	2285	2357	2513	2615	2442
UI 537	3111	2974	3039	3223	3086	2772	2650	2708	2872	2750
Mean	2629	2612	2673	2751		2342	2327	2382	2451	
CV (%)	7.4									
ANOVA	LSD (0.05)					LSD (0.05)				
Cultivar (C)	140					125				
Time (T)	NS[1]					NS				
C x T	280					249				

[1]not significant

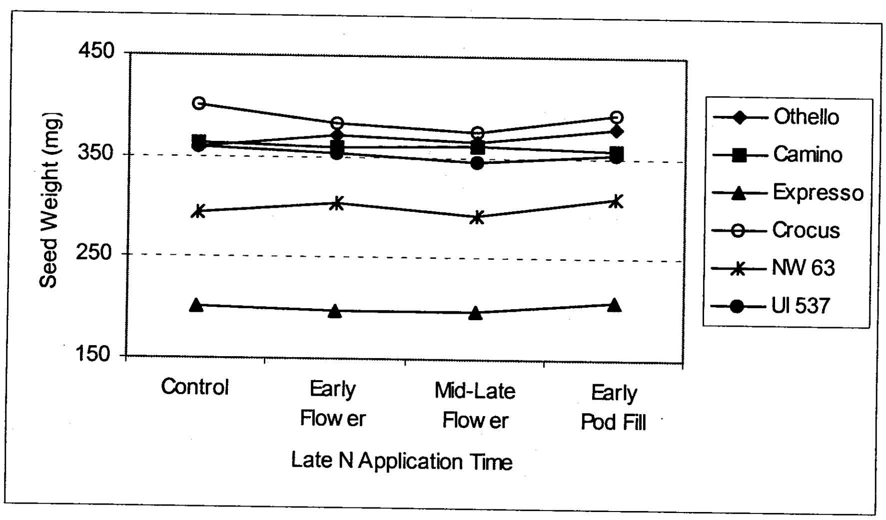


Figure 12. Effect of late nitrogen application on the seed weight of selected irrigated dry bean cultivars.

Control of Common and Halo Bacterial Blight in Dry Bean during Seed Multiplication

T. Hogg[1], A. MacDonald[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year one of two*

Objective: *To evaluate the effect of chemical control on common and halo blight during seed multiplication of dry bean grown under sprinkler irrigation.*

Bacterial blights (common blight, halo blight and brown spot) can be carried in the seed of dry bean. The use of quality pedigree, disease free seed is the best means of control. Wind and water droplets spread bacteria rapidly through a field. Plants grown under dry conditions generally have minimal bacterial infection. Thus, disease free seed is more likely to be produced under semi-arid conditions or in irrigated areas with low humidity. Under sprinkler irrigation conditions, the use of foliar copper bactericide applications in conjunction with seed treatment may help prevent the development and spread of bacterial blight.

A dry bean blight control trial was established in the spring of 2000 at the CSIDC. Treatments included two seed treatments (Vitaflo 280 (carbathiin + thiram) and Vitaflo 280 + Bluestone (Copper Sulfate)) and eight Kocide (50% metallic copper equivalent) post-emerge foliar applications (control, pre-flower (PF), early flower (EF), late flower (LF), PF + EF, PF + LF, PF + EF + LF and EF + LF). CDC Camino pinto bean was row crop seeded at a target plant population of 30 plants/m^2 using a 60 cm (24 in) row spacing. A factorial arrangement of the seed and Kocide foliar application treatments in a randomized complete block design with four replicates was used. Normal fertilizer, weed control and irrigation practices for irrigated dry bean production were followed. Each treatment measured 2.4 m x 8 m (8 ft x 24 ft).

Visual observations during the growing season indicated the presence of bacterial blight on the leaves and pods of the irrigated pinto bean. However, there was no significant effect of seed treatment and/or Kocide foliar application on the yield or seed weight of the CDC Camino pinto bean (Table 7). The halo blight pathogen, *Pseudomonas syringae* pv. *phaseolicola*, was detected in only two treatments, the Vitaflo 280 plus Kocide at early flower (1% incidence) and the Vitaflo 280 plus Kocide at early + late flower (2% incidence). There was no growth of the common blight pathogen, *Xanthomonas campestris* pv. *phaseoli*, observed in any of the treatments.

Even though bacterial blight was present on the foliage and pods the bacteria did not appear to be transferred to the seed. Further work needs to be conducted to determine the conditions required to control bacterial blight during dry bean seed multiplication under sprinkler irrigated conditions.

[1]*CSIDC, Outlook*

Table 7. Effect of seed treatment and Kocide foliar application on the yield and seed weight of irrigated CDC Camino pinto bean.

Time of application	Seed yield						Seed weight (mg)		
	Vitaflo 280		Vitaflo 280 + Bluestone		Mean				
	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	Vitaflo 280	Vitaflo 280 + Bluestone	Mean
Control	2314	2062	2057	1833	2186	1948	351	345	348
Pre-flower (PF)	2472	2203	2441	2175	2456	2188	352	352	352
Early flower (EF)	2326	2072	2349	2093	2337	2082	352	348	350
Late flower (LF)	2306	2055	2333	2079	2320	2067	351	351	351
PF + EF	2389	2129	2676	2384	2533	2257	352	357	355
PF + LF	2356	2099	2374	2115	2365	2107	354	356	355
PF + EF + LF	2447	2180	2504	2231	2476	2206	352	358	355
EF + LF	2360	2103	2262	2015	2311	2059	356	353	355
Mean	2371	2113	2375	2116			353	353	
CV (%)	9.3						2.0		
ANOVA	kg/ha			lb/ac					
Kocide (K)	NS[1]			NS				NS	
Treatment (T)	NS			NS				NS	
K x T	NS			NS				NS	

[1]not significant

Time of Weed Removal in Field Pea

T. Hogg[1], A. MacDonald[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year two of two*

Objective: *To evaluate the effect of time of weed removal in field pea.*

Field pea requires adequate weed removal to maintain optimum yield and quality. Dr. George Clayton and Dr. Neil Harker of the Lacombe Research Centre have shown that significant yield losses may be experienced when weed removal is delayed in field pea. Post-emergent herbicides can be used to decrease weed populations in field pea. Information on timing of applications is required by producers in order to best maximize their returns.

A time of weed removal trial was established in the spring of 2000 at the CSIDC. Treatments included two pea varieties (Swing and Grande) in combination with four time of weed removal post-emergent herbicide applications (check, one, two and three weeks after crop emergence). Timing for emergence was when distinct rows were visible. Odyssey (35% imazamox + 35% imazethapyr) was the post-emerge herbicide used for weed removal. The treatments were arranged in a factorial randomized complete block design with four replicates. Each treatment consisted of two passes with the drill and measured 3 m x 12 m (10 ft x 37 ft).

Pea yield was significantly affected by the delay in post-emergent herbicide application (Table 8). The 1 WAE and 2 WAE herbicide application times had significantly higher yield than the check while only the 2 WAE herbicide application time had a significantly higher yield than the 3 WAE herbicide application.

[1]*CSIDC, Outlook*

Herbicide application for weed removal had a greater effect on Swing pea, a semi-leafless variety, compared with Grande pea, a normal leaf variety. Significant yield loss of irrigated pea resulted with a delay in weed removal, thus, confirming the importance of early weed removal in pea production. Seed weight was also significantly affected by the time of post-emergent herbicide application. Swing pea had a significantly higher seed weight than Grande pea and showed the greatest effect of herbicide application time on seed weight.

Herbicide efficacy, as indicated by the visual ratings at 14 and 28 days after herbicide application, clearly indicates that the early application of the post-emergent herbicide provided more effective weed control (Table 9).

Table 8. Effect of time of weed removal on irrigated pea plant stand, plant height, seed yield, and seed weight.

Treatment	Yield						Seed weight (mg)			Plant height (cm)		
	Grande		Swing		Mean							
	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	Grande	Swing	Mean	Grande	Swing	Mean
Check	3491	3110	2752	2452	3121	2781	205	213	209	110	83	97
1 WAE[1]	3631	3235	5237	4666	4320	3849	203	228	213	98	88	94
2 WAE	4279	3813	5481	4884	4880	4343	205	239	222	100	91	96
3 WAE	3293	2934	4634	4129	3964	3532	203	248	225	96	91	93
Mean	3674	3274	4479	3991			204	232		101	88	
CV (%)	20.2						3.7			6.3		
ANOVA	kg/ha			lb/ac								
Cultivar (C)	606			540			6			4		
Treatment (T)	858			764			8			NS[2]		
C x T	1215			1083			12			9		

[1]Weeks after emergence
[2]not significant

Table 9. Visual rating of treatment effects on weed control for the irrigated pea time of removal trial.

Treatment	Visual Rating[1] 14 DAA[2]			Visual Rating 28 DAA		
	Grande	Swing	Mean	Grande	Swing	Mean
Check	0	0	0	0	0	0
1 WAE[3]	93	90	91	93	87	90
2 WAE	90	90	90	93	92	92
3 WAE	78	55	67	95	70	83
Mean	65	57		70	61	
CV (%)	4.6			9.2		
ANOVA						
Cultivar (C)	**			*		
Treatment (T)	***			***		
C x T	***			NS[4]		

[1]0 = no visual damage; 100 = total plant damage
[2]Days after application
[3]Weeks after emergence
Significance: * (0.05); ** (0.01); *** (0.001) based on $\sqrt{(x+1)}$ transformation
[4]not significant

Foliar Disease Management in Field Pea, Lentil, and Chickpea

T. Hogg[1], A. MacDonald[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress:** Year two of three*

***Objective:** To determine the merits of using a foliar fungicide for controlling diseases in field pea, lentil and chickpea and to aid in the development of a decision support system to assess disease risk and evaluate the need for fungicide application.*

Foliar diseases, such as anthracnose and ascochyta, in pulse crops can cause substantial losses in seed yield and quality. When anthracnose and ascochyta are developing rapidly, timely application of fungicide may reduce losses and increase net income. However, if disease development is limited by unfavourable weather or other factors, fungicide application isn't always cost-effective. The development of a disease risk assessment method is required to assist producers to determine the requirement for fungicide application in pulse crops.

Fungicide application had no significant effect on yield of field pea but did have a significant effect on the yield of lentil and chickpea (Tables 10 - 12). Quadris applied at late flower at a rate of 125 g ai/ha and Bravo Ultrex applied at mid flower at a rate of 1000 g ai/ha produced the highest overall yield and were the only two fungicide treatments that produced a significant yield increase over the control treatment for lentil. Two applications of Quadris (early + late flower) applied at a rate of 125 g ai/ha produced a significantly higher yield than all other treatments for chickpea. As well, single applications of Quadris applied at a rate of 125 g ai/ha at mid and late flower produced significantly higher yield compared to the control treatment. Quadris appears to have a slightly better effect on chickpea yield than Bravo Ultrex.

Seed weight for all three pulse crops showed a general trend of increasing with fungicide application.

Table 10. Effect of fungicide application on seed yield, seed weight, and disease incidence of Alfetta pea.

Treatment						% Aschocyta			
			Yield		Seed weight	July 10 bottom	July 19 bottom	July 19 middle	July 19 top
Fungicide	Time[1]	Rate (g a.i./ha)	kg/ha	lb/ac	(mg)	1/3	1/3	1/3	1/3
Control	---	---	5363	4778	275	1.9	13	1	tr[2]
Bravo Ultrex	mid	1000	4576	4077	281	1.9	14	1	1
Quadris	mid	125	4253	3789	280	2.8	12	1	tr
Dithane	mid	1500	5057	4506	278	2.1	12	2	tr
Bravo Ultrex	late	1000	4320	3849	282	2.1	13	2	tr
Quadris	late	125	4384	3906	285	2.3	14	2	tr
Dithane	late	1500	4682	4172	294	1.8	12	1	tr
LSD (0.05)			NS[3]		12	0.8	NS	NS	NS
CV (%)			19		3	25	21	56	99

[1]mid = mid-flower; late = late flower
[2]trace = less than 0.05%
[3]not significant

[1]*CSIDC, Outlook*

Table 11. Effect of fungicide application on seed yield, seed weight, and disease incidence of CDC Glamis lentil.							
Treatment			Yield			Leaf lesions July 26	Grey mold and Sclerotinia
Fungicide	Time[1]	Rate (g a.i./ha)	kg/ha	lb/ac	Seed weight (mg)	HB scale[2]	
Control	---	---	1798	1602	61	0.6	3.8
Quadris	early	125	1681	1498	59	0.6	4.3
Quadris	mid	125	1832	1632	64	0.7	3.2
Quadris	late	125	2277	2029	64	0.7	2.5
Quadris	early+late	125	2207	1966	64	0.6	2.8
Quadris	early	175	2008	1789	61	0.6	4.3
Quadris	mid	175	1922	1713	62	0.7	4.0
Bravo Ultrex	mid	1000	2240	1996	66	0.5	2.5
Dithane	mid	1688	2039	1817	64	0.8	3.5
LSD (0.05)			410	365	4	0.3	1.1
CV (%)			14		4	32	22

[1]early = early flower; mid = mid-flower; late = late flower
[2]Horsfall-Barratt system: 0 = no infection; 11 = total infection

Disease pressure for all three pulse crops was minimal at early plant growth stages but increased later in the growing season. Diseases present included ascochyta, grey mold and sclerotinia. Fungicide application did not significantly affect disease incidence (% ascochyta) in irrigated Alfetta pea. For CDC Glamis lentil, ascochyta incidence was relatively low on all treatments and thus fungicide application had no significant effect on this disease. However, grey mold and sclerotinia were significantly reduced with the application of Quadris applied at late flower at a rate of 125 g ai/ha and Bravo Ultrex applied at mid flower at a rate of 1000 g ai/ha. These treatments produced a significant yield increase in the irrigated lentil.

Fungicide application decreased disease incidence in the irrigated Myles chickpea. Disease incidence for the chickpea increased during the growing season with ascochyta present at all disease rating times and grey mold and sclerotinia present later in the growing season. Increasing the rate of Quadris from 125 to 175 g ai/ha did not increase efficacy. Dithane was less effective than either Quadris or Bravo.

Table 12. Effect of fungicide application on seed yield, seed weight, and disease incidence of Myles chickpea.								
Treatment			Yield			Aschochyta[2]		Aschochyta, Grey mold and Sclerotinia[2]
Fungicide	Time[1]	Rate (g a.i./ha)	kg/ha	lb/ac	Seed weight (mg)	July 19	July 27	August 11
Control	---	---	838	747	136	2.0	2.5	5.3
Quadris	early	125	1231	1097	156	1.2	1.6	3.3
Quadris	mid	125	1730	1541	171	1.2	2.4	2.8
Quadris	late	125	1582	1410	170	0.9	2.1	2.7
Quadris	early+late	125	2404	2142	183	1.5	1.9	2.5
Quadris	early	175	832	741	149	1.1	1.7	4.0
Quadris	mid	175	1080	962	141	1.7	2.3	4.2
Bravo Ultrex	mid	1000	1050	936	171	1.5	1.8	3.1
Dithane	mid	1688	770	686	140	1.5	2.1	4.8
LSD (0.05)			726	647	33	0.9	1.1	---
CV (%)			33		14	42	37	22

[1]early = early flower; mid = mid-flower; late = late flower
[2]0 = no infection; 11 = total infection

Varietal Investigations

Regional Adaptation of Pulse Crops

T. Hogg[1], A. MacDonald[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year four of four*

Objective: *To demonstrate the relative performance of a variety of pulse crops under irrigated conditions in 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 CSIDC in the spring of 2000. Six dry bean, six pea, two fababean, three lentil, three chickpea and two soybean varieties were used in the demonstration. Separate trials 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. All other pulse crops were solid seeded using a row spacing of 20 cm (8 in).

Dry Bean

CDC Expresso black and CDC Crocus great northern were the first varieties to reach 10% flowering with little difference among the other varieties (Table 13). There was only five days difference in days to maturity among the dry bean varieties with AC Redbond the earliest maturing variety and CDC Camino pinto bean the latest maturing variety. Yield was in the order small red> pink> black> great northern > pinto. Pinto bean yields were low probably due to the presence of sclerotinia. As well, the great northern bean yield was low due to excessive losses during the straight cut harvest operation. Seed size was in the range normally found for the different dry bean market classes and was of the order CDC Crocus great northern > Othello pinto > AC Redbond small red > UI 537 pink, CDC Camino pinto >> CDC Expresso black.

Table 13. Yield and agronomic data for the irrigated dry bean adaptation trial.

Variety	Plant stand (#/m²)	Days to 10% flower	Days to maturity	*Sclerotinia* Extent[1]	*Sclerotinia* Severity[1]	Pod clearance rating (%)	Plant height (cm)	Lodging rating[2]	Seed yield kg/ha	Seed yield lb/ac	Seed wt. (mg)	Water use (cm)
Othello	27	60	101	3	3	77	49	4	2093	1865	379	44
CDC Camino	29	60	102	2	2	83	43	1	2120	1889	345	44
CDC Expresso	30	53	100	2	2	95	42	1	2319	2066	212	44
CDC Crocus	26	56	100	3	3	68	51	4	2217	1975	392	44
AC Redbond	25	60	97	2	2	83	53	1	3214	2864	364	44
UI 537	31	60	98	3	3	78	53	4	2617	2332	346	44
LSD (0.05)	NS[3]					14	8		361	322	17	
CV (%)	8.5					9.7	9.1		8.2		2.8	

[1]0 = no disease; 5 = total disease
[2]0 = upright; 9 = flat
[3]not significant

[1]*CSIDC, Outlook*

Pod clearance rating, an indicator of suitability for direct cut harvesting, varied among dry bean classes as well as between varieties within a class. CDC Expresso black bean had the best pod clearance overall. The lowest pod clearance rating was obtained for CDC Crocus great northern bean. The pod clearance rating for the pink and Othello pinto varieties was intermediate to that of the other varieties. Water use was similar for all varieties.

Pea

Eclipse and CDC Mozart were earlier flowering than the other varieties. GRANDE and CDC Verdi were the latest of the varieties to mature while CDC Handel was the earliest maturing variety (Table 14). Disease, powdery mildew and mycosphaerella, was present on all varieties with GRANDE and CDC Verdi being infected to the greatest extent. MAJORET was the shortest variety while GRANDE was the tallest variety. All varieties showed similar lodging. Yield was greatest for MAJORET and CDC Mozart while CDC Verdi had the lowest yield of all pea varieties. Seed size was of the order MAJORET green pea > Eclipse yellow pea > CDC Mozart and GRANDE yellow pea > CDC Verdi green pea > CDC Handel yellow pea. Water use was similar for all varieties.

Table 14. Yield and agronomic data for the irrigated field pea adaptation trial.

Variety	Plant stand (#/m²)	Days to 10% flower	Days to maturity	Disease rating		Plant height (cm)	Lodging rating[2]	Seed yield		Seed wt. (mg)	Water use (cm)
				Extent[1]	Severity[1]			kg/ha	bu/ac		
GRANDE	75	63	104	4	4	99	6	4087	60.7	185	40
Eclipse	85	58	100	3	3	88	7	4485	66.6	198	40
CDC Handel	73	61	98	3	3	86	8	3972	59.0	148	40
CDC Mozart	76	58	100	3	3	86	7	4818	71.6	189	40
MAJORET	77	63	101	3	3	82	7	5081	75.5	223	40
CDC Verdi	79	63	104	4	4	85	7	3526	52.4	165	40
LSD (0.05)	NS[3]					NS		651	9.7	6	
CV (%)	11.6					6.4		8.2		1.8	

[1]0 = no disease; 5 = total disease
[2]0 = upright; 9 = flat
[3]not significant

Fababean

Aladin flowered seven days earlier than CDC Fatima (Table 15). There was no difference in the two varieties in days to reach maturity or plant height. Chocolate spot disease was present to the same extent on both varieties. Yield was higher for Aladin which also had a larger seed size. Water use was similar between the two varieties.

Table 15. Yield and agronomic data for the irrigated fababean adaptation trial.

Variety	Plant stand (#/m²)	Days to 10% flower	Days to maturity	Disease rating		Plant height (cm)	Lodging rating[2]	Seed yield		Seed wt. (mg)	Water use (cm)
				Extent[1]	Severity[1]			kg/ha	lb/ac		
Aladin	47	58	117	3	3	105	2	4085	3640	562	48
CDC Fatima	47	65	117	3	3	107	2	3562	3174	533	48
LSD (0.05)	NS[3]					NS		NS	NS	NS	
CV (%)	16.3					1.9		5.2		4.2	

[1]0 = no disease; 5 = total disease
[2]0 = upright; 9 = flat
[3]not significant

Lentil

CDC Milestone, an aschochyta resistant small green cotyledon type lentil variety, flowered five days earlier than CDC Glamis and CDC Vantage, aschochyta resistant large green and medium green cotyledon type lentils respectively (Table 16). There was little difference between the varieties for days to maturity or for plant height. Foliar disease was present on all varieties even though Bravo was applied at early flower and again ten days later. Yield was highest for CDC Milestone, with little difference between CDC Glamis and CDC Vantage. Seed size was in the range normally found for small, medium and large green cotyledon type lentils. Water use was similar for all varieties.

Table 16. Yield and agronomic data for the irrigated lentil adaptation trial.

Variety	Plant stand (#/m²)	Days to 10% flower	Days to maturity	Disease rating		Plant height (cm)	Lodging rating[2]	Seed yield		Seed wt. (mg)	Water use (cm)
				Extent[1]	Severity[1]			kg/ha	lb/ac		
CDC Glamis	87	59	99	3	3	42	6	2615	2330	58	31
CDC Vantage	84	59	99	4	4	44	7	2617	2332	46	31
CDC Milestone	90	54	99	4	4	41	5	3356	2990	34	31
LSD (0.05)	NS[3]					NS		486	433	3	
CV (%)	4.3					4.6		7.5		3.3	

[1]0 = no disease; 5 = total disease
[2]0 = upright; 9 = flat
[3]not significant

Chickpea

Myles, a desi type chickpea, flowered five days earlier than Amit (B90) and eight days earlier than Sanford, small and large seeded kabuli type chickpeas respectively (Table 17). Days to maturity was longer for Myles than Sanford possibly due to the greater incidence of foliar disease in the Sanford compared to the Myles. Bravo was applied at early flower and again ten days later for control of foliar disease, however, total control was not achieved. Sanford was taller than Myles. Sanford seed size was smaller than that of Amit but larger than that for Myles. The small seed size for Sanford was possibly due to the effect of foliar disease. Water use was similar for all varieties.

Table 17. Yield and agronomic data for the irrigated chickpea adaptation trial.

Variety	Plant stand (#/m²)	Days to 10% flower	Days to maturity	Disease rating		Plant height (cm)	Lodging rating[2]	Seed yield		Seed wt. (mg)	Water use (cm)
				Extent[1]	Severity[1]			kg/ha	lb/ac		
Sanford	68	62	125	4	5	69	2	710	633	207	35
Myles	64	54	139	2	3	58	2	738	658	144	35
Amit (B90)	62	59	131	3	3	61	3	1648	1468	227	35
LSD (0.05)	NS[3]					2		799	712	33	
CV (%)	10.0					1.3		34.2		7.6	

[1]0 = no disease; 5 = total disease
[2]0 = upright; 9 = flat
[3]not significant

Soybean

Both varieties flowered and reached maturity at the same time (Table 18). Terramax was taller than Pioneer 9007. Yield and seed weight was greater for Pioneer 9007 compared to Terramax. Yield was low for both varieties probably due to the cool growing season. Water use was similar between the two varieties.

Table 18. Yield and agronomic data for the irrigated soybean adaptation trial.

Variety	Plant stand (#/m²)	Days to 10% flower	Days to maturity	Plant height (cm)	Lodging rating[2]	Seed yield		Seed wt. (mg)	Water use (cm)
						kg/ha	lb/ac		
Terramax	89	68	134	89	1	2065	1840	124	42
Pioneer 9007	73	68	134	73	1	2295	2045	138	42
LSD (0.05)	16			16		NS[3]	NS	9	
CV (%)	5.5			5.5		8.1		1.9	

[1]0 = no disease; 5 = total disease
[2]0 = upright; 9 = flat
[3]not significant

Regional Variety Test of Dry Bean

T. Hogg[1], A. MacDonald[1], A. Vandenberg[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Ongoing*

Objective: *To assess the dry bean production of targeted environments within Saskatchewan using current and newly released varieties.*

The potential for development of the dry bean sector 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.

For all bean varieties similar yields were obtained under narrow row and wide row growing conditions (Table 19 and 20). All market classes except navy have relatively high yielding varieties. AC Black Diamond (black), CDC Rosalee (pink) and AC Polaris (great northern) produced the highest yields under narrow row conditions while AC Polaris (great northern) had the highest yield under wide row conditions. Some of the new varieties produced yields similar to the checks within each market class. The pinto variety CDC Pinnacle yielded similar to Othello under both narrow and wide row conditions while CDC Pintium yielded similar to Othello under narrow row conditions but lower under wide row conditions. All pinto varieties out yielded CDC Camino. The great northern variety AC Polaris out

[1]*CSIDC, Outlook*
[2]*Crop Development Centre, U of S, Saskatoon, Saskatchewan*

yielded the checks under both narrow and wide row conditions while the new great northern variety 93407 produced yields similar to the check varieties. The new pink variety CDC Rosalee produced higher yields than the check variety Viva under both narrow and wide row conditions while the new variety 95-34-6PK produced yields similar to the check. The new black variety AC Black Diamond and the new small red variety AC Earlired both appear to be high yielding.

Most bean varieties flowered within a range of 52 - 62 days. The highest yielding varieties generally showed the latest flowering times except for CDC Rosalee. Some of the new varieties flowered earlier than the checks.

Table 19. Irrigated Dry Bean Regional variety trial - narrow row.

Variety	Yield % of Othello	Lodging 0 = erect 9 = flat	Plant height (cm)	Days to flower	Days to maturity[1]	Seed weight (mg)	Pod clearance (%)[2]
Pinto							
Othello (check)	100	7	56	59	111	338	55
CDC Camino (check)	85	2	57	60	111	333	87
CDC Pinnacle	103	4	58	60	111	357	75
CDC Pintium	97	1	46	55	95	336	95
CDC Altiro	86	2	55	58	100	364	88
Great Northern							
CDC Crocus (check)	109	5	53	57	111	364	62
US 1140 (check)	106	7	51	58	115	316	55
CDC Bianca	76	4	51	59	112	372	67
AC Polaris	124	6	55	62	115	303	80
93407	109	7	51	59	112	365	70
Pink							
Viva (check)	98	6	54	59	111	243	68
CDC Rosalee	125	4	54	57	103	256	73
95-34-6PK	94	7	59	62	115	329	68
Black							
CDC Expresso	82	1	48	52	99	180	82
AC Black Diamond	127	2	58	61	109	260	88
Navy							
AC Skipper	62	2	46	61	111	181	82
92661	88	4	60	62	112	165	85
Small Red							
AC Earlired	112	5	53	59	99	301	83
S.E.	---	0.3	0.7	0.4	0.9	9.2	1.7
CV (%)	12.1	23.4	7.2	2.0	2.3	4.2	6.5

Yield of Othello = 3356 kg/ha (2990 lb/ac)
[1]50% of pods are buckskin colored
[2]% pods >5 cm (2 in) above ground surface

The pinto variety CDC Pintium matured up to two weeks earlier than the later maturing varieties. Most varieties required 111-115 days to mature. Generally, the later maturing varieties had higher yield except for CDC Rosalee which matured in 103 days and was one of the higher yielding varieties.

Pod clearance varied among the varieties. The newer pinto varieties had better pod clearance than Othello. The best pod clearance for all varieties tested was CDC Pintium (pinto). The same was found for the Great Northern varieties where the new varieties AC Polaris, CDC Bianca and CDC Crocus had better pod clearance than US 1140. The superior pod clearance rating for AC Polaris may account for its higher yield since all plots were direct cut and those varieties with a low pod clearance rating would have considerable seed loss during the harvest operation. The new pink variety CDC Rosalee had better pod clearance than Viva. The black and navy varieties all had good pod clearance ratings as did the small red variety AC Earlired.

Seed size was larger for some of the new varieties compared to the checks in each market class. The highest seed weight was obtained for the new great northern variety CDC Bianca while AC Polaris had a very low seed weight compared to the other new great northern varieties. The new pinto varieties CDC Pinnacle and CDC Altiro had seed weight higher than Othello. As well, the new pink varieties 95-34-6PK and CDC Rosalee had seed weight higher than Viva. The new black variety AC Black Diamond had a much higher seed weight than CDC Expresso. The black and navy market classes generally had the smallest seed weight. Seed weight was generally higher under wide row conditions than narrow row conditions except for the navy market class.

Plant height was similar for all varieties except for CDC Expresso black and AC Skipper navy varieties which were the shortest. Plant height was generally greater under wide row conditions than under narrow row conditions.

Table 20. Irrigated Dry Bean Regional variety trial - wide row.

Variety	Yield % of Othello	Lodging 0 = erect 9 = flat	Plant height (cm)	Days to flower	Days to maturity[1]	Seed weight (mg)	Pod clearance (%)[2]
Pinto							
Othello (check)	100	8	63	58	109	344	52
CDC Camino (check)	78	3	59	60	111	348	83
CDC Pinnacle	101	5	68	59	108	377	63
CDC Pintium	81	2	51	55	94	345	90
CDC Altiro	88	4	62	55	98	365	72
Great Northern							
CDC Crocus (check)	105	7	65	57	111	374	57
US 1140 (check)	104	7	63	59	114	336	50
CDC Bianca	70	5	53	59	114	375	63
AC Polaris	127	7	65	61	115	325	70
93407	99	8	62	60	112	354	58
Pink							
Viva (check)	89	8	65	59	111	253	68
CDC Rosalee	106	6	61	57	103	273	75
95-34-6PK	85	8	68	58	114	337	63
Black							
CDC Expresso	77	1	54	52	99	185	82
AC Black Diamond	109	2	61	60	111	267	85
Navy							
AC Skipper	48	2	52	60	111	176	80
92661	80	5	68	62	115	166	75
Small Red							
AC Earlired	117	7	59	58	99	324	77
S.E.	—	0.3	0.9	0.3	0.9	9.5	1.7
CV (%)	9.5	16.2	6.1	2.0	2.0	3.6	8.8

Yield of Othello = 3538 kg/ha (3152 lb/ac)
[1]50% of pods are buckskin colored
[2]% pods >5 cm (2 in) above ground surface

Irrigated Prairie Regional Dry Bean Wide-Row Co-operative Test

T. Hogg[1], A. MacDonald[1], H. Mundel[2], J. Braun[2]

Progress: *Ongoing*

Location: *Outlook*

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 under irrigated row crop conditions. The germplasm sources include advanced lines from the 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 CSIDC. Standard fertilizer, weed control and irrigation practices for irrigated dry bean production were followed. The test consisted of 16 entries in a 4 x 4 lattice design and included four bean types (pinto, small red, great northern and black). Seven test entries were in the first year of co-op testing (Pinto - L98B335, L98B336, L98B351; Small Red - L98D292, L98D347; Great Northern - L98E207, L98E209). The rest were either second or third year entries. Individual plots consisted of two rows with 60 cm (24 in) row spacing and measured 1.2 m x 3.7 m (4 ft x 12 ft). All rows of a plot were harvested to determine yield.

In the pinto group, the third year CDC line 95-82-13-PT yielded slightly higher than Othello with similar maturity and larger seed size (Table 21). The first year entries all tended to yield higher at comparable maturities to Othello. The small red entries all yielded higher than the check, NW63, with the first year entries maturing 5-8 days earlier. The first year entry L98D292 was three days earlier maturing than AC Earlired. In the blacks, AC Black Diamond, registered in 2000, was slightly earlier maturing and higher yielding than both other lines. Among the great northerns, all entries produced higher yield, reduced lodging and earlier maturity than the check, US1140. Two first year entries, L96E207 and L96E209, had improved seed weights and earlier maturity than the check.

Table 21. Yield and agronomic data for the irrigated dry bean wide-row co-operative test.

Variety	Yield % of Othello	Lodging 1 = erect 5 = flat	Vine length (cm)	Days to 50% flower[1]	Days to maturity[2]	Seed weight (mg)
Pinto						
Othello (check)	100	4.0	49	59	111	364
L98B335	107	3.7	51	59	112	354
L98B336	104	3.8	54	59	110	355
L98B351	113	4.0	54	59	111	372
95-82-13-PT	106	3.5	57	59	112	435
Small Red						
NW63 (check)	91	3.7	49	59	115	398
AC Earlired	112	4.0	49	59	101	326
L98D292	108	2.8	49	58	97	379
L98D347	123	3.8	52	58	110	347
Black						
UI 906 (check)	82	0.9	60	61	111	150
AC Black Diamond	90	1.5	55	58	110	268
316-12	83	1.5	58	60	112	187
Great Northern						
US1140 (check)	89	4.0	49	59	115	341
L96E108	111	3.5	57	61	114	319
L96E207	91	2.8	50	59	109	379
L96E209	98	2.7	50	56	106	370
CV (%)	9.6	14.8	7.5	2.5	1.8	3.1

[1]50% of plants/plot have open flowers
[2]50% of pods are buckskin colored

[1]*CSIDC, Outlook*
[2]*Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge*

Irrigated Prairie Regional Pea Co-operative Test A, Test B, and Test C

T. Warkentin[1], D. Bing[2], A. Sloan[2], T. Hogg[3], A. MacDonald[3]

Progress: *Ongoing*

Location: *Outlook*

Objective: *To evaluate new pea germplasm for irrigated cropping conditions in western Canada.*

This project evaluates pea germplasm for growing conditions in western Canada. The germplasm sources included advanced lines from the Agriculture and Agri-Food Canada Morden Research Centre, the Crop Development Centre, University of Saskatchewan and private seed companies. Entries were divided into three tests (A, B, C) with 30 candidate entries in Test A, 23 entries in Test B and 11 entries in Test C. Test A had six checks, Test B had seven checks and Test C had five checks. First year check cultivars were: Carrera, CDC Mozart, Eclipse and Nitouche; second year check cultivars were: Carrera, Carneval, CDC Mozart and Keoma. Relatively late maturing entries were placed in Test A.

An irrigated site was conducted at the CSIDC. Standard fertilizer, weed control and irrigation practices for irrigated pea production were followed. Test A and C were arranged in a lattice design with three replicates. Test B was 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.

In Test A, only four new yellow entries and two new green entries had yields lower than Carneval (Table 22). In the yellow entries only Ceb1484 had yield as high as the check variety Carrera. For the green entries only MP1802 yielded lower than Keoma while CDC0001 was the only entry that yielded higher than the check variety Nitouche. Most new entries had maturity equal to or slightly less than Carneval. Yellow entries CDC004 and CDC009 had slighlty superior lodging tolerance compared to Carneval while most other yellow entries lodged to a greater extent than Carneval. All green entries had relatively poor lodging tolerance compared to Carneval but better lodging tolerance than the green check variety Keoma. The two orange entries had very high yield but poor lodging tolerance.

In Test B, all yellow entries yielded higher than Carneval and only two green entries yielded lower than Carneval (Table 23). Yellow entry SW975504 and green entries Catania and SW95610 had the highest overall yields. Maturity was equal to or slightly less than for Carneval. Three yellow entries (A7026.2, SW975504 and CDC9907) and one green entry (AP9540-29) had slightly better lodging tolerance than Carneval. The high yielding green entry, SW95610, had very high seed weight compared to the check varieties.

In Test C, only two entries had yield lower than Carneval (Table 24). The only green entry was higher yielding than Carneval. Most entries had maturity equal to or slightly less than Carneval. Most entries had lower lodging tolerance than Carneval. One yellow entry (DS49379) had high seed yield compared to the checks.

[1]*Crop Development Centre, U of S, Saskatoon, Saskatchewan*
[2]*Agriculture and Agri-Food Canada, Morden Research Centre, Morden, Manitoba*
[3]*CSIDC, Outlook*

Table 22. Yield and agronomic data for the irrigated Pea Co-operative Test A.

