MANITOBA CROP DIVERSIFICATION CENTRE

2004 ANNUAL REPORT

Canada-Manitoba Crop Diversification Centre
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Canada MHPEC Inc. Manitoba

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Introduction

On behalf of the partners in the Canada-Manitoba Crop Diversification Centre, it is my pleasure to present the 2004 Annual Report. It is primarily a technical report on most of the MCDC projects conducted in 2004 by Centre staff and cooperating agencies. Thank-you to the individuals from those agencies who helped by providing material for many of the sections. This Report represents one of the several means by which the Centre and its research partners extend information on Centre projects and activities. You may also be familiar with our newsletter (*The Rainbow*), or have attended our field extension events, visited with us at our booth at trade shows, or took in our presentations on these projects by our research partners and staff at various conferences and meetings.

MCDC continues to be a partnership among governments and industry. A new operating agreement among the Centre partner agencies, to be in effect April 2004 through March 2008, was finalized in March 2004. A section of that Agreement that outlines the Centre's mission and program areas is included in this report. Signing by all parties was not completed until February 2005, but most resources for the 2004 field season were provided regardless, so the field research and demonstration program carried on. However, the delay did contribute to vacancies in two key Centre positions under the new Agreement - Potato Research Agronomist and Irrigation Specialist. We are looking forward to having both those new positions filled in 2005. Since the Centre's revised name under the new Agreement (*Canada-Manitoba Crop Diversification Centre*) was not adopted until signing was completed, the Centre operated as the *Manitoba Crop Diversification Centre* for most of 2004-2005, and that name will be used throughout this report.

Signatories to the new *Agreement on the Canada-Manitoba Crop Diversification Centre* include Canada (through Agriculture and Agri-Food Canada), Manitoba (through Manitoba Agriculture, Food and Rural Initiatives, and Manitoba Water Stewardship), and MHPEC (Manitoba Horticulture Productivity Enhancement Centre Inc.). MHPEC is a consortium of Manitoba potato processors (Midwest Foods Products Inc., McCain Foods [Canada] Ltd., and Simplot Canada Ltd.) and the processing potatoes growers association (Keystone Vegetable Producers Association). Simplot was welcomed as a new member of MHPEC for 2004-2005. Midwest Food Products was purchased by McCain Foods in late 2004. The Centre Overview following provides Centre operational details. All parties to the Agreement were actively involved in directing the Centre's management committee.

Most of the Centre's projects are coordinated and carried out in cooperation with a wide range of industry, government, and individual partners. Industry and producers have also generously supported our programs through contributions of inputs, study sites, and other donations, and their time at meetings and consultations.

2004 was another successful year operationally for field and plot activities, with average yields for most crops despite unprecedented cold for most of the growing season. A two-day storm with heavy snowfall in mid-May delayed most planting, but our staff rose to the challenge of establishing trials and crops quickly as soon as field conditions permitted.

Visitors are always welcome at all the CMCDC sites. Planned events provide opportunities to hear from our cooperators and visit with other producers, as well as with Centre staff. Call us or drop in for more information on anything in this report, or any of our programs and activities.

Dale J. Tomasiewicz
Centre Manager, CMCDC

Overview of the Manitoba Crop Diversification Centre - 2004

Background and Partners

The Manitoba Crop Diversification Centre (MCDC) was established in 1993 under a ten-year agreement among the Government of Canada, the Government of Manitoba, and Manitoba Horticulture Productivity Enhancement Centre Inc. (MHPEC). The goal was to develop and operate "a Centre through which crop diversification and production enhancing technologies can be investigated and demonstrated for the benefit of the agricultural industry in Manitoba." Most of the development and infrastructure costs, and a portion of the operating costs for the first few years, were provided for by Western Economic Diversification (WED) Canada through MHPEC.

A subsequent agreement (again, between Canada, Manitoba, and MHPEC) was completed in March 2004 for continued operation of the Centre, for April 2004 through March 2008, under the name *Canada-Manitoba Crop Diversification Centre*. Although signing of the Agreement was not completed until February 2005, most commitments were provided to allow for continuation of the Centre program through 2004. However, two staff positions under the new *Agreement* were not filled for 2004-2005.

Canada's commitment under the new Agreement, provided by Agriculture and Agri-Food Canada (AAFC), includes four staff positions, infrastructure support, and support services. **Manitoba**'s commitment is for two staff fte and cash support.

MHPEC is a consortium formed by the three Manitoba French-fry processors (Midwest Food Products Inc., Simplot Canada Inc., and McCain Foods [Canada] Ltd.), and Keystone Vegetable Producers Association (the processing potato growers association). MHPEC members provide their support to MHPEC as direct cash contributions. McCain Foods purchased Midwest Food Products in late 2004.

All three partners in MCDC actively participate in the Centre management and program advisory function committees. Input from other industry and stakeholder representatives is also obtained at annual program advisory meetings.

Infrastructure

The Centre operates sites at Carberry (headquarters), Portage la Prairie, and Winkler.

The **Carberry site** is located on a half section of excellent agricultural land (mostly Wellwood and Ramada clay loam and loam) at the junction of Highways #1 and 5. Buildings include an office-lab-classroom complex, a building for sample processing, shop work and machinery storage, a new chemical storage and handling building, and grain bins. Equipment for most operations is owned, while some field and research operations are contracted out or conducted by project cooperators. An advanced irrigation system has been installed which permits irrigation of approximately 70 ha of land, using three pivot irrigators and two linear-move systems well-adapted to meet the needs of irrigation research trials. This capability is unique to MCDC in Manitoba, so the Centre attracts most research in Manitoba requiring good irrigation control.

The **Portage la Prairie site** was previously an Agriculture and Agri-Food Canada Research Branch sub-station. It has an office-lab-workshop building, a new chemical storage and handling building, and a small greenhouse. Two linear-move field irrigators and an irrigation water supply system were set up to irrigate much of the land base of over one-quarter section, mostly good quality clay loam.

The **Winkler site** consists of approximately 16 ha of sandy loam land, mostly irrigable by a linear-move field irrigator. There are no buildings or full-time staff on-site. Most field and plot operations are carried out by a local seasonal technician and staff from the Portage la Prairie site; other services are contracted locally.

The three MCDC sites are strategically located in three areas of Manitoba with high-value crop production potential (including irrigation) and a range of representative soils.

Staff

AAFC is committed to provide four staff positions dedicated full-time to CMCDC, including the Centre Manager, Portage Site Supervisor, and other support staff.

Manitoba is committed to provide one staff position (Irrigation Specialist; vacant in 2004-2005) dedicated full-time to CMCDC, and portions of off-site staff totalling one fte. MHPEC provides one full-time staff position (Carberry Site Farm Supervisor) and up to fifteen seasonal support staff.

Project Partnerships

Most of the centre's programs and projects are carried out under some type of partnership with other public or private agencies. The nature of the cooperative arrangements are almost as numerous as the projects themselves; i.e. whatever is required to get the job done by using the resources of both parties efficiently in support of the common objectives. Through this type of cooperation, Centre projects can take advantage of the research knowledge, expertise, and large resources of other agencies, both public (e.g. Universities, AAFC Research Branch and PFRA, MB government) and private (e.g. consultants).

Extension

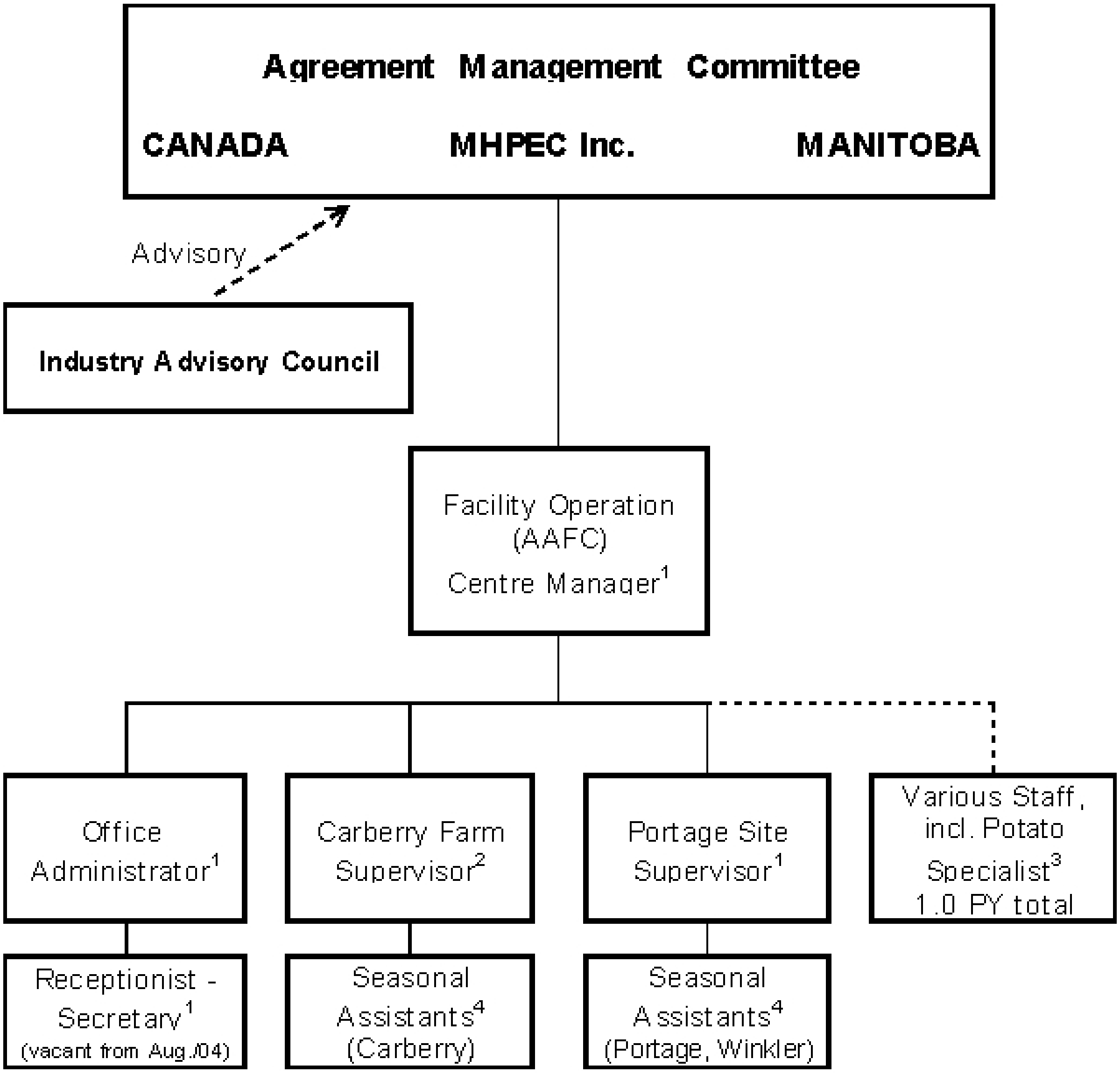
Results of CMCDC programs, and general information on agricultural diversification, potato production, irrigation, and environmentally responsible agriculture, are extended to the industry and the public by several means. The Centre's Annual Report and Newsletter (*The Rainbow*) are widely distributed. Staff take part in trade shows and seminars (e.g. Manitoba Potato Production Days), organize extension meetings, host annual events at each site, and respond to office and telephone inquiries. As most projects are cooperative, the cooperating agencies also transfer information through their established contacts and mechanisms.

Results, the Future

The value of diversification of the agricultural and rural economies is widely accepted, and highlighted at times of poor market returns to some of our standard agricultural products. The production of high-value crops facilitated by the Centre typically have farmgate values per acre in excess of ten times those of our standard grains and oilseeds. The Centre also plays a role in monitoring and promoting the environmental sustainability of intensive field agriculture.

The Centre is in its twelfth field season in 2005. Its mission statement, adopted after a strategic planning initiative which was completed in 2000, reads: *To develop agronomic solutions to enhance crop diversification and support sustainable water management*. A renewed operating agreement has been signed for operation of the Centre to 2008. Partners and stakeholders expect to see it continue to play a meaningful role in the development of sustainable intensive agriculture in Manitoba.

MCDC Management/Staff Organizational Structure - 2004



[1] Agriculture and Agri-Food Canada (AAFC) staff

[2] Manitoba Horticulture Productivity Enhancement Centre Inc. (MHPEC) staff

[3] Manitoba Agriculture, Food and Rural Initiatives staff; committed part-time to CMCDC program, working out of their regular office location.

[4] MHPEC and AAFC staff, and AAFC staff supported by MHPEC

Positions vacant through 2004-2005 are not shown.

MCDC Staff - 2004-2005

Carberry Site

Full time	Supporting MCDC Partner	Position
Clayton Jackson	MHPEC[1]	Farm Supervisor
Linda McLaughlin (retired August 2004)	AAFC[2]	Office Administrator
Sherree Olmstead	AAFC	Receptionist/Secretary (Office Administrator/A)
Dale Tomasiewicz	AAFC	Centre Manager

Seasonal	Supporting MCDC Partner	Position
Sharon Ardron	MHPEC	Research Assistant
Bernie Brecknell	MHPEC/AAFC	Field Research Assistant
Eric Claeys	MHPEC	Field Operations Assistant
Kevin Evans	MHPEC	Summer Student Assistant
Quelsa-An Oliver	MHPEC	Summer Student Assistant

Portage la Prairie Site

Full time	Supporting MCDC Partner	Position
Gerald Loeppky	AAFC	Portage Site Supervisor

Seasonal	Supporting MCDC Partner	Position
Pam Allen	MHPEC	Summer Student Assistant
Dan Bouchard	MHPEC/AAFC	Field Operations Assistant
Harvey Klippenstein	MHPEC	Field Operations Assistant
Terri Mauws	MHPEC	Research Assistant
Keith Maxwell	MHPEC	Operator and Maintenance Assistant
Dustin Troop	MHPEC	Summer Student Assistant
Henry Wolfe	MHPEC	Field Research Assistant (Winkler site)

Off-Site Staff with Part-time MCDC Program Commitments

Various MAFRI[3] Staff, including Bill Moons (Potato Specialist, Carman)

[1] Manitoba Horticulture Productivity Enhancement Centre Inc.
[2] Agriculture and Agri-Food Canada
[3] Manitoba Agriculture, Food and Rural Initiatives

Canada-Manitoba Crop Diversification Centre

Mission and Programs

The following is included in the new *Agreement on the Canada-Manitoba Crop Diversification Centre*, which provides the basis for participation of the Centre partners in delivering the CMCDC program for April 2004 through March 2008. This excerpt from the *Strategic and Operating Framework* section of the *Agreement* describes the Centre's mission and program areas.

Context

The Manitoba Crop Diversification Centre was established and has developed since 1993 based on an ongoing cooperation between industry and the Governments of Canada and Manitoba in support of advancing economically and environmentally sound crop production. Commitments and activities under the original agreement (*Agreement on the Manitoba Crop Diversification Centre*) among these partners was extended to 31 March 2004. The work of the Centre, however, is ongoing and its continued operation requires a common understanding among partner agencies of its role, committed resources, operations, and expected outcomes over the period of the Agreement. The programs and outcomes outlined here are based on the Centre's established roles and infrastructure, on priorities for work expressed by Centre partners and other industry representatives in many venues during the term of the first Agreement, on the established roles of the many other agencies with which the Centre cooperates, and on recognition of emerging issues and opportunities affecting the industry, such as increased pressures on soil and water resources due to expansions in irrigated potato production.

The mission of the Centre as adopted in 2000 is: *To develop agronomic solutions to enhance crop diversification and support sustainable water management*.

Programs and Outcomes

<u>Partnerships, Communication, Coordination, and Planning</u>

The Centre was established on a model of ongoing partnerships and communication within industry and with government. It provides linkages between the agriculture and agri-food sector and the science, innovation, and environment communities through regular cooperation and consultation, as well as facilitating ad-hoc issue-driven partnerships. Collaboration across the value chain is the goal, with both producer and processor partners, and federal and provincial levels of government. Certain Centre initiatives will be directed specifically to fostering coordination, communication and collaboration among the various agencies throughout the value chain and beyond the signatory agencies, such as Industry Advisory Council activities and Manitoba Potato Research Coordination meetings.

Coordination and cooperation with partners will allow Centre initiatives to take advantage of the substantial resources and experience of the several other public and private agencies that conduct programs and activities in areas related to those of the Centre. The intent is to complement, not displace or duplicate, those resources and programs. The Centre will seek to plan and work with those groups in areas of common concern, avoid duplication, and maximize efficiency and communication through partnerships. This may include sharing of equipment, personnel, and facilities, and other mutually beneficial collaborative endeavours. Through such partnership initiatives and communications, the Centre will serve as a catalyst to stimulate interest and programs related to its goals. Where a long-term partnership may be advantageous, appropriate private-sector agencies will be encouraged to join MHPEC Inc.

One aspect of partnership development will be application to funding programs. The Centre will apply to funding programs for financial support of its activities where such programs have a mandate relevant to the Centre project.