Variety	Yield % of Carneval	Lodging 0 = erect 9 = flat	Vine length (cm)	Days to 10% flower[1]	Days to maturity[2]	Seed weight (mg)
Yellow						
Carrera	135	5.6	79	58	96	221
Eclipse	118	5.0	92	59	101	228
CDC Mozart	120	5.2	81	59	100	194
Carneval	100	4.6	89	63	101	162
MP 1804	94	4.6	75	61	99	185
MP 1807	119	5.3	92	60	100	173
MP 1808	80	4.8	81	66	102	148
MP 1810	92	5.3	81	62	98	177
Ceb 1489	121	6.0	79	59	97	218
Ceb 1484	133	6.0	88	59	97	231
F12-31	94	5.4	79	64	99	178
F12-7	108	4.6	83	61	101	178
F13-32	118	4.7	89	61	101	197
SW94594	119	5.8	87	61	96	185
SW965210	116	5.6	88	57	95	223
CDC0004	114	4.2	85	63	101	194
CDC0005	118	5.2	80	64	101	194
CDC0006	125	4.6	92	63	101	196
CDC0009	118	4.3	85	65	101	194
CDC0010	126	4.6	92	59	101	195
Alberta	120	5.6	80	58	96	260
Green						
Nitouche	127	5.3	84	60	100	242
Keoma	92	6.4	81	60	97	168
MP 1802	79	5.4	81	64	103	219
MP 1809	112	4.9	85	61	101	219
Ceb1171	115	5.7	80	61	101	222
Ceb1158	119	6.2	71	59	95	240
Ceb1166	126	5.9	93	62	98	228
SW96641	113	6.4	88	57	98	221
CDC0001	133	5.1	81	63	100	221
CDC0002	117	6.0	87	62	101	184
CDC0003	116	6.0	81	59	99	130
CDC0011	123	5.0	80	62	100	234
RAH897	117	5.3	87	58	97	227
Orange						
Ceb 1486	133	5.9	84	57	97	206
Ceb 1487	140	6.1	83	57	98	216

Carneval yield = 4013 kg/ha (59.6 bu/ac)
[1]10% of plants/plot have open flowers
[2]75% of plants/plot are yellow and dry

Table 23. Yield and agronomic data for the irrigated Pea Co-operative Test B.

Variety	Yield % of Carneval	Lodging 0 = erect 9 = flat	Vine length (cm)	Days to 10% flower[1]	Days to maturity[2]	Seed weight (mg)
Yellow						
Carrera	138	6.0	76	57	98	217
Eclipse	126	5.0	91	60	101	203
CDC Mozart	114	6.3	85	61	101	181
Carneval	100	5.3	93	63	101	148
Ceb4103	148	6.7	83	57	95	195
Ceb4105	119	6.3	83	59	97	216
Ceb4106	127	6.7	86	61	98	198
A7026.2	113	4.3	85	58	101	243
Sponsor	124	7.0	92	61	98	225
SB2000-1	126	6.0	87	58	99	189
SB2000-2	126	5.0	90	60	100	201
SB2000-3	106	6.0	95	63	101	167
SW975504	155	4.3	90	58	98	209
UNMA1372	115	6.7	92	59	100	209
CDC9906	107	5.0	83	63	101	173
CDC9907	106	4.7	82	63	100	166
CDC0007	116	5.3	97	64	101	181
CDC0008	103	5.3	83	61	99	141
Green						
Nitouche	131	5.7	97	60	101	235
Keoma	117	7.7	77	59	95	167
AP9540-29	38	4.3	77	62	98	172
AP9540-43	124	5.7	91	57	99	198
AP9553.24	97	5.3	80	58	99	120
Catania	157	6.0	91	58	98	216
NZ4L08	134	6.3	82	59	97	167
Ceb1074	123	6.3	81	62	100	220
Ceb1075	140	5.7	80	60	98	224
SW95610	160	5.7	86	57	98	268
CDC9908	68	5.7	78	64	103	140

Carneval yield = 3329 kg/ha (49.4 bu/ac)
[1]10% of plants/plot have open flowers
[2]75% of plants/plot are yellow and dry

Table 24. Yield and agronomic data for the irrigated Pea Co-operative Test C.

Variety	Yield % of Carneval	Lodging 0 = erect 9 = flat	Vine length (cm)	Days to 10% flower[1]	Days to maturity[2]	Seed weight (mg)
Yellow						
Carrera	113	5.7	82	57	98	219
Eclipse	102	5.3	91	61	101	204
CDC Mozart	97	5.7	87	61	99	192
Carneval	100	5.0	96	64	100	165
Ceb4104	115	6.7	83	57	96	205
SW955142	135	4.7	93	61	98	196
SW975514	106	6.3	89	57	96	192
ADV3154.78	94	6.0	82	63	101	212
SWS98-110-7	107	5.7	85	56	97	278
SGL-14	114	5.7	92	62	98	220
DS49360	124	5.7	96	61	98	192
DS49379	106	4.7	77	57	98	246
4-0743.114	117	6.3	92	57	97	197
4-0831.076	93	5.3	89	63	101	197
Green						
Keoma	99	7.3	75	60	95	173
ADV203.13	108	4.7	87	62	98	217

Carneval yield = 4138 kg/ha (61.5 bu/ac)
[1]10% of plants/plot have open flowers
[2]75% of plants/plot are yellow and dry

Irrigated Field Pea Variety Trial

C. Ringdal[1], I. Bristow[2]

Funded by the Irrigated Crop Diversification Corporation

Progress: *Ongoing*

Objective: *To evaluate the agronomic performance of current and newly released pea varieties under irrigation.*

Pea Regional variety trials were conducted at four locations in the Outlook irrigation area. Each site and soil type are as follows:
CSIDC: Bradwell very fine sandy loam
CSIDC off-station: Asquith sandy loam
H. Jeske: Tuxford clay loam
R. Pederson: Elstow loam

The trials were seeded from May 8 to May 19. Plots measured 1.5 m x 4 m (5 ft x 13 ft). Phosphorus fertilizer was sideband applied during the seeding operation according to soil test recommendations. Yields were estimated by harvesting the entire plot.

[1]*CSIDC, Outlook*
[2]*Irrigation Crop Diversification Corporation*

Irrigated pea yield, height and lodge rating varied among the four sites (Table 25). Most of the newer varieties produced higher yield than Radley. The green varieties M98 and MAJORET and the yellow variety Alfetta produced high yields with highest overall yield obtained for the green variety M98 averaged over the four sites. Two yellow varieties (CDC Handel and DS Stalwarth) and both the Marrowfat (Courier) and Maple (MF10) varieties had yield lower than Radley.

The results from these trials are used to update the irrigation variety trial database at CSIDC and provide recommendations to irrigators on the best pea varieties suited to irrigated condtions.

Table 25. Yield and agronomic data for the irrigated field pea variety test.

	Jeske site			Pederson site			Off-station site			CSIDC			Mean yield		
Variety	Yield (kg/ha)	Height (cm)	Lodging[1] rating	Yield (kg/ha)	Height (cm)	Lodging rating	Yield (kg/ha)	Height (cm)	Lodging rating	Yield (kg/ha)	Height (cm)	Lodging rating	kg/ha	bu/ac	% of Radley
Green															
Radley	3581	73	9	2618	58	8	4735	68	9	3634	79	9	3642	54	100
MAJORET	4278	77	7	4180	74	3	5107	78	7	4469	73	4	4509	67	124
Nitouche	3958	75	7	3493	72	4	4874	76	7	4403	78	5	4182	62	115
SW PARADE	3862	65	8	3880	65	7	4545	78	7	3943	78	7	4058	60	111
M98	4628	64	8	4440	62	3	5478	71	7	5209	84	4	4939	73	136
Yellow															
AC Melfort	2893	58	9	3879	58	7	4671	66	9	3991	87	9	3859	57	106
Alfetta	4002	66	8	3911	64	4	5911	76	8	5283	79	7	4777	71	131
CDC Mozart	3611	71	9	4030	63	7	5195	76	9	4115	79	8	4238	63	116
CDC Handel	3148	70	9	3027	64	7	3924	79	9	2865	81	9	3241	48	89
DS Stalwarth	3257	78	7	3015	78	4	4088	78	7	3266	75	4	3407	51	94
Eclipse	3319	72	7	3706	63	4	4951	82	6	4376	74	3	4088	61	112
SW93550	3533	71	7	3816	69	2	4763	80	7	3775	84	4	3972	59	109
Marrowfat															
Courier	2731	71	7	3538	63	8	4376	74	6	2983	81	6	3407	51	94
Maple															
MF10	3013	72	8	2604	67	9	3794	75	8	3265	75	7	3169	47	87
CV (%)	7.5	6	6.9	6.4	5.4	17.1	7.8	7.0	9.6	10.1	8.5	18.6	—	—	—

[1]0 = erect; 9 = flat

Weed Control in Special Crops

C. Ringdal[1], T. Hogg[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress:** Year four of five*

***Objective:** To develop data in support of minor use registration of herbicides for weed control in selected specialty crops.*

CSIDC in Outlook was one of eight sites where minor use registration data for special crops was collected in 2000. Data from all sites will be summarized for submission for minor use registration.

Successful production of special crops depends on good weed control. One important means of weed control is the use of herbicides. However, for many special crops there are few if any herbicides available. CSIDC in Outlook is collecting data for minor use registration.

The seeding and herbicide application information is included with each trial. All trials are four replicate randomized complete blocks grown under irrigated conditions. All crops received 50 kg/ha 11-52-0 and all non-legume crops received 100 kg/ha 46-0-0. Rating data was collected three times for each test using a 0-100 visual rating scale (Table 1). Analysis of variance was used to determine differences between treatment means.

Table 1. Visual rating scale.

Phytotoxicity range	Assessment of injury
0 - 9%	Slight discoloration and/or stunting
10%	Just acceptable
11 - 30%	Not acceptable
> 30%	Severe

Chickpea Pre-Emerge

Desi

The desi chickpea was marginally tolerant to the pre-emergent Spartan and the two lower rates of Odyssey and glyphosate (Table 2). As time progressed the desi chickpea seemed to show some recovery from all treatments except for the pre-plant incorporated Spartan. By the third visual rating the high rate treatment of Odyssey and glyphosate had not yet recovered and still showed poor tolerance. The pre-plant incorporated Spartan treatments were unacceptable as they significantly reduced the plant stand and produced smaller plants with smaller leaves. No yield data is available due to a late maturing crop and disease (yields were less than 50 g/plot).

Seeding date:	May 23
Seeding rate:	40 plants/m^2
Row spacing:	25 cm
Rows per plot:	6
Length of rows:	4 m
Application volume:	100 L/ha

Date of herbicide application:
PPI - May 12
Pre-emergent - May 31

[1]*CSIDC, Outlook*

Kabuli

The kabuli chickpea responded differently than the desi chickpea. Tolerance was good to the pre-emergent Spartan treatments (Table 2). At the time of the first visual rating tolerance was very poor to the pre-plant incorporated Spartan but recovered to an acceptable level by the third visual rating. The two high rates of Odyssey and glyphosate reduced the plant stand and produced smaller plants at the early rating periods. As the season progressed the kabuli chickpea appeared to fill in such that visual differences were not as apparent and tolerance was marginally acceptable for the two high rates. The yields were very low due to late maturity and disease (yields were less than 50 g/plot).

Table 2. Chickpea crop tolerance to pre-emergent herbicide application.

Treatment	Rate kg/ha ai	Desi			Kabuli		
		Tolerance Rating[1] (0%=no damage; >30%=severe damage)			Tolerance Rating (0%=no damage; >30%=severe damage)*		
		10 DAA[2]	23 DAA	37 DAA	10 DAA	23 DAA	37 DAA
Untreated		0 a	0 a	0 a	0 a	0 a	0 a
Odyssey Glyphosate	0.015 0.450	4 a	3 ab	3 ab	4 ab	2 a	0 a
Odyssey Glyphosate	0.030 0.450	5 ab	1 ab	1 ab	16 c	12 b	7 bc
Odyssey Glyphosate	0.060 0.450	14 bc	10 bc	7 bc	21 c	19 b	8 c
Spartan PPI	0.280	24 c	25 c	32 c	16 c	11 b	1 ab
Spartan PPI	0.560	27 c	25 c	30 c	12 bc	16 b	6 bc
Spartan Pre-E	0.140	2 a	3 ab	3 ab	1 a	1 a	1 ab
Spartan Pre-E	0.280	3 ab	5 ab	2 ab	1 a	1 a	0 a

Means within a column followed by the same letter are not significantly different at $P<0.05$ (ANOVA performed using $\sqrt{(x+0.5)}$ transformation).
[1]0 = no damage; >30 = severe damage
[2]Days after application

Chickpea Desiccant

The test was abandoned due to an extremely poor mature seed count that decreased the value of the data. The poor seed count was due to disease and a late maturing crop. Prior to abandoning the test, ten plants were picked from each plot then the seeds were separated into green, yellow and brown classes. The number of each seed type was recorded and moisture content determined on a combined seed sample for each herbicide treatment (Table 3).

Seeding date:	May 23
Seeding rate:	40 plants/m^2
Row spacing:	25 cm
Rows per plot:	6
Length of rows:	4 m
Application volume:	100 L/ha
Date of herbicide application:	September 25

Table 3. Kabuli chickpea response to Reglone application.									
		1 DAA[1]				3 DAA			
Treatment	Rate kg/ha a.i.	Green seeds	Yellow seeds	Brown seeds	% H_2O	Green seeds	Yellow seeds	Brown seeds	% H_2O
Untreated		5	4	1	35	1	4	2	34
Reglone	0.40	3	2	2	28	3	4	3	32
Reglone	0.80	5	5	3	35	1	1	2	23

[1]Days after application

Dry Bean

Pinto (Table 4), Black (Table 5) and Great Northern (Table 6) dry bean showed excellent visual tolerance to the Fomsafen and Basagran treatments. Variable soil conditions reduced emergence and plant stand which affected the yield data. Visual ratings taken from the existing plants with lower plant stands from one plot to another were not considered in the ratings. In the Pinto bean test, the Basagran treatment was significantly lower than the untreated check. This was likely a result of the variable soil conditions and not a treatment effect. There were no other significant treatment differences.

Seeding date:	June 23
Seeding rate:	35 seeds/m^2
Row spacing:	25 cm
Rows per plot:	6 rows
Application volume:	100 L/ha

Date of herbicide applications:
Pink, Red and Navy Beans - June 27
Pinto, Great Northern and Black - June 28

Table 4. Crop tolerance ratings and seed yield for post emergent herbicides: Pinto bean.						
		Visual Tolerance Rating[1]			Seed yield	
Treatment	Rate kg/ha a.i.	9 DAA[2]	22 DAA	36 DAA	kg/ha	lb/ac
Untreated		0	0	0	1029	917
Fomsafen Agral 90	0.250	0	0	0	908	808
Fomsafen Agral 90	0.500	0	0	0	1032	918
Fomsafen Basagran Assist	0.140 0.840	0	0	0	944	840
Basagran Assist	0.840	0	0	0	686	611
Fomsafen Agral 90	0.140	0	0	0	976	869
LSD (0.05)					275	245

[1]0 = no damage; >30 = severe damage
[2]Days after application

Table 5. Crop tolerance ratings and seed yield for post emergent herbicides: Black bean.

Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1]			Seed yield	
		9 DAA[2]	22 DAA	36 DAA	kg/ha	lb/ac
Untreated		0	0	0	668	595
Fomsafen Agral 90	0.250	0	0	0	857	763
Fomsafen Agral 90	0.500	0	0	0	983	875
Fomsafen Basagran Assist	0.140 0.840	0	0	0	761	677
Basagran Assist	0.840	0	0	0	744	662
Fomsafen Agral 90	0.140	0	0	0	747	665
LSD (0.05)					NS[3]	

[1]0 = no damage; >30 = severe damage
[2]Days after application
[3]not significant

Table 6. Crop tolerance ratings and seed yield for post emergent herbicides: Great Northern bean.

Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1]			Seed yield	
		9 DAA[2]	22 DAA	36 DAA	kg/ha	lb/ac
Untreated		0	0	0	932	829
Fomsafen Agral 90	0.250	0	0	0	829	738
Fomsafen Agral 90	0.500	0	0	0	1156	1029
Fomsafen Basagran Assist	0.140 0.840	0	0	0	1249	1112
Basagran Assist	0.840	0	0	0	1122	999
Fomsafen Agral 90	0.140	0	0	0	1025	912
LSD (0.05)					NS[3]	

[1]0 = no damage; >30 = severe damage
[2]Days after application
[3]not significant

The Navy bean (Table 7) showed good tolerance to all treatments. Variable soil conditions caused some plots to have poor emergence and a very low plant stand. Visual ratings considered the existing plants and did not take into account the low plant stand. No yield data is available as the test was abandoned following the third tolerance rating as a result of the low plant stand.

Table 7. Crop tolerance ratings for post emergent herbicides: Navy bean.

Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1]		
		10 DAA[2]	23 DAA	37 DAA
Untreated		0	0	0
Select Amigo	0.046	0	0	0
Select Amigo	0.092	0	0	0
Fomsafen Agral 90	0.250	0	0	0
Fomsafen Agral 90	0.500	0	0	0
Fomsafen Basagran Assist	0.140 0.840	0	0	0
Basagran Assist	0.840	0	0	0
Fomsafen Agral 90	0.140	0	0	0

[1]0 = no damage; >30 = severe damage
[2]Days after application

Table 8. Crop tolerance ratings and seed yield for post emergent herbicides: Red Bean.

Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1]			Seed yield	
		10 DAA[2]	23 DAA	37 DAA	kg/ha	lb/ac
Untreated		0	0	0	736	655
Select Amigo	0.046	0	0	0	625	556
Select Amigo	0.092	0	0	0	697	620
LSD (0.05)					NS[3]	

[1]0 = no damage; >30 = severe damage
[2]Days after application
[3]not significant

The Red (Table 8) and Pink (Table 9) beans showed excellent visual tolerance to the Select treatments from the first rating to maturity. Soil variability reduced the value of the yield data.

Table 9. Crop tolerance ratings and seed yield for post emergent herbicides: Pink Bean.

Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1]			Seed yield	
		10 DAA[2]	23 DAA	37 DAA	kg/ha	lb/ac
Untreated		0	0	0	290	178
Select Amigo	0.046	0	0	0	325	289
Select Amigo	0.092	0	0	0	387	344
LSD (0.05)					NS[3]	

[1]0 = no damage; >30 = severe damage
[2]Days after application
[3]not significant

Fenugreek

Seeding date: May 25
Seeding rate: 17 kg/ha
Row spacing: 25 cm
Rows per plot: 6
Length of rows: 4 m
Application volume: 100 L/ha
Date of herbicide application: June 29

Tolerance was excellent to the Odyssey and the Poast Ultra by the third rating period (Table 10). The Poast Ultra had stunted the Fenugreek briefly, but the crop was able to recover. Tolerance was also acceptable to the Basagran although maturity was slightly delayed. The Poast Ultra + Merge treatment was unacceptable. It killed many of the plants and severely stunted them. By the middle of August the plots that had 70-90% damage had filled in. There was no longer a visual difference. Yields would have been very useful in determining how well these plots rebounded. The plants never dried down due to late maturity. Thrashing the pods was impossible even after freeze up, therefore yields were not collected.

Table 10. Crop tolerance ratings for post emergent herbicides: Fenugreek.

Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1] 8 DAA[2]	21 DAA	35 DAA
Untreated		0 a	0 a	0 a
Odyssey	0.015	2 ab	1 a	1 a
Odyssey	0.030	1 ab	0 a	0 a
Poast Ultra	0.200	3 b	2 a	0 a
Poast Ultra	0.400	2 ab	1 a	0 a
Basagran	0.840	3 ab	1 a	3 a
Basagran	1.260	3 ab	2 a	1 a
Poast Ultra Merge	0.200	69 c	80 b	80 b
Poast Ultra Merge	0.400	81 c	81 b	71 b

Means within a column followed by the same letter are not significantly different at P<0.05.
[1]0 = no damage; >30 = severe damage
[2]Days after application

Coriander

Seeding date: May 25
Seeding rate: 15 kg/ha
Row spacing: 25 cm
Rows per plot: 6
Length of rows: 4 m
Application volume: 100 L/ha
Date of herbicide application: June 30

Tolerance was acceptable in the coriander to all treatments although slight damage was reported with a few treatments (Table 11). Visual tolerance ratings were taken at three times and showed that Pardner by itself was harder on the crop than Pardner and Select together. The high rate of Poast Ultra and Linuron together as well as Select and Linuron together also caused slight stunting. By 40 days after application there were no longer any visual differences between treatments. Maturity was even and seed set was uniform across the test. Soil variability which led to poor and inconsistent emergence decreased the value of the yield data. The visual tolerance ratings were observed on the existing plants and not the plant stand itself.

Table 11. Crop tolerance ratings for post emergent herbicides: Coriander.						
Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1]			Seed yield	
		7 DAA[2]	20 DAA	34 DAA	kg/ha	lb/ac
Untreated		0 a	0 a	0 a	1063	946
Select Amigo	0.046	1 ab	1 ab	1 ab	985	877
Linuron	0.800	0 a	0 a	0 a	1578	1404
Select Linuron Amigo	0.046 0.800	0 a	4 c	1 ab	1278	1137
Select Linuron Amigo	0.092 1.600	1 ab	2 abc	1 abc	1313	1169
Pardner	0.140	0 a	2 abc	1 abc	1038	924
Pardner	0.280	1 ab	4 bc	4 c	1219	1085
Poast Ultra Linuron Merge	0.200 0.800	0 a	1 abc	0 ab	1334	1187
Poast Ultra Linuron Merge	0.400 1.600	2 b	2 abc	3 bc	1348	1200
Select Pardner	0.046 0.140	0 a	0 a	0 a	1134	1009
Select Pardner	0.092 0.280	0 a	0 a	0 a	1406	1251
LSD (0.05)					322	287

Means within a column followed by the same letter are not significantly different at P<0.05.
[1]0 = no damage; >30 = severe damage
[2]Days after application

Caraway

Tolerance was good to the Select, Linuron and both of the Select + Pardner treatments (Table 12). Pardner alone was unacceptable and seemed to be harder on the crop than in a tank mix with Select. The Select + Linuron and Poast Ultra + Linuron treatments were also unacceptable. Many of the plants in these treatments were killed. Any treatments that were considered unacceptable had lower plant stands, the plants were stunted and maturity was delayed. Yield data was not collected as frost injury prevented maturity.

Seeding date:	May 26
Seeding rate:	10 kg/ha
Row spacing:	25 cm
Rows per plot:	6
Length of rows:	4 m
Application volume:	100 L/ha
Date of herbicide application:	June 30

Table 12. Crop tolerance ratings for post emergent herbicides: Caraway.

Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1]		
		7 DAA[2]	20 DAA	34 DAA
Untreated		0 a	0 a	0 a
Select Amigo	0.046	1 ab	0 ab	1 ab
Linuron	0.800	0 a	1 abc	1 ab
Select Linuron Amigo	0.046 0.800	1 ab	6 bcde	9 bcd
Select Linuron Amigo	0.092 1.600	9 cd	25 f	33 e
Pardner	0.140	5 bcd	3 abcd	4 abc
Pardner	0.280	14 d	17 ef	19 de
Poast Ultra Linuron Merge	0.200 0.800	2 abc	9 cde	11 cd
Poast Ultra Linuron Merge	0.400 1.600	1 ab	11 def	8 bcd
Select Pardner	0.046 0.140	5 bcd	5 abcd	2 abc
Select Pardner	0.092 0.280	9 cd	5 abcd	3 abc

Means within a column followed by the same letter are not significantly different at $P<0.05$.
[1]0 = no damage; >30 = severe damage
[2]Days after application

Dill

Seeding date:	May 26
Seeding rate:	8 kg/ha
Row spacing:	25 cm
Rows per plot:	6
Length of rows:	4 m
Application volume:	100 L/ha
Date of herbicide application:	June 30

Tolerance to the Select and Linuron treatments was acceptable (Table 13). The low rate of Select and Linuron together was marginally acceptable as well as the Poast Ultra and Linuron treatment. The high rate of Select and Linuron was unacceptable. Any treatment that included Pardner was also unacceptable. Heights were recorded on the dill to better illustrate how the herbicides stunted the dill. Pardner stunted the crop to the greatest extent. All treatments that were unacceptable or marginally unacceptable delayed the maturity of the crop and seemed to decrease the seed set per plant even though dill is a very plastic crop that can rebound from damage very well. Soil variability decreased emergence and the value of the yield data. Visual tolerance ratings were done on existing plants except for the Pardner treatments. In this case the ratings took into account the fact that the herbicide decreased the plant stand.

Table 13. Crop tolerance ratings, plant height, and seed yield for post emergent herbicides: Dill.

Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1]			Height (cm)	Seed yield	
		7 DAA[2]	20 DAA	34 DAA		kg/ha	lb/ac
Untreated		0 a	0 a	0 a	93	1063	946
Select Amigo	0.046	0 a	0 a	0 a	91	985	877
Linuron	0.800	1 ab	1 ab	0 a	90	1578	1404
Select Linuron Amigo	0.046 0.800	3 abc	12 cd	8 bc	89	1278	1138
Select Linuron Amigo	0.092 1.600	8 cd	26 ef	28 de	86	1313	1169
Pardner	0.140	16 de	15 cd	22 cd	87	1038	924
Pardner	0.280	35 f	39 e	48 e	77	1219	1085
Poast Ultra Linuron Merge	0.200 0.800	3 abc	12 cd	6 abc	93	1334	1187
Poast Ultra Linuron Merge	0.400 1.600	5 bc	7 bc	6 ab	93	1348	1200
Select Pardner	0.046 0.140	20 ef	22 de	35 de	84	1134	1009
Select Pardner	0.092 0.280	21 ef	19 cde	19 bcd	81	1405	1251
LSD (0.05)					9	321	286

Means within a column followed by the same letter are not significantly different at P<0.05.
[1]0 = no damage; >30 = severe damage
[2]Days after application

Sunflower

The sunflowers showed poor tolerance to all treatments at the first visual rating (Table 14). By the second rating the Spartan treatments and the low rate of Muster Gold treatment had come close to full recovery. The high rate of Muster Gold stunted the sunflowers throughout plant development and resulted in a significantly lower yield than the other treatments suggesting that it is not suitable for weed control in sunflowers.

Seeding date:	May 9
Seeding rate:	2 seeds/m^2
Row spacing:	60 cm
Rows per plot:	2
Length of rows:	6 m
Application volume:	100 L/ha
Date of herbicide application:	June 8

Table 14. Crop tolerance ratings for post emergent herbicides: Sunflower.						
Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1]			Seed yield	
		12 DAA[2]	27 DAA	38 DAA	kg/ha	lb/ac
Untreated		0 a	0 a	0 a	2684	2389
Spartan	0.140	9 bc	0 a	0 a	2837	2525
Spartan	0.280	10 c	2 b	1 ab	2796	2488
Muster Gold	0.015	4 b	0 a	3 b	2773	2468
Muster Gold	0.030	21 d	11 c	11 c	2134	1899
LSD (0.05)					317	282

Means within a column followed by the same letter are not significantly different at P<0.05.
[1]0 = no damage; >30 = severe damage
[2]Days after application

Canary Seed

Tolerance was excellent to both Attain treatments in the canary seed (Table 15). There were no visual differences to record except slight stunting at the second rating period but the crop had recovered by the third rating period. Maturity and yield was similar throughout the test. Yields are not presented because of an infestation of green foxtail that could not be cleaned from the threshed samples.

Seeding date:	May 25
Seeding rate:	400 seeds/m^2
Row spacing:	25 cm
Rows per plot:	6
Length of rows:	4 m
Application volume:	100 L/ha
Date of herbicide application:	June 27

Table 15. Crop tolerance ratings for post emergent herbicides: Canary seed.					
Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1]			Height (cm)
		10 DAA[2]	23 DAA	37 DAA	
Untreated		0	0 a	0	50
Attain A Attain B	0.108 0.564	0	1 ab	0	49
Attain A Attain B	0.216 1.128	0	3 b	0	50
LSD (0.05)					NS[3]

Means within a column followed by the same letter are not significantly different at P<0.05.
[1]0 = no damage; >30 = severe damage
[2]Days after application
[3]not significant

Borage

The Borage showed excellent tolerance to the Select, Poast Ultra, and the low rate of Assert (Table 16). Visual tolerance was marginal for the high rate of Assert, however the yield data showed the plots had fully recovered by harvest as there was not a significant difference in yield compared to the untreated check. Pursuit treatments severely damaged the Borage at the time of the visual ratings and killed many plants, but because Borage is such a plastic crop pre-emergent applied Pursuit treatments had actually recovered somewhat. The only treatment that was significantly lower than the untreated check was the post-emergent Pursuit treatment. Results from this trial would suggest that the application of Pursuit should not be recommended for weed control in Borage.

Seeding date:	May 25
Seeding rate:	10 kg/ha
Row spacing:	25 cm
Rows per plot:	6
Length of rows:	4 m
Application volume:	100 L/ha
Date of herbicide application:	
Pre-emergent:	May 31
Post-emergent:	June 29

Table 16. Crop tolerance ratings, and seed yield for post emergent herbicides: Borage.

Treatment	Rate kg/ha a.i.	Visual Tolerance Rating[1]			Seed yield	
		8 DAA[2]	21 DAA	35 DAA	kg/ha	lb/ac
Untreated		0 a	0 a	0 a	263	234
Select Amigo	0.046	0 a	0 a	0 a	218	194
Select Amigo	0.092	0 a	0 a	0 a	246	219
Assert Acidulant	0.250	1 a	0 a	0 a	280	249
Assert Acidulant	0.500	2 a	3 a	3 ab	283	252
Poast Ultra Merge	0.200	3 a	0 a	0 a	233	207
Poast Ultra Merge	0.400	1 a	1 a	0 a	268	239
Pursuit (Pre-emerge)	0.0125	21 b	20 b	17 b	278	247
Pursuit (Pre-emerge)	0.025	70 c	58 c	55 c	217	193
Pursuit Merge	0.025	44 c	71 c	80 c	195	174
LSD (0.05)					84	75

Means within a column followed by the same letter are not significantly different at P<0.05.
[1]0 = no damage; >30 = severe damage
[2]Days after application

Potato Development Program

Potato Development Program

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

The Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) has expanded its potato research and development program to support the needs of the expanding potato industry in Western Canada including Saskatchewan. These projects are conducted collaboratively between the Saskatchewan Seed Potato Growers Association, the Department of Plant Sciences, University of Saskatchewan (Dr. Doug Waterer) and Agriculture and Agri-Food Canada, Lethbridge Research Centre (Dr. Dermot Lynch), and several private companies. The Canada-Saskatchewan Agri-Food Innovation Fund provided financial support to this program. The main objectives of the CSIDC potato development program include:

- the identification and evaluation of improved germplasm for the 'seed', 'processing, and 'table' markets,
- the development of cost-effective agronomic practices suited for the relatively short and cool growing seasons in Saskatchewan, and
- the development of economically viable and environmentally sustainable potato-based crop rotations.

The Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) has expanded its potato research and development program to support the needs of this expanding industry.

Objective:
- To identify superior cultivars for the seed, table, and processing markets,
- To develop cost-effective agronomic practices to suit the relatively short and cool growing seasons of Saskatchewan, and
- To develop economically viable and sustainable potato-based crop rotations.

All test plots, except the dryland treatments, were grown under supplemental irrigation using standard management practices. The agronomic practices included Eptam 8E as pre-plant herbicide; 91 cm (36 in) row spacing; 100 kg N/ha (90 lb N/ac), 60 kg P_2O_5/ha (55 lb P_2O_5/ac) and 50 kg K_2O/ha (45 lb K_2O/ac) at planting and 100 kg N/ha (90 lb N/ac) at hilling; one application of Ripcord for Colorado potato beetle control; three applications of Bravo 500, one application of Dithane, one application of Acrobat, and one application of Tattoo for disease control, and two application of Reglone for top-kill prior to harvest. Treatments were applied appropriately for the various tests. The crop received 212 mm (8.4 in) of rain during the growing season and 140 mm (5.5 in) of supplemental irrigation was applied to maintain the soil moisture status at 65% Field capacity. The harvested tubers were graded according to tuber diameter. The 'seed' grade included tubers between 30 mm (1.2 in) and 70 mm (2.8 in) for oblong tubers, and 30 mm (1.2 in) and 80 mm (3.2 in) for round tubers. The 'consumption' category included tubers larger than 45 mm (1.8 in) diameter. Tuber specific gravity and culinary characteristics (boiled, baked, chip, and french fry) were determined using recommended AAFC protocols. Fry colour categories were based on USDA standards.

Prairie Regional Trials

J. Wahab[1], D. Lynch[2], G. Larson[1]

The Prairie Regional 'Early' and 'Maincrop' Trials were conducted at the CSIDC under irrigation. This project is conducted in collaboration with Agriculture and Agri-Food Canada, Lethbridge Research Centre. The 'Early' test included four advanced clones and four industry standards. The 'Maincrop' trial consisted of 20 advanced clones and six industry standards. Yield, tuber characteristics and culinary attributes were evaluated for crops harvested at 80 and 90 days after planting for the 'Early' trial and at 125 days after planting for the 'Maincrop' trial. This information will be used to support registration of new potato cultivars.

Western Seed Potato Consortium

J. Wahab[1], D. Lynch[2], G. Larson[1]

Promising french fry, chipping, and fresh market clones offered by the Western Seed Potato Consortium were grown in single-row plots under standard irrigated production. The crop was harvested and displayed to the members of the Saskatchewan Seed Potato Association, Western Seed Potato Consortium, and other governmental and industry personnel during the field day conducted on August 8, 2000. Over 100 participants attended this field day.

Nitrogen Source, Rate, and Application Time Study

J. Wahab[1], D. Waterer[3], T. Hogg[1], G. Larson[1]

Previous studies have shown variable yield and quality responses to sources of nitrogen fertilizer. It is likely that different nitrogen sources could have variable effects under the relatively cool Saskatchewan growing environments with respect to growth, yield, and quality characteristics for contrasting potato cultivars.

This study examined two sources of nitrogen (urea, ammonium sulphate), three nitrogen rates (100, 200, 400 kg N/ha; i.e. 90, 180, 360 lb N/ac) and two application times (all at planting, and split applied at planting and at hilling) for Norland (early season fresh market), Russet Norkotah (mid-season fresh market), and Russet Burbank (late-season french fry) potatoes. Spring soil test results for the various cultivar test sites are summarized in Table 1.

Table 1. Spring soil nutrient levels at 30 cm (12 in) depth for the nitrogen source study.

Nutrient	Norland		Russet Burbank		Russet Norkotah	
Texture	Loam		Loam		Loam	
pH	8.2		8.1		8.1	
EC (dS/m)	0.5		0.5		0.5	
Nutrient level						
	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
Nitrogen	41	37	35	31	47	42
Phosphorus	26	23	20	18	25	22
Potassium	936	836	977	872	856	764
Sulfur	69	62	67	60	80	71

[1]CSIDC, Outlook
[2]Agriculture and Agri-Food Canada Research Centre, Lethbridge, Alberta
[3]Dept. of Plant Sciences, U of S, Saskatoon

The effects of nitrogen source, rate, and time of application on 'seed' and 'consumption' grade tuber yields are presented in Table 2 and Table 3 respectively.

Table 2. Nitrogen source, rate, and timing effects on 'seed' grade yield for Norland, Russet Burbank, and Russet Norkotah potato.

Treatment	'Seed' grade yield					
	Norland		Russet Burbank		Russet Norkotah	
	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Nitrogen source						
Ammonium sulphate	49.7	441	44.0	390	36.9	327
Urea	42.8	380	38.1	338	34.7	308
Nitrogen rate						
100 kg N/ha	46.5	412	40.6	360	36.1	320
200 kg N/ha	47.3	420	42.7	379	37.1	329
400 kg N/ha	45.0	399	39.9	354	34.3	304
Time of application						
N at Planting	46.4	412	40.0	355	34.3	304
N at Planting & hilling	46.1	409	42.2	374	37.4	332
Analysis of variance						
Nitrogen source (S)	***(2.6)		***(2.2)		*(1.8)	
Nitrogen rate (R)	NS		NS		**(2.2)	
Time of application (T)	NS		*(2.2)		***(1.8)	
S x R	NS		***(3.9)		*(3.1)	
S x T	NS		*(3.1)		NS	
R x T	**(4.6)		NS		NS	
S x R x T	NS		NS		**(4.3)	
CV (%)	9.7		9.2		8.4	

***,**, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for corresponding treatments.

Ammonium sulphate produced higher 'seed' and 'consumption' grade yields than urea for all cultivars tested. The increase in 'seed' grade yield with ammonium sulphate over urea was 6% for Russet Norkotah and 16% for Norland and Russet Burbank (Table 2). The corresponding yield advantages for 'consumption' grade yields were 5% for Russet Norkotah, 8% for Russet Burbank, and 15% for Norland (Table 3).

Both 'seed' and 'consumption' grade yields optimized at 200 kg N/ha (180 lb N/ac) for all cultivars (Tables 2 and 3). Applying 200 kg N/ha (180 lb N/ac) produced 7% higher 'consumption' grade yield for Norland and 11% higher yield for Russet Burbank relative to 100 kg N/ha (90 lb N/ac).

Nitrogen source x nitrogen rate interactions were significant with 'seed' grade yields for Russet Burbank and Russet Norkotah (Table 2) and with 'consumption' grade yields for all three cultivars (Table 3). This indicates that Ammonium sulphate and urea responded differently to rate effects, i.e. with urea, increasing nitrogen rate from 200 kg N/ha (180 lb N/ac) to 400 kg N/ha (360 lb N/ac) reduced 'seed' (Figure 1) and 'consumption' (Figure 2) grade yields. By contrast, with ammonium sulphate, tuber yields remained stable or increased between 200 and 400 kg N/ha (360 lb N/ac).

Table 3. Nitrogen source, rate, and timing effects on 'consumption' grade yield and french fry color for Norland, Russet Burbank, and Russet Norkotah potato.

Treatment	'Consumption' grade yield and fry color								
	Norland			Russet Burbank			Russet Norkotah		
	t/ha	Cwt/ac	Fry color	t/ha	Cwt/ac	Fry color	t/ha	Cwt/ac	Fry color
Nitrogen source									
Ammonium sulphate	52.3	464	1.7	36.9	327	1.7	45.7	405	2.5
Urea	45.4	403	1.8	34.1	302	2.0	43.5	386	2.5
Nitrogen rate									
100 kg N/ha	46.2	410	1.5	33.4	296	2.0	44.3	393	2.0
200 kg N/ha	49.6	440	2.0	36.9	327	1.8	45.8	406	2.8
400 kg N/ha	50.8	451	1.8	36.2	321	2.0	43.7	388	3.0
Time of application									
Planting	47.9	425	1.8	34.1	302	1.8	42.4	378	3.0
Planting + hilling	49.8	442	1.7	36.8	326	2.0	46.9	416	2.5
Analysis of variance									
Nitrogen source (S)	***(2.2)			**(1.9)			**(1.8)		
Nitrogen rate (R)	**(2.7)			*(2.3)			NS		
Time of application (T)	NS			**(1.9)			***(1.8)		
S x R	***(3.9)			**(3.3)			*(3.1)		
S x T	NS			NS			NS		
R x T	***(3.9)			**(3.3)			NS		
S x R x T	NS			NS			NS		
CV (%)	7.8			9.2			6.8		

***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for corresponding treatments.

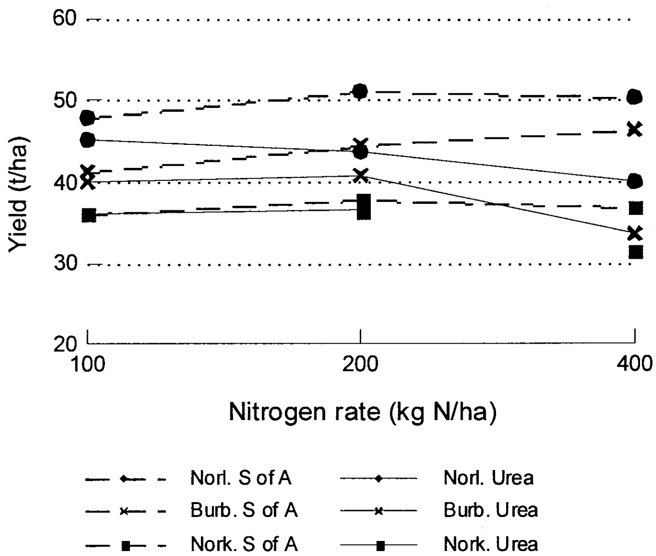


Figure 1. Seed grade tuber yields of potato cultivars in response to ammonium sulphate and urea application.

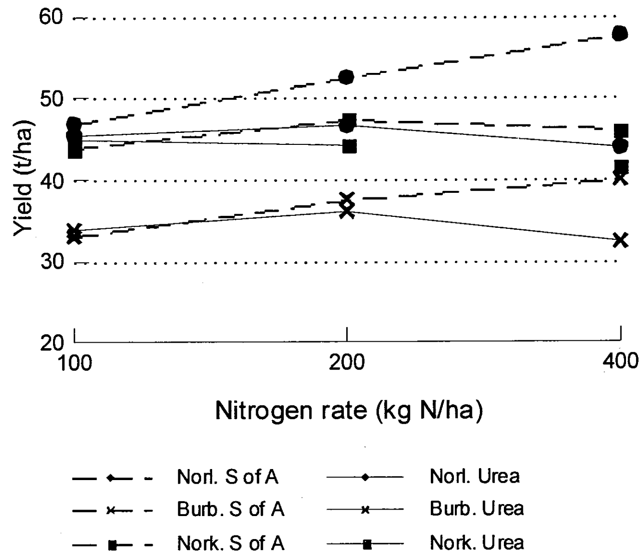


Figure 2. Consumption grade tuber yields of potato cultivars in response to ammonium sulphate and urea application.

The early-season Norland, produced similar 'seed' and consumption' grade yields when nitrogen was applied all at planting or split applied at planting and at hilling (Tables 2 and 3). By contrast, the mid-season Russet Norkotah and the late-season Russet Burbank responded positively to split application of nitrogen compared to the single application at planting. For example, Russet Burbank yielded 6% higher 'seed' grade tubers and 8% higher consumption grade tubers when nitrogen was split applied relative to single application. With Russet Norkotah, the corresponding yield advantage was 9% for 'seed' grade and 11% for 'consumption' grade potato.

Russet Burbank produced light coloured fries. There was no indication that higher nitrogen rates produced darker fries (Table 3).

Split Application of Nitrogen

J. Wahab[1], D. Waterer[2], T. Hogg[1], G. Larson[1]

Careful nitrogen management is essential for potato production. It is particularly critical under the short growing seasons in Saskatchewan. Rate and timing of application are important considerations to optimize yields and maintain quality. It is likely that various cultivars would respond differently to rate and timing of nitrogen application.

This study examined the effects different rates of nitrogen, given as urea, applied at different growth stages on yield and processing quality for Russet Norkotah, Ranger Russet, and Shepody potato. The nitrogen treatments included three rates (150, 200, 400 kg N/ha; i.e. 135, 180, 360 lb N/ac) applied at four different stages i.e. (i) all at planting, (ii) at planting and hilling, (iii) planting, hilling and three weeks after hilling, and (iv) planting, hilling, three weeks after hilling, and two weeks later. Results of spring soil analysis at the test site are summarized in Table 4.

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[2]*Dept. of Plant Sciences, U of S, Saskatoon*

Table 4. Spring soil nutrient levels at 30 cm (12 in) depth for the nitrogen split application study.		
Texture	Loam	
pH	8.2	
EC (dS/m)	0.5	
Nutrient level		
	kg/ha	lb/ac
Nitrogen	47	42
Phosphorus	25	22
Potassium	856	764
Sulfur	80	71

Shepody and Russet Norkotah produced approximately 5% higher 'seed' grade yield than Ranger Russet (Table 5). Shepody produced the highest 'consumption' grade yield which was 22% higher that Russet Norkotah and 27% higher than Ranger Russet (Table 5).

The highest yields of both 'seed' and 'consumption' grade tubers was obtained with 150 kg N/ha (135 lb N/ac). Excess nitrogen tended to reduce tuber yields for both market classes and this decline was more marked for 'seed' grade yield than for 'consumption' grade yield (Table 5).

Split application of nitrogen had no effect on 'consumption' grade yield while four equal splits produced the highest 'seed' grade yield (Table 5).

Ranger Russet produced tubers with highest specific gravity compared to Russet Norkotah or Russet Burbank (Table 5). Increased nitrogen application decreased tuber specific gravity. Timing of nitrogen application had no effect on tuber specific gravity.

All three cultivars tested in this study produced acceptable fry colour (Table 5). High nitrogen produced slightly darker fries than low nitrogen. Nitrogen application method did not show any identifiable trends with respect to fry colour.

Table 5. Nitrogen rate and timing effects on tuber yield and tuber specific gravity for Russet Norkotah, Ranger Russet, and Shepody potatoes.

Treatment	'Seed' grade yield		'Consumption' grade yield		'Consumption' grade specific gravity	Fry color
	t/ha	Cwt/ac	t/ha	Cwt/ac		
Cultivar						
Russet Norkotah	40.7	361	34.6	307	1.0878	3.0
Ranger Russet	38.6	342	33.2	294	1.0931	1.8
Shepody	40.5	359	42.1	373	1.0818	2.5
Nitrogen rate						
150 kg N/ha	41.4	367	37.5	333	1.0894	2.2
200 kg N/ha	40.5	359	36.9	327	1.0898	2.5
400 kg N/ha	37.9	336	35.5	315	1.0835	2.6
Nitrogen timing						
P	37.3	331	35.7	317	1.0867	2.7
P+H	40.6	455	37.2	330	1.0881	2.4
P+H+3	40.6	455	36.8	326	1.0880	1.6
P+H+3+5	41.2	365	37.0	328	1.0875	2.5
Analyses of variance						
Cultivar (C)	*(1.7)		***(1.8)		***(0.0023)	
Nitrogen (N)	***(1.7)		NS		***(0.0023)	
Timing (T)	***(1.9)		NS		NS	
C x N	NS		NS		NS	
C x T	NS		NS		NS	
N x T	NS		NS		NS	
C x N x T	NS		NS		NS	
CV (%)	10.3		12.0		0.53	

***, *, and NS indicate significance at P<0.001, 0.05 levels of probability and not significant respectively.
Values within parentheses are LSD (5%) estimates for corresponding treatments.

Nitrogen and Phosphorus Rate Study

J. Wahab[1], D. Waterer[2], T. Hogg[1], G. Larson[1]

Nitrogen and phosphorus are the two most limiting nutrients for potato production. Careful management of these elements is essential to optimize yield and maintain superior tuber quality of all potato market classes. Nitrogen management is particularly important for processing potato under the relatively cool and short growing seasons in Saskatchewan. Nitrogen shortage can reduce vigour and predispose the crop to diseases while excess nitrogen can delay maturity and adversely affect yield and quality. Previous studies at the CSIDC have shown differential cultivar response to nitrogen and phosphorus application.

Table 6. Spring soil nutrient levels at 30 cm (12 in) depth for the nitrogen and phosphorus trials.

	Shepody		Russet Norkotah		Ranger Russet	
Texture	Loam		Loam		Loam	
pH	8.2		8.2		8.3	
EC (dS/m)	0.5		0.7		0.5	
Nutrient Level						
	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
Nitrogen	49	44	47	42	46	41
Phosphorus	22	20	22	20	19	17
Potassium	726	648	829	740	744	664
Sulphur	83	78	92	82	76	68

This study examined the effects of six levels of applied nitrogen (50, 100, 150, 200, 250, 300 kg N/ha; i.e. 45, 90, 135, 180, 225, 270 lb N/ac) and two levels of phosphorus (60, 120 kg P_2O_5/ha, i.e. 55, 110 lb P_2O_5/ac) for Russet Norkotah, Ranger Russet, and Shepody potato. Spring soil analysis results for the various tests are summarized in Table 6.

Nitrogen application significantly affected 'seed' grade tuber yield (Table 7). The 'seed' grade yield optimized around 50 to 100 kg N/ha (45 to 90 lb N/ac) for Ranger Russet, 150 kg N/ha (135 lb N/ac) for Shepody, and 200 kg N/ha (180 lb N/ac) for Russet Norkotah (Table 7). Nitrogen rates beyond these levels resulted in substantial yield reduction for all cultivars. The corresponding yield losses were 17% for Ranger Russet and Shepody and 19% for Russet Norkotah.

Table 7. Nitrogen and phosphorous rate effects on 'seed' grade yield for Shepody, Ranger Russet, and Russet Norkotah potatoes.

Treatment	'Seed' grade yield					
	Shepody		Ranger Russet		Russet Norkotah	
	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Nitrogen rate						
50 kg N/ha	34.8	309	36.2	321	31.9	283
100 kg N/ha	35.2	312	34.2	303	34.9	310
150 kg N/ha	36.6	325	34.7	308	30.6	271
200 kg N/ha	34.5	306	35.0	310	33.0	293
250 kg N/ha	31.5	279	31.7	281	31.2	277
300 kg N/ha	30.5	271	30.0	266	29.4	261
Phosphorous rate						
60 kg P_2O_5/ha	33.5	297	31.6	280	30.4	270
120 kg P_2O_5/ha	34.2	303	35.3	313	33.3	295
Analyses of variance						
Nitrogen (N)	***(3.0)		***(3.2)		NS	
Phosphorous (P)	NS		***(1.8)		**(2.3)	
N x P	NS		NS		**(5.6)	
CV (%)	8.6		9.4		12.2	

***, ** and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability and not significant respectively.
Values within parentheses are LSD (5%) estimates for corresponding treatments.

All cultivars produced higher 'seed' grade yields with 120 kg P_2O_5/ha (110 lb P_2O_5/ac) relative to 60 kg P_2O_5/ha (55 lb P_2O_5/ac) and this response reached significant proportions for and Ranger Russet and Russet Norkotah (Table 7). The yield advantages by applying 120 kg P_2O_5/ha (110 lb P_2O_5/ac) over 60 kg P_2O_5/ha (55 lb P_2O_5/ac) were 2% for Shepody, 10% for Russet Norkotah, and 12% for Ranger Russet.

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Table 8. Nitrogen and phosphorous rate effects on consumption grade yield for Shepody, Ranger Russet, and Russet Norkotah potatoes.

Treatment	Consumption grade yields					
	Shepody		Ranger Russet		Russet Norkotah	
	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Nitrogen rate						
50 kg N/ha	38.2	339	33.9	301	34.2	303
100 kg N/ha	44.0	390	34.6	307	35.6	316
150 kg N/ha	42.7	379	34.2	303	36.1	320
200 kg N/ha	43.8	389	34.8	309	36.3	322
250 kg N/ha	40.2	357	34.1	302	38.5	341
300 kg N/ha	39.1	347	30.7	272	34.3	304
Phosphorous rate						
60 kg P_2O_5/ha	40.4	358	32.7	290	35.1	311
120 kg P_2O_5/ha	42.3	375	34.7	308	36.5	324
Analyses of variance						
Nitrogen (N)	**(3.2)		NS		NS	
Phosphorous (P)	*(1.8)		**(1.7)		NS	
N x P	*(4.5)		NS		**(4.4)	
CV (%)	7.6		8.5		8.5	

**, * and NS indicate significance at P<0.01, 0.05 levels of probability and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Table 9. Nitrogen and phosphorous rate effects on specific gravity and french fry color of consumption grade tubers for Shepody, Ranger Russet, and Russet Norkotah potatoes.

Treatment	Shepody		Ranger Russet		Russet Norkotah	
	Sp. gravity	Fry color	Sp. gravity	Fry color	Sp. gravity	Fry color
Nitrogen rate						
50 kg N/ha	1.0898	2.3	1.0966	2.0	1.0907	3.0
100 kg N/ha	1.0869	2.0	1.0994	2.3	1.0914	3.0
150 kg N/ha	1.0845	2.3	1.0949	2.0	1.0893	3.0
200 kg N/ha	1.0810	3.4	1.0958	2.0	1.0903	3.0
250 kg N/ha	1.0794	2.0	1.0879	2.0	1.0899	3.0
300 kg N/ha	1.0788	2.3	1.0903	2.0	1.0885	3.0
Phosphorous rate						
60 kg P_2O_5/ha	1.0830	2.7	1.0948	2.0	1.0900	3.0
120 kg P_2O_5/ha	1.0838	2.3	1.0935	2.0	1.0900	3.0
Analyses of variance						
Nitrogen (N)	NS		NS		NS	
Phosphorous (P)	NS		NS		NS	
N x P	NS		NS		NS	
CV (%)	0.75		0.76		0.08	

NS indicates non-significant treatment effects.

The 'consumption' grade yield optimized at 100 kg N/ha (90 lb/ac) for Shepody, 200 kg N/ha (180 lb N/ac) for Ranger Russet and 250 kg N/ha (225 lb/ac) for Russet Norkotah (Table 8). Applying 300 kg N/ha (270 lb N/ac) reduced tuber yields. This yield reduction relative to the maximum yields for the various ranged between 11% to 12%.

Shepody and Ranger Russet produced significantly higher 'consumption' grade yields with 120 kg P_2O_5/ha (110 lb P_2O_5/ac) than 60 kg P_2O_5/ha (55 lb P_2O) (Table 8). This yield advantages were 5% for Shepody, and 6% for Ranger Russet. Russet Norkotah produced 4% (non significant) higher yields with 120 kg P_2O_5/ha (110 lb P_2O_5/ac) relative to 60 kg P_2O_5/ha (55 lb P_2O).

The effects of nitrogen and phosphorus application on tuber specific gravity and french fry colour for Shepody, Ranger Russet, and Russet Norkotah potatoes are summarized in Table 9. Although non-significant, increasing nitrogen rates generally lowered tuber specific gravity. The two phosphorus rates tested in this study had no effect on tuber specific gravity for the various cultivars.

All three cultivars produced commercially acceptable fries and Ranger Russet produced the lightest fries compared to Shepody or Russet Norkotah (Table 9). There was no indication that the rates of nitrogen and phosphorus tested in this study had any effect on fry colour for the different cultivars.

Nitrogen and Phosphorus Placement Study

J. Wahab[1], D. Waterer[2], T. Hogg[1], G. Larson[1]

Efficient nutrient uptake by crops depend on the proximity of fertilizer to the root zone. This is particularly important for crops that have limited root growth such as potato .

This study examined the effects of placement (broadcast, side-band) and rates of nitrogen (100, 150, 200 kg N/ha; i.e. 90, 135, 180 lb N/ac) and phosphorus (60, 120 kg P_2O_5/ha; i.e. 54, 108 lb P_2O_5/ac) for Norland and Russet Burbank potato grown under irrigation. For the broadcast treatment, the fertilizer was spread evenly in the furrow prior to planting. For side-banding, the fertilizer was placed 5 cm (2 in) away and 2.5 cm (1 in) above the seed piece.

Spring soil analysis results from the test sites for Norland and Russet Burbank are summarized in Table 10.

Table 10. Spring soil nutrient levels at 30 cm (12 in) depth for the nitrogen and phosphorus placement study.

Nutrient	Norland		Russet Burbank	
Texture	Loam		Loam	
pH	8.2		8.1	
EC (dS/m)	0.7		0.7	
Nutrient Level				
	kg/ha	lb/ac	kg/ha	lb/ac
Nitrogen	54	48	49	44
Phosphorus	35	31	27	24
Potassium	672	600	627	560
Sulfur	87	78	74	66

For Norland, nitrogen rates, phosphorus rates and method of application, i.e. broadcasting or side banding, had no effect on 'seed' and 'consumption' grade yields, and tuber specific gravity (Table 11).

For Russet Burbank, side banding produced 4% higher 'consumption' grade yield and 6% higher 'seed' grade yields than broadcast application (Table 12).

For Russet Burbank, high phosphorus produced higher tuber specific gravity, whereas, nitrogen rates and method of application had no effect on tuber specific gravity (Table 12). There were no identifiable trends for the effect nitrogen, phosphorus, or placement on french fry colour for Russet Burbank.

Table 11. Nitrogen and phosphorous placement effects on 'seed', and 'consumption' grade yields and tuber specific gravity for Norland potato.

Treatment	'Seed' grade yield		'Consumption' grade yield		Tuber specific gravity
	t/ha	Cwt/ac	t/ha	Cwt/ac	
Nitrogen rate					
100 kg N/ha	48.6	431	41.7	370	1.0835
150 kg N/ha	47.5	421	42.2	374	1.0802
200 kg N/ha	47.6	422	42.5	377	1.0814
Phosphorous rate					
60 kg P_2O_5/ha	47.1	418	42.3	375	1.0812
120 kg P_2O_5/ha	48.6	431	41.9	372	1.0822
Placement					
Broadcast	48.0	426	42.5	377	1.0817
Side-band	47.8	424	41.8	371	1.0817
Analyses of variance					
Nitrogen (N)	NS		NS		NS
Phosphorous (P)	NS		NS		NS
Placement (L)	NS		NS		NS
N x P	NS		NS		NS
N x L	NS		NS		NS
P x L	NS		NS		NS
N x P x L	NS		NS		NS
CV (%)	7.4		9.2		0.37

NS indicates non-significant treatment effects.

[1]*CSIDC, Outlook*
[2]*Dept. of Plant Sciences, U of S, Saskatoon*

Table 12. Nitrogen and phosphorous placement effects on 'seed' and 'consumption' grade yields, tuber specific gravity and french fry color for Russet Burbank potato.

Treatment	'Seed' grade yield t/ha	'Seed' grade yield Cwt/ac	'Consumption' grade yield t/ha	'Consumption' grade yield Cwt/ac	Tuber specific gravity	Fry color
Nitrogen rate						
100 kg N/ha	43.0	381	32.1	285	1.0930	2.3
150 kg N/ha	41.4	367	32.3	287	1.0896	1.8
200 kg N/ha	40.6	360	32.2	286	1.0868	2.0
Phosphorous rate						
60 kg P_2O_5/ha	41.4	367	32.2	286	1.0875	1.7
120 kg P_2O_5/ha	42.0	373	32.2	286	1.0920	2.3
Placement						
Broadcast	40.5	359	31.5	279	1.0902	2.2
Side-band	42.8	380	32.9	292	1.0894	1.8
Analyses of variance						
Nitrogen (N)	NS		NS		NS	
Phosphorous (P)	NS		NS		*0.0043	
Placement (L)	NS		*(1.7)		NS	
N x P	*(3.5)		NS		NS	
N x L	NS		NS		NS	
P x L	NS		NS		NS	
N x P x L	NS		NS		NS	
CV (%)	7.0		7.4		0.68	

* and NS indicate significance at P<0.05 level of probability and not significant respectively. Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Potassium Source and Rate Study

J. Wahab[1], D. Waterer[2], T. Hogg[1], G. Larson[1]

Saskatchewan soils are high in potassium. This study examined the requirement of supplementary potassium for contrasting french fry cultivars such as Russet Burbank, Ranger Russet, and Shepody. The fertilizer treatments included two potassium sources (potassium chloride, potassium sulphate) and three rates of application (50, 100, 200 kg K_2O/ha; i.e. 45, 90, 180 lb K_2O/ac). Potassium was applied all at planting. Spring soil analysis results for the various tests are summarized in Table 13.

Potassium source or rate of application had no effect on 'seed' grade yield (Table 14), 'consumption' grade yield (Table 15), and tuber specific gravity (Table 16) for Russet Burbank, Ranger Russet, or Shepody potatoes.

Table 13. Spring soil nutrient levels at 30 cm (12 in) depth for the potassium source study.

	Russet Burbank		Ranger Russet		Shepody	
Texture	Loam		Loam		Loam	
pH	8.2		8.1		8.2	
EC (dS/m)	0.7		0.7		0.7	
Nutrient level						
	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
Nitrogen	46	41	47	42	52	46
Phosphorus	27	24	21	19	15	13
Potassium	797	712	712	636	726	648
Sulfur	81	72	85	76	96+	96+

[1]*CSIDC, Outlook*
[2]*Dept. of Plant Sciences, U of S, Saskatoon*

Table 14. Potassium source and rate effects on 'seed' grade yield for Russet Burbank, Ranger Russet, and Shepody potatoes.

	'Seed' grade yield					
	Russet Burbank		Ranger Russet		Shepody	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Potassium source						
Potassium chloride	42.5	377	37.3	331	34.9	310
Potassium sulphate	40.5	359	36.0	319	36.9	327
Potassium rate						
50 kg K_2O/ha	41.7	370	38.1	338	35.5	315
100 kg K_2O/ha	42.1	373	36.2	321	34.9	310
200 kg K_2O/ha	40.8	362	35.8	318	37.4	332
Analyses of variance						
K source (S)	NS		NS		NS	
K rate (R)	NS		NS		NS	
S x R	NS		NS		NS	
CV (%)	9.8		8.8		10.3	

NS indicates non-significant treatment effects.

Table 15. Potassium source and rate effects on 'consumption' grade yield for Russet Burbank, Ranger Russet, and Shepody potatoes.

	'Consumption' grade yield					
	Russet Burbank		Ranger Russet		Shepody	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Potassium source						
Potassium chloride	36.2	321	37.5	333	40.4	358
Potassium sulphate	34.0	302	37.1	329	41.7	370
Potassium rate						
50 kg K_2O/ha	34.6	307	36.9	327	41.9	372
100 kg K_2O/ha	36.2	321	38.3	340	40.3	357
200 kg K_2O/ha	34.5	306	36.7	326	41.0	364
Analyses of variance						
K source (S)	NS		NS		NS	
K rate (R)	NS		NS		NS	
S x R	NS		NS		NS	
CV (%)	9.7		9.5		9.6	

NS indicates non-significant treatment effects.

Table 16. Potassium source and rate effects on specific gravity and french fry color of consumption grade tubers for Russet Burbank, Ranger Russet, and Shepody potatoes.

	Russet Burbank		Ranger Russet		Shepody	
Treatment	Sp. gravity	Fry color	Sp. gravity	Fry color	Sp. gravity	Fry color
Potassium source						
Potassium chloride	1.0845	1.0	1.0948	2.0	1.0858	2.0
Potassium sulphate	1.0861	1.3	1.0935	1.7	1.0858	1.7
Potassium rate						
50 kg K_2O/ha	1.0851	1.5	1.0946	2.0	1.0859	2.0
100 kg K_2O/ha	1.0861	1.0	1.0938	2.0	1.0849	2.0
200 kg K_2O/ha	1.0846	1.0	1.0940	1.5	1.0865	1.5
Analyses of variance						
K source (S)	NS		NS		NS	
K rate (R)	NS		NS		NS	
S x R	NS		NS		NS	
CV (%)	0.33		0.24		0.25	

NS indicates non-significant treatment effects.

Plant Population Study for European Potato Cultivars

J. Wahab[1], D. Waterer[2], T. Hogg[1], G. Larson[1]

Saskatchewan is becoming a major seed potato exporter to several countries in the world. Some countries favour European cultivars. Agronomic information for growing European potato cultivars is not available for Saskatchewan. This study examines the effect of seed piece spacing for selected European potato cultivars in comparison to several North American french fry standards. The study included three potato cultivars (Agria, Fianna, Penta) and three standards (Russet Burbank, Ranger Russet, and Shepody).

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The growth characteristics were different for the various cultivars. For example, Agria and Penta produced on average three mainstems per hill; Russet Burbank and Ranger Russet, 2.6 mainstems per hill; and Shepody, 2.3 mainstems per hill (Table 17).

Agria produced the highest 'seed' and 'consumption' grade yields (Table 17). Shepody produced the lowest 'seed' grade yield and Russet Burbank produced the lowest 'consumption' grade yield.

Table 17. Mainstem count, yield potential and quality characteristics for selected European and North American cultivars

Treatment	Mainstem #/hill	'Seed' grade yield		'Consumption' grade yield		Specific gravity	Fry color
		t/ha	Cwt/ac	t/ha	Cwt/ac		
Cultivar							
Agria	2.9	53.5	475	56.9	505	1.0764	2
Fianna	2.6	49.3	437	41.0	364	1.0923	2
Penta	3.0	50.5	448	44.4	394	1.0848	3
Russet Burbank	2.6	44.2	392	34.4	305	1.0941	1 - 3
Ranger Russet	2.6	42.6	378	41.2	365	1.0928	2
Shepody	2.3	40.5	359	48.5	430	1.0803	4
Spacing							
30 cm	2.7	49.1	436	47.5	421	1.0873	1 - 4
40 cm	2.7	44.4	394	41.3	366	1.0862	2 - 4
Analyses of variance							
Cultivar (C)	*(0.04)	***(5.5)		***(6.0)		***(0.0008)	
Spacing (S)	NS	**(3.2)		NS		NS	
C x S	NS	NS		NS		NS	
CV (%)	15.2	11.6		13.3		0.75	

***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Closer seed piece spacing of 30 cm (12 in) produced higher 'seed' and 'consumption' grade yields than the wider spacing of 40 cm (16 in). The corresponding yield differences were 11% for 'seed' grade yield and 15% for 'consumption' grade yield (Table 17).

The highest and the lowest specific gravity were produced by Russet Burbank and Agria respectively (Table 17). Shepody produced darker fries than the other cultivars tested. The fry colour did not appear to be associated with tuber specific gravity for the various cultivars.

Effect of Seed Piece Type on Mainstem Production and Tuber Yield

J. Wahab[1], D. Waterer[2], G. Larson[1]

Potato yield is considered to be a function of the number of mainstems. Mainstems originate from the eyes on the seed potato (whole tuber or seed piece). In a potato tuber, eyes are concentrated towards the apical end compared to the mid or basal sections of the tuber. Therefore, apical seed pieces will likely produce more stems and higher yields than seed pieces derived from other parts of a tuber. This study compared five seed piece types such as (i) whole tubers (drop seed), (ii) half-longitudinal cut, (iii) half-apical portion, (iv) half-basal portion, (v) apical and basal portions (1:1) for Russet Burbank, Russet Norkotah, and Shepody potato.

The longitudinally cut seed pieces produced the fewest mainstem than all other cut seed types or whole tuber (Table 18).

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Table 18. Effect of cultivar and seed piece type on mainstem number, and tuber yields under irrigated production.

Treatment	Mainstem #/ hill	'Seed' grade yield		'Consumption' grade yield	
		t/ha	Cwt/ac	t/ha	Cwt/ac
Cultivar					
Russet Burbank	2.5	46.5	412	39.2	348
Russet Norkotah	2.6	44.2	392	46.3	411
Shepody	2.6	43.3	384	55.5	492
Seed piece type					
Drop seed	2.7	46.0	408	46.6	413
Long. cut	2.2	42.0	373	42.8	380
Trans. cut apical	2.6	44.7	396	47.4	420
Trans. cut basal	2.7	46.0	408	49.2	436
Trans. cut apical and basal	2.6	44.7	396	48.9	434
Analyses of variance					
Cultivar (C)	NS	NS		***(6.0)	
Type (T)	*(0.3)	NS		NS	
C x T	NS	NS		NS	
CV (%)	15.1	14.3		14.3	

***, * and NS indicate significance at P<0.001, 0.05 levels of probability and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Plant Population and Seed Piece Spacing Uniformity Study

J. Wahab[1], D. Waterer[2], G. Larson[1]

Plant population and the uniformity of seed piece spacing are critical considerations to maximize potato yields and ensure uniform tuber size distribution. Optimum plant population depends on cultivars and crop production practices. Irregular seed spacing and moisture stress can adversely affect tuber yields and tuber size distribution.

This study examined the effects of two plant populations (37,000, 74,000 seed pieces/ha, i.e.15,000, 30,000 seed pieces/ac) and three spacing-uniformity treatments (coefficients of variation of 0%, 32%, 65% for seed piece spacing) for Russet Burbank, Russet Norkotah, and Shepody potato under irrigated and dryland production. Potato seed pieces were spaced at predetermined intervals to obtain the required variation effects. For example, 0% C.V. contained seed pieces placed at equal distance within the row. The 65% C.V. contained the most irregular seed piece spacings within the row.

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Under dryland, Russet Burbank produced the highest 'seed' grade and the lowest 'consumption' grade tuber yields (Table 19). The higher plant population of 74,000 hills/ha (30,000 hills/ac) produced 16% higher 'seed' grade yield than the 37,000 hills/ha (15,000 hills/ac) plant population. 'Consumption' grade yields were similar between both plant populations. Doubling plant population doubled the mainstem count. Plant spacing uniformity had no effect on mainstem count, 'seed' grade, or 'consumption' grade yield s (Table 19).

Cultivar x plant population interactions were significant for mainstem number, 'seed' and 'consumption' grade yields (Table 19). For example, doubling plant population from 37,000 hills/ha (15,000 hill/ac) to 74000 hills/ha (30000 hills/ac) resulted in:

- 80%, 90%, and 96% increase in mainstem number for Russet Norkotah, Shepody, and Russet Burbank respectively,
- 11%, 14%, and 25% increase in 'seed' grade yield for Russet Norkotah, Russet Burbank, and Shepody respectively, and
- 12% increase, and a 3% and 15% decrease in consumption grade yield for Shepody, Russet Norkotah, and Russet Burbank respectively.

Table19. Effects of plant population and seed piece spacing uniformity on mainstem count and tuber yield for potato cultivars under dryland production.

Treatment	Mainstem #/m row	'Seed' grade yield t/ha	'Seed' grade yield Cwt/ac	'Consumption' grade yield t/ha	'Consumption' grade yield Cwt/ac
Cultivar					
Russet Burbank	12.9	39.2	348	21.8	193
Russet Norkotah	10.8	34.5	306	28.5	253
Shepody	10.6	36.2	321	34.2	303
Plant density					
37,000 hills/ha	7.9	33.9	301	28.2	250
74,000 hills/ha	15.1	39.4	349	28.2	250
Plant spacing uniformity					
0% seed spacing CV	12.2	37.9	336	28.8	255
32% seed spacing CV	11.1	36.1	320	28.5	253
65% seed spacing CV	11.1	36.0	319	27.3	242
Analyses of variance					
Cultivar (C)	***(0.8)	***(1.9)		***(1.9)	
Plant population (P)	***(0.7)	NS		NS	
Seed spacing CV (CV)	NS	NS		NS	
C x P	*(1.2)	*(2.7)		*(2.7)	
C x CV	NS	NS		NS	
P x CV	NS	NS		NS	
C x P x CV	NS	NS		NS	
CV (%)	12.2	8.3		11.6	

***, * and NS indicate significance at P<0.001, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Under irrigation, the general absence of interaction between the various factors (Table 20) indicates that all three cultivars responded similarly to plant population and seed piece spacing effects.

Russet Burbank produced the highest 'seed' grade, Shepody the highest 'consumption' grade yields (Table 20). Doubling plant population doubled the mainstem count. The higher plant population of 74,000 hills/ha (30,000 hills/ac) produced 23% higher 'seed' grade yield and 6% higher (non-significant) 'consumption' grade yield than the 37,000 hills/ha (15,000 hills/ac) plant population. Plant spacing uniformity had no effect on mainstem count, 'seed' grade yield, or 'consumption' grade yield.

Table 20. Effects of plant population and seed piece spacing uniformity on mainstem count and tuber yield for potato cultivars under irrigated production.

	Mainstem #/m row	'Seed' grade yield		'Consumption' grade yield	
		t/ha	Cwt/ac	t/ha	Cwt/ac
Cultivar					
Russet Burbank	11.5	46.5	412	31.6	280
Russet Norkotah	10.1	41.5	368	37.5	333
Shepody	10.5	40.7	361	41.7	370
Plant density					
37,000 hills/ha	7.4	38.4	341	35.9	318
74,000 hills/ha	14.0	47.4	420	38.0	337
Plant spacing uniformity					
0% seed spacing CV	11.1	43.7	388	37.2	330
32% seed spacing CV	10.5	42.9	381	36.7	326
65% seed spacing CV	10.5	42.2	374	36.9	327
Analyses of variance					
Cultivar (C)	***(0.8)	***(2.4)		***(2.7)	
Plant population (P)	***(0.6)	***(1.9)		NS	
Seed spacing CV (CV)	NS	NS		NS	
C x P	NS	NS		*(3.9)	
C x CV	NS	NS		NS	
P x CV	NS	NS		NS	
C x P x CV	NS	NS		NS	
CV (%)	12.2	9.5		12.8	

*** and NS indicate significance at P<0.001 level of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Methods and Stage of Top-kill for Contrasting Cultivars

J. Wahab[1], G. Larson[1]

Potatoes are top killed prior to harvest to ensure proper skin set and facilitate mechanical harvest. Seed crops are harvested early, while processing and table crops are harvested relatively late in the season. Top kill dates should be adjusted to maximize yields of target tuber size grades for seed potato, and size grade and culinary characteristics for processing potato. Timing of top kill can vary with maturity classes of cultivars, growing conditions (e.g. irrigation or dryland), and agronomic practices.

This study examined the effects of two methods of top kill (flailing + Reglone, and standard two Reglone applications) performed at three crop growth stages (100, 107, and 114 days after planting) for five contrasting potato cultivars (Alpha, Norland, Russet Burbank, Russet Norkotah, Shepody). This trial was conducted under both irrigation and under dryland. The crop was planted on May 23, 2000 and

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top killed on August 31, September 7, September 14, and harvested approximately 20 days later. A portion of the plots were harvested on the day of top kill to determine the interactive influence of cultivars, top kill methods and timing on post- top-kill tuber bulking and yield.