These activities will ensure that communication remains open among industry, government, and the public. Opportunities and issues will be raised and discussed at an early stage. The result will be more informed participating agencies, aware of each others issues and activities, and effective programs that employ the strengths and resources of all participants.

In addressing constraints to crop diversification, irrigation, and sustainable agricultural development, the Centre will not be limited to the types of programs described in the following sections below. Subject to approval by the Agreement Management Committee, the Centre may undertake other types of activities within its resources and capabilities, to address priorities identified by its partners.

Water Supply and Irrigation

Irrigation is essential for sustainable commercial production of potatoes and many other high-value crops in Manitoba and much of the rest of Canada. Irrigation requires large volumes of water, a multi-use public resource of increasing importance, concern, and value. Optimum irrigation management serves to conserve water, and to improve efficiency of production by minimizing the use of inputs, resulting in less leaching of contaminants into groundwater.

The Centre will play a central and ongoing role in development and extension of agricultural water management practices (irrigation and associated drainage), and is the only agency in Manitoba well equipped in terms of land and infrastructure for some of the work involved. Increasing irrigated potato production to supply the expanding potato processing industry heightens the importance of this work.

Program activities in this area will include the full range from replicated small-plot research trials, to field scale investigations and demonstrations, working directly with producers, and extending information by all appropriate means to the industry and the public. In addition, the Centre will help to develop, guide, and communicate the vision for irrigation development and expansion in Manitoba, participating in initiatives to identify potential developments and to promote principles of sustainability and cooperation in development programs.

These program activities will help to optimize production efficiency for irrigated crops, to ensure efficient use of the increasingly important water resource, to promote most rational development of irrigation, and to assure the public that irrigation development and management are sustainable and beneficial.

Potato Industry Support - Applied Research and Technology Transfer

The CMCDC should establish itself as a Centre of Excellence, as it is the best-equipped facility in Manitoba for field research and demonstration with potatoes. Manitoba potato processors and growers played a leading role in development, direction, and funding of the Centre since its inception, and continue to provide virtually all of its industry support. Much of the potato field research and demonstration in Manitoba, involving various federal, provincial, and industry agencies, is conducted at Centre sites in cooperation with the Centre. Thus the Centre provides important infrastructure and support for all involved in potato research and development in Manitoba. The irrigation and potato programming areas are closely linked and involve most of the same stakeholders, since most of Manitoba potato acreage is irrigated, and it accounts for more than three-fourths of the agricultural irrigation in the Province. The expanding potato industry accounts for about ten percent of farm cash receipts for crops in Manitoba. Potato production creates environmental concerns, however, which can be a focus of public attention. These are related mostly to the relatively intensive use of pesticides, tillage, and water in production of the crop.

As for its irrigation programming, Centre potato programming will include field research, demonstration, extension, public awareness, and representation of the industry and Centre partners in potato initiatives. Projects will address needs identified and prioritized with industry input, such as pest management, cultivar development and evaluation, crop nutrition, soil/rotation management (cropping systems), and other agronomic production practices and environmental issues. Crop quality as well as yield will be evaluated for interpretation of results. Management practices that optimize economic return, food quality/safety, and environmental sustainability will be developed and extended. With capability to work at the small plot to full field scale, and a focus on bringing technology to the farm, the Centre will bridge the gap between the earlier stages of innovation and development of concepts, and their application within production systems under local conditions.

The potato program will support the Canadian and Manitoba potato industry by helping to keep it competitive, financially stable, and a recognized reliable supplier of the quality produce needed for development of the processing industry. Development and promotion of practices that are environmentally sustainable will reduce risks to soil, water, and air quality, and improve the profile of the industry in the eyes of customers and the public.

Understanding and Protection of the Environment

Centre partners are all very aware of environmental risks associated with the intensive field crop production practices required for the culture of many high-value crops. The industry and the public are also increasingly aware of these potential threats to the environment. Much of the Centre's past activity has been directed at determining and monitoring the effects of intensive field agriculture (especially irrigated potato production) on soil and water resources, and at development of environmentally beneficial production practices.

Development and extension of information for management of nutrients (from all sources), pesticides, irrigation, crop rotations, and other agronomic practices, for environmental protection as well as production efficiency will continue to be a central theme. The headquarters site at Carberry, located over the large unconfined Assiniboine Delta Aquifer, provides an excellent opportunity for conducting long-term monitoring and analysis to help develop a better understanding of the interaction of agriculture with the environment. Agro-environmental indicators such as soil nutrients, groundwater quality and water use efficiency can be monitored, and data on the performance of the sector in environmental issues documented.

The Centre will play a significant role in the investigation, development and promotion of the new and innovative beneficial management practices for intensive field crop production, particularly for irrigated and high-value crops. The industry will require these in the next five years to meet demands from the public, consumers, and industry for environmental sustainability and accountability.

Environmental programs and activities will also cover the range from replicated research trials to extension to the industry and public by all appropriate means, and include cooperation with concurrent initiatives of industry, Canada, and Manitoba, such as those under the Agricultural Policy Framework. Environmentally sustainable resource development and crop/land management practices will be an ongoing theme in the Centre's technology transfer and education program. It will be proactive in promoting the stewardship achievements and environmental responsibility of agriculture in Manitoba. The Centre will foster partnership among government, industry, and other stakeholders for action on agro-environmental issues.

Activities at Centre sites will be managed by staff qualified to select appropriate environmentally sound agronomic practices for use and demonstration to industry and the public. These include soil testing and crop monitoring, and good management related to fertilizer and pesticide use, chemical and fuel storage, tillage, residue handling, documentation of field operations, etc. A safe environment for staff and Centre visitors will also be maintained through appropriate staff training, availability of personal protection equipment, and signage.

Environmental programs will contribute to the development and adoption of environmentally sound field crop production practices for high-value crops, and generate information on the effects of crop management practices on our soil and water resources for the industry and the public. This will provide information to guide management practices and any future expansion in the industry, help ensure its sustainability and efficient use of natural resources, and improve its public profile. These will have longer term benefits in terms of access to markets.

Crop Diversification

In addition to the Centre's central role in irrigation/potato and related environmental issues, it also supports and conducts other activities in support of general crop diversification. It manages land and facilities representing three different and important agro-ecological regions within Agro-Manitoba. These sites are well-positioned and equipped to support investigation and technology transfer initiatives advancing crop diversification and advanced field crop production practices in the respective regions. Activities for support are identified and prioritized by Centre partners and industry representatives, based on opportunities perceived and the ability of the Centre to facilitate the industry in taking advantage of them. As high-value irrigated crops are generally grown in rotation with other dryland crops, general crop diversification initiatives may also support irrigators, but applicability to rotations including irrigated crops is not a pre-requisite for all the Centre's work.

Crop diversification projects are generally conducted in cooperation with other agencies, to take advantage of such specialized expertise or other resources as required in each case for the crop or technology involved.

The Centre will continue to support crop diversification initiatives that assist with the development and adoption of new crops, varieties, and technologies, to the benefit of the agricultural economy and the environment. This can often be done at relatively low incremental cost to the Centre. These projects attract a wider clientele to the Centre sites, providing visibility for all its work to the industry and local communities.