The cultivar x top kill method interaction were not significant for 'seed' and 'consumption' grade yields at all harvest dates and growing conditions (Tables 21, 22, 23, 24). This indicates that all cultivars responded similarly to top kill treatments at the various harvest dates both under irrigation and dryland.

The irrigated crop overall produced higher 'seed' and 'consumption' grade yields than the dryland crop. This advantage was consistent across all cultivars at all harvest dates (Tables 21, 22, 23, 24).

The yield potential at specific growth/top-kill stages for the various cultivars are represented by the 'Flail' treatment. At 100 days from planting, the early-season Norland and the mid-season Russet Norkotah and Shepody produced higher yields than the late-season cultivars (e.g. Alpha, Russet Burbank) under both irrigation and dryland. These differences were more pronounced for 'consumption' grade yields than the 'seed' grade yields (Tables 21, 22, 23, 24). Tuber yield increased considerably up to the 107 day-harvest (September 7) under both dryland and irrigation. Delaying the harvest by seven days, i.e. from 107 (September 7) to 114 (September 14) produced higher yields under irrigation but had no effect under dryland.

Cultivars responded differently to changing harvest dates under irrigated and dryland growing conditions. For example, early-maturing Norland when grown in dryland produced the optimum 'seed' and 'consumption' grade yields at the second top kill stage (Tables 21, 22). Delaying top kill resulted in a yield reduction which is likely

Table 21. Effect of method and time of top kill on 'seed' grade yield for constrasting potato cultivars grown under dryland.

	'Seed' grade yield					
	Harvest I		Harvest II		Harvest III	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Cultivar						
Alpha	30.5	271	33.4	296	36.8	326
Norland	48.5	430	51.4	456	47.2	419
Russet Burbank	38.7	343	44.7	396	44.7	396
Russet Norkotah	37.3	331	41.5	368	40.3	357
Shepody	41.0	364	50.5	448	45.2	401
Top kill method						
Flail	34.7	308	42.0	373	44.6	396
Flail + Reglone	41.7	370	45.1	400	42.0	373
Reglone	41.2	365	45.8	406	41.8	371
Analyses of variance						
Cultivar (C)	***(4.2)		***(5.1)		***(5.1)	
Top kill method (M)	***(1.1)		NS		NS	
C x M	NS		NS		NS	
CV (%)	13.1		13.9		14.4	

***, and NS indicate significance at P<0.001 level of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Table 22. Effect of method and time of top kill on 'consumption' grade yield for constrasting potato cultivars grown under dryland.

	'Consumption' grade yield					
	Harvest I		Harvest II		Harvest III	
Treatment	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Cultivar						
Alpha	7.6	67	9.2	82	17.4	154
Norland	40.7	361	45.2	401	40.6	360
Russet Burbank	21.5	191	29.7	263	30.9	274
Russet Norkotah	29.0	257	34.5	306	34.3	304
Shepody	35.5	315	45.7	405	41.5	368
Top kill method						
Flail	23.1	205	30.8	273	33.1	294
Flail + Reglone	29.2	259	33.8	300	33.0	293
Reglone	28.3	251	34.0	302	32.8	291
Analyses of variance						
Cultivar (C)	***(4.3)		***(4.7)		***(5.4)	
Top kill method (M)	***(1.2)		NS		NS	
C x M	NS		NS		NS	
CV (%)	19.5		17.3		19.9	

***, and NS indicate significance at P<0.001 level of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

due to dehydration. Under irrigation yields optimized at the earliest top kill date and delaying harvest did not relate to any yield improvements (Tables 23, 24). Late maturing Alpha produced progressively higher 'seed' and 'consumption' grade yields with later harvests both under dryland and irrigation. However, with Russet Burbank (late maturing) yields optimized at the second harvest date for dryland and the third harvest date for irrigated production.

The flailed crop and the chemically desiccated crops were harvested approximately three weeks from the date of top kill for all three harvest dates. Flailing and the chemical top kill methods produced similar 'seed' and 'consumption' grade yields under dryland (Tables 21, 22) and under irrigation (Tables 23, 24) during all three top kill dates.

Under dryland, during the first top kill stage (August 31, i.e. 100 DAP), the three-week period from flailing or chemical desiccation to harvest resulted in 20% and 19% increase in 'seed' and 'consumption' grade yields respectively. A corresponding 26% and 23% yield increase was observed for 'consumption' grade yield (Tables 21, 22). Under irrigation, three-week delay after flailing resulted in a 15% and 18% increase in 'seed' and 'consumption' grade yield and chemical desiccation resulted in a 16% to 21% increase in 'seed' and 'consumption grade tubers (Tables 23, 24). By contrast, during the second (September 7, i.e. 107 DAP) and third (September 14, i.e. 114 DAP) harvests, the delay of three weeks from top kill (both methods) to harvest did not cause any significant changes in yield.

Table 23. Effect of method and time of top kill on 'seed' grade yield for contrasting cultivars grown under irrigation.

Treatment	'Seed' grade yield					
	Harvest I		Harvest II		Harvest III	
	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Cultivar						
Alpha	34.9	310	35.4	314	43.5	386
Norland	54.8	486	52.6	467	53.4	474
Russet Burbank	46.8	415	46.4	412	50.0	444
Russet Norkotah	41.4	367	43.3	384	44.7	396
Shepody	49.4	438	49.9	443	54.1	480
Top kill method						
Flail	41.2	365	46.0	408	49.6	440
Flail + Reglone	47.5	421	46.6	413	47.9	425
Reglone	47.7	423	44.0	390	49.9	443
Analyses of variance						
Cultivar (C)	***(3.7)		***(6.1)		***(5.9)	
Top kill method (M)	***(3.3)		NS		NS	
C x M	NS		NS		NS	
CV (%)	9.8		16.3		14.5	

*** and NS indicate significance at P<0.001 level of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Table 24. Effect of method and time of top kill on 'consumption' grade yield for contrasting cultivars grown under irrigation.

Treatment	'Consumption' grade yield					
	Harvest I		Harvest II		Harvest III	
	t/ha	Cwt/ac	t/ha	Cwt/ac	t/ha	Cwt/ac
Cultivar						
Alpha	11.8	105	12.4	110	20.7	184
Norland	48.4	429	44.9	398	48.5	430
Russet Burbank	29.5	262	33.3	295	36.9	327
Russet Norkotah	34.3	304	37.1	329	38.2	339
Shepody	45.0	399	47.9	425	52.6	467
Top kill method						
Flail	29.9	265	35.9	318	39.6	351
Flail + Reglone	35.4	314	35.4	314	37.6	334
Reglone	36.2	321	34.1	302	41.0	364
Analyses of variance						
Cultivar (C)	**(4.3)		***(5.8)		***(5.0)	
Top kill method (M)	***(3.9)		NS		*(2.3)	
C x M	NS		NS		NS	
CV (%)	15.4		19.8		16.0	

***, **, *, and NS indicate significance at P<0.001, 0.01, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Effects of Soil Moisture Status during Seed Crop Production on the Performance of Progeny

J. Wahab[1], D. Waterer[2], G. Larson[1]

Table 25. Effects of cultivar, irrigation regime, and seed piece spacing of the seed crop on 'seed' and 'consumption' grade yields of the progeny.

Treatment	'Seed' grade yield		'Consumption' grade yield	
	t/ha	Cwt/ac	t/ha	Cwt/ac
Cultivar				
Atlantic	49.2	436	46.6	413
Norland	46.7	414	40.9	363
Russet Burbank	45.1	400	35.5	315
Russet Norkotah	44.0	390	38.8	344
Shepody	51.9	460	50.3	446
Irrigation regime				
Dryland	48.7	432	43.4	385
40% field capacity	48.4	429	42.9	381
65% field capacity	45.1	400	41.0	364
Seed piece spacing				
15 cm	48.2	428	42.9	381
20 cm	47.4	420	42.7	379
30 cm	46.5	412	41.8	371
Analyses of variance				
Cultivar (C)	***(2.6)		***(2.8)	
Irrigation (I)	***(2.7)		NS	
Spacing ()	NS		NS	
C x R	NS		NS	
C x S	NS		NS	
R x S	NS		NS	
C x R x S	NS		NS	
CV (%)	11.8		14.2	

*** and NS indicate significance at P<0.001 level of probability and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Previous studies have shown conflicting results on the productive capacity of seed potato grown under different soil moisture conditions. Studies conducted at the CSIDC showed that the moisture condition under which the seed crop was raised and the seed piece spacing utilized to grow the crop had no effect on productivity for five contrasting potato cultivars.

This study examined performance of seed for contrasting potato cultivars (Atlantic, Norland, Russet Burbank, Russet Norkotah, Shepody) produced under different moisture regimes (dryland, 40% FC, 65% FC) and seed piece spacings (15, 20, 30 cm, i.e. 6, 8, 12 in). The seed crop was raised in 1999 and the performance was evaluated in the summer of 2000.

Seed grown in dryland and under 40% field capacity produced 7%-8% higher 'seed' grade yield than the crop from seed raised at 65% field capacity. Moisture status of the seed crop had no effect on 'consumption' grade yields of the progeny (Table 25).

Seed piece spacing utilized to raise the seed crop had no effect on the productivity of the progeny tubers (Table 25).

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Effects of Nitrogen and Phosphorus Status during Seed Crop Production on the Performance of Progeny

J. Wahab[1], D. Waterer[2], G. Larson[1]

Management practices utilized for seed potato production can influence the performance of progeny tubers. Studies conducted at the CSIDC showed that seed potato grown with 100 kg N/ha (90 lb N/ac) produced higher 'seed' grade yield than seed grown using 50 kg N/ha (45 lb N/ac). The phosphorus levels under which the seed crop was grown did not affect the productivity of the progeny.

This study examined the performance Russet Norkotah, Ranger Russet, and Shepody seed potato raised under two nitrogen levels (50, 200 kg N/ha, i.e. 45, 180 lb N/ac) and two phosphorus levels (60, 120 kg P_2O_5/ha, i.e. 54, 108 lb P_2O_5/ac). The seed crop was grown in 1999 and its performance was evaluated in 2000.

The nitrogen and phosphorus levels utilized to raise the seed crops of Russet Norkotah, Ranger Russet, and Shepody had no effect on 'seed' or 'consumption' grade yields of the progeny (Table 26).

Table 26. Effects of nitrogen and phosphorus fertilization of the seed crop on 'seed' and 'consumption' grade yields of the progeny.

Treatment	'Seed' grade yield		'Consumption' grade yield	
	t/ha	Cwt/ac	t/ha	Cwt/ac
Cultivar				
Russet Norkotah	41.6	369	35.3	313
Ranger Russet	38.1	338	32.4	287
Shepody	51.9	460	50.7	450
Nitrogen				
50 kg N/ha	43.6	387	38.8	344
200 kg N/ha	44.0	390	40.1	356
Phosphorus				
60 kg P_2O_5/ha	43.8	389	39.0	346
120 kg P_2O_5/ha	43.8	389	40.0	355
Analyses of variance				
Cultivar (C)	***(3.5)		***(3.1)	
Nitrogen (N)	NS		NS	
Phosphorus (P)	NS		NS	
C x N	NS		NS	
C x P	NS		NS	
N x P	NS		NS	
C x N x P	NS		NS	
CV (%)	11.2		11.1	

*** and NS indicate significance at P<0.001 level of probability and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

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Crop Rotations Studies

J. Wahab[1], D. Waterer[2], T. Hogg[1], G. Larson[1]

Suitable crop rotation is essential for successful crop production. Proper management of soil, water, nutrients, weeds, insects, and diseases, is the key to successful crop production including potato. This project is designed to examine (i) the effects of the previous crop on potato, (ii) the influence of crop inputs and management used for potato on the performances of the succeeding crop in the rotation, and (iii) interactive effects of cropping sequence on potato growth and productivity.

The Effect of Previous Crop on Potato Productivity

J. Wahab[1], D. Waterer[2], G. Larson[1]

This study was designed to examine growth and productivity of potato when grown on wheat, dry bean, and canola stubble. Five contrasting potato cultivars (Norland, Russet Burbank, Russet Norkotah, Ranger Russet, Shepody) were evaluated under three nitrogen levels (150, 200, 250 kg N/ha; i.e. 135, 180, 225 lb N/ac) and two phosphorus levels (60, 120 kg P_2O_5/ha, i.e. 54, 108 lb P_2O_5/ac). Spring soil analysis results for the various tests are summarized in Table 27.

Table 27. Spring soil nutrient levels at 30 cm (12 in) depth for canola, wheat, and bean stubble prior to planting potato.

Nutrient	Canola		Wheat		Dry bean	
Texture	Loam		Loam		Loam	
pH	8.0		8.0		8.0	
EC (dS/m)	0.7		1.6		0.9	
	Nutrient Level					
	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
Nitrogen	72	64	43	38	50	45
Phosphorus	31	28	21	19	38	34
Potassium	730	652	721	644	900	804
Sulfur	102	91	96+	96+	84	75

The soil test for canola stubble plots indicated higher levels of nitrogen than the wheat stubble.
'Seed' grade yield for the various cultivars in response to nitrogen, and phosphorus application, and the stubble on which the potato crop was raised are summarized in Table 28.

Norland and Russet Burbank produced higher 'seed' grade yield and Shepody the lowest 'seed' grade yield when grown on wheat, dry bean, or canola stubble. Nitrogen and phosphorus rates had no effect on 'seed' grade yield on all three stubbles. This indicates that there is no advantage to increasing nitrogen rates beyond 150 kg N /ha (135 lb N/ac) applied nitrogen or phosphorus rates above 60 kg P_2O_5/ha (54 lb P_2O_5/ac) applied phosphorus.

All cultivars produced similar consumption grade yields when grown on wheat, dry bean, or canola stubble (Table 29).

There was no effect of nitrogen or phosphorus indicating that 150 kg N/ha (135 lb N/ac) and 60 kg P_2O_5/ha (54 lb P_2O_5/ac) was sufficient to grow a successful potato crop on all three stubbles.

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Table 28. Cultivar, nitrogen, and phosphorus effects on 'seed' grade yield for potato grown on wheat, bean, and canola stubble.

Treatment	'Seed' grade yield Wheat stubble t/ha	Wheat stubble Cwt/ac	Dry bean stubble t/ha	Dry bean stubble Cwt/ac	Canola stubble t/ha	Canola stubble Cwt/ac
Cultivar						
Norland	47.7	423	47.9	425	47.7	423
Russet Burbank	48.5	430	42.2	374	46.9	416
Russet Norkotah	40.4	358	37.1	329	41.4	367
Ranger Russet	41.5	368	41.5	368	42.0	373
Shepody	35.1	311	38.9	345	38.7	343
Nitrogen rate						
150 kg N/ha	44.8	397	42.9	381	43.4	385
200 kg N/ha	41.5	368	41.7	370	43.7	388
250 kg N/ha	41.6	369	40.0	355	43.0	381
Phosphorus rate						
60 kg P_2O_5/ha	43.5	386	42.3	375	43.6	387
120 kg P_2O_5/ha	41.4	367	40.8	362	43.1	382
Analyses of variance						
Cultivar (C)	***(4.1)		***(3.6)		***(2.6)	
Nitrogen (N)	NS		NS		NS	
Phosphorus (P)	NS		NS		NS	
C x N	NS		NS		NS	
C x P	NS		NS		*(3.7)	
N x P	NS		NS		NS	
C x N x P	NS		NS		NS	
CV (%)	16.8		15.0		10.5	

***, *, and NS indicate significance at P<0.001, 0.05 levels of probability, and not significant respectively.
Values within parentheses are LSD (5%) estimates for the corresponding treatments.

Table 29. Cultivar, nitrogen, and phosphorus effects on 'consumption' grade yield and french fry color for potato grown on wheat, bean, and canola stubble.

Treatment	'Consumption' grade yield Wheat stubble t/ha	Wheat stubble Cwt/ac	Dry bean stubble t/ha	Dry bean stubble Cwt/ac	Canola stubble t/ha	Canola stubble Cwt/ac	Fry color
Cultivar							
Norland	46.7	414	47.5	421	45.2	401	1.8
Russet Burbank	43.4	385	40.0	355	41.2	365	2.2
Russet Norkotah	44.3	393	44.8	397	43.8	289	2.2
Ranger Russet	43.8	389	44.2	392	41.2	365	2.2
Shepody	43.5	386	50.8	451	49.1	436	2.3
Nitrogen rate							
150 kg N/ha	44.3	393	45.9	407	42.9	381	1.9
200 kg N/ha	43.1	382	45.4	403	45.2	401	2.4
250 kg N/ha	45.2	401	45.5	404	44.2	392	2.0
Phosphorus rate							
60 kg P_2O_5/ha	45.4	403	46.5	399	43.7	388	2.1
120 kg P_2O_5/ha	43.3	384	44.4	394	44.5	395	2.1
Analyses of variance							
Cultivar (C)	NS		NS		NS		
Nitrogen (N)	NS		NS		NS		
Phosphorus (P)	NS		NS		NS		
C x N	NS		NS		NS		
C x P	NS		NS		NS		
N x P	NS		NS		NS		
C x N x P	NS		NS		NS		
CV (%)	16.0		13.8		13.9		

NS indicates non-significant treatment effects.

Productivity of Crops When Grown after Potato

J. Wahab[1], D. Waterer[2], G. Larson[1]

Potato is grown using large amounts of nitrogen and phosphorus fertilizers. It is likely that considerable amounts of nitrogen and phosphorus may remain in the soil after the potato crop. These residual nutrients can be productively utilized to grow crops after the potato.

This study is designed to examine the effect of potato residues on the productivity of field crops grown after potato. Nitrogen and phosphorus interactions for durum wheat (AC Morse) pinto bean (CDC Camino), field pea (CDC Handel), and canola (LG2153) were evaluated in this trial.

High to above average yields were obtained for wheat, canola, dry bean and field pea when grown without any fertilizer nitrogen and phosphorus (Table 30).

Soil analysis showed that substantial amounts of nitrogen and phosphorus remained in the top 30 cm (12 in) of soil even after growing the field crops subsequent to potato (Table 31).

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Table 30. Nitrogen and phosphorus effects on yield for selected field crops when grown after potato.

Treatment	Seed yield							
	Wheat		Canola		Dry bean		Pea	
	kg/ha	bu/ac	kg/ha	bu/ac	kg/ha	lb/ac	kg/ha	bu/ac
Nitrogen rate								
0 kg N/ha	5155	76.3	1795	31.8	1720	1530	2886	42.7
45 kg N/ha	5340	79.0	1766	31.3	1700	1510	3001	44.4
90 kg N/ha	5233	77.4	1741	30.8	1655	1470	2900	42.9
Phosphorus rate								
60 kg P_2O_5/ha	5253	77.7	1717	30.4	1726	1535	2914	43.1
120 kg P_2O_5/ha	5233	77.4	1817	32.1	1657	1475	2945	43.6
Analyses of variance								
Nitrogen (N)	NS		NS		NS		NS	
Phosphorus (P)	NS		NS		NS		NS	
N x P	NS		NS		NS		NS	
CV (%)	5.1		12.6		12.2		9.5	

NS indicates non-significant treatment effects.

For example, over 160 kg N/ha (over 160 lb N/ac) and 49 kg P_2O_5/ha (44 lb P_2O_5/ac) were recovered from wheat plots that did not receive any nitrogen or phosphorus fertilizer (Table 31). Somewhat similar amounts of nitrogen and phosphorus were recovered from the unfertilized canola and dry bean crops. Soil analyses consistently showed higher levels of soil phosphorus for crops that received phosphorus fertilizer.

Table 31. Fall residual soil nutrient levels at 30 cm (12 in) depth for the high and low fertility field crop treatments when grown on potato stubble.

	Treatment				Residual nutrient levels					
	Nitrogen		Phosphorus		Nitrogen		Phosphorus		Potassium	
Crop	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
Wheat	0	0	0	0	160+	160+	49	44	670	600
Wheat	90	80	25	22	160+	160+	96	86	860	768
Canola	0	0	0	0	160+	154	62	55	730	652
Canola	90	80	25	22	160+	160+	87	78	968	864
Dry bean	0	0	0	0	130	117	65	58	654	584
Dry bean	90	80	25	22	160+	160+	81	72	865	772

Potato Rotation

J. Wahab[1], D. Waterer[2], G. Larson[1]

Agronomic and economic impacts of potato-based long and short term rotations are being evaluated. Thirty-two cropping sequences containing potato, wheat, canola, dry bean, and field pea are being compared. This study is in progress.

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Processing Potato Agronomy

J. Wahab[1], D. Waterer[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year three of three*

Locations: *Saskatoon, CSIDC, Outlook*

Objective: *To develop production practices which enhance yields and quality of Saskatchewan grown seed potatoes.*

This series of studies examined the impact of top kill timing and method on yields and processing quality of several varieties of potatoes under Saskatchewan growing conditions

Trial 1. Vine kill and yields as a function of time after top-kill.

This project evaluated how several important varieties of potatoes respond to chemical desiccation. Trials were conducted from 1998-2000. The crop was planted in mid-May. In all three years Ranger Russet, Russet Burbank and Russet Norkotah were tested, while in 1999 and 2000 Shepody was also evaluated. The crop was irrigated and standard pest management and fertility recommendations were followed. The desiccant Reglone (diquat) was applied in the first week of September at 1.0 l/a via a ground sprayer in 120 l/ac of water. Seven days after the initial application of top killer, a second application was made (0.75 l/a in 120 l/ac water). The crop was harvested at specific intervals after top-killing with a small plot harvester.

Timing of harvest:

a) Fresh harvest (first week of September) - this approximates the typical time of top kill for seed and table potatoes in Saskatchewan.
b) Top-Kill + 10 days (third week of September) - 10-14 days after top killing represents the earliest growers can typically expect to harvest after top killing.
c) Top-Kill + 20 days (first week of October) - by this point, growers expect the crop should be ready to harvest. Any further delay increases the risk of frost damage.

One third of the plot was harvested at each interval. The plots for each harvest were 8 m long with four replicates of each treatment arranged in a randomized complete block design. Just prior to each harvest, the moisture content of the vines was also determined.

The Russet Norkotah vines died back more quickly than the other cultivars (Figure 3). This was expected as Norkotahs are early maturing and produce a relatively small and weak plant canopy. Ranger Russet was the slowest to desiccate - this also corresponds with most growers experience with this cultivar. Growing conditions following application of the top killer had a significant impact on how much yields increased following desiccation. In 1998, growing conditions were excellent for several weeks after application of the top killer. Yields increased quite substantially (30%) during this period (Table 32). By contrast, conditions in 1999 and 2000 were less conducive to crop growth and there was very little change in yields following the initial application of top killer in these years. The four

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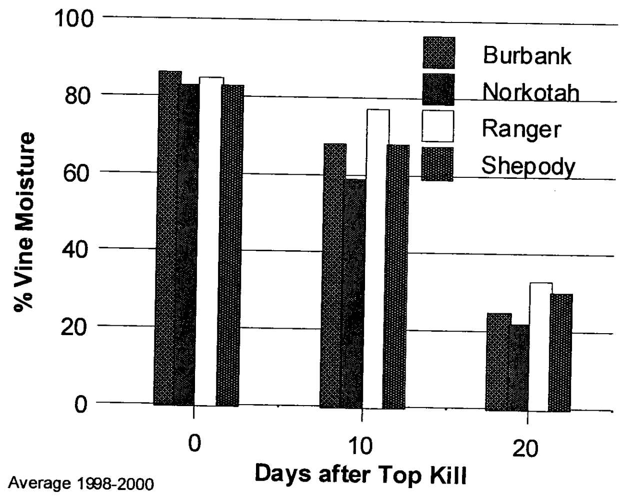

Figure 3. Vine moisture content for potato cultivars at different top kill dates.

cultivars were very similar in terms of how much their yields changed following top killing.

The results confirm growers observations as to the relative ease of top kill on processing type potato varieties. Cool conditions after top kill slowed desiccation, but frost accelerated drying. Contrary to expectation, the degree of yield change following application of the top killer did not increase in situations where vine kill was slow. The warm conditions conducive to rapid top kill actually appear to promote tuber bulking after top kill. By contrast cool conditions which slow top kill may also slow translocation of assimilates into the tubers after top kill.

Trial 2. <u>Changes in yields and processing quality after chemical top-killing for four potato varieties at four harvest dates.</u>

The previous trial indicated the potential for changes in yields from the time of top-killing through until harvest depended on crop vigor and prevailing growing conditions. This trial evaluated the relative changes in yields and processing quality which occurred following chemical top kill for four processing varieties. The crop was top killed at four dates, to further examine how the stage of crop maturity and prevailing weather conditions influence changes in yield and processing quality after top-killing.

Table 32. Influence of time after chemical top-kill on potato yields (1998-2000).

	1998		1999		2000	
	t/ha	Cwt/a	t/ha	Cwt/a	t/ha	Cwt/a
Top kill	31.7	283	34.0	303	44.6	397
Top kill + 10 days	37.3	333	36.1	322	44.1	393
Top kill + 20 days	41.4	369	37.6	335	44.6	397
LSD (0.05)	4.6	41	2.6	23	2.9	26

Yields averaged over four cultivars.

Trials were conducted in 1998, 1999 and 2000 in Saskatoon using Russet Burbank, Ranger Russet, Shepody and Russet Norkotah. Standard management practices were employed for both the dryland and irrigated crops. The crop was top killed at the following points and harvested two weeks later:

1) first week of August
2) third week of August
3) first week of September
4) third week of September

The first week of September approximates the standard date for chemical top-kill of potatoes in Saskatchewan. Late September would approximate the time of mechanical top kill employed by growers of processing potatoes in Manitoba. At each date, half of the plot was top-killed by mechanical removal of the vines at or near the soil surface. This treatment fixed yields at the instant of top kill. The other half of each test plot was sprayed with the standard chemical desiccant Reglone (diquat) applied at 1 l/ac via a ground sprayer in 120 l/ac of water. Seven days after the initial application of top killer, a second application was made (0.75 l/ac in 120 l water). The plots were harvested using a small plot harvester and graded into size categories. Fry color, texture and uniformity were evaluated using samples stored for four weeks at 10°C after harvest.

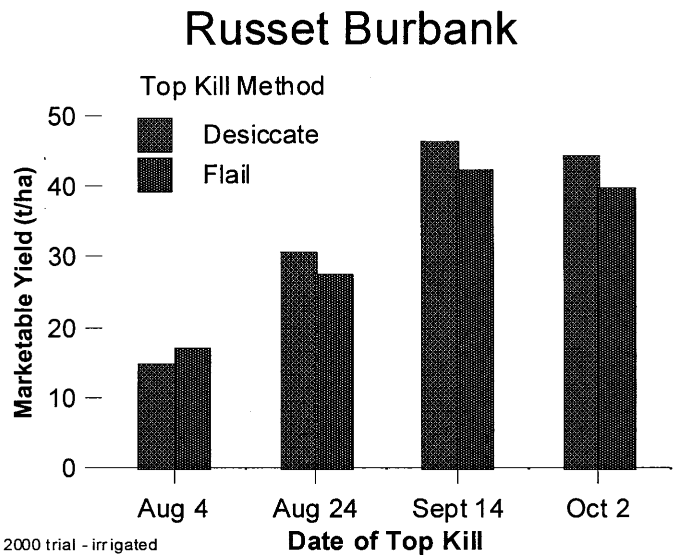

Figure 4. Effects of top kill methods and dates on marketable yield for Russet Burbank potato.

For all three test years the results for all test cultivars were consistent; the data for Russet Burbank is presented. In 1998, weather conditions and management practices combined to produce a difficult to kill canopy. In the two to three weeks it took for the tops treated with chemical desiccants to die back adequately, the crop continued to support tuber bulking. By contrast, flailing the tops stopped bulking instantaneously. Consequently in the 1998 trial, yields for the chemically desiccated crop were consistently higher than for a crop flailed on the same date. The crop canopy was far less vigorous in 1999 than in the previous year and as a consequence the chemical top killer worked rapidly. Frost in mid-September supplemented the activity of the chemical top killer. As a consequence, the degree of weight gain following chemical dessication was small. Similarly, the yield gained by each delay in the harvest was small by comparison to previous years. In 2000, chemically desiccating the crop again increased yields, particularly at the later harvest dates. Like 1998, the first fall frost in 2000 did not occur until late September. This allowed the chemically desiccated crop to translocate assimilates from the tops into the tubers resulting in improved yields over the flailed crop. The substantial increase in yields with the second and third harvests illustrates the fact that conditions were still suitable for growth of the potato crop at this time. In all cases where delaying the harvest increased yield the response was due to an increase in average tuber size (Figure 5).

Chemical desiccation serves two functions in potato production: It stimulates skin set and makes the tops more manageable with mechanical harvest. For a vigorous cultivar grown under irrigation, it takes two or more weeks following chemical desiccation for the tops to dry to the point that they can be efficiently handled. By contrast, flailing instantaneously eliminates the tops leaving the crop ready for harvest immediately, providing the lack of skin set is not a concern. Consequently a crop killed by flailing can be left to grow for at least a week longer than when chemical desiccants are used. This delay can result in a substantial yield. Averaged over the three test years, a Russet Burbank crop chemically desiccated during the third week of August gained 4 t/ha during the time required for the tops to dry enough to allow harvest (second week of September). However, a crop flailed during the second week of September was substantially (9 -12 t/ha) larger than the crop chemically desiccated in late August.

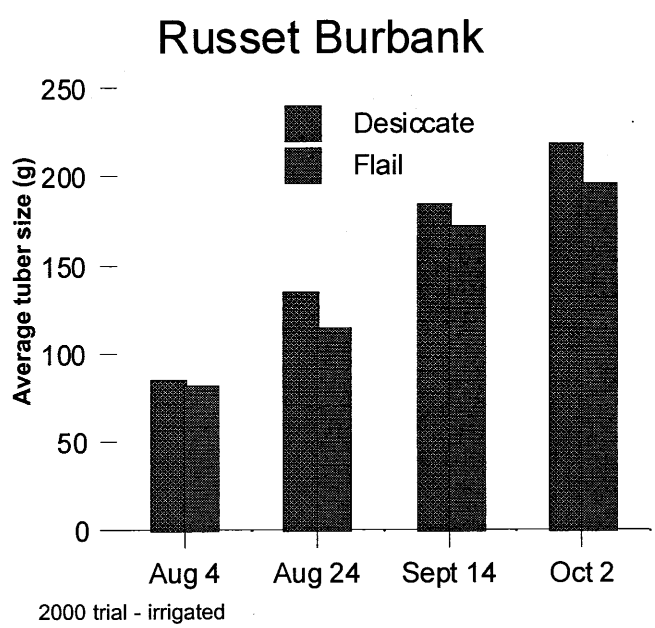

Figure 5. Effects of top kill methods and dates on average tuber weight for Russet Burbank potato.

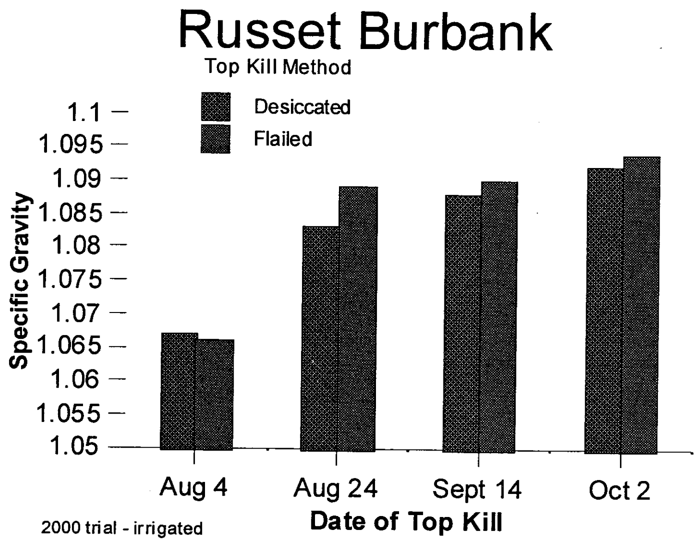

Figure 6. Tubers specific gravity for Russet Burbank potato in response to date and method of top kill.

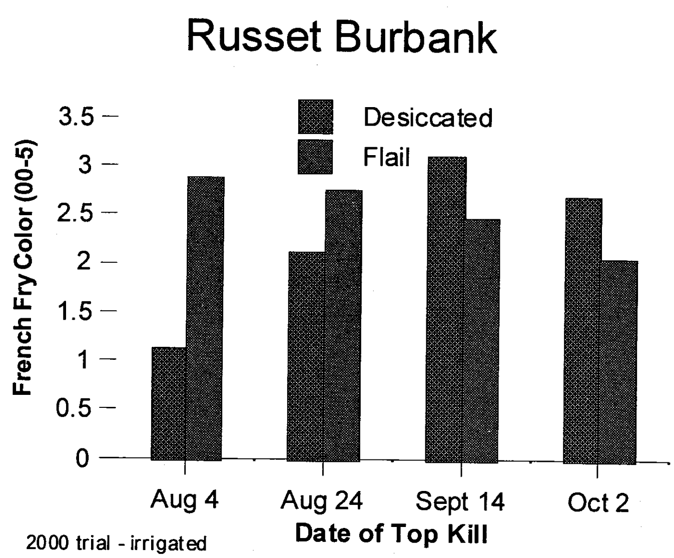

Figure 7. Fry colour for Russet Burbank potato in response to date and method of top kill.

Flailing appears to represent a higher yielding option than chemical desiccation where long season cultivars are grown in areas with a limited production season.

When evaluating the relative merits of chemical versus mechanical top-killing, a range of additional factors must be considered beyond basic yields;

a) cost in time and equipment of flailing relative to chemical desiccation,

b) impact on ease of harvest. Incomplete stolon removal is a common problem in flailed crops,

c) problems with skin set in the flailed crop may open the tubers to disease and/or desiccation during storage.

The impact of desiccation method on processing quality also must be considered. At any given harvest date, the specific gravities and fry colors of the chemically desiccated crop were either equivalent to or better than those of the flailed crop. Specific gravities tended to increase with each delay in harvesting the crop (Figure 6). Opting to delay harvest and then flailing the crop would have resulted in a consistent increase in specific gravities. As high gravities improve recovery percentages during frying, this improvement would be highly desirable in a processing crop. Typically fry colors also improve as the crop matures if the crop avoids exposure to chilling temperatures. In the three years of testing there was no consistent improvement in fry color as the crop matured: The delay in harvest made possible with flailing had no beneficial impact on fry quality (Figure 7). This suggests that there is a trade-off between the improved fry colors obtained with increasing maturity and the decline in fry quality caused by extended periods of cold weather.

Agronomics of New Potato Cultivars

D. Waterer[1], J. Wahab[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year three of three*

Locations: *Saskatoon, CSIDC, Outlook*

Objective: *To evaluate the agronomic characteristics and management requirements of newly released cultivars of interest to Saskatchewan's potato industry.*

This trial was designed to evaluate some of the basic agronomic characteristics and management parameters required by several newly released tablestock and processing cultivars of interest to Saskatchewan's potato industry.

The trials were conducted on the Plant Sciences Department Potato Research plots located in Saskatoon, and at the CSIDC using standard production practices for commercial potatoes. The crop was seeded in mid-May, in rows 1 m apart. Irrigated plots were watered once soil water potentials rose above -60kPa. Typically, 2.5 cm of water was applied at each irrigation event. The dryland plots relied solely on rainfall. Yields were evaluated at 90 and 120 days after planting. At both harvests, the crop was graded into size categories: small = < 44 mm diameter; 44 mm < medium < 88 mm; and oversize = > 88 mm diameter. Table stock yields included the medium and oversize categories. The seed category included the pooled yield of small and medium sized tubers.

Cultivars tested:

AC Peregrine Red — ***A newly released very dark red skinned variety under exclusive Canadian licence to the Saskatchewan Seed Potato Growers' Association.***

Cherry Red — ***This Colorado variety is exceptionally red and holds its colour well, but is late maturing.***

Umatilla — ***A new release from the Idaho breeding program, this russet skinned potato is believed to have superior processing and disease resistance characteristics to Russet Burbank.***

Gem Russet — ***A new release from the Oregon breeding program, this russet skinned potato is believed to have better yields and processing characteristics than Russet Burbank.***

Legend Russet — ***A new release from the Oregon breeding program, this russet skinned potato is believed to have better processing characteristics and table appeal than Russet Burbank.***

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Norland was consistently higher yielding than either AC Peregrine Red or Cherry Red at both harvests in both dryland and irrigated trials (Table 33). None of the new russet lines were as early, high yielding or uniform in appearance as Russet Norkotah (Table 34). All of the new russet lines produced final yields better than or equal to Russet Burbank. Umatilla was particularly early and high yielding. Specific gravities of the new russet lines were often higher than Russet Burbank, indicating excellent processing ability but also suggesting the potential for problems with blackspot bruising. The average tuber size of Legend was considerably larger than the other new russet varieties.

Table 33. New red-skinned potato cultivar yields in 2000.

	Early harvest - 90 days				Final harvest - 120 days			
	Table (t/a)	Seed (t/a)	Average tuber wt. (g)	Specific gravity	Table (t/a)	Seed (t/a)	Average tuber wt. (g)	Specific gravity
Dryland								
Norland	13	13.3	147	1.072	15	15.6	165	1.095
AC Peregrine	8.5	10.9	96	1.076	10.2	15.3	104	1.074
Cherry Red	10.2	10.9	145	1.083	13.4	13.5	164	1.099
Irrigated								
Norland	18.5	19.1	170	1.072	20.6	19.8	175	1.077
AC Peregrine	11.9	14.9	102	1.074	17.6	19.1	128	1.082
Cherry Red	14	14.6	163	1.078	18.2	16.8	185	1.09

Table 34. Yields for new russet-skinned lines in 2000.

	Early harvest - 90 days				Final harvest - 120 days			
	Table (t/a)	Seed (t/a)	Average tuber wt. (g)	Specific gravity	Table (t/a)	Seed (t/a)	Average tuber wt. (g)	Specific gravity
Dryland								
Russet Burbank	6.4	8.9	122	1.074	10.4	12.1	156	1.098
Russet Norkotah	10.6	11.9	177	1.078	14.2	14.6	210	1.093
Gem Russet	2.9	7.8	88	1.096	9	12.1	118	1.114
Umatilla	8.4	10.9	124	1.081	11.5	13.2	158	1.104
Legend	6.5	6.5	133	1.092	9.5	8.8	174	1.103
Irrigated								
Russet Burbank	8.2	10.9	120	1.078	15.8	17.1	170	1.097
Russet Norkotah	13.1	14.6	174	1.079	20.1	19.8	200	1.085
Gem Russet	8.4	11.4	119	1.09	17.6	19.2	171	1.103
Umatilla	10.8	13.5	138	1.079	19.2	20.6	172	1.096
Legend	10.5	10.4	165	1.091	17.2	16.2	185	1.099

Horticultural Crops Program

Horticultural Crops Program

Saskatchewan Vegetable Production - An Opportunity Awaits

O. Green[1], B. Vestre[2], L. Tollefson[2], H. Clark[2], D. Waterer[3]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year five of five*

Objective: *To demonstrate commercial scale vegetable production using new technologies under Saskatchewan conditions.*

Unloads of fresh vegetables in 1999 into the prairie provinces was approximately 244,500,000 kg (537,900,000 lb) (excluding potatoes and greenhouse vegetables). Saskatchewan supplied 0.4%. Saskatchewan's share of the 34,750,000 kg (76,450,000 lb) originating from the prairie provinces was 2.7%. 45.9% originated from Manitoba and 51.4% came from Alberta. Earlier analysis had placed Saskatchewan's "in-season" self- sufficiency in vegetables at 7% as compared to Manitoba at 57% and Alberta at 33%.

The total value of vegetable production on the prairies in 1998 was $84,700,000. The industry was worth $22,600,000 (26.7%) in Manitoba, $2,900,000 (3.4%) in Saskatchewan and $59,200,000 (69.9%) in Alberta.

Consumers in Saskatchewan spend approximately $25,000,000 annually for fresh vegetables that could be grown within the province. About 40 to 50% of that business goes to vegetable growers in other Canadian provinces, primarily Manitoba. The remaining 50 to 60% goes to support the economy of the United States.

In 1996 the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) initiated a vegetable project to demonstrate production and newer technologies such as drip irrigation, mulch, mini-tunnels, floating row covers and wind protection. In 1997 and 1998 the Agri-Food Innovation Fund (AFIF) provided funding to continue the project with eleven vegetable crops.

Project Description

The vegetable crops were grown on 0.2 ha (½ acre) sized blocks to simulate a commercial operation. The produce was harvested, washed, graded, packaged as appropriate and marketed to wholesale buyers to simulate commercial production. Data obtained was used to calculate a Saskatchewan-based cost of production for each crop.

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IRT (infrared transmissible) mulch was used alone or in combination with mini-tunnels and/or row covering where applicable for pumpkin, cucumber, pepper and cantaloupe. To make most efficient use of the mulch, crops were planted in a double row configuration along the outer edge with drip tape running between the two rows.

Wind protection was provided for the pumpkin, cucumber, cantaloupe and pepper by means of fall-rye solid seeded between the mulch rows either the previous fall or early in the spring.

A waterwheel planter was used to transplant cabbage, peppers, cantaloupe, broccoli, cauliflower, romaine lettuce, Brussels Sprouts and celery transplants directly or through the mulch. Pumpkin and cucumber were also seeded through the mulch with the waterwheel planter. A Stanhay precision seeder was used to direct seed pelleted carrot seed on raised beds.

Field days and tours were held to demonstrate production techniques to interested individuals. Wholesale buyers were invited to similar events to view the quality of the resulting crops and begin the process of encouraging the use of more "Saskatchewan Grown" produce.

The resulting produce was harvested, washed, graded and packed as appropriate and moved to wholesale and/or processing markets. Peppers remaining at season end were processed and marketed as a frozen diced product in two years of the project.

Results

During the first year of the project, cumulative corn heat units were near average at 2369 (refer to weather summary). 1998 saw much higher values at 2545. 1999 was much lower at 2077 and 2000 near average at 2300. These are compared to the long term average of 2253 (1931-2000). The heat loving crops (pumpkin, cucumber and pepper) performed exceptionally well in 1998 while cabbage, being a cool season crop, performed much better in 1999.

Pumpkin

Pumpkin has produced the most impressive results. Yields from 87 to 143 t/ha (38.7 to 63.5 tons/ac) were achieved. The average price was $0.319/kg ($0.145/lb) (Table 1).

The quality of the pumpkin was excellent and was well received. Most were completely orange in the field. Some late pollinated pumpkin required further ripening but there was very little loss due to green colour.

The net returns were positive each year ranging from a low of $7,324/ha ($2,964/ac) in the last year of the project to a high of $21,675/ha ($8,772/ac) in the second year. These results have encouraged a number of private operations to grow pumpkin. Since there is a limited market for pumpkins and it is also very seasonal, persons interested in growing pumpkins should exercise caution.

Carrot

In terms of ease of production, quality, yield, and market demand, carrot production is one of the more attractive options for further development. They are one of the few vegetable crops that can be entirely mechanized similar to potato.

Bunched carrots (6 to 8 per bunch X 24/case) returned the equivalent of 1,740 cases/ha (704 cases/ac) valued at $20,613/ha ($8,342/ac). This is for one production year of data.

Topped carrot yields ranged from a low of 19.6 t/ha (8.7 tons/ac) in 1999 to a high of 57.5 t/ha (25.5 tons/ac) in the first year of the project (Table 1). The higher yield would be more indicative of carrot production potential.

Of the total marketable crop, an average of 78.3% was sold as a Canada No.1 product either in a 0.9 or 2.3 kg (2 or 5 lb) poly consumer pack while the remaining 21.7% was moved into the processing market.

The scale of this project did not lend itself to efficiencies in harvest nor in the washing, grading and packaging operation. As a consequence the actual costs did not result in a positive net return. Assuming machine harvest and a washing, grading and packaging line along with good storage, it would appear that net returns in the range of $7,500/ha ($3,000/ac) could be achievable.

Cabbage

Comparison of direct seeded cabbage to transplant production in the first two years indicated yields of 62.8 t/ha (27.9 tons/ac) for transplants and 18.3 t/ha (8.1 tons/ac) for direct seeding. Transplant production incurred extra costs of $2,000/ha ($807/ac). At an average selling price of $0.246/kg ($0.112/lb) the net return for transplant production was $11,000/ha ($4,430/ac) which more than covered the additional expense. In addition, transplanted cabbage was harvested about 10 days earlier than direct seeded cabbage. In spite of a spraying schedule for flea beetle, root maggot and imported cabbage worm control, the direct seeded cabbage appeared to suffer more than transplants further encouraging the use of transplants.

The average yield from transplants over the three years of the project was 72 t/ha (32.0 tons/ac). With an average price of $0.246/kg ($0.112/lb) the gross returns were $17,732/ha ($7,153/ac) (Table 1).

Peppers

Pepper production is weather dependent and as such results have been more variable than those obtained for the other crops. Total heat units not only affected yield but quality in terms of both fruit size and of the volume of red peppers produced. Overall marketed yields ranged from 340 kg/ha (300 lb/ac) in the last year of the project to a high of 49,200 kg/ha (43,667 lb/ac) in the second year (Table 1).

Peppers are sold on the basis of size and color. Those not sufficiently sized can be sold as chopper grade for restaurants and institutions. Red peppers for the retail market command a premium price. The price ranged from a low of $0.72/kg ($0.327/lb) for green chopper peppers to a high of $2.60/kg ($1.18/lb) for retail red peppers.

The option of making diced frozen peppers from produce picked immediately prior to freeze up was explored in the latter two years of the project. An acceptable product could be produced. Efficiencies of scale and some degree of mechanization, particularly to the cutting operation, would be required in order to make it economically viable.

Slicing Cucumber

Cucumber production is a labour intensive crop requiring careful harvest every two days during the peak picking period. Moving vines aggressively during harvest resulted in abrasion damage to young undeveloped fruit. This later resulted in scarring. These fruit were subsequently not saleable. Leaving vines relatively intact while searching for harvestable fruit and removing cucumbers with minimal vine disturbance is necessary.

High harvest costs resulted in this crop being the least attractive in the project. Losses from scarring and temporary surpluses on occasion resulted in losses ranging from 20 to 36% of marketed yields.

Marketed yield ranged from a low of 2,400 cases/ha (968 cases/ac) (24 count/case) as a result of lower heat units in the last year of the project to a high of 5,820 cases/ha (2,347 cases/ac) with gross dollar return ranging from $12,500 to $31,500/ha ($5,041 to $12,705/ac) (Table 1).

Further mechanization in terms of picking aids and improved packaging efficiencies would significantly improve the economics of cucumber production.

Broccoli

Broccoli was grown sequentially using transplants. Direct seeded broccoli did not perform well. The larger heads were of excellent quality and well received. Harvesting frequency was critical with earlier harvests but slower development later in the fall allowed more flexibility in harvest and marketing. Light frosts were not a problem allowing harvest to continue into early October.

The heads were field trimmed, placed in pallet bins, stored in a filacell cooler and subsequently graded, packed 14 count per case, top iced, and shipped.

In 1999, a yield equivalent of 3,043 cases/ha (1,232 cases/ac) were marketed at an average price of $10.39/case for a gross return of $31,616/ha ($12,800/ac) (Table 1). Average yield was lower but the 1999 results should be more indicative of potential.

Cauliflower

Problem with head discoloration reduced the economics of cauliflower production in this project. The market demands a white head that is achieved through the use of self blanching varieties, adequate moisture and fertility that ensures maximum leaf growth, and earlier harvest at the 12 count size to avoid any exposure of the head to sunlight. While several frosts did not damage the cauliflower it was very slow to size during late September and early October.

Most of the cauliflower was harvested as a 12 count head, individually wrapped, and sold 12 heads per case.

A total of 2,383 cases/ha (965 cases/ac) were marketed at an average price of $9.80/case in 1999 for a total return of $23,363/ha ($9,459/ac) (Table1). Average returns over the term of the project, however, were negative.

Brussels Sprouts

This is a labour intensive crop when harvested by hand. In addition, the sprouts are difficult to remove and would create some distress to workers with a larger area to harvest. In 2000 the stalks were harvested and marketed with the sprouts attached. This method of harvest reduced labour cost by three to four times but did increase packing costs.

Yields of 16,300 kg/ha (14,520 lbs/ac) and 13,325 kg/ha (11,870 lbs/ac) were achieved in 1999 and 2000. Gross returns of $19,962/ha ($8,082/ac) and $23,455/ha ($9,496/ac) resulted in an average net return of $7,850/ha ($3,178/ac) in the project.

The quality of the sprouts seemed acceptable but variability in size may require some mechanical means of sizing. The success of this crop will depend on the introduction of some means of mechanical harvest or consumer acceptance of stalks with sprouts attached.

Celery

This is a long season crop requiring transplants started in March and field planted in early June after the temperature remains above 10°C (50°F). It is a crop that needs and responds well to good moisture levels throughout the growing period.

The celery was harvested commencing in early September and concluded in early October. Quality was good to excellent with very little stringiness although some plants did develop a more open stature as the season progressed. These were not marketable. Exposure to several light frosts did no serious harm but a severe frost of -9.4°C in October 2000 destroyed the remaining crop.

An average of 1,491 (24 count) cases/ha (604 cases/ac) or 66% of the population planted was marketed at an average price of $15.66 per case for a gross of $21,475/ha ($8,695/ac) (Table 1). Celery had the highest labour to variable cost ratio in the project, however, which contributed to a break even net return. Harvest and field trimming were the most significant labour cost. Celery is difficult to cut but some means of mechanical cutting combined with more efficient trimming would improve the economics of celery production.

Romaine Lettuce

Romaine lettuce was sequentially planted using transplants exclusively as the project progressed. The bulk of the harvest originated from the first two plantings. Lettuce maturing later in the mid-summer heat did not form adequate heads for harvest. The quality of this early production was excellent with good-sized heads and no tip burn.

The equivalent of 1,356 (24 count) cases/ha average (549 cases/ac) was marketed at an average price of $10.47 per case giving a gross return of $13,782/ha ($5,580/ac) (Table 1). This lower than expected yield (60% of the population planted) limited the trial to a break even net return. The price in 1999 of $8.49 per case was also less than the more normal $11 to $12/case.

Cantaloupe

Cantaloupe was successfully grown from transplants as well as seed on IRT mulch under mini-tunnels in this project. Harvest commenced in early August and continued until all fruit was harvested in September. Even after light frost had destroyed the vines the fruit continued to mature and was still marketable.

Consumers continue to be impressed with the quality of "Saskatchewan Grown" cantaloupe picked at or close to full slip. Sugar content of this cantaloupe was as high as 14% but more normally in the 9 to 12% range. Imported cantaloupe is harvested several days prior to full slip to accommodate shipping requirements and has about half the sugar content. Cantaloupe harvested at or close to full slip, however, has limited shelf life which will require the co-operation of the wholesale/retail sector to move produce through the system faster. An educational program for consumers may also be required.

Identifying locally grown cantaloupe, which is essentially identical to imported produce in appearance, and subsequent promotion will be essential to command a premium for this superior quality.

Cantaloupe is sold by count (9, 12, 15, 18 or 23/case) with the greatest demand for 15 and 18 count. An average yield of 1,919 cases/ha (777 cases/ac) was marketed at an average price of $12.01 per case for a gross return of $22,971/ha ($9,300/ac) (Table 1). Yields based on sampling ranged as high as 3,031 cases/ha (1,308 cases/ac).

Table 1a. Average yield, selling price, gross and projected net return for irrigated vegetable crops, 1997 to 2000, SI units.

Crop	Mean yield (kg/ha)		Mean selling price ($/kg)	Gross return ($/ha)	Net return ($/ha)	Projected net return ($/ha)
Pumpkin	109,473		0.321	35,141	15,460	16,450
Carrot	40,498		0.488	19,763	3,670	9,050
Cabbage	71,792		0.247	17,733	3,870	4,840
Pepper	25,249		1.092	27,572	2,210	5,440
Brussels Sprouts	14,778		1.50	22,167	7,880	10,200
	Mean yield (cases/ha)	#/case	Mean selling price ($/case)	Gross return ($/ha)	Net return** ($/ha)	Projected net return ($/ha)
Cucumber	4,622	24	5.38	24,866	2,020	3,740
Broccoli*	3,043	14	11.74	35,725	2,335	7,700
Cauliflower*	1,718	12	9.38	16,115	(3,550)	4,220
Romaine Lettuce*	1,362	24	10.47	14,260	370	5,430
Celery*	1,498	24	15.66	23,459	(450)	3,490
Cantaloupe*	1,927	9 - 23	12.01	23,143	1,640	7,700

*1999 and 2000 only
**Values in brackets indicate a negative return

Table 1b. Average yield, selling price, gross and projected net return for irrigated vegetable crops, 1997 to 2000, Imperial units.

Crop	Mean yield (lb/ac)		Mean selling price ($/lb)	Gross return ($/ac)	Net return ($/ac)	Projected net return ($/ac)
Pumpkin	97,740		0.146	14,150	6,235	6,640
Carrot	36,160		0.222	9,360	1,480	3,650
Cabbage	64,100		0.122	7,150	1,560	1,950
Pepper	22,540		0.495	11,160	890	2,190
Brussels Sprouts*	13,195		0.680	8,790	3,180	4,120
	Mean yield (cases/ac)	#/case	Mean selling price ($/case)	Gross return ($/ac)	Net return** ($/ac)	Projected net return ($/ac)
Cucumber	1,865	24	5.38	10,030	810	1,510
Broccoli*	558	14	11.74	6,223	940	3,100
Cauliflower*	693	12	9.38	5,410	(1,430)	1,700
Romaine Lettuce*	549	24	10.47	5,580	150	2,190
Celery*	604	24	15.66	8,700	(180)	1,410
Cantaloupe*	777	9 - 23	12.01	9,300	665	3,100

*1999 and 2000 only
**Values in brackets indicate a negative return

Table 2a. Range in yield, selling price, gross and projected net return for irrigated vegetable crops, 1997 to 2000, SI units.

Crop	Mean yield (kg/ha)		Mean selling price ($/kg)		Gross return ($/ha)		Projected net return* ($/ha)	
	Low	High	Low	High	Low	High	Low	High
Pumpkin	191,950	314,835	0.330	0.380	28,770	42,185	7,340	21,750
Carrot	99,030	126,650	0.520	0.590	21,900	24,530	3,500	3,840
Cabbage	124,420	199,910	0.250	0.320	13,320	20,060	2,650	5,630
Pepper	740	108,300	1.13	1.41	350	48,610	(12,000)	12,970
Brussels Sprouts	29,440	36,010	1.39	1.98	20,040	23,560	6,200	9,570
	Mean yield (cases/ha)		Mean selling price ($/case)		Gross return ($/ha)		Projected net return ($/ha)	
	Low	High	Low	High	Low	High	Low	High
Cucumber	2,405	5,830	5.20	5.58	12,500	31,500	(1,165)	3,770
Broccoli	260	3,050	10.39	14.00	2,800	31,740	(2,850)	9,598
Cauliflower	890	2,390	7.50	10.84	6,740	23,460	(7,265)	2,852
Romaine lettuce	1,115	1,770	8.49	11.99	13,170	15,015	(2,260)	1,810
Celery	965	2,255	12.00	22.25	16,340	26,980	(3,695)	4,538
Cantaloupe	1,440	2,230	11.10	12.47	17,980	27,750	(2,730)	4,092

*Values in brackets indicate a negative return

Table 2b. Range in yield, selling price, gross and net return for the irrigated vegetable crop demonstration, 1997 to 2000, Imperial units.

Crop	Mean yield (lb/ac)		Mean selling price ($/lb)		Gross return ($/ac)		Projected net return* ($/ac)	
	Low	High	Low	High	Low	High	Low	High
Pumpkin	77,400	126,950	0.134	0.155	11,600	17,010	2,960	8,770
Carrot	39,930	51,070	0.210	0.238	8,830	9,890	1,410	1,550
Cabbage	50,170	80,610	0.100	0.130	5,370	8,090	1,070	2,270
Pepper	300	43,670	0.454	0.570	140	19,600	(4,830)	5,230
Brussels Sprouts	11,870	14,520	0.560	0.800	8,080	9,500	2,500	3,860
	Mean yield (cases/ac)		Mean selling price ($/case)		Gross return ($/ac)		Projected net return ($/ac)	
	Low	High	Low	High	Low	High	Low	High
Cucumber	970	2,350	5.20	5.58	5,040	12,700	(470)	1,520
Broccoli	105	1,230	10.39	14.00	1,130	12,800	(1,150)	3,870
Cauliflower	360	965	7.50	10.84	2,720	9,460	(2,930)	1,150
Romaine lettuce	450	715	8.49	11.99	5,310	6,055	(910)	730
Celery	390	910	12.00	22.25	6,590	10,880	(1,490)	1,830
Cantaloupe	580	900	11.10	12.47	7,250	11,190	(1,100)	1,650

*Values in brackets indicate a negative return

Labour

The most significant cost associated with vegetable production in this project was labour. Labour cost ranged from a low of 33.2% of total for pumpkin variable cost to a high of 70.1% for celery. The average was approximately 50%.

The development of mechanization and efficient operating systems is an essential requirement to improve the profitability for commercial operations. Managing the human resource by selecting suitable employees, motivating employees and rewarding productivity is equally important to assure production efficiencies.

Cost of Production

A detailed cost of production analysis based on actual experience for each of the three years along with an average and a projection for each crop is available. The projected cost of production for each crop reflects an estimation of what a commercial operation should reasonably expect in terms of yields, returns and costs.

Conclusion

The results from this project have shown that acceptable yields of suitable quality produce can be grown in Saskatchewan. Where proximity to market is a factor allowing more timely harvest and delivery then superior quality produce can be offered for sale. Net returns have been positive for the most part. Since labour is such a significant component of variable costs, produce and efficient use of labour is critical.

This project has resulted in additional private production, particularly with pumpkin, and interest in other vegetable crops. A new generation co-operative, in the formative stages, is an attempt to further develop the vegetable industry by co-ordinating marketing to the wholesale/retail and processing market.

The Canada food guide recommends the consumption of five to ten servings of fruits and vegetables per day for a healthy diet. Why not make it "Saskatchewan Grown"?

High Tunnel Demonstration

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Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

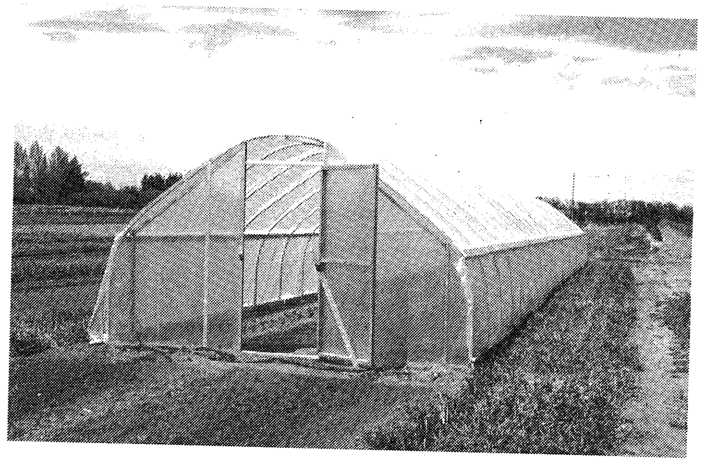
Progress: *Year three of three*

Location: *Saskatoon; CSIDC, Outlook*

Objective: *To evaluate high tunnel growing systems for high value horticultural crops under Saskatchewan growing conditions.*

High tunnels are similar to low tunnels in design and function, except that; a) one high tunnel covers several rows, b) the high tunnels are wide enough to allow crop growth to full maturity under the tunnels, and c) the tunnels are tall enough to allow spraying, cultivation and harvesting to occur with the tunnels intact. Rolling up the sides and/or opening the end doors of the high tunnels provide both ventilation and access to the crop by pollinating insects.

Interior and exterior views of high tunnel structure.



The initial costs of materials and installation of high tunnels are considerably higher than traditional low tunnels. However, the economics of production with high tunnels may be favourable if; a) they increase yields, b) they enhance earliness resulting in greater market access at a time when prices are at a premium, and c) the high tunnels are durable enough to be used for several seasons, thereby amortizing the costs of materials and installation over a greater length of time.

High tunnel trials have been compared with standard low tunnels in three years of trials (1998-2000) conducted at the Horticulture Science Field Research Station in Saskatoon and at the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) in Outlook. Peppers and melons were tested at both sites and tomatoes were also tested in Saskatoon. All crops were transplanted. Plants in the standard management plots were covered from transplanting until early July by tunnels constructed of clear perforated polyethylene or spun bonded polyester over metal hoops. The tomatoes were not covered. Air and soil temperatures were monitored inside the high tunnel, in the standard tunnels and

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in the open. The crops were harvested twice weekly once fruit reached maturity. Fruit were counted, weighed and graded for acceptability based on locally accepted standards. Harvesting of the standard management plots continued until the first killing frost at which time all remaining fruit were harvested. Harvesting of the high tunnel was discontinued once cold temperatures or senescence effectively ended fruit production.

The 1999 and 2000 growing seasons were much cooler than in 1998. The first frost was two weeks later in 1998 than in 1999 and 2000.

High Tunnel Management - At the conclusion of the third growing season, the cover at the Saskatoon site was still in good condition, but the cover at the more exposed Outlook site had to be repaired due to tearing. Daytime temperatures within the high tunnels at Saskatoon were well above outside air temperatures but were somewhat lower than the temperatures recorded inside the standard low tunnels. Consequently, the crop under the low tunnel developed as quickly in the spring as the crop in the high tunnel. Only after the low tunnels had to be removed due to crowding did the high tunnel produce a significant growth advantage. No unusual problems with insects or diseases were observed in the high tunnel. The high tunnel only provided about 1-3°C of frost protection, suggesting limited potential for extension of the growing season.

Melons

Saskatoon site

Crop development was more rapid in 1998 than in 1999 and 2000, resulting in substantial differences in yields. The first fruit always matured two to three weeks earlier in the high tunnel than in the standard treatments. In 1998, total yields of mature fruit of cv. Earligold were 23% higher in the high tunnel than in the standard treatment (Table 3). In 1999, the high tunnel out-yielded the standard tunnels by a factor of four fold, while in 2000 none of the fruit in the standard tunnel treatments matured before the first frost. Fruit flavor and sugar content were comparable for fruit produced either inside or outside the high tunnel.

Table 3. Yield characteristics for Earligold melon grown inside the high tunnel as compared to standard production practices in 1998, 1999, and 2000 at Saskatoon and Outlook, Saskatchewan.

	1998				1999				2000			
	Ripe fruit yield	% mature	Mean fruit weight		Ripe fruit yield	% mature	Mean fruit weight		Ripe fruit yield	% mature	Mean fruit weight	
Treatment	(kg/m row)	fruit	(kg)	(lb)	(kg/m row)	fruit	(kg)	(lb)	(kg/m row)	fruit	(kg)	(lb)
Saskatoon site												
High tunnel	32.0	98	1.66	3.65	12.6	82	1.28	2.82	8.7	90	1.10	2.42
Standard	24.3	85	1.27	2.79	2.4	35	0.76	1.67	0	0	0.90	1.98
LSD	NS	**	**		**	**	**		**	**	*	
Outlook site												
High tunnel	22.0		1.52	3.34	17.6		1.32	2.90	12.3		1.51	3.32
Mini-tunnel early[1]	5.0		1.11	2.44	0.4		0.69	1.52	1.1		0.59	1.30
Mini-tunnel late[2]	15.0		1.48	3.26								

[1]Transplants started late April, planted late May
[2]Transplants started mid May, planted late May
*, **, and NS indicate significance at P<0.05, P<0.01, and not significant respectively

Outlook site

Similar results were observed at the Outlook site. High tunnel production was earlier by one to three weeks. The first fruit were harvested July 22, August 8, and July 27 in 1998, 1999, and 2000 respectively. Yields were increased in the high tunnel. High tunnel yields on an area basis were 4,856, 5,360, and 3,917 cases/ha (1,966, 2,170, and 1,586 cases/ac) in 1998, 1999, and 2000 respectively. In comparison, the greatest yield recorded using standard production techniques was 3,231 cases/ha (1,308 cases/ac) in 1998.

Tomato

Flowering was first noted two weeks earlier inside the high tunnel than in the standard management regime. In all three years, the first fruit matured two to three weeks earlier in the high tunnel than in the standard treatment. Only a small fraction of the fruit set in the standard production system matured prior to the first frost. Plants in the high tunnel were largely unaffected by frost through until October. Total yields (weight) of mature fruit of cv. Spitfire were 33% greater in the high tunnel than for the standard treatment in 1998 (Table 4). In 1999, yields of mature fruit in the high tunnel were 200% greater than outside, while in 2000, yields for cv Sunbrite were 50% higher in the high tunnels than outside. Fruit taste and overall appearance was comparable inside or outside the high tunnel. The incidence of fruit rot was lower inside the tunnel than outside in 1998 and 1999, but in 2000 a high percentage of the fruit in the high tunnels were graded out due to bacterial speck. At the termination of the trial there were still substantial numbers of immature fruit on plants growing inside the high tunnel. Total yields (mature + immature) were only slightly higher inside the high tunnel than in the standard management regime.

Table 4. Yield characteristics for Spitfire tomato grown inside the high tunnel as compared to standard production practices in 1998, 1999, and 2000 at Saskatoon, Saskatchewan.

	1998			1999			2000		
Treatment	Ripe fruit yield (kg/m row)	% mature fruit	Mean fruit weight (g)	Ripe fruit yield (kg/m row)	% mature fruit	Mean fruit weight (g)	Ripe fruit yield (kg/m row)	% mature fruit	Mean fruit weight (g)
Saskatoon site									
High tunnel	23.1	68	144	11.6	63	146	14.8	52	172
Standard	14.8	50	186	3.8	28	106	7.9	44	195
LSD	*	NS	*	**	**	**	**	NS	*

*, **, and NS indicate significance at P<0.05, P<0.01, and not significant respectively

Peppers

Saskatoon site

In 1998 and 2000, the pepper plants inside the high tunnel lacked vigor throughout the season. No definitive cause of this problem could be determined. The first fruit turned red two to three weeks earlier in the high tunnel than in the standard treatment. In 1998, yields of mature red fruit for cv. Staddon's Select were 73% greater in the high tunnel than for the standard treatment. In 1999, no fruit matured outside of the high tunnel, while yields of mature fruit inside the high tunnel were excellent. In 2000, yields inside the high tunnel were very poor. Outside the high tunnel, the crop grew normally, but few fruit matured prior to fall frost. Average fruit size and overall appearance were comparable for fruit produced either inside or outside the high tunnel. At the termination of the trial, there were still some immature fruit on the plants both inside and outside the high tunnel. With these fruit included in the total yields, the high tunnel produced a 68% yield advantage over the standard tunnel treatment.

Outlook site

Peppers matured earlier with more red fruit produced in the high tunnel than with standard production techniques. Harvest was 14 days earlier in 1998, and 10 days earlier in 1999 and 2000. Mature peppers were harvested in the high tunnel as early as July 29 in 1998, and as late as September 2 in 1999. Yields under the high tunnel were equivalent to 51 850, 66 960, and 72 800 kg/ha (46,198, 59,661, and 64,865 lb/ac) in 1998, 1999, and 2000 respectively. The varieties Whopper Improved and Superset produced superior quality and size of red fruit than did Valencia or Ultraset, although total fruit yield was lower.

Table 5. Yield characteristics for peppers grown inside the high tunnel as compared to standard production practices in 1998, 1999, and 2000 at Saskatoon and Outlook, Saskatchewan.

Treatment	1998			1999			2000		
	Ripe fruit yield (kg/m row)	Total yield (kg/m)	Mean fruit weight (g)	Ripe fruit yield (kg/m row)	Total yield (kg/m)	Mean fruit weight (g)	Ripe fruit yield (kg/m row)	Total yield (kg/m)	Mean fruit weight (g)
Saskatoon site[1]									
High tunnel	4.5	5.01	133	2.4	2.8	116	0.9	2.4	104
Standard	1.1	1.56	120	0.1	0.3	136	0.1	3.1	124
LSD	**	**	NS	**	**	NS	*	**	**
Outlook site[2]									
High tunnel	9.4	9.4			12.1			13.2	
Mini-tunnel		8.9			0.1			4.2	

[1]Variety = Staddon's Select
[2]Variety = Valencia and Ultraset in 1998 and 1999; Whopper Improved and Ultraset in 2000
*, **, and NS indicate significance at P<0.05, P<0.01, and not significant respectively

Economic analysis

As indicated by Table 6, the high tunnels generally produced a higher gross return/unit row length than did the standard production practices. However, the material costs for the high tunnels ($31.00/m of row (assuming three rows) or $36.50/m^2) far exceed the cost of the standard tunnels ($ 0.78/m of row or 0.39/m^2 assuming rows are 2 m apart). As a consequence, the net returns over capital costs for the high tunnels were only marginally better than for the standard tunnels (Table 7).

Table 6. Gross returns for high tunnel and standard production systems, Saskatoon.

Treatment	Wholesale price[1] ($/kg)	Gross return ($/m row)		
		1998	1999	2000
Peppers				
High tunnel	1.08[2]	5.40	3.02	2.70
Standard		1.73	0.21	2.25
Melons				
High tunnel	0.68	18.22	9.65	5.16
Standard		14.48	2.85	0
Tomato				
High tunnel	0.81	16.68	12.47	11.01
Standard		11.50	3.42	3.68

[1]FOB Saskatoon
[2]Red fruit price

Table 7. Number of seasons before returns net of costs of material for high tunnels exceeds standard low tunnels.				
Crop	1998	1999	2000	Mean
Peppers	8.2	10.7	---	>10
Melon	8.0	4.4	7.0	6.5
Tomato	5.8	3.3	4.9	4.6

Conclusion

Based on three years of study, the high tunnels do not provide enough yield advantage to offset their much higher purchase and operating costs if growers are selling into the wholesale market.

Options for making High Tunnels more economical:

1) **reduce capital costs** - through lower cost materials and more efficient construction;

2) **increase yields/unit area** - through use of better varieties, closer spacing of rows, staking and use of agronomic practices tailored for high intensity production; and

3) **grow higher value crops** - attach price premiums to produce available either earlier or later than the competition. Direct sales result in substantially better returns than marketing through the wholesale system.

Cultivar Evaluation Trials and New Cultivar Development for Native Fruit Species

R. St-Pierre[1], L. Tollefson[2], B. Schroeder[3]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Native fruit crops, such as black currant, chokecherry, highbush cranberry, and pincherry have substantial potential to contribute to the diversification of Saskatchewan's agricultural economy. Native and traditional fruit cultivar evaluation trials were established previously under the Canada-Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED).

All native fruit crops tested at the CSIDC were planted in the fall of 1994 and the spring of 1995. During the project, survival and growth data are being collected from black currant, chokecherry, highbush cranberry, and pincherry cultivar trials. Fruit yield and size data are collected from the black currant and chokecherry trials.

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Development of Irrigation Guidelines to Enhance Saskatoon and Chokecherry Production and Fruit Quality

R. St-Pierre[1], L. Tollefson[2], B. Schroeder[3]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Scientifically established guidelines for irrigation of chokecherry and saskatoon are currently not available. Chokecherry and saskatoon irrigation trials were established previously at the CSIDC (Outlook) and PFRA (Indian Head) under the Canada-Saskatchewan Partnership Agreement on Water-Based Economic Development (PAWBED). Continuation of these trials under AFIF funding will help address the needs for improved management guidelines for these crops.

For the irrigation component of this project, experimental orchards were established at the CSIDC, Outlook and the Shelterbelt Centre, Indian Head. Each site was approximately 0.8 hectare in area and was surrounded by a multiple row shelterbelt consisting of buffaloberry, sea buckthorn and chokecherry seedlings. Saskatoons and chokecherries were planted as separate trials. A randomized complete block experimental design with six replicates of six soil moisture treatments (irrigation at 15, 30, 45, 60, 75 and 90 centibars) was used. Data collection from the field trials included rainfall, soil water tension, mean annual shoot growth, mean sucker production, and, when fruit were produced, mean bush yield and mean fruit weight.

Large amounts of precipitation received during the 1998 and 1999 seasons meant that it was not possible to determine the impact of irrigation on yield and growth in established saskatoon and chokecherry orchards. However, from the results of the additional greenhouse trials, and through observations made during the trial period, a number of general conclusions could be made. Soil moisture during May and early June rarely required irrigation treatments to be applied. In the absence of rainfall, most soil moisture loss occurred during periods of rapid growth and fruit development, that is, during the months of June and July. In treatments of the field study of saskatoon and chokecherry, where soil moisture was depleted to levels above 60 centibars, it was noted that repeated irrigation applications were required to completely replenish soil moisture. This suggests that a typical trickle irrigation system may not be able to immediately supply adequate moisture if the soil is allowed to dry out excessively before the system is turned on. This is not surprising considering trickle irrigation systems are only designed to replenish soil moisture lost during a single day. This would also suggest that there may be risks associated with delaying irrigation applications if a grower is using a trickle irrigation system.