MCDC Site Infrared Aerial Photos

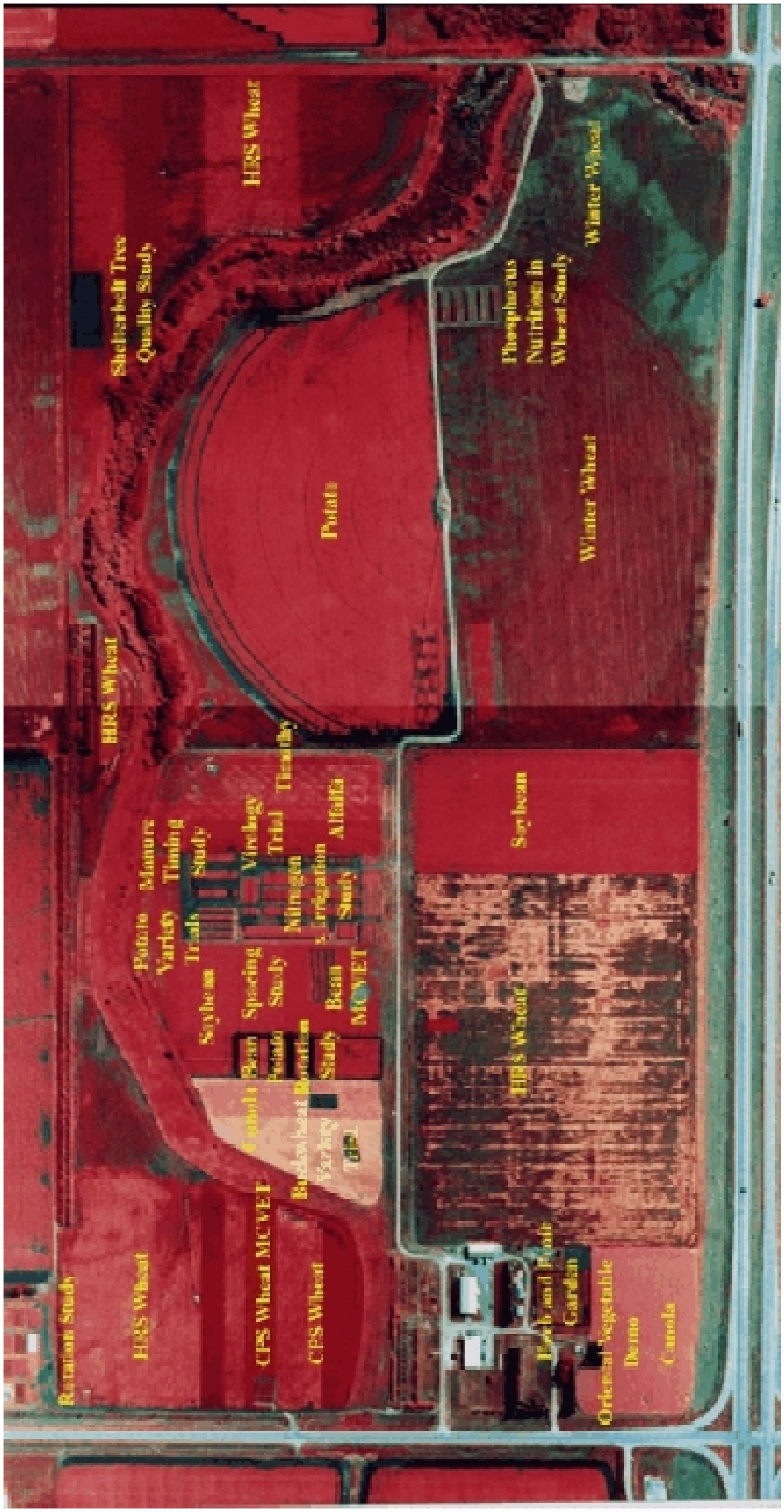


Figure 1. Infrared aerial photo of MCDC-Carberry site taken August 5, 2004.

Figure 2. Infrared aerial photo of MCDC-Winkler site taken August 14, 2004.

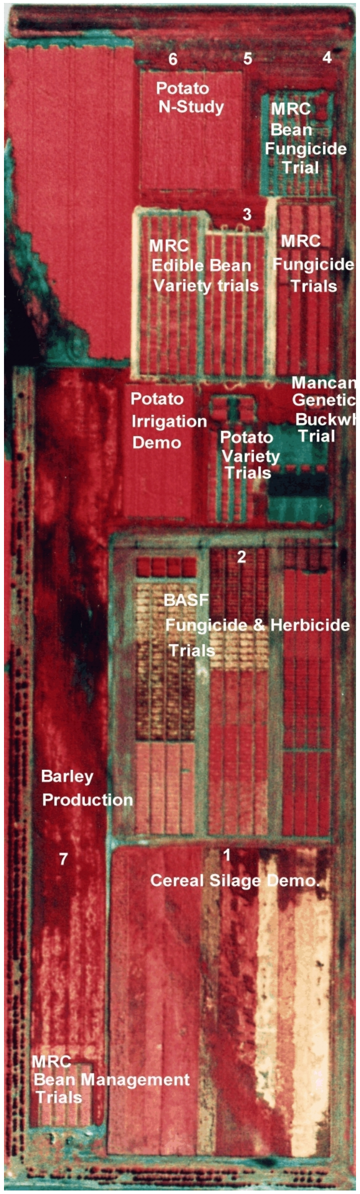


Figure 3. Infrared aerial photo of MCDC-Portage la Prairie site taken August 5, 2004.

Meteorological Data for MCDC Locations - April-October 2004

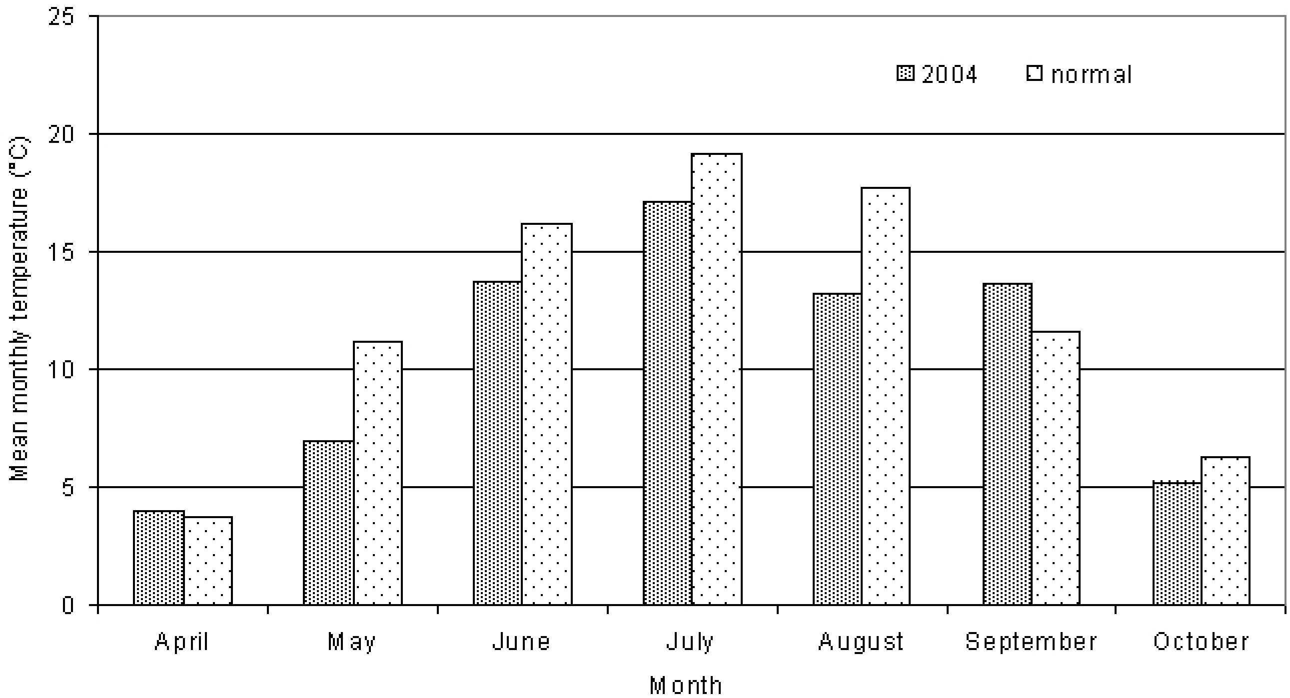


Figure 1. Growing season temperature at MCDC-Carberry.

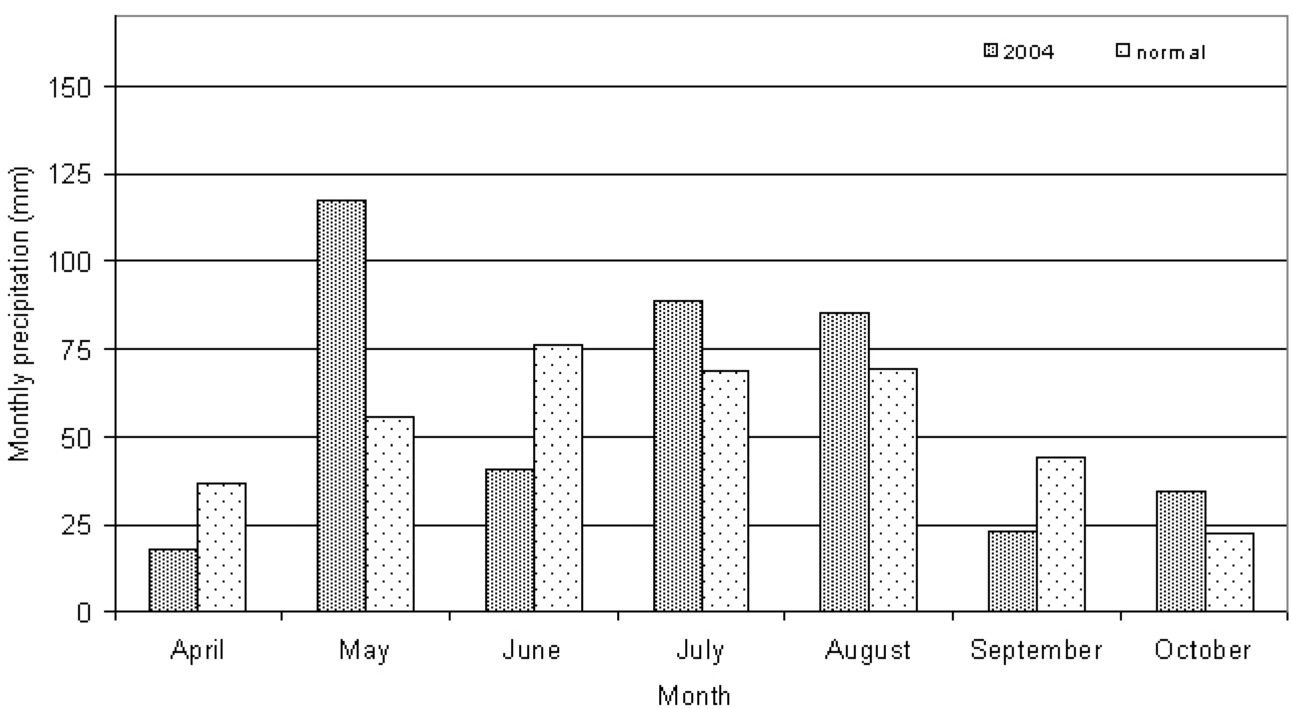


Figure 2. Growing season precipitation at MCDC-Carberry.

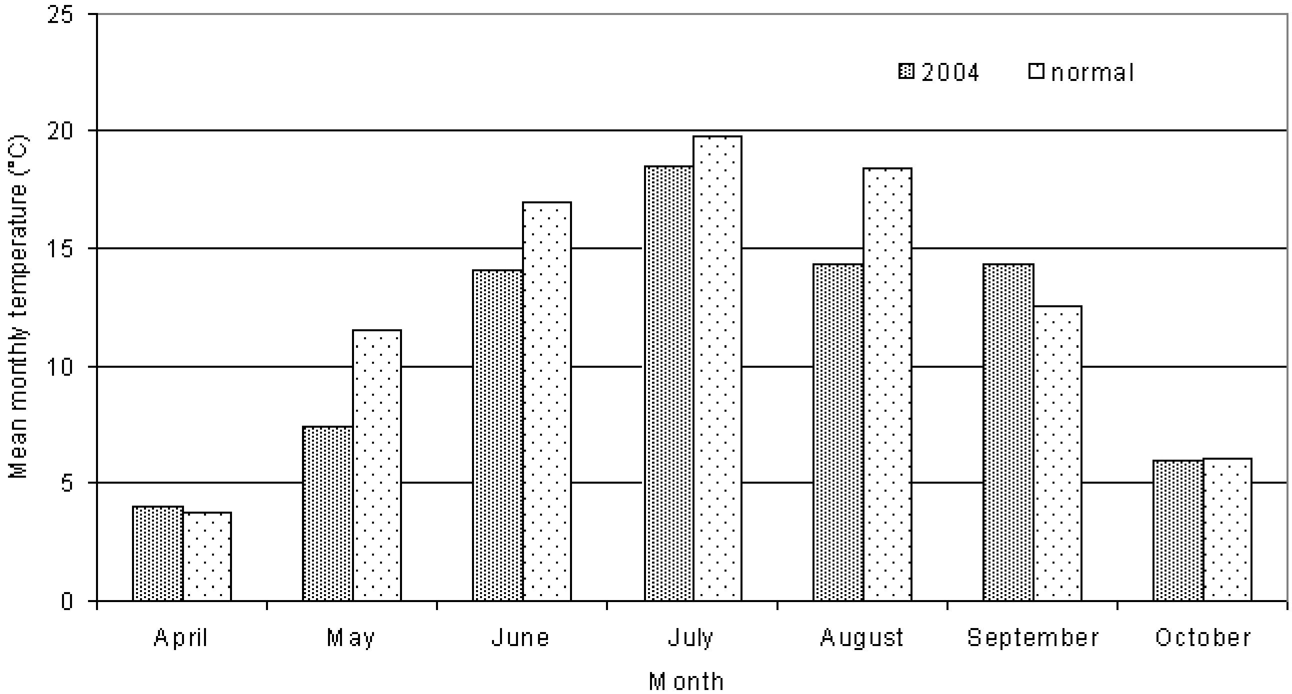


Figure 3. Growing season temperature at MCDC-Portage la Prairie.

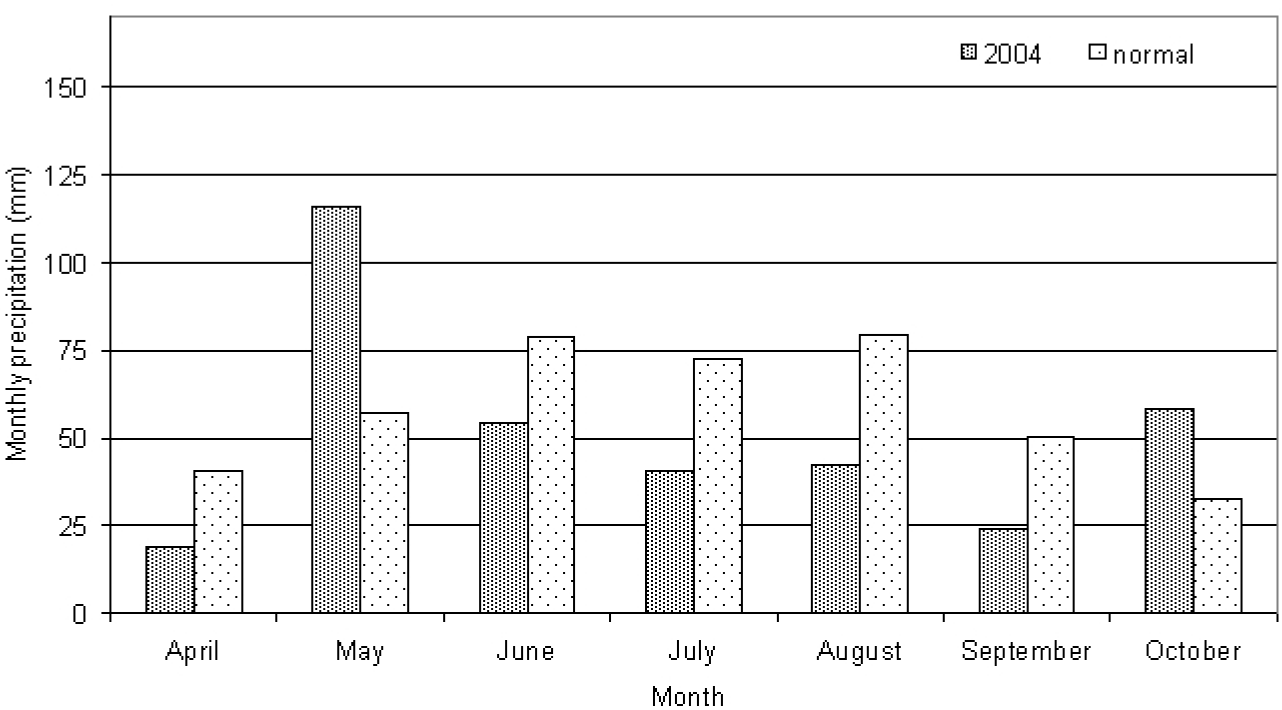


Figure 4. Growing season precipitation at MCDC-Portage la Prairie.