When using soil moisture sensors with recently transplanted saskatoons, it was found that placement of the sensing unit next to the base of the transplant's root plug would not accurately reflect water loss occurring inside the root plug. It was determined that the root plug of young saskatoon transplants dehydrate at the rate of soil near the top of the root plug even if soil near the base of the plug is adequately moist. To prevent root damage from dehydration in newly transplanted saskatoons, the moisture level of the soil near the top of the root plug must be monitored.

Based on the information gathered in this study, it is recommended that growers use soil moisture sensors in their orchards, and that soil moisture levels be maintained at the 20 to 40 centibar level at 5 to 30 cm (2.5 to 12 in) soil depth, depending on plant size. New transplants should be monitored closely and irrigated every one to two days so as to ensure that the root plug does not dry out.

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Herb Agronomy

J. Wahab[1], G. Larson[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: *Year four of five*

Location: *CSIDC, Outlook*

Objective:
- To evaluate the adaptability of promising herbs to Saskatchewan growing conditions,
- To develop labour saving management practices for mechanized commercial production,
- To identify appropriate production and harvest methods to increase yield and improve quality, and
- To compare the effects of dryland and irrigated production on yield and quality.

The Canada-Saskatchewan Irrigation Diversification Centre (CSIDC), with financial support from the Canada-Saskatchewan Agri-Food Innovation Fund, is conducting research to develop cost effective and labour saving management practices for large scale production of commercially important herbs. This project is being conducted with market directions from the Saskatchewan Herb and Spice Association. The herb species included in this years agronomic studies include *Echinacea angustifolia*, feverfew, milk thistle, stinging nettle, and St. John's Wort. Many other aromatic, culinary, and medicinal herbs are also being evaluated in observational plots.

Studies were conducted at the field plots of CSIDC, Outlook. The treatments and production practices employed for *Echinacea,* feverfew, milk thistle, and stinging nettle trials are similar to the previous year's studies. Feverfew and St. John's Wort transplants were raised in the greenhouse. Field transplanting was done using a Waterwheel Planter as before. A plant spacing of 60 cm (24 in) (between-row) and 30 cm (12 in) (within-row) was utilized for all tests except for the plant population studies. For the plant population studies, plant populations were adjusted by varying the within-row spacing while maintaining the between-row spacing constant at 60 cm (24 in). Milk thistle and *Echinacea angustifolia* were direct seeded using a small-plot double-disc press drill. For the irrigation studies, soil moisture status was maintained at approximately 50% Field Capacity through supplemental irrigation using overhead sprinklers.

Plant material from the various field trials will be analysed to examine the effects of agronomic treatments on quality attributes.

The 2000 growing season (May to September) was slightly cooler than the long-term average and received 216 mm (8.5 in) of rain, which was similar to the 60-year average of 219 mm (8.6 in).

[1]*CSIDC, Outlook*

Echinacea angustifolia

Seeding rate and row spacing effects on yield and quality for direct seeded crop grown under dryland and irrigation.

Inherent seed dormancy and the requirement of light for germination renders *Echinacea* a difficult crop for direct seeding. Consequently, *Echinacea* is generally produced using transplants. Raising *Echinacea* from transplants requires high capital and labour inputs. This study examines the feasibility of direct seeding *Echinacea angustifolia* with the objective of reducing transplanting costs.

Echinacea angustifolia grown under irrigation produced on average nine per cent higher dry root yield than the dryland crop (Table 8).

The co-efficients of variation for the dry root weights in the dryland and irrigated tests are relatively high. This is likely due to variability in root development of individual plants.

Seeding rate had no significant effect on root weight under dryland or irrigation (Table 8). Superior yields were generally obtained at higher seeding rates with optimal yields at 150 seeds/m^2 (14 seeds/ft^2) for irrigation and 180 seeds/m^2 (17 seeds/ft^2) for dryland.

Table 8. Seeding rate and row spacing effects on dry root yield for direct seeded *Echinacea angustifolia* grown under dryland and irrigation: three-year crop.

Seeding rate		Dry root yield			
		Dryland		Irrigation	
(seeds/m^2)	(seeds/ft^2)	kg/ha	lb/ac	kg/ha	lb/ac
60	6	750	668	1157	1030
90	8	1237	1101	1158	1030
120	11	1318	1173	994	885
150	14	1119	996	1801	1603
180	17	1480	1317	1343	1195
Row spacing					
(cm)	(in)				
40	16	1007	896	1507	1341
60	24	1354	1205	1074	996
Analyses of Variance					
Seeding rate (R)		NS[1]		NS	
Row spacing (S)		NS		*(382.2)	
R x S		*(980.7)		NS	
CV (%)		48.4		36.6	

[1]not significant
*significant at P<0.05 level of probability
Value within parenthesis is LSD (5%) estimate for each treatment.

Contrasting responses were observed for row spacing effects under the two growing conditions (Table 8). Under dryland the wider row spacing (60 cm/24 in) produced 35% higher yield than the narrow row spacing (40 cm/16 in). However, under irrigation the narrow row spacing produced 40% higher yield than the wider row spacing.

Significant seeding rate x row spacing interaction was observed for the dryland crop (Table 8), but there were no identifiable trends for this interaction (Figure1).

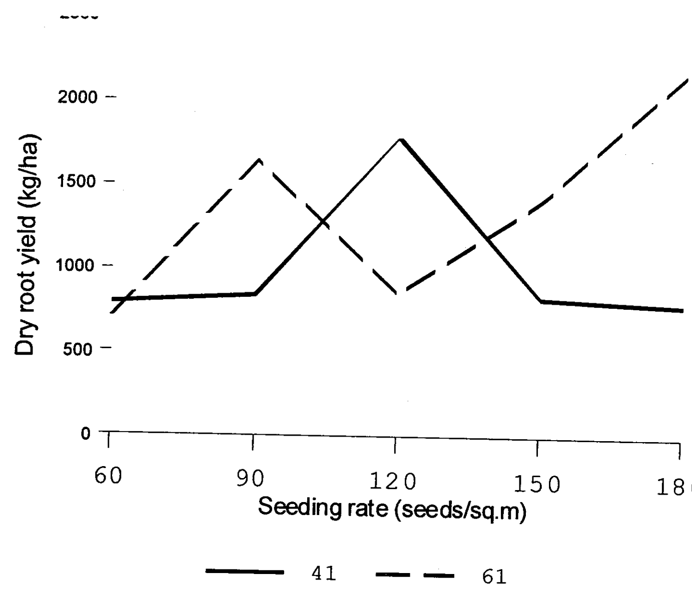

Figure 1. Interactive effects of seeding rate and row spacing for *Echinacea angustifolia* grown on dryland: three-year crop.

Fertilizer response studies for direct seeded Echinacea angustifolia.

Presently, *Echinacea angustifolia* is grown under small-scale organic and non-organic conditions. Effective fertilizer management is essential to increase yields and improve quality. Information on fertility management for direct seeded *Echinacea angustifolia* is lacking and not available for Saskatchewan and the prairies. This study examines the effects of nitrogen and phosphorus application on root yield under irrigated production.

The rate and time of nitrogen application or the rate of phosphorus application did not produce any significant effects with respect to dry root yields although substantial yield differences for nitrogen timing and phosphorus rate effects were observed (Table 9). For example, spring and fall application of nitrogen produced 37% higher yield than spring application only, and 100 kg P_2O_5/ha (90 lb P_2O_5/ac) produced 54% higher dry root yield than 50 kg P_2O_5/ha (45 lb P_2O_5/ac) (Table 9). The lack of significant treatment effects is likely due to the relatively high coefficient of variation in the trial (66.2%).

Table 9. Nitrogen and phosphorus effects on dry root yield of direct-seeded *Echinacea angustifolia* under irrigation: three-year crop.

Treatment		Dry root yield	
		kg/ha	lb/ac
Nitrogen rate	50 kg N/ha (45 lb N/ac)	1296	1153
	100 kg N/ha (90 lb N/ac)	1218	1084
Time of application	Spring	1059	943
	Spring & fall	1455	1295
Phosphorus	50 kg P_2O_5/ha (45 lb P_2O_5/ac)	1524	1356
	100 kg P_2O_5/ha (90 lb P_2O_5/ac)	991	882
ANOVA LSD (0.05)			
Nitrogen rate (N)		NS[1]	
Nitrogen application (A)		NS	
Phosphorus rate (P)		NS	
N x A		NS	
N x P		NS	
A x P		NS	
N x A x P		NS	
CV (%)		66.2	

[1]not significant

Comparison of planting material types for transplanted Echinacea angustifolia.

Raising *Echinacea* transplants in the spring requires heated greenhouse facilities at substantial additional cost. Alternatively, transplants can be raised during the fall, over-wintered in a straw covered pit, and planted in the following spring. The second method does not require any specialized growth structures, thereby reducing cost. This study was designed to compare the effects of different methods of producing and over-wintering *Echinacea angustifolia* transplants on root yield.

Transplants raised in the fall and over-wintered in the straw covered pit produced the highest root yield of 2,312 kg/ha (2,058 lb/ac) dry root (Table 10). The bare-root transplants produced the lowest yield of 1,619 kg/ha (1,441 lb/ac). The higher coefficient of variation likely contributed to the non-significant planting material effect.

Plants spaced at 15 cm (6 in) within-row produced 2,859 kg/ha (2,545 lb/ac) dry root relative to a yield of 1,020 kg/ha (908 lb/ac) for the wider 30 cm (12 in) within-row spacing (Table 10).

Table 10. Effect of planting material and plant spacing on dry root yield for transplanted *Echinacea angustifolia* harvested two years after planting under dryland production

Treatment	Dry root yield					
	15 cm (6 in) spacing		30 cm (12 in) spacing		Mean	
	kg/ha	lb/ac	kg/ha	lb/ac	kg/ha	lb/ac
Transplant type						
Raised during fall 1997/ grown in greenhouse over winter	2721	2422	998	888	1860	1655
Raised during fall 1997/ over-wintered in a straw covered pit	3605	3209	1019	907	2312	2058
Transplants raised in 1998: plug trays	2983	2655	952	847	1968	1752
Transplants raised in 1998: bare root	2216	1972	1112	990	1619	1441
Mean	2859	2545	1020	908		
Analysis of Variance						
Planting material (P)	NS[1]					
Spacing (S)	***(783.8)					
P x S	NS					
CV (%)	58.0					

[1]not significant
*** significant at P<0.001 level of probability
Values within parenthesis are LSD (5%) estimates for kg/ha yields of the treatments.

Interactive effects of nitrogen, phosphorus and harvest age on root yield for transplanted *Echinacea angustifolia.*

Echinacea angustifolia roots are generally harvested three to four years after planting. Recent studies show that younger roots have higher concentration of marker compounds than older roots. However, the root yield will be lower when harvested at an early stage. This study examines the influence of fertilizers on root yield and active ingredient levels for *Echinacea angustifolia* when harvested at different crop ages.

The third-year *Echinacea angustifolia* crop out yielded the second-year crop by 32% when grown with fertilizer and by 12% when grown without any fertilizer (Table 11). High variability resulted in the lack of treatment effects. The following trends were observed in this study:

1) Higher rates of nitrogen depressed yields (25% yield reduction) for both the second- and third-year crops,
2) Spring only or spring and fall application of nitrogen produced similar root yields, and
3) High levels of phosphorus produced slightly lower yield.

Table 11. Nitrogen and phosphorus effects on dry root yield of transplanted *Echinacea angustifolia* harvested two and three years after planting.

Treatment		Dry root yield			
		Year two		Year three	
		kg/ha	lb/ac	kg/ha	lb/ac
Nitrogen rate	50 kg N/ha (45 lb N/ac)	1402	1248	1733	1542
	100 kg N/ha (90 lb N/ac)	1051	935	1307	1163
Time of application	Spring	1107	985	1576	1403
	Spring & fall	1222	1088	1446	1287
Phosphorus	50 kg P_2O_5/ha (45 lb P_2O_5/ac)	1211	1078	1548	1378
	100 kg P_2O_5/ha (90 lb P_2O_5/ac)	1087	967	1490	1326
No fertilizer check		1119	996	1252	1114
Analyses of Variance					
Nitrogen rate (N)		NS[1]		NS	
Nitrogen application (A)		NS		NS	
Phosphorus rate (P)		NS		NS	
N x A		NS		NS	
N x P		NS		NS	
A x P		NS		NS	
N x A x P		NS		NS	
CV (%)		84.3		53.6	

[1]not significant

Spacing and fertilizer effects for transplanted *Echinacea angustifolia.*

Under commercial scale production, appropriate agronomic practices should be adopted to maximize yields. This includes suitable plant populations and proper fertility management practices. It is likely that the response to fertility levels and plant populations can vary between dryland and irrigated production. This study examines the interactive effects of nitrogen, phosphorus and plant population for transplanted *Echinacea angustifolia* grown under dryland and irrigated conditions.

The 15 cm (6 in) within-row spacing produced higher dry root yields than the 30 cm (12 in) within-row spacing. Closer plant spacing produced approximately two-fold higher yield than the wider spacing under both dryland and irrigated production (Table 12).

Higher nitrogen rates tended to depress root yields, while higher phosphorus rates produced slightly higher yields (non-significant) under the two growing conditions (Table 12).

Significant nitrogen x phosphorus interaction was observed for *Echinacea angustifolia* grown under dryland conditions (Table 12). A positive yield response was observed to additional phosphorus when the crop received nitrogen fertilizer, whereas, the crop responded negatively to additional phosphorus with no added nitrogen (Figure 2).

Table 12. Plant spacing, nitrogen and phosphorus effects on dry root yield for transplanted *Echinacea angustifolia* grown under dryland and irrigation: three-year crop.

Treatment		Dry root yield			
		Dryland		Irrigation	
		kg/ha	lb/ac	kg/ha	lb/ac
Spacing	15 cm (6 in)	1309	1165	843	750
	30 cm (12 in)	581	517	435	387
Nitrogen	0 kg N/ha (0 lb N/ha)	1147	1021	782	696
	75 kg N/ha (67 lb N/ha)	1119	996	758	675
	150 kg N/ha (53 lb N/ha)	570	507	377	336
Phosphorus	0 kg P_2O_5/ha (0 lb P_2O_5/ac)	908	808	520	463
	60 kg P_2O_5/ha (53 lb P_2O_5/ac)	982	874	757	674
Analyses of Variance					
Spacing (S)		***(330)		***(281)	
Nitrogen (N)		**(405)		*(345)	
Phosphorus (P)		NS[1]		NS	
S x N		NS		NS	
S x P		NS		NS	
N x P		*		NS	
S x N x P		NS		NS	
CV (%)		59.4		74.8	

[1]not significant
*, **, *** significant at P<0.001, 0.01, and 0.05 levels of probability
Values within parenthesis are LSD (5%) estimates for the kg/ha yields of the corresponding treatments.

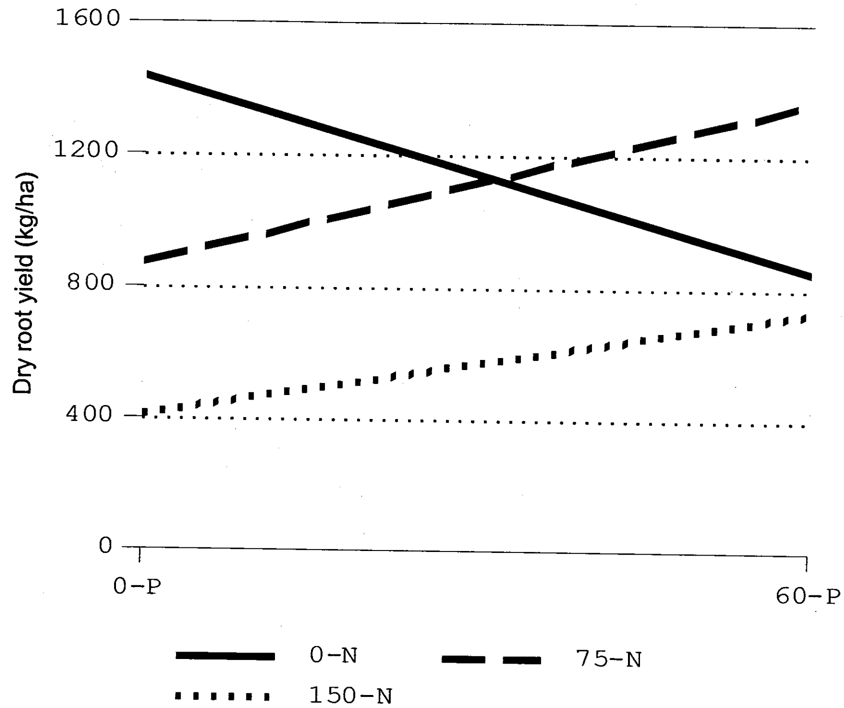

Figure 2. Interactive effects of nitrogen and phosphorus on dry root yield of *Echinacea angustifolia* grown on dryland.

Feverfew

Spacing and fertilizer effects for transplanted feverfew.

Under commercial scale production, suitable agronomic practices should be adopted to maximize yields. This includes suitable plant populations and proper fertility management practices. It is likely that the response to fertility levels and plant populations can vary between dryland and irrigated production. This study examines the interactive effects of nitrogen, phosphorus and plant population for transplanted feverfew grown under dryland and irrigated conditions.

Feverfew grown under irrigation produced higher fresh (two-fold) and dry (three-fold) herbage yield than the dryland crop (Table 13).

Closer within-row spacing (15 cm/6 in) produced higher fresh and dry herbage yields both under irrigation and dryland, but this response reached statistically significant proportion only for fresh yield under irrigation (Table 13).

Significant nitrogen effects were observed on fresh and dry herbage yields for dryland production. It is not clear why the yields are lower for the intermediate nitrogen level (75 kg N/ha) (67 lb N/ac) compared to the no nitrogen control or the higher 150 kg N/ha (134 lb N/ac) application (Table 13).

Table 13. Plant spacing and fertility effects on herbage yield for feverfew grown under dryland and irrigation.

Treatment		Dryland yield				Irrigated yield			
		Fresh		Dry		Fresh		Dry	
		t/ha	tons/ac	t/ha	tons/ac	t/ha	tons/ac	t/ha	tons/ac
Spacing	15 cm (6 in)	11.9	5.2	1.7	0.75	21.7	9.5	6.6	2.9
	30 cm (12 in)	10.7	4.7	1.6	0.70	18.5	8.1	5.8	2.6
Nitrogen	0 kg N/ha (0 lb N/ac)	12.5	5.5	1.8	0.79	19.8	8.7	6.1	2.7
	75 kg N/ha (67 lb N/ha)	9.7	4.3	1.5	0.66	20.0	8.8	6.2	2.7
	150 kg N/ha (53 lb N/ha)	11.6	5.1	1.7	0.75	20.4	9.0	6.2	2.7
Phosphorus	0 kg P_2O_5/ha (0 lb P_2O_5/ac)	11.3	5.0	1.7	0.75	19.4	8.5	6.0	2.6
	60 kg P_2O_5/ha (53 lb P_2O_5/ac)	11.2	4.9	1.7	0.75	20.7	9.1	6.4	2.8
Analyses of Variance									
Spacing (S)		NS[1]		NS		**(2.4)		NS	
Nitrogen (N)		*(1.9)		*(0.3)		NS		NS	
Phosphorus (P)		NS		NS		NS		NS	
S x N		NS		NS		NS		NS	
S x P		NS		NS		NS		NS	
N x P		NS		NS		NS		NS	
S x N x P		NS		NS		NS		NS	
CV (%)		15.5		15.1		20.6		22.8	

[1]not significant
*, and ** significant at P<0.01 and 0.05 levels of probability
Values within parenthesis are LSD (5%) estimates for the t/ha yields of the corresponding treatments.

Effects of plant population and cutting stage on productivity and quality of transplanted feverfew.

Different herb buyers tend to prefer feverfew harvested at different growth stages such as (i) prior to flowering, (ii) during early flowering, or (iii) at full bloom. This study examines the interactive effects plant spacing and harvest stage on herbage yield and quality characteristics for transplanted feverfew grown under dryland and irrigated conditions.

Irrigated feverfew on average produced 73% higher fresh herb yield and 56% higher dry herb yield than the dryland crop (Table 14).

Under dryland conditions, plant spacing had no effect on fresh or dry herbage yield, whereas under irrigation 15 cm (6 in) plant spacing produced approximately 14% higher fresh and dry yields relative to the 30 cm (12 in) plant spacing (Table 14).

Harvesting feverfew at the pre-flowering stage produced the lowest yield. Harvesting at more advanced stages (10% and 100% flowering) produced higher fresh and dry herb yields under both dryland and irrigated conditions (Table 14).

Table 14. Plant spacing and harvest stage effects on herbage yield for feverfew grown under dryland and irrigation.

Treatment		Dryland yield				Irrigated yield			
		Fresh		Dry		Fresh		Dry	
		t/ha	tons/ac	t/ha	tons/ac	t/ha	tons/ac	t/ha	tons/ac
Spacing	15 cm (6 in)	7.6	3.3	2.5	1.1	13.8	6.1	4.0	1.8
	30 cm (12 in)	7.3	3.2	2.3	1.0	12.1	5.3	3.5	1.5
Harvest stage	Pre-flower	6.5	2.9	2.0	0.9	11.5	5.1	3.4	1.5
	10% flower	7.4	3.3	2.4	1.1	13.9	6.1	4.3	1.9
	100% flower	8.5	3.7	2.8	1.2	13.4	5.9	3.7	1.6
Analyses of Variance									
Spacing (S)		NS[1]		NS		*(1.4)		*(0.4)	
Nitrogen (N)		NS		*(0.6)		*(1.7)		*(0.5)	
Phosphorus (P)		NS		NS		NS		NS	
CV (%)		21.1		21.5		12.3		13.2	

[1]not significant
* significant at P<0.05 level of probability
Values within parenthesis are LSD (5%) estimates for t/ha yields for the corresponding treatments.

Milk Thistle

Seeding rate and row spacing effects on plant stand, seed yield and quality.

Milk thistle is a late maturing species with indeterminate growth and flowering habit. Under relatively short Saskatchewan growing conditions, the later formed flowers may not mature. Cool environmental conditions and excess moisture can further delay flowering and maturity. This study examines the effects of seeding rate and row spacing on yield and quality of milk thistle grown under dryland.

Relatively cool temperatures during the 2000 growing season delayed maturity resulting in overall reduction in seed yield.

Seeding rate or row spacing had no significant effects on seed yield (Table 15). The highest seeding rate (200 seeds/m²) (19 seeds/ft²) and the intermediate row spacing (40 cm/16 in) produced the highest seed yield although they were not significantly different to the other corresponding treatments tested in this study.

Table 15. Seeding rate and row spacing effects on seed yield for milk thistle grown under dryland.

Treatment		Seed yield kg/ha	Seed yield lb/ac
Seeding rate	50 seeds/m² (5 seeds/ft²)	311	277
	100 seeds/m² (9 seeds/ft²)	309	275
	200 seeds/m² (19 seeds/ft²)	324	288
Row spacing	20 cm (8 in)	297	264
	40 cm (16 in)	340	303
	60 cm (24 in)	307	273
Analysis of Variance			
Seeding rate (S)		NS[1]	
Row spacing (R)		NS	
S x R		NS	
CV (%)		32.8	

[1]not significant

Fertilizer response study.

Milk thistle is a late maturing species with indeterminate growth and flowering habit. Under short Saskatchewan growing conditions, the later formed flowers may not mature. Cool environmental conditions, excess moisture, and high rates of nitrogen can further delay flowering and maturity. This study examines the effects of seeding rate in combination with nitrogen and phosphorus application on yield and quality of milk thistle grown under dryland.

The overall seed yields were relatively low, likely due to the cooler temperatures during the growing season.

Seeding rate, nitrogen, or phosphorus had no effect on seed yield (Table 16). Standing water in a part of the experiment caused considerable variability: indicated by 63% coefficient of variation. This study did not suggest that high nitrogen application reduced yield through delayed maturity.

Table 16. Seeding rate and fertility effects on seed yield for milk thistle grown on dryland.

Treatment		Seed yield kg/ha	Seed yield lb/ac
Seeding rate	50 seeds/m² (5 seeds/ft2)	302	269
	100 seeds/m² (9 seeds/ft2)	276	246
	200 seeds/m² (19 seeds/ft2)	331	295
Nitrogen rate	0 kg N/ha (0 lb N/ha)	298	265
	50 kg N/ha (45 lb N/ha)	300	267
	100 kg N/ha (90 lb N/ha)	311	277
Phosphorus rate	0 kg P_2O_5/ha (0 lb P_2O_5/ac)	322	287
	60 kg P_2O_5/ha (53 lb P_2O_5/ac)	307	273
	120 kg P_2O_5/ha (107 lb P_2O_5/ac)	281	250
Analyses of Variance			
Seeding rate (S)		NS[1]	
Nitrogen (N)		NS	
Phosphorus (P)		NS	
S x N		NS	
S x P		NS	
N x P		NS	
S x N x P		NS	
CV (%)		63.4	

[1]not significant

Stinging Nettle

Planting material comparison under dryland and irrigation.

Stinging nettle is a hardy perennial with extremely small seeds. Stinging nettle can be grown commercially using transplants. This study is a continuation of the plots established in 1997 that was intended to examine the effects of plant material on herbage yield.

Stinging nettle grown under irrigation produced 45% higher fresh and 43% higher dry herbage yields than the dryland crop (Table 17).

Under dryland, the 1998-transplants produced the highest herbage yield (Table 17). Under irrigation, the 1997-transplants from the greenhouse produced the highest yields. Further work is required to determine this differential response.

Table 17. Effect of planting material on herbage yield for stinging nettle grown under dryland and irrigation.

	Herbage yield							
	Dryland				Irrigation			
	Fresh weight		Dry weight		Fresh weight		Dry weight	
Treatment	t/ha	tons/ac	t/ha	tons/ac	t/ha	tons/ac	t/ha	tons/ac
Transplant type								
Raised during fall 1997/ grown in greenhouse over winter	16.7	7.3	7.0	3.1	40.8	18.0	16.4	7.2
Raised during fall 1997/ over-wintered in a straw covered pit	23.8	10.5	10.2	4.5	26.0	11.4	11.3	5.0
Transplants raised in 1998: plug trays	27.7	12.2	12.2	5.4	31.8	14.0	14.4	6.4
Analyses of Variance								
Planting material (P)	*(6.8)		**(2.5)		***(6.8)		**(3.1)	
CV (%)	23.3		19.9		19.2		20.8	

*, **, *** significant at P<0.05, 0.01, and 0.001 levels of probability
Values within parenthesis are LSD (5%) estimates for the t/ha yields of the corresponding treatments.

Fertility studies for transplanted stinging nettle grown under dryland and irrigation.

Stinging nettle root and shoot are the plant components used by the herb medicinal industry. It is likely that fertilizer application and production conditions (dryland or irrigation) can influence crop growth and root:shoot ratio. This study examines the effects of nitrogen and phosphorus application on root and shoot yield. The data on shoot yield is presented in this report.

Stinging nettle grown under irrigation on average produced 25% higher fresh herb yield and 28% higher dry herb yield relative to dryland (Table18).

Nitrogen rate, nitrogen timing, or phosphorus rate had no effect on fresh and dry herb yields under dryland and fresh herb yield under irrigation (Table 18). A significant nitrogen rate x phosphorus rate interaction was observed for dry herb yield under irrigation (Table 18, Figure 3). It appears that under high nitrogen levels (100 kg N/ha) (90 lb N/ac), increasing phosphorus increased herb yields. By contrast, under low nitrogen (50 kg N/ha) (45 lb N/ac), increasing phosphorus tended to reduce yields.

Table 18. Nitrogen rate and timing and phosphorus effect on herbage yields for transplanted stinging nettle grown under dryland and irrigation.

Treatment		Herbage yield							
		Dryland				Irrigation			
		Fresh weight		Dry weight		Fresh weight		Dry weight	
		t/ha	tons/ac	t/ha	tons/ac	t/ha	tons/ac	t/ha	tons/ac
Nitrogen rate	50 kg N/ha (45 lb N/ac)	21.8	9.6	8.2	3.6	27.3	12.0	10.9	4.8
	100 kg N/ha (90 lb N/ac)	21.7	9.5	8.8	3.8	26.9	11.8	10.8	4.8
Time of application	Spring	22.1	9.7	8.6	3.8	27.5	12.1	11.4	5.0
	Spring & fall	21.0	9.2	8.2	3.6	26.7	11.7	10.3	4.5
Phosphorus	50 kg P_2O_5/ha (45 lb P_2O_5/ac)	20.7	9.1	8.2	3.6	27.2	12.0	10.8	4.8
	100 kg P_2O_5/ha (90 lb P_2O_5/ac)	22.8	10.0	8.8	3.9	26.9	11.8	10.9	4.8
Nitrogen rate (N)		NS[1]		NS		NS		NS	
Nitrogen application (A)		NS		NS		NS		NS	
Phosphorus rate (P)		NS		NS		NS		NS	
N x A		NS		NS		NS		*	
N x P		NS		NS		NS		NS	
N x A x P		NS		NS		NS		NS	
CV (%)		28.5		30.8		16.4		18.7	

[1]not significant
*significant at P<0.05 level of probability

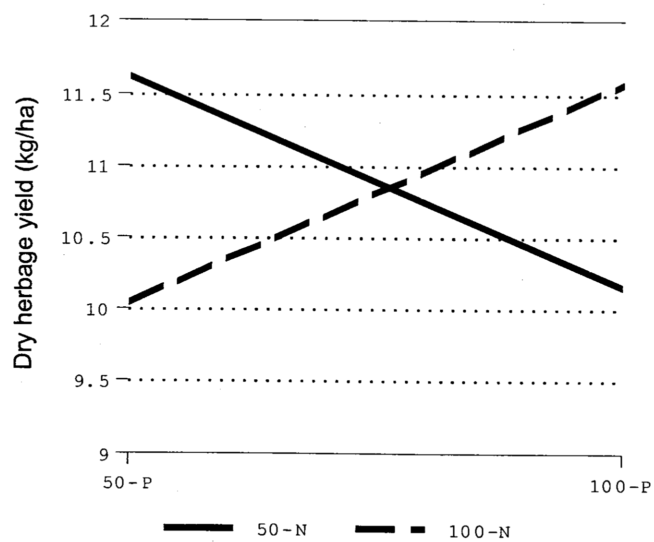

Figure 3. Interactive effects of nitrogen and phosphorus rates on dry herbage yield of stinging nettle grown on irrigation.

Plant spacing and cutting height effects for transplanted stinging nettle grown under dryland and irrigation.

Stinging nettle leaf is one of the plant parts used for herbal remedies. Plant spacing and cutting height can affect herbage yield and quality. Moisture status during the growing season can also influence productivity and level of marker compounds. This study examines the effects of plant population and cutting height on the third-year stinging nettle crop grown under dryland and irrigation.

Stinging nettle grown under irrigation produced 40% higher fresh herbage yield and 23% higher dry herb yield than dryland production (Table 19).

Plant spacing or cutting height had no effect on fresh and dry herb yields under irrigated or dryland production (Table 19).

Table 19. Plant spacing and cutting height effects on herbage yields for transplanted stinging nettle grown under dryland and irrigation.

Treatment		Herbage yield							
		Dryland				Irrigation			
		Fresh weight		Dry weight		Fresh weight		Dry weight	
		t/ha	tons/ac	t/ha	tons/ac	t/ha	tons/ac	t/ha	tons/ac
Within-row spacing	15 cm (6 in)	16.5	6.6	6.7	2.9	22.8	10.0	8.2	3.6
	30 cm (12 in)	17.0	7.5	6.8	3.0	24.1	10.6	8.4	3.7
Cutting height	Ground	17.5	7.7	7.1	3.1	24.1	10.6	8.6	3.8
	10 cm (4 in)	16.4	7.2	6.5	2.9	23.3	10.3	8.0	3.5
	15 cm (6 in)	16.2	7.1	6.6	2.9	23.0	10.1	8.3	3.7
Spacing (S)		NS[1]		NS		NS		NS	
Cutting height (H)		NS		NS		NS		NS	
S x H		NS		NS		NS		NS	
CV (%)		29.2		33.1		33.5		31.2	

[1]not significant

St. John's Wort

Effects of plant population and harvest methods on yield and quality characteristics for different biotypes: Year-1 and Year-2 harvest.

St. John's Wort is a perennial. Flowering tops are harvested for commercial use as the flowers and leaves are found to contain higher levels of hypericin. Plant growth characteristics and harvest height can affect yield and quality. Plant growth and flowering habit can be a function of many factors including genotype, population density, and growing conditions. This study examines the effects of plant spacing and harvest height on yield and quality attributes of St. John's Wort cultivars grown under irrigation and dryland. Comparisons will be made on yield and quality aspects for crops harvested at different years from planting.

Year-1 Harvest:
During the establishment year only one cut was possible. Fresh and dry herbage yields in relation to plant spacing and cutting height under dryland and irrigated production are summarized in Table 20 and Table 21 respectively.

Different cultivars responded differently when grown under irrigation or dryland. Anthos and Topaz produced higher herb yields under irrigation than dryland, Standard under dryland produced higher yield than under irrigation, while Elixir produced similar yields under both growing conditions.

Both 15 cm (6 in) and 30 cm (12 in) plant spacings produced similar fresh and dry herb yield under irrigation and dryland, except for fresh yield of Anthos under dryland and dry yield of Topaz under both irrigation and dryland, where closer spacing produced higher yields than the wider spacing (Tables 20 and 21).

The lowest cutting height, i.e. Top-2/3, produced the highest herb yields under both irrigation and dryland (Tables 20 and 21). The two higher cutting heights, i.e. Top-1/3 and Top-1/2 produced similar fresh and dry herb yields for all cultivars under both growing conditions.

Year-2 Harvest:
Two cuts were taken for the irrigated crop while only one cut was possible for the dryland crop. The effects of plant spacing and cutting height on fresh and dry herbage yields for the various cultivars grown under dryland is summarized in Table 22. For the irrigated crop fresh and dry yields are presented in Table 23 and Table 24 respectively.

Dryland Crop:
The dryland crop yielded one cut during the second year of production. Soil salinity caused considerable variability in growth and yield as reflected by the relatively high coefficients of variation (Table 22).

Closer spacing (15 cm/6 in) produced higher fresh and dry herbage yields than the wider spacing (30 cm/12 in) for all cultivars. This yield increase for fresh herb was three-fold for Anthos, 91% for Standard, 74% for Topaz, and 44% for Elixir (Table 22). Similar trends were also observed for dry herb yields.

Table 20. Plant spacing and cutting height effects on fresh and dry herbage yields during the first year of production for St. John's Wort cultivars grown under dryland.

Treatment		Fresh weight (t/ha)				Dry weight (t/ha)			
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard
Plant spacing	15 cm (6 in)	6.84	5.38	5.62	6.64	2.74	1.97	2.05	2.62
	30 cm (12 in)	5.70	5.13	5.04	6.49	2.41	1.92	1.82	2.36
Cutting height	Top 1/3	5.51	4.51	4.83	6.36	2.22	1.69	1.76	2.42
	Top 1/2	5.95	5.17	4.85	5.76	2.51	1.90	1.80	2.10
	Top 2/3	7.34	6.08	6.31	7.56	3.00	2.23	2.24	2.95
Analyses of Variance									
Spacing (S)		**(0.81)	NS	NS	NS	NS	*(0.35)	NS	NS
Cutting height (H)		***(0.99)	*(1.05)	***(0.77)	***(0.77)	*(0.51)	*(0.42)	*(0.26)	*(0.58)
S x H		NS	NS	NS	NS	NS	NS	NS	NS
CV (%)		12.9	15.6	15.3	19.4	15.5	17.0	15.1	22.9

Treatment		Fresh weight (tons/ac)				Dry weight (tons/ac)			
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard
Plant spacing	15 cm (6 in)	3.0	2.4	2.5	2.9	1.2	0.9	0.9	1.2
	30 cm (12 in)	2.5	2.3	2.2	2.8	1.1	0.8	0.8	1.0
Cutting height	Top 1/3	2.4	2.0	2.1	2.8	1.0	0.7	0.8	1.0
	Top 1/2	2.6	2.3	2.1	2.5	1.1	0.8	0.8	0.9
	Top 2/3	3.2	2.7	2.8	3.3	1.3	1.0	1.0	1.3

*, **, ***, and NS indicate significance at P<0.05, 0.01, and 0.001 levels of probability and not significant respectively
Values within parentheses are LSD estimated at the 5% probability level.