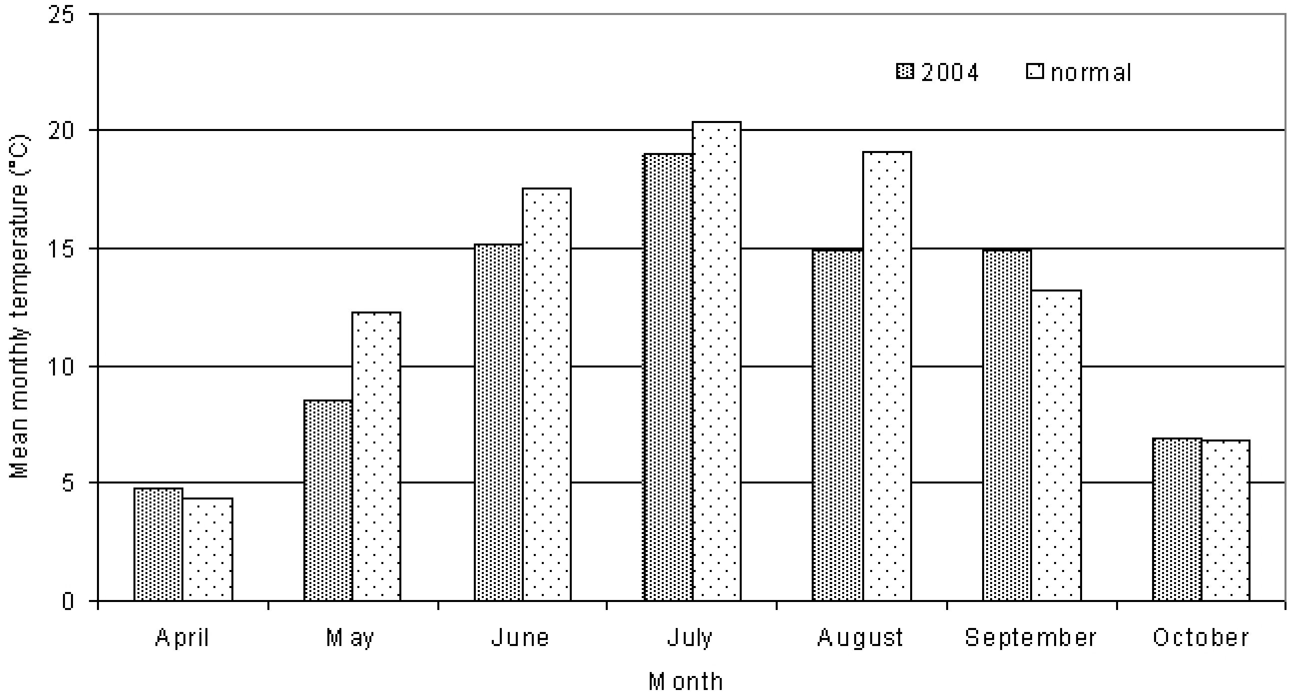


Figure 5. Growing season temperature at MCDC-Winkler.

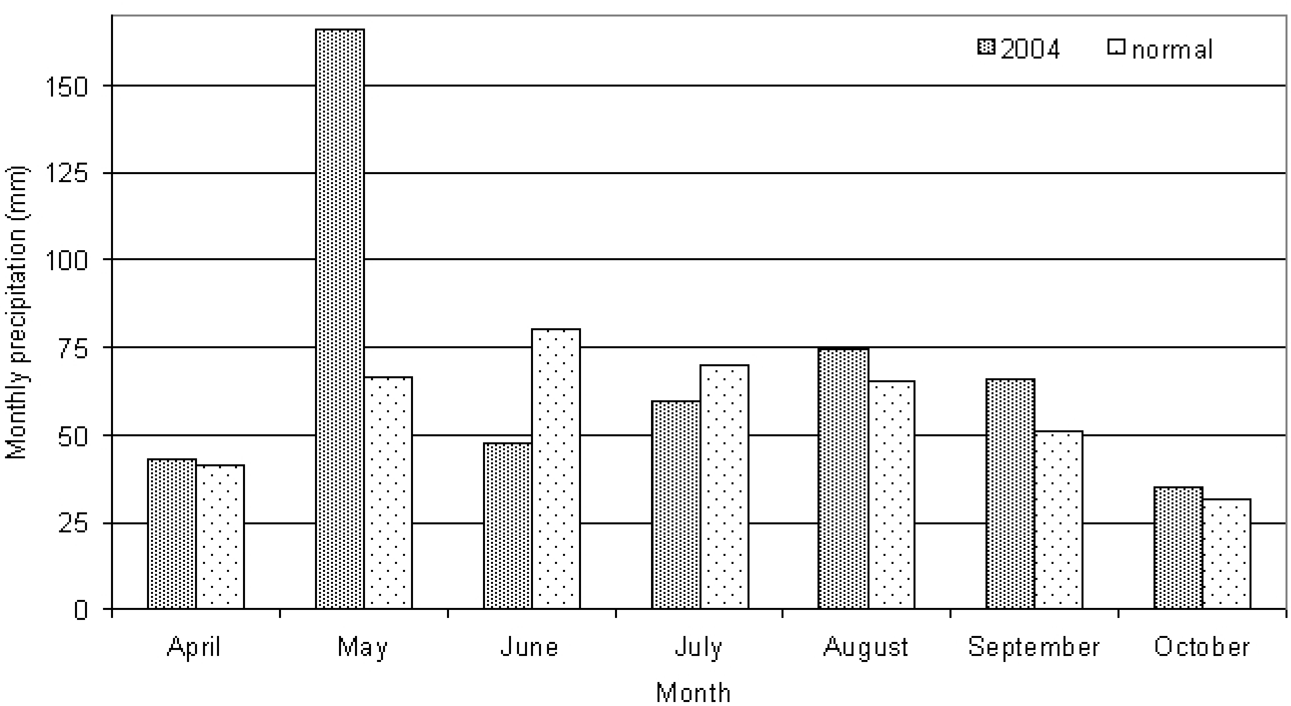


Figure 6. Growing season precipitation at MCDC-Winkler.

Potato Projects

Potato Rotation Study

Principal Investigators: K.M. Volkmar, R.M. Mohr, A. Moulin, D. McLaren, M. Khakbazan, and M. Monreal, AAFC-Brandon Research Centre

Co-Investigators: D.J. Tomasiewicz and C.J. Jackson, MCDC

Funding: MCDC, AAFC Matching Investment Initiative

Progress: Eighth year of the ongoing research project; seventh year of the rotations in place and of MII support.

Objective: To identify crop management strategies that maintain or enhance potato yield and quality, as well as soil and water quality, to ensure long-term viability and sustainability of irrigated potato production in Manitoba

Demand for process potatoes has grown steadily since 1962. With limited land base for expansion, there is growing pressure to shorten potato rotation from the traditionally recommended four-year cycle to three and even two years. In reducing the length of the rotation cycle, there is a corresponding increased risk of loss in tuber yield and quality due to a higher incidence of diseases and weeds as well as deterioration in soil quality caused by wind erosion. Because of high start-up costs, producers have little room for error in managing their potato crop.

This collaborative long-term potato rotation study between MCDC and the Brandon Research Centre was initiated in 1997 to address the shortage of regionally-relevant information on sustainable irrigated potato rotations. The specific objectives of this study are to identify potato rotations that reduce the risk of yield and quality loss associated with pests and weeds, and to maintain or enhance soil quality, without compromising the profitability of potato production. It compares the impact of crop species and rotation duration in the context of sustainable land management. In 2004, the rotation had completed the third year of its second four-year cycle. This report concentrates on rotation effects for the current year.

Experimental Design and Agronomic Management

In 1998, crop rotation treatments were initiated with six crop rotations ranging in duration from two to four years, and including a combination of oilseed, cereal and legume crops:

- Potato-Canola
- Potato-Wheat
- Potato-Canola-Wheat
- Potato-Oat-Wheat
- Potato-Wheat-Canola-Wheat

The study follows a randomized complete block design with four replicates. Each phase of each rotation is present each year, resulting in 18 treatments per replicate. Plot dimensions are 21.4 x 12.2 m. See previous MCDC Annual Reports for more detail on agronomic management and measurements.

Results and Discussion

A detailed report summarizing the results of the rotation for 1998 -2003 was provided in the 2003 MCDC Annual Report. This report focuses primarily on results of the 2004 field season. All Tables follow the Conclusions.

Yield and yield components

Cool and moist conditions prevailed through much of the 2004 growing season. Frost in August resulted in considerable damage to potato tops and some damage to canola.

In potato, gross tuber yields ranged from 285 to 347 cwt acre^{-1} in 2004, with tubers <3 oz accounting for between 15 and 20% of total yield (Table 1). Crop rotation did not affect the yield of tubers <3 oz, but did have a significant effect on the yield of bonus tubers (>10 oz) and tended to influence both marketable (>3 oz) and maingrade (3 oz to 10 oz) yield (Table 1).

Maingrade tuber yield ranged from 224 to 272 cwt ac^{-1}. Higher maingrade yields were produced in the P-C(A)-A-A rotation than in that P-W and P-O-W rotations, while yields in the P-C, P-C-W and P-W-C-W rotations were intermediate. For bonus tubers, yield was significantly higher in the two-year P-C rotation (35 cwt ac^{-1}) than the P-W, P-C-W, and P-W-C-W rotations, which produced less than 13 cwt ac^{-1} of bonus tubers. Yields in the remaining treatments were intermediate. Overall, marketable yield (>3 oz) ranged from 235 to 293 cwt ac^{-1}, with higher yields obtained in the P-C(A)-A-A rotation than in the P-W and P-W-C-W rotations.

Specific gravity of tubers ranged from 1.0838 to 1.0913, with the P-C(A)-A-A rotation producing tubers with a lower specific gravity than most of the other rotations. Interestingly, in relation to the other rotations, the P-C(A)-A-A rotation had comparatively high maingrade and marketable yields in 2004, and an intermediate bonus tuber yield.

Average yields of wheat and oat were 2600 and 3538 kg ha^{-1}, respectively (Table 2). Although wheat yield varied somewhat among rotation treatments, observed differences were not statistically significant.

In 2004, the canola harvested contained significant quantities of very small canola seed, possibly due to frost damage prior to crop maturity. This small canola seed would typically be removed during cleaning, however, in order to assess the impact of this small seed on yield, yields were determined with and without the weight of small seed included. Yields excluding the small seed varied considerably among treatments with P-W-C-W > P-C-W > P-C. When small seed was included as a component of the canola yield, P-C again produced the lowest yield, and P-C-W and P-W-C-W produced similar yields. As in previous years, canola underseeded with alfalfa produced comparatively lower yields.

Disease incidence

Plots were examined throughout the 2004 season for the prevalence of disease. All crops, including potatoes, canola, canola underseeded to alfalfa, alfalfa, wheat and oats were rated for disease. Wheat and oat plots were rated for foliar diseases on August 10 and 17, respectively. Canola and potato plots were rated for diseases on September 7 and 17, respectively. Wheat, oat and alfalfa ratings were based on approximately 25, 25 and 50 plants/plot, respectively. Canola, potato plant and potato tuber ratings were based on approximately 25 plants, 25 plants and 50 tubers per plot, respectively.

The 2004 crop production year was a difficult one for many producers. A cool, moist spring and summer along with a major frost on August 20 prompted many producers to call this one of the worst years in memory. Disease was prominent in most crops with sclerotinia (*Sclerotinia sclerotiorum*) being very damaging in canola, field beans, peas and sunflower. Although the potato crop is also susceptible to sclerotinia, little disease was evident in the current study. Leaf diseases showed up in early stages of growth especially where wheat grown on wheat stubble. Tan spot and septoria leaf diseases were common in cereal crops.

Wheat was rated for foliar diseases which were predominately septoria leaf blotch and tan spot. Alfalfa was also rated for leaf spot pathogens which were the predominant pathogens in the crop. Canola was rated for sclerotinia stem rot, blackleg, alternaria pod spot and aster yellows. The potato crop was rated for early blight, blackleg, rhizoctonia, verticillium wilt, potato virus Y and potato leafroll virus. Late blight ratings were also conducted although this pathogen is not impacted by rotation. Potato tubers are currently being rated for numerous diseases including fusarium dry rot, hollow heart, soft rot, rhizoctonia, scab, net necrosis, sclerotinia, etc. and results are not available for this report. Tuber damage due to wireworm will also be noted.

Sclerotinia and blackleg (*Leptosphaeria maculans*) were observed in 100% and 69% of canola plots, respectively. The highest levels of sclerotinia stem rot were seen in the potato-canola(alfalfa)-alfalfa-alfalfa [P-C(A)-A-A] rotation followed by the tight rotation of potato-canola. Sclerotia, the overwintering structures of the pathogen, require 10 days to two weeks of moist soil conditions to germinate and produces ascospores. Canopy crops provide this microclimate effect once the canopy closes in and precipitation is received. In 2004, environmental conditions were very favourable for the development of stem rot and levels were significantly greater than observed in 2003, a much drier year. The recommended rotation for sclerotinia susceptible crops is four years and the tight canola rotation in the current study would not be long enough to reduce populations of sclerotia of Sclerotinia sclerotiorum within the plots. The P-C(A)-A-A rotation also experienced higher disease levels and this would presumably be due to the canola underseeded to alfalfa which would enhance the microclimate effect and promote disease. Although disease levels were less in 2003 than in 2004, the greatest incidence of sclerotinia stem rot of canola was also observed in the P-C(A)-A-A rotation.

Blackleg has been reported to be significantly impacted by length of rotation in canola. The development of severe basal lesions has been associated with infection of canola early in the season and this depends on moisture events and the release of ascospores. Lack of coordination of these events would result in lower levels of disease. In 2004, highest levels of blackleg were observed in the P-C(A)-A-A rotation. During the seven years of rating canola in this experiment, this trend was observed during 3 of the 7 seasons. During three of the remaining seasons, highest disease levels were seen in the tight P-C canola rotation. It appears that although the canola, which is underseeded to alfalfa, is in a longer rotation, development of blackleg may be enhanced due to the favourable environmental conditions created by the alfalfa crop.

During 2001-04, alternaria pod spot was observed more often than during the two previous years. During 2002-04, the lowest levels were reported in the pea/wheat/canola/wheat rotation which represents three years out of canola. In comparing this rotation with three years out of canola due to potato and alfalfa, levels and severity of alternaria pot spot were higher in the rotation with alfalfa. This again may be a result of the favorable microclimate which may be beneficial for the production of air-borne inoculum from plant debris. Aster yellows was found at trace levels within the study. Fusarium wilt, a new disease of canola, which was first observed in Manitoba in 2000, was not found in this study.

With most soil- and stubble-borne diseases, rotation with non-host crops reduces the amount of initial inoculum while continuous cropping can increase the inoculum load In 2004, results of alfalfa foliar diseases are not available to date. The levels of wheat leaf diseases were similar across all rotations in 2002. However, during 2003-04, disease incidence was greatest in wheat following oats and in the tight rotation of wheat following canola, respectively. In 2004, disease incidence was lowest in the P-C-W rotation, representing two years out of wheat.

Lowest levels of Early Blight were observed in 2003, a warm dry field season. Spore production and germination are favoured by cool nights (<15 °C) and dew-forming or moist conditions. Primary infection of leaflets is caused by inoculum that survives in or on soil or plant debris. Spores can move long distances on air currents so that all but the most isolated fields will be exposed to some degree. With this in mind, it is possible that infected debris from other areas may have nullified any rotational benefit due to the presence of inoculum from sources outside the rotation study. In 2004, low levels of early blight were observed in some plots. Unfortunately, no early blight ratings were available in 2004 due to application of Reglone to the plots just prior to assessment for this disease. As with early blight, late blight levels were very low in plots and ratings were not available in 2004.

Blackleg (*Erwinia carotovora*) inoculum is borne on or in seed tubers and will survive for at least a short time in soil. During 2003-04, blackleg disease levels were greater than in 2002 and highest levels of disease were observed in the tight rotations of potato-wheat and potato-canola.

In the potato rotation study, further data collected from the Carberry site over the next year(s) will help to determine the impact of crop rotation on the incidence and severity of diseases in potatoes and in rotational crops in subsequent years.

<u>Disease Incidence Summary</u>

- Due to the wet, cool 2004 field season, sclerotina was more prevalent in canola than in three previous years.
- Canola underseeded to alfalfa had greater levels of sclerotinia stem rot than canola not underseeded to alfalfa. This was presumably due to the enhanced canopy effect which promoted favourable environmental conditions for disease development over an extended period of time.
- Basal blackleg of canola was prominent in tight rotations and also in canola underseeded to alfalfa in 2004.
- Alternaria pod spot of canola was greater in the rotation with alfalfa than in the rotation with wheat and potato during 2002-04.
- Disease incidence of wheat foliar diseases during 2003-04 were greater in wheat following oats and in the tight rotation of wheat following canola.
- No early or late blight ratings available for 2004.
- During 2003-04, blackleg disease levels in potato were greater than in 2002 and highest levels of disease were observed in the tight rotations of potato-wheat and potato-canola.
- Oat or canola in a potato rotation may impact Rhizoctonia solani. Additional research over subsequent years of the current study would provide critical data in this area.
- Tuber data will be available in the near future.

<u>Weed Populations</u>

Seedling, and residual weed communities are sampled each year in mid-June (seedling) and late July (residual), respectively. Weeds were counted by species in 10 quadrats (0.5m X 0.5m) at each time of assessment. Samples were taken in different locations within plots at each assessment. Due to difficulties in field identification of species at the seedling stage, prostrate and redroot pigweed were combined as pigweed species and volunteer canola and mustard plus wild mustard were labelled as mustard species.

Potato was the only crop counted for residual just prior to being sprayed with Gramoxone to kill the tops in preparation for harvest.

At this time data presentation consists the average total density +/- standard error of all weeds and dominant species in each crop within rotations, average by crop, and averaged by rotation. Subsequent analysis will involve ANOVA, contrasts, and multivariate techniques.