Table 21. Plant spacing and cutting height effects on fresh and dry herbage yields during the first year of production for St. John's Wort cultivars grown under irrigation.

Treatment		Fresh weight (t/ha)				Dry weight (t/ha)			
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard
Plant spacing	15 cm (6 in)	7.26	9.30	5.74	5.79	1.74	1.84	1.15	1.35
	30 cm (12 in)	6.79	8.28	5.54	5.65	1.63	1.59	1.16	1.33
Cutting height	Top 1/3	5.92	8.27	4.65	4.90	1.40	1.63	0.98	1.13
	Top 1/2	6.49	7.36	5.45	4.85	1.51	1.42	1.10	1.13
	Top 2/3	8.66	10.73	6.84	7.41	2.14	2.10	1.39	1.76
Analyses of Variance									
Spacing (S)		NS	NS	NS	NS	NS	*(0.25)	NS	NS
Cutting height (H)		***(0.97)	***(1.46)	***(0.92)	***(1.18)	***(0.28)	***(0.31)	***(0.19)	***(0.33)
S x H		NS	NS	NS	NS	NS	NS	NS	NS
CV (%)		12.9	15.6	15.3	19.4	15.5	17.0	15.1	22.9

Treatment		Fresh weight (tons/ac)				Dry weight (tons/ac)			
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard
Plant spacing	15 cm (6 in)	3.2	4.1	2.5	2.5	0.8	0.8	0.5	0.6
	30 cm (12 in)	3.0	3.7	2.4	2.5	0.7	0.7	0.5	0.6
Cutting height	Top 1/3	2.6	3.6	2.0	2.2	0.6	0.7	0.4	0.4
	Top 1/2	2.9	3.2	2.4	2.1	0.7	0.6	0.5	0.4
	Top 2/3	3.8	4.7	3.0	3.3	0.9	0.9	0.6	0.8

*, **, ***, and NS indicate significance at P<0.05, 0.01, and 0.001 levels of probability and not significant respectively
Values within parentheses are LSD estimated at the 5% probability level.

Table 22. Plant spacing and cutting height effects on fresh and dry herbage yields during the second year of production for St. John's Wort cultivars grown under dryland.

Treatment		Fresh weight (t/ha)				Dry weight (t/ha)			
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard
Plant spacing	15 cm (6 in)	7.96	10.54	10.88	7.30	2.13	2.55	2.55	2.02
	30 cm (12 in)	2.61	6.05	7.53	3.83	0.77	1.46	1.67	1.03
Cutting height	Top 1/3	3.87	5.38	7.45	4.22	1.09	1.27	1.64	1.15
	Top 1/2	5.01	8.61	9.93	5.25	1.41	2.03	2.32	1.47
	Top 2/3	6.97	10.89	10.23	7.22	1.85	2.71	2.37	1.96
Analyses of Variance									
Spacing (S)		***(2.22)	*(3.65)	NS	**(2.40)	***(0.62)	*(0.83)	*(0.81)	**(0.65)
Cutting height (H)		NS	NS	NS	NS	NS	*(1.02)	NS	NS
S x H		NS	NS	NS	NS	NS	NS	NS	NS
CV (%)		48.3	50.6	45.2	49.6	48.7	47.6	44.1	49.1
Treatment		Fresh weight (tons/ac)				Dry weight (tons/ac)			
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard
Plant spacing	15 cm (6 in)	3.5	4.6	4.8	3.2	0.9	1.1	1.1	0.9
	30 cm (12 in)	1.1	2.7	3.3	1.7	0.3	0.6	0.7	0.5
Cutting height	Top 1/3	1.7	2.4	3.3	1.9	0.5	0.5	0.7	0.5
	Top 1/2	2.2	3.8	4.4	2.3	0.6	0.9	1.0	0.6
	Top 2/3	3.1	4.8	4.5	3.2	0.8	1.2	1.0	0.9

*, **, ***, and NS indicate significance at P<0.05, 0.01, and 0.001 levels of probability and not significant respectively
Values within parentheses are LSD estimated at the 5% probability level.

The crop cut closest to the ground (Top-2/3) produced higher fresh and dry herb yields than cutting at higher levels (Top-1/3 and Top-1/2). For fresh herb, the yield increase by cutting the Top-2/3 relative to cutting the Top-1/3 ranged between 37% for Elixir and over 100% for Topaz. The trend was somewhat similar for dry yields (Table 22).

Irrigated Crop:

The irrigated crop yielded two cuts compared to only one cut for the dryland crop. The fresh and dry herb yields in response to plant spacing and cutting heights for the various cultivars are presented in Table 23 and Table 24 respectively.

Under irrigated production, the average total fresh herb yield ranged between 13.3 t/ha (5.9 tons/ac) (Standard) and 18.0 t/ha (8.0 tons/ac) (Topaz). The first and the second cuts produced similar yields, although yields were slightly higher (an average of 10%) during the second cut compared to the first cut (Table 23).

Closer plant spacing (15 cm/6 in) produced higher herb yield than the wider spacing (30 cm/12 in). This yield increase varied from 30% for Elixir to 150% for Standard during the first harvest. During the second harvest, plant spacing had no effect on fresh herb yield except for Standard where the closer spacing out yielded the wider spacing by 73% (Table 23).

Cutting height did not affect the overall yields for the different cultivars (Table 23). However, cutting height affected yields during the individual harvests. For example, during the early harvest, the lower cutting height (Top-2/3) produced higher fresh herb yields relative to the higher cutting height (Top 1/3) although the differences were not significant for Topaz and Elixir (Table 23). By contrast, during the second harvest, the lower cutting height (Top-2/3) produced lower yield and the higher cutting height (Top-1/2) produced higher yields. This resulted in non-significant cutting height effects for total fresh herbage yields for the various cultivars (Table 23).

St. John's Wort herbage dried down to approximately 31% of the fresh weight. The effects of plant spacing and cutting heights on dry herbage yields for the various cultivars were similar to that observed for fresh weight (Table 24).

Table 23. Plant spacing and cutting height effects on fresh herbage yields during the second year of production for St. John's Wort cultivars grown under irrigation.

Treatment		First cut				Second cut				Total yield							
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard	Anthos		Topaz		Elixir		Standard	
		t/ha				t/ha				t/ha	t/ac	t/ha	t/ac	t/ha	t/ac	t/ha	t/ac
Plant spacing	15 cm (6 in)	8.61	9.07	9.17	9.23	7.41	10.47	8.80	8.67	16.03	7.0	19.53	8.6	17.97	7.9	17.8	7.8
	30 cm (12 in)	5.26	7.15	7.08	3.69	7.09	9.36	8.64	5.01	12.35	5.4	16.51	7.3	15.72	6.9	8.7	3.8
Cutting height	Top 1/3	4.08	6.65	6.33	3.96	7.15	12.28	10.73	7.47	11.23	4.9	18.93	8.3	17.07	7.6	11.44	5.0
	Top 1/2	8.57	9.73	9.91	7.36	7.86	10.62	8.68	7.47	16.43	7.2	20.35	9.0	18.59	8.2	14.83	6.5
	Top 2/3	8.16	7.95	8.13	7.91	6.74	6.84	6.74	5.58	14.90	6.6	14.79	6.5	14.88	6.5	13.49	5.9
Analyses of Variance																	
Spacing (S)		*(2.95)	NS	NS	***(2.57)	NS	NS	NS	**(2.04)	NS		NS		NS		***(4.55)	
Cutting height (H)		*(3.61)	NS	NS	*(3.15)	NS	***(1.95)	*(2.65)	NS	NS		NS		NS		NS	
S x H		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
CV (%)		46.1	45.9	36.4	45.9	32.7	18.5	28.5	34.3	33.1		27.5		28.4		32.2	

*, **, ***, and NS indicate significance at P<0.05, 0.01, and 0.001 levels of probability and not significant respectively
Values within parentheses are LSD estimated at the 5% probability level.

Table 24. Plant spacing and cutting height effects on dry herbage yields during the second year of production for St. John's Wort cultivars grown under irrigation.

Treatment		First cut				Second cut				Total yield							
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard	Anthos		Topaz		Elixir		Standard	
		t/ha				t/ha				t/ha	t/ac	t/ha	t/ac	t/ha	t/ac	t/ha	t/ac
Plant spacing	15 cm (6 in)	2.76	2.70	2.77	2.84	2.41	3.44	2.65	2.93	5.17	2.3	6.13	2.7	5.43	2.4	5.77	2.5
	30 cm (12 in)	1.71	2.10	2.08	1.19	2.30	3.15	2.82	1.53	4.01	1.8	5.25	2.3	4.89	2.2	2.72	1.2
Cutting height	Top 1/3	1.27	1.95	1.89	1.29	2.56	4.47	3.76	2.70	3.84	1.7	6.42	2.8	5.65	2.5	3.99	1.8
	Top 1/2	2.73	2.87	3.04	2.31	2.51	3.38	2.56	2.26	5.24	2.3	6.24	2.8	5.59	2.5	4.57	2.0
	Top 2/3	2.69	2.37	2.35	2.45	1.99	2.05	1.89	1.73	4.68	2.1	4.42	1.9	4.24	1.9	4.18	1.8
Analyses of Variance																	
Spacing (S)		*(0.94)	NS	NS	***(0.78)	NS	NS	NS	**(0.97)	NS		NS		NS		***(1.42)	
Cutting height (H)		*(1.15)	NS	*(0.92)	*(0.95)	NS	***(0.74)	**(0.90)	NS	NS		NS		NS		NS	
S x H		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
CV (%)		48.8	45.9	36.4	46.1	32.7	18.5	28.5	34.3	33.1		27.5		28.4		32.2	

*, **, ***, and NS indicate significance at P<0.05, 0.01, and 0.001 levels of probability and not significant respectively
Values within parentheses are LSD estimated at the 5% probability level.

Fertility management and cutting height effects on yield and quality: Second-year crop.

Dryland Crop:
Anthos and Standard yielded two cuts while Elixir and Topaz produced only one cut.

During the first cut, St. John's Wort harvested closer to the ground (Top-2/3) produced higher herbage yields than harvesting at a higher level (Top-1/3). High variability in the trial resulted in non-significant cutting height effects for fresh yield with Anthos, Topaz, and Standard (Table 25) and dry yields with Anthos and Topaz (Table 26).

During the second cut, nitrogen, phosphorus, and cutting height effects on fresh and dry yields were similar to that observed during the first cut (Tables 25 and 26).

Nitrogen and phosphorus application had no effect on total yields of fresh herb (Table 25) and dry herb (Table 26). However, application of 100 kg N/ha (90 lb P_2O_5/ac) caused a slight increase in yield while application of 100 kg P_2O_5/ha (90 lb P_2O_5/ac) produced a slight reduction in yield than the check treatment. Cutting height had no effect on total yield (similar to the previous study).

Irrigated Crop:
When grown under irrigation, all cultivars of St. John's Wort produced two cuts. The fresh and dry herb yields as influenced by nitrogen and phosphorus application and height of cutting are summarized in Table 27 and Table 28 respectively.

The average cumulative fresh herb yield for the two cuts varied from 14.48 t/ha (6.46 tons/ac) (Standard) to 27.78 t/ha (12.39 tons/ac) (Topaz) and the dry herb yield varied from 5.23 t/ha (2.33 tons/ac) (Standard) to 10.05 t/ha (4.48 tons/ac) (Topaz).

Nitrogen application had no effect on fresh or dry herb yields (Table 27 and 28). Phosphorus (100 kg P_2O_5/ha) (90 lb P_2O_5/ac) application tended to reduce fresh and dry herb yields compared to the no phosphorus check treatment and this effect reached significant proportions in the following cases: (i) Elixir fresh weight, first cut, (ii) Standard, total fresh weight, (iii) Standard, dry weight during first cut and total.

Lower cutting height (Top-2/3) produced higher fresh (Table 27) and dry (Table 28) yields during the first cut. By contrast, cutting height had no effect on fresh or dry yields during the second cut (Tables 27 and 28). During the first cut, the lower cutting height produced 55-56% higher fresh herb yield for Standard, Topaz, and Anthos, and 65% higher yield for Elixir. The increase in total yield (Cut-1 + Cut-2) of fresh herbage for the various cultivars ranged between 26% to 30% (Table 27). The lower cutting height produced 52-70% higher dry herb yield during the first cut and 18% to 25% increase for the combination of both cuts (Table 28).

Table 25. Nitrogen, phosphorus, and cutting height effects on fresh herbage yields during the second year of production for St. John's Wort cultivars grown under dryland.

Treatment		First cut				Second cut				Total yield							
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard	Anthos		Topaz		Elixir		Standard	
		t/ha				t/ha				t/ha	t/ac	t/ha	t/ac	t/ha	t/ac	t/ha	t/ac
Nitrogen	check	9.28	5.41	7.55	6.08	6.56	---	---	4.51	15.85	7.0	5.41	2.4	7.55	3.3	10.59	4.7
	100 kg/ha (90 lb/ac)	11.95	7.44	9.46	6.85	9.19	---	---	5.80	21.14	9.3	7.44	3.3	9.46	4.2	12.65	5.6
Phosphorus	check	11.62	6.46	9.09	6.46	8.93	---	---	5.21	20.55	9.0	6.46	2.8	9.09	4.0	11.66	5.1
	100 kg/ha (90 lb/ac)	9.62	6.39	7.92	6.47	6.82	---	---	5.10	16.44	7.2	6.39	2.8	7.92	3.5	11.57	5.1
Cutting height	Top 1/3	9.21	5.33	6.89	5.54	9.42	---	---	5.79	18.63	8.2	5.33	2.3	6.89	3.0	11.34	5.0
	Top 2/3	12.03	7.52	10.12	7.39	6.33	---	---	4.52	18.36	8.1	7.52	3.3	10.12	4.5	11.92	5.2
Analyses of Variance																	
Nitrogen (N)		NS	NS	NS	NS	*(2.65)			NS	NS						NS	
Phosphorus (P)		NS	NS	NS	NS	NS			NS	NS						NS	
Cutting height (H)		NS	NS	**(2.29)	NS	*(2.65)			NS	NS						NS	
N x P		NS	NS	NS	NS	NS			NS	NS						NS	
N x C		NS	NS	NS	NS	NS			NS	NS						NS	
P x C		NS	NS	NS	NS	NS			NS	NS						NS	
N x P x C		NS	NS	NS	NS	NS			NS	NS						NS	
CV (%)		43.4	54.2	36.6	40.7	45.7			62.2	41.1						45.4	

*, **, ***, and NS indicate significance at $P<0.05$, 0.01, and 0.001 levels of probability and not significant respectively
Values within parentheses are LSD estimated at the 5% probability level.

Table 26. Nitrogen, phosphorus, and cutting height effects on dry herbage yields during the second year of production for St. John's Wort cultivars grown under dryland.

Treatment		First cut				Second cut				Total yield							
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard	Anthos		Topaz		Elixir		Standard	
		t/ha				t/ha				t/ha	t/ac	t/ha	t/ac	t/ha	t/ac	t/ha	t/ac
Nitrogen	check	1.77	1.06	1.45	1.14	2.43	---	---	1.60	4.19	1.8	1.06	0.5	1.45	0.7	2.74	1.2
	100 kg/ha (90 lb/ac)	2.17	1.51	1.84	1.28	3.38	---	---	2.03	5.54	2.4	1.51	0.7	1.84	0.8	3.30	1.5
Phosphorus	check	2.15	1.34	1.76	1.21	3.28	---	---	1.81	5.42	2.4	1.34	0.6	1.76	0.8	3.00	1.3
	100 kg/ha (90 lb/ac)	1.78	1.22	1.53	1.20	2.53	---	---	1.82	4.31	1.9	1.22	0.5	1.53	0.7	3.02	1.3
Cutting height	Top 1/3	1.68	1.07	1.32	1.02	3.64	---	---	2.18	5.32	2.3	1.07	0.5	1.32	0.6	3.19	1.4
	Top 2/3	2.25	1.49	1.97	1.40	2.17	---	---	1.45	4.42	1.9	1.49	0.7	1.97	0.9	2.85	1.3
Analyses of Variance																	
Nitrogen (N)		NS	NS	NS	NS	*(1.35)			NS	NS						NS	
Phosphorus (P)		NS	NS	NS	NS	NS			NS	NS						NS	
Cutting height (H)		NS	NS	**(0.6)	*(0.52)	**(1.35)			NS	NS						NS	
N x P		NS	NS	4.00	NS	NS			NS	NS						NS	
N x C		NS	NS	NS	NS	NS			NS	NS						NS	
P x C		NS	NS	NS	NS	NS			NS	NS						NS	
N x P x C		NS	NS	NS	NS	NS			NS	NS						NS	
CV (%)		42.6	50.7	36.4	40.3	45.7			62.2								

*, **, ***, and NS indicate significance at P<0.05, 0.01, and 0.001 levels of probability and not significant respectively
Values within parentheses are LSD estimated at the 5% probability level.

Table 27. Nitrogen, phosphorus, and cutting height effects on fresh herbage yields during the second year of production for St. John's Wort cultivars grown under irrigation.

Treatment		First cut				Second cut				Total yield							
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard	Anthos		Topaz		Elixir		Standard	
		t/ha				t/ha				t/ha	t/ac	t/ha	t/ac	t/ha	t/ac	t/ha	t/ac
Nitrogen	check	10.04	13.64	13.20	5.79	13.40	13.12	14.14	8.69	23.43	10.3	27.77	12.2	27.34	12.0	14.48	6.3
	100 kg/ha (90 lb/ac)	10.49	13.36	12.12	5.51	13.36	14.47	12.91	9.03	23.86	10.5	26.27	11.6	25.03	11.0	14.55	6.4
Phosphorus	check	10.83	13.60	13.57	6.41	13.43	14.08	13.12	9.79	24.27	10.7	26.73	11.8	26.69	11.7	16.20	7.1
	100 kg/ha (90 lb/ac)	9.69	13.40	11.76	4.89	13.33	13.51	13.92	7.94	23.02	10.1	27.32	12.0	25.68	11.3	12.83	5.6
Cutting height	Top 1/3	8.03	10.57	9.56	4.44	12.73	13.76	13.19	8.41	20.76	9.1	23.76	10.5	22.75	10.0	12.85	5.7
	Top 2/3	12.50	16.43	15.77	6.86	14.04	13.83	13.85	9.32	26.53	11.7	30.28	13.3	29.52	13.0	16.18	7.1
Analyses of Variance																	
Nitrogen (N)		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
Phosphorus (P)		NS	NS	*(1.60)	NS	NS	NS	NS	NS	NS		NS		NS		*(3.22)	
Cutting height (H)		***(2.13)	***(1.60)	***(1.60)	**(1.62)	NS	NS	NS	NS	**(3.83)		***(3.39)		**(2.82)		*(3.22)	
N x P		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
N x C		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
P x C		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
N x P x C		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
CV (%)		28.2	16.1	17.2	38.9	23.3	18.1	23.1	29.8	22.0		17.1		14.7		30.2	

*, **, ***, and NS indicate significance at $P<0.05$, 0.01, and 0.001 levels of probability and not significant respectively
Values within parentheses are LSD estimated at the 5% probability level.

Table 28. Nitrogen, phosphorus, and cutting height effects on dry herbage yields during the second year of production for St. John's Wort cultivars grown under dryland.

Treatment		First cut				Second cut				Total yield							
		Anthos	Topaz	Elixir	Standard	Anthos	Topaz	Elixir	Standard	Anthos		Topaz		Elixir		Standard	
		t/ha				t/ha				t/ha	t/ac	t/ha	t/ac	t/ha	t/ac	t/ha	t/ac
Nitrogen	check	3.39	4.45	4.23	2.00	5.24	5.24	5.66	3.18	8.63	3.8	9.70	4.3	9.89	4.4	5.18	2.3
	100 kg/ha (90 lb/ac)	3.58	4.30	3.97	1.85	5.20	6.09	5.19	3.42	8.78	3.9	10.39	4.6	9.16	4.0	5.27	2.3
Phosphorus	check	3.71	4.46	4.46	2.21	5.22	5.88	5.18	3.66	8.93	3.9	10.34	4.6	9.64	4.2	5.87	2.6
	100 kg/ha (90 lb/ac)	3.26	4.29	3.74	1.64	5.22	5.46	5.67	2.94	8.48	3.7	9.75	4.3	9.41	4.1	4.58	2.0
Cutting height	Top 1/3	2.66	3.37	3.04	1.53	5.12	5.78	5.44	3.27	7.78	3.4	9.15	4.0	8.47	3.7	4.80	2.1
	Top 2/3	4.31	5.38	5.17	2.32	5.31	5.56	5.41	3.33	9.63	4.2	10.94	4.8	10.58	4.7	5.66	2.5
Analyses of Variance																	
Nitrogen (N)		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
Phosphorus (P)		NS	NS	***(0.48)	*(0.55)	NS	NS	NS	NS	NS		NS		NS		*(1.16)	
Cutting height (H)		***(0.73)	***(0.53)	***(0.48)	**(0.55)	NS	NS	NS	NS	**(1.37)		***(1.16)		***(0.93)		NS	
N x P		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
N x C		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
P x C		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
N x P x C		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS		NS		NS	
CV (%)		28.2	16.1	17.2	38.9	23.3	18.1	23.1	28.8	21.4		15.8		13.3		30.2	

*, **, ***, and NS indicate significance at $P<0.05$, 0.01, and 0.001 levels of probability and not significant respectively
Values within parentheses are LSD estimated at the 5% probability level.

Collaborative Studies:

1. Provided St. John's Wort to the Department of Agricultural and Bio-Resource Engineering University of Saskatchewan for post-harvest studies.

2. Produced *Echinacea angustifolia* to the Department of Plant Sciences, University of Saskatchewan for quality determination.

Observational Plots:

Produced a wide range of medicinal, aromatic and culinary herbs for demonstration purposes.

Soils and Water Management Program

Soil and Water Management Program

Effect of Water Quality on Herbicide Efficacy

T. Hogg[1], S. Brown[1], A. Masich[2], L. Braul[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: One year

Objectives:
- To evaluate the effect of water hardness level and herbicide application rate on the efficacy of Roundup Transorb.
- To evaluate the effect of carrier water dissolved organic carbon level and herbicide application rate on the efficacy of Roundup Transorb.

Studies were conducted at the Canada-Saskatchewan Irrigation Diversification Centre, Outlook, Saskatchewan to determine the effect of water quality and herbicide application rate on the efficacy of Roundup Transorb. One trial was established to determine the effect of water hardness level in combination with Roundup Transorb application rate on herbicide efficacy while a second trial was established to determine the effect of dissolved organic carbon level in combination with Roundup Transorb application rate on herbicide efficacy.

Results indicated that water quality had little effect on the efficacy of Roundup Transorb. All herbicide water treatments significantly reduced the growth of the indicator crop compared to the untreated check for both the hard water and dugout water trials (Tables 1 and 2). There were no trends to indicate that reducing the water hardness level or the dissolved organic carbon level increased Roundup Transorb efficacy. As well, increasing the rate of Roundup Transorb had little effect on herbicide efficacy.

Water quality problems may only become apparent when other factors are present that also reduce herbicide efficacy. Where water quality is suspected to be a factor in reduced herbicide efficacy then the carrier water should be analyzed to determine its suitability for herbicide application.

Further work needs to be conducted to determine the merits of using good quality water for mixing with herbicides.

[1]*CSIDC, Outlook*
[2]*Agriculture and Agri-Food Canada, PFRA*

Table 1. Effect of water hardness level and herbicide rate of application on the efficacy of Roundup Transorb.

Treatment			Visual rating (0-100)[1]		21 DAA fresh weight biomass (g/m^2)
Water (Hard:Distilled)	Targeted hardness (µg/ml)	Roundup transorb application rate (g ai/ha)	14 DAA[2]	28 DAA	
Untreated	---	---	0 a	0 a	1007 a
Hard	1400	450	98 b	97 bcde	48 bc
Hard 3:1	1050	450	97 b	99 bc	50 bc
Hard 1:1	700	450	94 bcdef	94 cdef	65 bcd
Hard 1:3	350	450	96 bcd	99 bc	42 c
Distilled	---	450	98 b	99 b	45 c
Hard + AMS[3]	1400	450	94 bcde	95 bcd	87 bc
Hard	1400	360	82 g	82 h	147 b
Hard 3:1	1050	360	92 bcdef	94 cdef	147 b
Hard 1:1	700	360	88 efg	89 defg	102 bc
Hard 1:3	350	360	86 fg	89 efgh	106 bc
Distilled	---	360	97 b	98 bc	47 bc
Hard + AMS	1400	360	93 bcdef	94 bcde	68 bc
Hard	1400	270	84 g	85 gh	132 bc
Hard 3:1	1050	270	87 fg	89 efgh	93 bc
Hard 1:1	700	270	89 defg	92 cdefg	64 bc
Hard 1:3	350	270	89 defg	93 cdefg	60 bc
Distilled	---	270	86 fg	86 fgh	78 bc
Hard + AMS	1400	270	81 g	86 fgh	82 bc

Means in a column followed by the same letter are not significantly different at P=0.05. (ANOVA for Visual Ratings based on Arcsine (x/100) transformation).
[1]Expert Committee on Weeds Visual Rating Scale (0=no control; 100=total control)
[2]Days after application
[3]Ammonium sulfate

Table 2. Effect of carrier water dissolved organic carbon level and herbicide rate of application on the efficacy of Roundup Transorb.

Treatment		Visual rating[1]		21 DAA fresh weight biomass (g/m^2)
Water (Raw:Distilled)	Roundup transorb application rate (g ai/ha)	14 DAA[2]	28 DAA	
Untreated	—	0 a	0 a	980 a
Raw dugout	450	86 de	96 bcdef	76 cd
Raw 3:1	450	95 bcde	99 b	56 d
Raw 2:1	450	89 bcde	99 b	47 d
Raw 1:1	450	95 bcde	99 bcde	70 cd
Treated dugout	450	94 bcde	99 bcd	59 d
Distilled	450	96 bc	99 b	47 d
Raw dugout	360	93 bcde	96 cdefg	63 d
Raw 3:1	360	90 bcde	99 b	77 bcd
Raw 2:1	360	85 de	91 cdefg	127 bc
Raw 1:1	360	94 bcde	99 abcd	81 bcd
Treated dugout	360	97 bcd	99 bc	49 d
Distilled	360	94 bbcde	98 bcdefg	63 d
Raw dugout	270	87 e	94 fg	94 bcd
Raw 3:1	270	89 cde	95 defg	66 cd
Raw 2:1	270	95 bcde	95 defg	67 cd
Raw 1:1	270	98 b	99 b	59 d
Treated dugout	270	88 e	95 efg	139 b
Distilled	270	90 bcde	93 g	94 bcd

Means in a column followed by the same letter are not significantly differerent at P=0.05. (ANOVA for Visual Ratings based on Arcsine (x/100) transformation).

[1]Expert Committee on Weeds Visual Rating Scale (0=no control; 100=total control)

[2]Days after application

Re-cropping Dry Bean on Land Treated with Curtail M

T. Hogg[1], A. MacDonald[1]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

Progress: Year two of two

Objective: To determine if it is safe to seed dry bean on cereal stubble that was sprayed with Curtail M during the cereal year.

It is recommended that re-cropping land treated with Curtail M be restricted to cereals, corn, flax, canola and mustard. With the acreage for pulse crops increasing in Saskatchewan there is interest in shorting the time interval for re-cropping restrictions using this chemical.

Curtail M is a Group 4 herbicide (growth regulator type) that controls a wide range of broadleaf weeds in cereal crops. It is recommended that re-cropping land treated with Curtail M be restricted to cereals, corn, flax, canola and mustard. Curtail M contains clopyralid and MCPA Ester. Both chemicals are known to have re-cropping effects on pulse crops. With the large acreage of pulse crops in Saskatchewan and the desire to crop pulses on cereal stubble that has had good weed control there is interest in re-cropping pulses on cereal stubble that has been treated with Curtail M at reduced rates.

A dry bean Curtail M re-cropping trial was established in the spring of 2000 at the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) located on the SW15-29-08-W3. The soil at this site was developed on medium textured lacustrine deposits and was classified as Bradwell SiL-L.

The trial area was seeded to AC Barrie HRSW in 1999 and the following treatments were applied: Curtail M 495 g ai/ha, 660 g ai/ha, 990 g ai/ha and 1320 g ai/ha and Buctril M 560 g ai/ha. The entire area was harvested and cleaned off in the fall of 1999.

In the spring of 2000 a dry bean plot was established on the area that had received the Curtail M treatments in 1999. All seeding operations were conducted using a specially designed small plot six row double disc press drill with two sets of discs. One set of discs was used for seed placement while the second set of discs allowed for side band placement of fertilizer. Treatments were the Curtail M and Buctril M applications that were applied to the previous wheat crop. All plots received a side band application of 12-51-0 at a rate of 45 kg P_2O_5/ha (40 lb/P_2O_5/ac) during the seeding operation. Othello pinto bean was row crop seeded at a target plant population of 30 plants/m^2 using a 60 cm (24 in) row spacing. The treatments were arranged in a randomized complete block design and replicated four times. Each treatment consisted of two passes with the drill and measured 2.4 m x 8 m (8 ft x 24 ft).

Weed control consisted of a pre-seeding, soil incorporated application of Edge (ethafluralin) and separate post emerge applications of Basagran (bentazon) and Poast (sethoxydim).

Benlate (benomyl) was applied to the dry bean at approximately 10% flowering for control of *sclerotinia*. Days to 10% flower was determined from a visual estimate of the proportion of plants with at least one

[1]*CSIDC, Outlook*

open flower present. Days to maturity was determined from a visual estimate of mature plants. Maturity was indicated when 50% of the pods were at the buckskin stage.

Visual tolerance ratings (0 = no injury; 100 = fully damaged) were conducted at stand establishment, flowering and maturity.

At harvest all plots were direct cut using a small plot combine. The two center rows were cut from each treatment. The seed samples were cleaned, weighed and a sub-sample was used to determine seed weight.

The trial was seeded on May 18 and harvested on September 25. Growing season rainfall (seeding to harvest) and irrigation were 224 mm (8.8 in) and 115 mm (4.5 in) respectively.

There was no effect of the treatments on days to flower or days to maturity. The time required to reach 10% flower and maturity were 60 and 110 days respectively for the Othello pinto bean.

There was no observed visual effect on Othello pinto bean from the Curtail M applied to the previous cereal crop (Table 3). As well, there was no significant effect of the previous Curtail M treatments on the stand establishment or yield of Othello pinto bean.

It would appear that it is safe to re-crop irrigated dry bean on land previously treated with Curtail M.

Table 3. Effects of re-cropping irrigated dry bean on Curtail M treated land.

		Visual tolerance rating[1]			Yield	
Treatment	Plants/m²	Establishment	Flower	Maturity	(kg/ha)	(lb/ac)
Buctril M 560 g ai/ha	23	0	0	0	3525	3141
Curtail M 495 g ai/ha	21	0	0	0	2814	2507
Curtail M 660 g ai/ha	23	0	0	0	4077	3633
Curtail M 990 g ai/ha	23	0	0	0	3373	3005
Curtail M 1320 g ai/ha	22	0	0	0	3277	2920
LSD (0.05)	NS[2]	-	-	-	NS	
CV (%)	11.4	-	-	-	21.2	

[1]Expert Committee on Weeds Visual Rating Scale (0=no control; 100=total control)
[2]not significant

Agrochemicals in the Soil and Groundwater Under Intensively Managed Irrigated Crop Production

J. Elliott[1], A. Cessna[1], E. Zoski[1], T. Hogg[2], J. Wahab[2], L. Tollefson[2], B. Vestre[2]

Funded by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF)

***Progress**: Ongoing*

Objectives:
- To quantify the effect of agro-chemical use under intensive irrigated potato production on soil and groundwater
- To assist in the development of environmentally sustainable best management practices for potatoes.

In this study, potatoes are grown in a three-year rotation followed by canola and a cereal. Nitrate (NO_3) leaching is monitored throughout the rotation by measuring concentrations in soil and groundwater under different fertilizer regimes for potatoes and groundwater is analysed for the applied pesticides. In 2000, potatoes were not grown on our test plots. On the North field, canola was grown in the second year of the rotation and on the South field, wheat was grown in the third year of the rotation. Both the canola and wheat were fertilized to meet crop requirements at an average rate for the field.

Canola yields were highest on the treatment that received the **SPLIT** application in the previous year and yields on the fertigated treatment (**FERT**) were also higher than those on the single application treatments (**200** and **300**). However, it is difficult to attribute the yield differences to the fertilizer treatments in the previous year, since spring soil-test N was actually lower in the treatments with the higher yields. There were no significant differences in the yields of wheat on the South field.

Nitrogen -Fertilizer treatments in the potato year of the rotation:

300	300 kgN/ha (270 lbN/ac) incorporated prior to seeding
200	200 kgN/ha (180 lbN/ac) incorporated prior to seeding
Split	100 kgN/ha (90 lbN/ac) incorporated prior to seeding and 100 kgN/ha (90 lbN/ac) applied at hilling
Fert	100 kgN/ha (90 lbN/ac) incorporated prior to seeding and the balance applied through fertigation according to petiole analysis

The water level in the piezometers rose on both fields in 2000. On the South field the water table reached its highest level in early June but on the North field the water table continued to rise until late July. The rise in water table was accompanied by small gains in NO_3 in the shallow groundwater beneath the South field and substantial gains in NO_3 beneath the North field. The most significant gains were beneath the **200** and **300** plots in the North field. The nitrate concentrations in these wells were less than 0.2 mg L^{-1} in the early spring but maximum concentrations measured in June and July exceeded 5 mg L^{-1} on the **200** plot and concentrations reached almost 10 mg L^{-1} beneath the **300** plot.

[1]*National Water Research Institute, Saskatoon*
[2]*CSIDC, Outlook*

In both fields the NO_3 and NH_4 (ammonium) measured to 1.8 m (6 ft) depth in the soil profile decreased from spring to fall in 2000. On the South field the loss of N from the soil profile was of a magnitude that could be attributed to crop uptake. There was an average decrease of 500 kg N ha^{-1} (445 lb N/ac) from spring to fall on the North field. This loss exceeds the N that could be utilized by the canola crop and is reflected in the observed increase in NO_3 in shallow groundwater.

Although no pesticides were measured in the groundwater under the South field in 1998 when potatoes were grown, a number of pesticides were detected beneath both fields in 1999 (Table 4). Most detections were only of trace amounts but MCPA, chlorothalonil (Bravo) and phorate (Thimet) were present in quantifiable concentrations (>0.05 µg L^{-1}). Data for samples from 2000 are not yet available.

Table 4. Pesticides detected in groundwater in 1999.

Pesticide	Use	Last applied	Date detected	Maximum amount µg L^{-1}
South Field				
MCPA	Herbicide	?	May & September 1999	0.228
Chlorothalonil	Fungicide	Fall 1998	August, September & October 1999	0.056
Triallate	Herbicide	Fall 1997	April & May 1999	<0.05
EPTC	Herbicide	Spring 1998	May, June & September 1999	<0.05
Iprodione	Seed treatment	Spring 1999	May 1999	<0.05
Dimethomorph	Fungicide	Fall 1998	June 1999	<0.05
North Field				
MCPA	Herbicide	?	June - October 1999	0.132
Chlorothalonil	Fungicide	August 1999	August - October 1999	<0.05
EPTC	Herbicide	May 1999	July 1999	<0.05
Phorate	Seed treatment	May 1999	September 1999	0.160

Salinity Monitoring

G. Weiterman[1], G. Dyck[1], S. Pawlus[1], R. Holmlund[1]

The Agro Environmental Unit of Sask Water conducted a survey on Fields 11, 4, and 5, and on the CSIDC off-station site (NW12-29-08-W3) in the fall of 2000. Field 11 has been monitored with the use of a non-contacting EM 38 conductivity meter prior to and following installation of the drainage system in 1986.

Previous surveys were done manually collecting EM38 readings at each node of an established grid. This labour intensive method has been automated with the use of a Differential Global Positioning System (DGPS), which provides accurate location measurements, and allows continuous logging of the instrument readings.

The survey begins by setting up a GPS base station at a known location. This is generally a survey marker or piezometer nest site where location co-ordinates have been established. The EM38 equipment is calibrated and the operator drives the boundary of the survey area. A grid spacing and orientation is selected, and a series of survey lines are displayed on the computer screen of the mobile unit. The operator drives down the gridlines, logging EM38 and location data. The survey is done in both a shallow (<0.75 m) and deep (<1.5 m) reading mode.

The EM38 readings are displayed in real time on the computer screen. This aids in the selection of a series of sites where samples are collected for detailed salinity analyses. These results are regressed against the EM38 readings and a correlation co-efficient is determined. The EM38 readings can then be converted to electrical conductivity measurements.

The field data is exported to geographic information system software. The data is interpolated and maps depicting areas of each salinity class are generated. A salinity map for deep (<1.5 m) EM38 readings taken on Field 11 is shown in Figure 1. The DGPS also collects topographic information which is used to create an elevation map. Figure 2 depicts the elevation map for the off-station site.

This "picture in time" of the salinity levels is used to track changes and to assist with management decisions. This automated salinity mapping system is the same method used to assist in determining the irrigation suitability of land throughout the province.

[1]*Sask Water, Outlook*

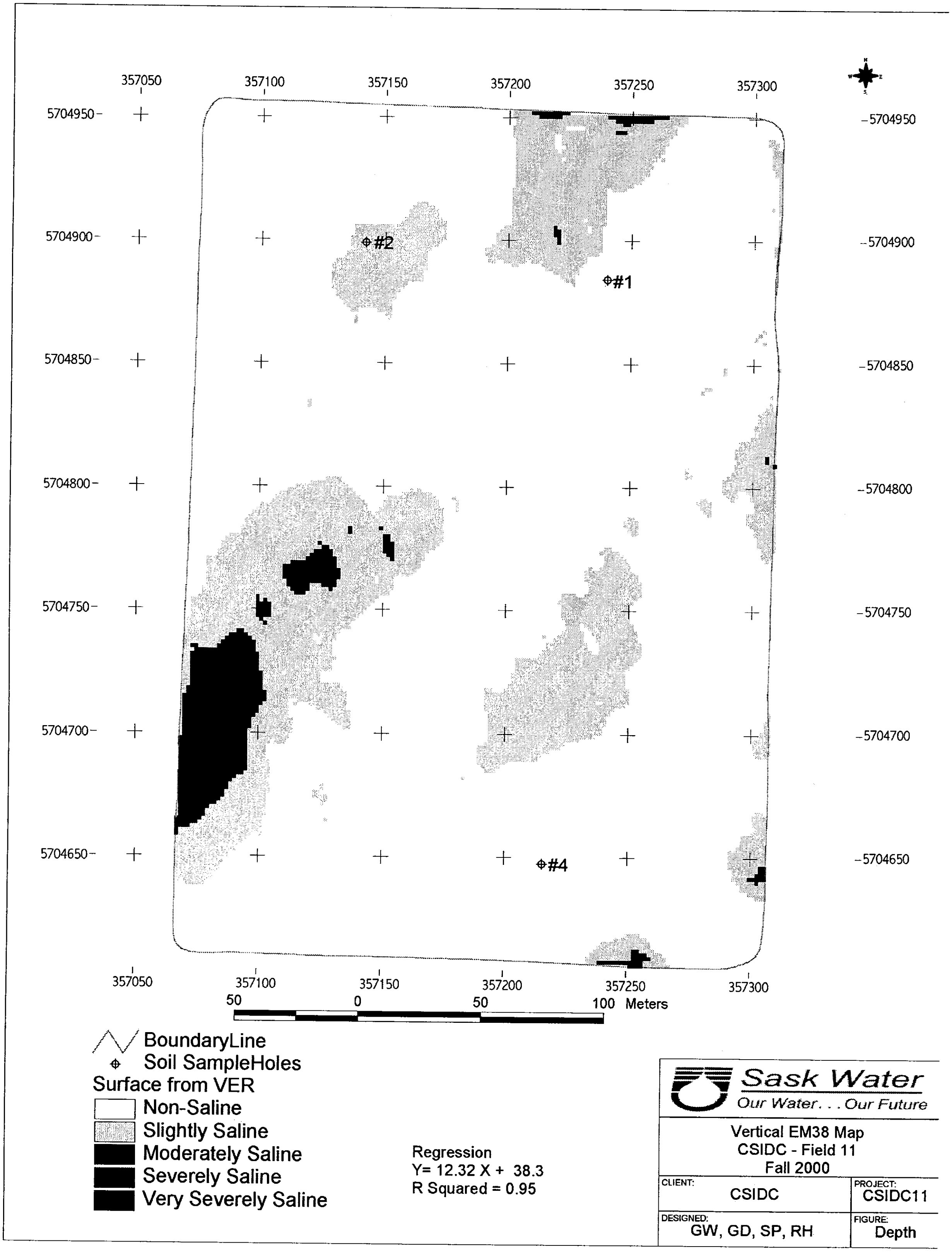

Figure 1. Salinity map for deep (<1.5 m) EM38 readings taken on Field 11, CSIDC.

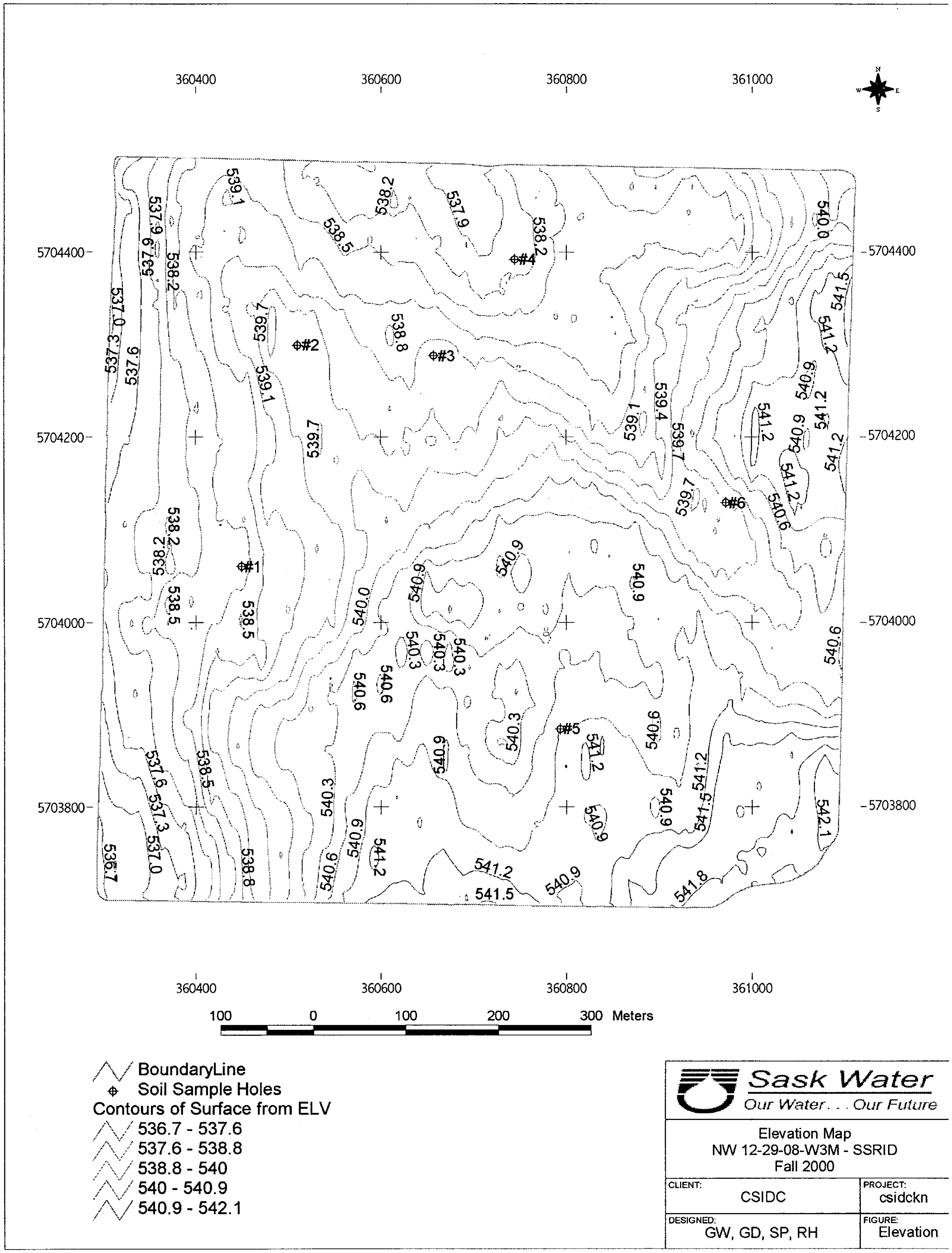

Figure 2. Elevation map for the CSIDC off-station site.

Market Analysis and Economics

Market Analysis and Economics

H. Clark[1]

Progress: *Ongoing*

Objectives:
- To assist producers to diversify by identifying higher value market opportunities.
- To help direct the CSIDC applied research and demonstration program by evaluating the potential for irrigated crops.
- To assist the establishment of value-added processing by identifying markets.
- To assist rural development by evaluating crop diversification and processing opportunities.

The objectives of the economic analysis program are met, in part, by gathering and analysing price, cost, and return data for irrigated and specialty crops. The analyses are used to evaluate the economic potential of these crops as a means of providing input for research and demonstration priority planning at the CSIDC. Potential for value added enterprise are also determined to support the planning process.

Collection and analysis to meet the objectives of the economic analysis program are an ongoing activity. In addition, the program provides other services. For example, the Centre provides and maintains information on industries closely related to agriculture such as ethanol production. These activities are performed at the request of management.

Potential for Vegetable Production in Saskatchewan

H. Clark[1]

The average vegetable farm size in Canada is 11.5 ha (28 ac). In Saskatchewan in 1996 it was 1.6 ha (4 ac). Both Statistics Canada and Saskatchewan Agriculture and Food estimate that Saskatchewan's vegetable area has declined by 60% since the 1996 census. By contrast all Canada's farm cash receipts for vegetables expanded by 38% between 1996 and 2000, while Alberta's and Manitoba's farm cash receipts for vegetables expanded by 19% in the same period. Saskatchewan's self-sufficiency for in-season vegetable production has declined from about 7% of in-season demand in 1991 to under 5% in 1999 (Table 1).

With the Canadian dollar declining from an average value of $0.74 U.S. in 1996 to under $0.65 U.S. in 2000, and with prices for vegetables in Saskatoon rising since 1998, Saskatchewan should be in a position to share in the expansion of its domestic vegetable industry.

Vegetable studies at the CSIDC over the past four years have indicated a greater potential for vegetable production than most growers in Saskatchewan may realize. Reasons for the optimistic potential for the vegetable industy, some of the challenges faced by new and current growers, and estimates of comparative advantage between potential vegetable crops are reported.

[1]*CSIDC, Outlook*

Table 1. Vegetable supply and in-season self sufficiency estimates for Saskatchewan, July to December 1999.					
	Source of vegetable supply (tonnes)				In-season self sufficiency (%)
	Sask. production[1]	Western Canada[2]	Imports[3]	Total	
Asparagus[4]	5	15	121	140	3.3
Beans, Green	11	38	128	177	6.2
Beets	7	26	17	50	13.9
Broccoli	37	332	1180	1548	2.4
Brussels Sprouts	4	8	42	53	7.5
Cabbage	608	926	521	2055	29.6
Carrot	61	931	1455	2447	2.5
Cauliflower	11	554	690	1254	0.9
Celery[5]	33	217	1256	1506	2.2
Corn, Sweet	79	435	375	890	8.9
Cucumber	16	805	484	1305	1.2
Lettuce	7	3768	3870	7645	0.1
Onions, Dry	72	625	3199	3896	1.8
Parsnips	2	31	2	35	5.7
Peas, Green	41	0	103	144	28.6
Peppers	5	174	933	1112	0.4
Pumpkin	114	421	0	535	21.3
Radish	10	57	159	226	4.5
Rutabaga	198	1501	0	1699	11.7
Spinach	1	17	302	320	0.3
Squash	9	39	417	465	1.9
Tomato	100	357	2870	3327	3.0
Vegetables excluding potato	1431	11 275	18 124	30 831	4.6
Potato	39 652	1628	2633	43 914	90.3
Vegetables including potato	41 083	12 904	20 757	74 744	55.0

[1]Based on Statistics Canada data or estimated from acreage data and yields where production data is unavailable
[2]Canadian provinces excluding Saskatchewan
[3]Cases where import figures is available for all of western Canada only have been weighted by population figures for each province
[4]May to July only
[5]Estimated using Manitoba yield and area data

Reasons for Optimism in the Vegetable Industry

U.S. farm programs are focussed mostly on the grain sector. Vegetable and potato farmers in the U.S. have had to cope on their own with the stronger U.S. dollar. Since Canada imports a large portion of its vegetables from the U.S., and most local vegetables are priced in relation to imported product, this means that Canadian domestic prices for vegetables have risen. Declining production of vegetables in Saskatchewan has also boosted local Saskatchewan vegetable prices, particularly in the winter months when domestic vegetable supplies decline.

Vegetable production in North America and elsewhere is most efficient with the use of irrigation. U.S. supplies of water are limited, and it is water for irrigation that is restricted first when shortages arise. California's water supplies in particular are becoming increasingly limited. While the vegetable area and production in California are still expanding, vegetable prices are expected to rise to reflect the limited supplies, thus giving Canadian growers an opportunity to supply more of their own market. Higher transportation costs will also add to the cost of importing vegetables.

Much of Saskatchewan's vegetables are purchased from Manitoba (and increasingly from Alberta). Manitoba growers are developing export markets for vegetables in the U.S. and elsewhere. This may allow Saskatchewan vegetable growers an opportunity to compete in the local market.

Research at the CSIDC with commercial scale vegetable production has consistently shown that Saskatchewan can achieve yields of excellent quality vegetables. This provides a basis of optimism for the Saskatchewan vegetable industry.

Why has Saskatchewan Vegetable Production been Declining?

As noted Saskatchewan's supply of vegetables has declined to 4.6% of in-season demand[1]. It has already been noted that one commercial wholesaler chose to move their operation to Calgary for the collection and distribution of vegetables for the prairies. This increases the cost of transportation for those Saskatchewan vegetable growers who continue to supply this market.

Other reasons which could influence the development of the prairie vegetable industry are:
(1) proximity to large retail markets (Saskatchewan's cities are small in comparison to Calgary, Edmonton, and Winnipeg); (2) higher yields for many vegetables in other provinces at present;
(3) a greater abundance of natural rainfall in Manitoba, and (4) a longer history of established production and marketing of vegetables in Alberta and Manitoba.

Manitoba has benefited from a large co-operative marketing of vegetables which has been highly successful.

Challenges for Commercial Vegetable Growers in Saskatchewan

Marketing

While the AFIF vegetable projects have demonstrated that Saskatchewan can produce commercial vegetables for local sale, they have not diminished the need for a greater co-ordination in marketing among vegetable growers. All budgeted production costs were below the wholesale selling prices for the vegetables grown in the demonstration project. Wholesalers exercise considerable control over prices, generally offering growers a few cents above their cost of production, because this is the price at which they can bring the vegetables in from other areas. Without a storage facility, a grower will also have to sell early in the season when prices are seasonally depressed, and before the premiums of winter sales materialize.

A co-ordinated sale of vegetables should net to a grower a price somewhere between that offered by commercial wholesalers, and that offered by direct sales, such as the farmers' market. In reality, commercial wholesale trading practises and the regulations for farmers' markets, do not allow a grower to sell to both markets at the same time. Thus the challenge of marketing to obtain an optimum price for growers still exists.

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[1] Self sufficiency was estimated for the period of July to December 1999 when local new crop vegetables are available. The calculation is based on domestic production estimates from Statistics Canada or estimates based on planted area in cases where domestic production data is not available (and therefore includes farmer's market sales).

Storage

Saskatchewan has a shortage of storage space available for vegetables. Yet the best price for many vegetables is during the winter months. Manitoba growers store carrots, beets, rutabagas, parsnips, potatoes, and cabbage throughout the year. Most of the storage in Manitoba is individually owned, with a small amount of throughput storage owned by the marketing organization.

The Learning Curve

New growers often have higher production costs for vegetables than growers who have been established for many years. It was the experience of the CSIDC that production costs tend to fall as more experience is gained with a particular vegetable. Similarly, the production costs for vegetables in Manitoba appeared to fall over time as growers gained more experience.

Labour Cost

A large portion of the production costs for any vegetable crop is labour. The CSIDC budgets assume a minimal charge of $7.50 an hour for labour. This is comparable to what some growers are paying in the Outlook area, but will be higher in many areas of the province. Saskatchewan does not allow temporary workers from outside the country to compete for local employment opportunities. However, both Manitoba and Alberta have developed programs in conjunction with Canadian laws whereby temporary workers can be brought in from areas such as Mexico. This labour remains relatively expensive as transportation, legal, and housing costs must be covered.

Equipment Availability

Vegetables such as carrot and onion can be produced at cheaper cost, or sold more effectively, when a large area is grown and proper machinery is used for harvest, cleaning, and packaging. In developing the budgets at the CSIDC, the demonstration project used the best equipment available to it, but since vegetables are not produced on a large scale in Saskatchewan, equipment that would be available to commercial producers in other parts of Canada could not be used. Investing in additional machinery could further reduce the costs of production.

Transportation

Distance from market will have a great effect on the size of individual operations and the transportation costs they incur. Nearby growers delivering to a farmers' market in Saskatoon will be able to receive higher prices for their produce than growers further away. Generally the further a grower is from their major market, the more they will have to specialize in a few vegetables to save on transportation costs. Large vegetable farms are often located within an hour's drive of their target markets. If a grower is too far from their target market, transportation costs can become prohibitive.

Climate

For many vegetables, the CSIDC was able to obtain high yields because the heat units available in Outlook are normally greater than in other parts of Saskatchewan. Other areas of the prairies that have higher heat units than Outlook tend to have higher yields as well. Growers need to determine which vegetables grow best with the climate and soils in their area. Rutabagas, for example, have been infested with maggot when grown in close proximity to canola. The best rutabaga area may well be in areas where canola is less commonly grown.

Crop Insurance

A crop insurance program is not available to vegetable growers (other than seed potatoes) in Saskatchewan. Growers often cite this as a disincentive to new or expanded vegetable production.

Irrigation

Most vegetables in Canada and in North America are grown under irrigation. This helps to reduce production costs per pound. This will be especially so in a moisture deficient area such as Saskatchewan. For some vegetables such as potato and carrot, sprinkler irrigation will be sufficient. Trickle irrigation has been used in conjunction with plastic mulch at the CSIDC to improve irrigation efficiencies and to reduce weed control costs. For some growers, lack of a suitable water supply will limit opportunities in vegetable production.

Production Budgets

Table 2 summarizes the budgets developed thus far for the vegetables grown at the CSIDC. It also includes estimates of costs for other vegetables using the CSIDC budgets for similar vegetables, yields from tests done by the University of Saskatchewan, or budgets for vegetables from other areas of Canada. The vegetables grown at the CSIDC tend to show higher returns than the budget estimates for other vegetables, probably because there is some degree of caution in developing budgets for crops which have not been tested on a large scale.

Table 2. Marketable yield, target price, cost of production summary and potential net return estimates for Saskatchewan vegetable production.

	Marketable yield		Target price[1]		Estimated cost/unit		Net return	
Crop	t/ha	tons/ac	$/kg	$/lb	$/kg	$/lb	$/ha	$/ac
CSIDC vegetable demonstration								
Pumpkins	60.1	26.7	0.381	0.173	0.280	0.127	6698	2701
Celery	36.9	16.4	0.716	0.325	0.555	0.252	6584	2655
Green Peppers	19.8	8.8	1.400	0.635	1.128	0.512	5952	2400
Brussels Sprouts	11.3	5.0	1.763	0.800	1.289	0.585	5880	2371
Cucumbers	37.6	16.7	0.639	0.290	0.511	0.232	5277	2128
Cabbage	58.7	26.1	0.335	0.152	0.256	0.116	5201	2097
Broccoli	17.6	7.8	1.102	0.500	0.860	0.390	4677	1886
Cantaloupe	31.7	14.1	0.679	0.308	0.549	0.249	4533	1828
Carrots	40.7	18.1	0.544	0.247	0.469	0.213	3403	1372
Cauliflower	17.8	7.9	1.038	0.471	0.868	0.394	3293	1328
Romaine Lettuce	20.9	9.3	0.776	0.352	0.672	0.305	2383	961
Estimates for selected crops								
Green Onions	11.0	4.9	1.501	0.681	1.054	0.478	5483	2211
Zucchini	23.9	10.6	0.912	0.414	0.705	0.320	5431	2190
Beets	20.5	9.1	0.873	0.396	0.639	0.290	5285	2131
Parsnips	9.0	4.0	1.968	0.893	1.479	0.671	4846	1954
Squash	18.2	8.1	0.853	0.387	0.648	0.294	4127	1664
Corn	13.5	6.0	0.551	0.250	0.317	0.144	3514	1417
Potatoes	29.9	13.3	0.236	0.107	0.130	0.059	3504	1413
Rutabagas	32.4	14.4	0.586	0.266	0.489	0.222	3460	1395
Green Peas	5.4	2.4	2.632	1.194	2.078	0.943	3256	1313
Snow Peas	4.5	2.0	3.110	1.411	2.486	1.128	3107	1253
Radishes	7.7	3.4	1.314	0.596	0.952	0.432	3043	1227
Asparagus	2.5	1.1	3.152	1.430	2.383	1.081	2897	1168
Onions	27.0	12.0	0.500	0.227	0.421	0.191	2363	953
Green Beans	6.8	3.0	1.904	0.864	1.609	0.730	2195	885
Spinach	9.7	4.3	1.031	0.468	0.908	0.412	1302	525
Tomatoes	12.4	5.5	1.261	0.572	1.188	0.539	1079	435
						Average	3869	1566

[1]The geometric mean between the wholesale selling price and the estimated cost of production

Comparative Advantage

The vegetables in which Saskatchewan appears most competitive at the moment are potatoes, rutabagas, pumpkins, beets, and parsnips. For these vegetables, Saskatchewan should be able to supply 75% to 100% of the in-season demand.

The budgets also show celery, green peppers, Brussels Sprouts, green onions, and zucchini as potentially having good returns based on recent prices. In addition to potatoes, Western Canada has exported carrots, greenhouse tomatoes, and Brussels Sprouts (from B.C.). Most vegetables, however, show potential for a positive return. Traditionally, growers have had more trouble growing crops such as field tomato or leaf crops such as lettuce and spinach.

Notes on Self-Sufficiency

Table 3 supplies further information on the self-sufficiency of vegetables for Western Canada. Excluding potato, Saskatchewan produced 4.6% of its in-season demand for vegetables in 1999 compared to 56% for Western Canada as a whole. For potatoes, Saskatchewan produced 90% of its in-season requirements compared to 88% for Western Canada as a whole. Including potato, Saskatchewan's in-season vegetable self-sufficiency rises to 55% compared to 67% for Western Canada. Other than potatoes, Saskatchewan is most self-sufficient in cabbage, pumpkin, and green pea (although none of the green peas appear to be sold through commercial wholesale channels).

Table 3. Vegetable supply and in-season self sufficiency estimates for western Canada, July to December 1999.

	Source of vegetable supply (tonnes)				In-season self sufficiency (%)
	W. Canada production[1]	Canada[2]	Imports	Total	
Asparagus[3]	384	0	1511	1895	20.3
Beans, Green	4152	0	1154	5306	78.3
Beets	2529	0	899	3428	73.8
Broccoli	6022	0	10 639	16 661	36.1
Brussels Sprouts	3774	0	375	4149	91.0
Cabbage	13 556	2	4698	18 256	74.3
Carrot	34 756	0	13 127	47 883	72.6
Cauliflower	3108	0	6161	9269	33.5
Celery	2158	0	11 331	13 489	16.0
Corn, Sweet	24 514	437	3384	28 335	86.5
Cucumber[4]	17 943	361	4292	22 596	79.4
Lettuce	7178	86	34 903	42 167	17.0
Onions, Dry	20 232	2	28 853	49 087	41.2
Parsnips	501	0	14	515	97.4
Peas, Green	7895	0	929	8824	89.5
Peppers	7895	125	8415	16 435	48.0
Pumpkin	5192	0	0	5192	100.0
Radish	498	0	492	990	50.3
Rutabaga	2953	0	0	2953	100.0
Spinach	469	0	2726	3195	14.7
Squash	3268	0	3758	7026	46.5
Tomato	39 620	448	25 889	65 957	60.1
Vegetables excluding potato	208 597	1461	163 551	373 609	55.8
Potato[5]	168 686	0	24 095	192 780	87.5
Vegetables including potato	377 283	1461	187 646	566 390	66.6

[1]Based on Statistics Canada data or estimated from acreage data and yields where production data is unavailable
[2]Canadian provinces excluding British Columbia, Alberta, Saskatchewan and Manitoba
[3]May to July only
[4]Includes greenhouse production using a conversion of 30 cucumbers = 1.0 kg
[5]Fresh market only; excludes seed and processing

Future Opportunity

There appears to be a turnaround in Saskatchewan vegetable production for 2000 as compared to 1999. Cash receipts per acre have been rising steadily since the last census in 1996. In 2000 it appears the average Saskatchewan vegetable grower received over $5,000 per acre in gross returns. The CSIDC budgets would indicate this could be doubled yet again in a good production year with careful marketing.

The falling Canadian dollar, higher transportation costs, and reduced supplies of water in the U.S. leave hope that there will be expansion in the vegetable industry in Saskatchewan.

Field Demonstration Program

Field Demonstration Program

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 conducts field demonstrations in the Lake Diefenbaker area in order to field test ideas that come from research at CSIDC and other institutions. These field demonstrations are monitored weekly and data is collected. This data is entered into a database and is used to develop agronomic recommendations. This information will be used to direct and influence irrigated crop production in the province. Demonstration co-operators pay $2.00 per acre to have their field monitored. ICDC informs the co-operator of any problems developing in the crop. ICDC reimburses the co-operator for any extra cost involved in hosting the demonstration plot.

Crop Manager Demonstration

I. Bristow[1], D. Oram[2], L. Schoenau[2]

The crop manager demonstration program is designed to take results from irrigation research and demonstrate them on a field scale. It involves irrigation producers working on various projects in their fields with the help of ICDC agrologists. The purpose is to develop an ongoing agronomic information database to direct and influence irrigated crop production in the province.

Foliar Feed on Dry Bean

The purpose of this demonstration is to determine if there is a yield and cost benefit to applying micronutrient fertilizer on dry bean. Foliar applied micronutrient fertilizer was tank mixed with fungicide and sprayed at the onset of flowering. Soil tests were taken to establish levels in the soil. Tissue tests were taken to examine the levels of nutrients in the plants.

The 2000 trials did not show any significant yield increases and therefore no economic benefit. This result has been consistent through four years of testing.

[1]*ICDC, Outlook*
[2]*Bloomfield Consulting, Central Butte, Saskatchewan*

Soil Ripping in Dry Bean Crops

This project demonstrates the benefits of using soil rippers on row crop cultivators for dry bean. Five tests were done with a row crop cultivator. The cultivator has shanks with spike tips attached. These rip the soil between the rows. Each pass rips to a depth of approximately 8 cm (3 in). After two or three cultivations the soil is ripped to a depth of 15 to 23 cm (6 to 9 in).

Ripping the soil improves aeration and water infiltration. Reduced soil compaction allows easier undercutting and reduced harvest loss. Ripping can bring rocks and subsoil to the surface. It is important to know the soil profile characteristics before using this practice.

Results from three years of tests show a yield increase with soil ripping in many cases. Results from 2000 are shown in Table 1.

Table 1. Soil and crop yield data for the 2000 dry bean soil ripping demonstration.

Soil texture	Bean market class	Soil nitrogen (lb/ac)	Unripped yield kg/ha	Unripped yield (lb/ac)	Ripped yield kg/ha	Ripped yield (lb/ac)	Yield difference kg/ha	Yield difference (lb/ac)
Silt loam	Small red	20	2462	2198	2560	2286	99	88
Loam	Great northern	20	3515	3138	3288	2936	(226)	(202)
Clay loam	Pinto	32	2314	2066	2664	2379	351	313
Clay loam	Small red	4	2071	1849	1952	1743	(119)	(106)
Loam	Pinto	30	2528	2257	2691	2403	164	146
Mean			2578	2302	2631	2349	53	47

Cereal Fungicide Demonstration

This projects demonstrates the use of foliar fungicide in wheat crops. The disease decision guide developed at the CSIDC was evaluated for its accuracy in predicting the need for fungicide application.

The fungicide Tilt was applied and compared to check strips. Plant samples were taken and the CSIDC disease decision guide was used to decide if spraying was required. Yields and grain quality were sampled to determine the economics of the fungicide application.

The decision guide was found to be accurate in predicting an economic benefit in 65% of the trials. It is a useful tool in deciding when to apply fungicide to wheat crops.

Canola Fungicide Demonstration

Four sites were studied to explore the use of foliar fungicide for control of *Sclerotinia*. Untreated check strips were compared to applications of Ronilan and Benlate. The fungicide applications provided control of the disease. There was a yield increase at all sites in 2000 (Table 2).

Table 2. Yield results for the 2000 canola fungicide application demonstration.

Field #	Fungicide	Untreated yield kg/ha	Untreated yield (bu/ac)	Treated yield kg/ha	Treated yield (bu/ac)	Difference kg/ha	Difference (bu/ac)
1	Ronilan	2066	36.9	2358	42.1	291	+ 5.2
2	Benlate	1904	34.0	2145	38.3	241	+ 4.3
3	Ronilan	2139	38.2	2234	39.9	94	+ 1.7
4	Ronilan	2794	49.9	3114	55.6	319	+ 5.7

Durum Wheat Variety Demonstration

The objective of this trial is to field test durum wheat varieties on a field scale.

AC Avonlea, AC Navigator, and AC Morse have performed well. These varieties have improved lodging resistance, higher yield, and better quality than older varieties such as Sceptre and Plenty which have been commonly grown under irrigation.

Forage Manager Demonstration

L. Bohrson[1], K. Olfert[1], Chad Lawley[1]

Haywatch Saskatchewan

Haywatch Saskatchewan has focussed on increasing producer awareness of the quality factors of alfalfa hay. The primary objective is to increase the value of irrigated alfalfa. This is accomplished in two steps. First, quality has to be described. The factors used to describe quality must have a direct relationship to milk and beef production. Second, a method for easy and accurate prediction of the quality of standing alfalfa is necessary. This prediction will be useful if it can be used to manage cutting dates. The combination of these steps will improve the producer's ability to target the quality that the market requests.

Relative Feed Value (RFV) is a method of determining alfalfa quality. RFV is calculated based on acid detergent fibre (ADF) and neutral detergent fibre (NDF) contents. The greater the RFV index, the greater the quality of the forage. Hay with an RFV of 150 or greater is acceptable dairy quality hay.

The Haywatch program has compiled a large data set describing irrigated alfalfa. This data has been used to generate equations that estimate RFV under Saskatchewan conditions. To date these equations predict RFV indices greater than lab analysis results. Work is ongoing to improve the accuracy of the equations. Similar to equations developed in the dairy states of the U.S., the equations use the height of the tallest plant and the maturity of the most mature plant to predict fibre levels.

Swift Current Alfalfa Variety Trial

The variety trial, located adjacent to Highway 4 and the city of Swift Current completed its final year in 2000. Beaver, Absolute, AC Blue Jay, Defiant, Heinrichs, and Impact alfalfa varieties were sown in six, two-acre strips on a clay to clay loam soil irrigated by a wheel move sprinkler system fed directly from Swift Current Creek.

Table 3. Mean yield and relative feed value for the Swift Current alfalfa variety trial, 1996 to 2000.

	Mean yield			Relative feed value	
Variety	tonnes/ha	tons/ac	% of Beaver	Mean index	% of Beaver
Beaver	43.0	19.2	100	112	100
Absolute	45.9	20.5	107	119	106
AC Blue Jay	45.9	20.5	107	114	102
Defiant	47.5	21.2	111	118	105
Heinrichs	42.8	19.1	99	114	102
Impact	45.2	20.2	105	116	104
Overall mean	45.0	20.1		115	

Yield and Relative Feed Value results are shown in Table 3. All six varieties had excellent yields. Beaver had the lowest RFV. Heinrichs, a dryland variety, was the lowest yielding cultivar under irrigation.

[1]*ICDC, Swift Current*

Alfalfa on Flood Irrigated Clay Soils

Three flood irrigated alfalfa variety trials are currently in progress near Eastend, Val Marie, and Consul. Yield results for 2000 are shown in Table 4.

Cypress Lake Irrigated Hay Demonstration

Table 4. Yield and relative feed value for the 2000 flood irrigated alfalfa variety demonstrations in Southwest Saskatchewan.

	Eastend			Val Marie			Consul		
	Yield		Relative	Yield		Relative	Yield		Relative
Variety	tonnes/ha	(tons/ac)	feed value	tonnes/ha	(tons/ac)	feed value	tonnes/ha	(tons/ac)	feed value
Rangelander	9.9	4.4	126	7.6	3.4	177	4.3	1.9	138
Beaver	10.5	4.7	135	7.8	3.5	172			
AC Blue Jay	9.2	4.1	137	6.7	3.0	185	2.2	1.0	140
Absolute	10.1	4.5	133	9.2	4.1	148			
Spredor 2				9.2	4.1	151	3.4	1.5	139
MF 8920				7.4	3.3	150			
MultiKing				7.4	3.3	160			
Impact				8.5	3.8	170			
Legend							3.6	1.6	130

A 13.8 ha (34 ac) water use efficiency demonstration project at Cypress Lake, Saskatchewan produced nearly 181 tonnes (two hundred tons) of baled alfalfa in the first year of full production. The average yield was 1.6 tonnes/ha (5.2 tons/ac). The majority of the field received 300 mm (12 in) of irrigation water. 1.2 ha (3 ac) were irrigated to a near optimum 450 mm (18 in) and produced 15.2 tonnes/ha (6.8 tons/ac). The additional yield was achieved with adequate irrigation, excellent stand vigor, and deep band placement of phosphorus at establishment.

A third plot received 15 cm (6 in) of irrigation. With the help of timely rainfall, first cut yield was 6.3 tonnes/ha (2.8 tons/ac). The second cut reached only 36 cm (14 in) height and was left standing to provide winter protection. The rainfed field border yielded 44.8 tonnes (20 tons) in total and showed no regrowth after the first cut. These results mirror the experience of the majority of the growers in the Consul area in 2000.

The Saskatchewan Forage Council provided assistance in the 1999 establishment year, and the 2000 yield and quality tests of four legumes and 13 grass species at this site. The alfalfa produced more than 13.4 tonnes/ha (6 tons/ac). Cicer milkvetch and sainfoin produced excellent quality but only one third the yield of alfalfa. Intermediate, tall and crested wheatgrasses, dahurian wildrye grass, tall fescue, and smooth and meadow bromegrass had total yields similar to alfalfa. The highest quality grasses contained five percentage points less protein and more fibre than alfalfa. Russian and altai wildrye grasses, meadow bromegrass, tall fescue and western wheatgrass are considered grazing species and produced highest forage quality. More information will be collected over the next two years.

Pocket Gopher Control

The ICDC held a series of pocket gopher control demonstrations in six central and southern irrigation districts, attracting 155 participants. Elton Weich of Nebraska, and Brodie Blair of Manitoba led a practical training demonstration of control methods.

Effective control of pocket gophers can be achieved by:

1) Smoothing the field first: Effective smoothing can be performed with harrows, a float, and land leveler, or an old rod weeder. Combine these with rolling.

2) Starting the control program three days after levelling: Attack every sign of fresh digging with bait or traps. You may have fewer gophers than expected.

3) Going after the source of infestation: Early defense of borders is essential. Controlling only the in-field pests allows immigration from ditches, fence lines, road allowances, bale stacks, and waste areas.

4) Using traps, or hand or machine baiting: Although commercial traps are available, effective hand bait placement is cheaper, faster, and produces multiple kills. Use a rolled oat zinc phosphide bait.

5) Using proper hand baiting: Careful probing at a 45 degree angle to locate and trowel out the entry tunnel will expose the main burrow less than a foot below the surface. Tunnels are not directly below the mounds. Check the field in early morning before the gophers have fully plugged the fresh rising tunnels. Funnel a half cup of bait into the main burrow, plug the tunnel, and always level the mound.