Pre-spray weed numbers in the potato phase of crop rotations were highest in the P-O-W rotation as has been the case in 3 of the last 4 seasons (Table 3, 11, 12). Over the previous seasons, residual weed numbers were low in the potato crop (Tables 6, 9, 10). This reflects the excellent weed management in the potato crop. Weed numbers have generally been higher in the potato crop when oat is in the rotation, perhaps reflecting the reduced weed control options in the oat crop. However, wild oats are not a problem in any rotation.

Variation in pre-spray weediness between seasons appears to be dependent on the environmental conditions in the previous fall and prior to planting rather than the weediness of preceding crops since, at least in potato, residual weed counts have been very low. The consistently high numbers in the 4-year rotation with alfalfa may adversely impact potato production.

Unlike previous years, canola and wheat had higher weed numbers following potato than other crops (Table 3). This was despite very low residual weed numbers in the potato crop in previous seasons (Table 7). However the differences between the 2 and 3 year rotations vary between seasons. Canola underseeded to alfalfa continues to be weedy since only trifluralin is applied and this product does not control many species. Prespray weed numbers in wheat increased ever year since 2002 (Tables 3, 11, 12). A similar result occurred in the potato phase of most crop rotations (Table 5). As in previous years the major weeds in all rotations were broadleafed weeds and green foxtail (Table 4). Wild buckwheat and stinkweed were major weeds in all seasons but in 2004 red root pigweed was a major weed and this was not present to any degree in any of the previous seasons.

Residual weed numbers in the potato phase of rotation are unlikely to be biologically significant (Table 7). Weed control in the potato portion of the crop rotation continues to extremely good, and from 2002 to 2004, there were no significant differences. This is to be expected given the level of tillage with hilling and herbicides applied.

Soil Chemical and Physical Properties - not available at time of publication.

Conclusions

As in past years, the two- and three-year rotations that include canola have tended to yield higher than both the short and longer rotations with cereals or alfalfa. While this does not appear to be associated with weed control, it is possible that canola may have a low level influence on potato pathogens. This year (2004) represents the third year of the second four-year cycle of the potato rotation study. Next year's results will provide us with two full four year rotation cycles.

Table 1. Potato yield and specific gravity as affected by crop rotation in 2004.

		<3 oz		3 oz to 10 oz		>10 oz		Marketable (>3 oz)		Gross yield		Specific Gravity	
Treatment	Rotation	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
		----------	----------	----------	----------	----------	----------	cwt $acre^{-1}$	----------	----------	----------		
1	P-W	49.8 a[1]	7.5	224.0 c	7.5	11.3 b	5.5	235.3 c	12.8	285.0 c	14.8	1.0913 a	0.0021
3	P-C	51.0 a	14.0	246.4 abc	9.6	35.0 a	12.6	281.5 ab	12.4	332.5 ab	7.3	1.0873 ab	0.0015
5	P-C-W	56.4 a	5.1	269.9 ab	34.0	11.2 b	4.8	281.1 ab	37.2	337.5 ab	32.5	1.0883 a	0.0015
8	P-O-W	58.7 a	6.8	235.7 bc	32.7	20.5 ab	9.8	256.2 abc	40.7	314.8 bc	34.5	1.0895 a	0.0013
11	P-W-C-W	64.1 a	19.5	237.1 abc	19.9	12.5 b	6.8	249.6 bc	26.7	313.5 bc	7.9	1.0900 a	0.0024
15	P-C(A)-A-A	54.1 a	6.3	271.5 a	27.6	21.1 ab	15.6	292.6 a	20.5	346.8 a	20.0	1.0838 b	0.0067
LSD $_{(0.05)}$		17.9		35.0		15.3		40.6		30.5		0.0045	
		----------	----------	----------	----------	----------	----------	P-value	----------	----------	----------	----------	
Rep		0.85		0.24		0.52		0.35		0.12		0.17	
Rotation		0.65		0.06		0.04		0.07		0.009		0.05	
C.V. (%)		21.3		9.4		54.6		10.1		6.3		0.27	

s.d. indicates the standard deviation of the mean.

[1] Mean values within a column which are followed by the same letter are not significantly different ($P \leq 0.05$) according to the least significant difference test.

Table 2. Yield of canola and cereals as affected by crop rotation in 2004.

	Yield (kg ha^{-1})[1]			Adjusted yield (kg ha^{-1})[2]		
Rotation Treatment	Mean		s.d.	Mean		s.d.
Canola						
P-C	935	c[3]	82	1063	b	67
P-C-W	1049	b	98	1175	a	84
P-W-C-W	1153	a	36	1248	a	28
P-value						
Rep	0.06			0.18		
Rotation	0.003			0.008		
C.V. (%)	5			4.6		
Wheat						
P-W	2607	ab	65			
P-C-W	2797	a	56			
P-O-W	2621	ab	187			
P-W-C-W	2526	b	282			
P-W-C-W	2451	b	46			
P-value						
Rep	0.64					
Rotation	0.1					
C.V. (%)	6.3					
Canola (underseeded to alfalfa)[4]						
P-C(A)-A-A	452		96	671		121
Oat						
P-O-W	3538		283			

s.d. indicates the standard deviation of the mean.

[1]Yield is based on cleaned, dried grain.

[2]Adjusted yield for canola includes very small canola seed removed during cleaning.

[3]Mean values within a column which are followed by the same letter are not significantly different ($P \leq 0.05$) according to the least significant difference test.

[4]Canola in canola(alfalfa) plots includes some weed seeds not removed during cleaning.

Table 3: Average density of all weeds prior to in crop spraying, 2004.

	Total Weed Density									
Rotation	Potato	Wheat	Wht/Pot	Wht/Can	Canola	Can/Alf	Oat	Alfalfa 1	Alfalfa 2	Mean
P-W	45.7 b	215.1 a								130.4
P-C	30.4 b				55.3 a					42.9
P-C-W	25.2 b	141.6 ab			95.9 a					87.6
P-O-W	149.7 a	76.0 b					373.6			199.8
P-W-C-W	24.4 b		249.9	149.3	27.2 a					112.7
P-C(A)-A-A	47.3 b					189.3		319.1	238.8	198.6
Mean	53.8	144.2	249.9	149.3	59.5	189.3	373.6	319.1	238.8	

Table 4: **Average density of major weeds for prior to in crop spraying, 2004.**

Rotation	All weeds	AMAXX	POLCO	SETVI	THLAR
P-W	130.4	94.3	15.5	9.2	4.5
P-C	42.9	10.3	11.7	1.2	17.9
P-C-W	87.6	45.5	14.3	5.0	9.4
P-O-W	199.8	45.4	9.9	133.8	4.2
P-W-C-W	112.7	74.9	11.2	11.3	6.0
P-C(A)-A-A	198.6	44.4	20.0	10.6	94.9
MEAN	136.3	53.3	14.0	29.2	27.2

AMAXX=pigweed species; POLCO= wild buckwheat; SETVI=green foxtail; THLAR= stinkweed.

Table 5: Average density of all weeds prior to in crop spraying in Potatoes

Rotation	**2002**	**2003**	**2004**
P-W	16.3	27.0	45.7 b
P-C	32.9	23.2	30.4 b
P-C-W	11.1	17.0	25.2 b
P-O-W	18.6	51.2	149.7 a
P-W-C-W	10.2	25.8	24.4 b
P-C(A)-A-A	26.2	59.2	47.3 b
Mean	18.5	35.8	53.8

Table 6: Average density of major weeds prior to in crop spraying in Potatoes, 2004.

Rotation	TOTW (Table 5)	AMAXX	POLCO	SETVI	THLAR
P-W	45.7 b	18.6 a	23.0 a	1.7 b	0.0 b
P-C	30.4 b	4.8 bc	22.0 a	1.5 b	0.2 b
P-C-W	25.2 b	5.4 bc	16.5 a	1.4 b	0.0 b
P-O-W	149.7 a	10.3 b	20.7 a	115.8 a	0.4 b
P-W-C-W	24.4 b	2.9 c	5.3 b	10.3 b	0.4 b
P-C(A)-A-A	47.3 b	1.8 c	13.6 ab	5.2 b	1.6 a
MEAN	53.8	7.3	16.9	22.7	0.4

AMAXX=pigweed species; POLCO= wild buckwheat; SETVI=green foxtail; THLAR= stinkweed.

Table 7: Average density of all weeds for residual weed counts in Potatoes

Rotation	2002	2003	2004
P-W	0.5	2.3	4.7
P-C	0.1	0.0	3.1
P-C-W	0.4	1.1	1.3
P-O-W	0.3	3.9	11.1
P-W-C-W	2.5	4.3	5.4
P-C(A)-A-A	0.1	2.8	5.4
Mean	0.7	2.4	5.2

Table 8: Average density of major weeds for residual weed counts in Potatoes, 2004.

Rotation	TOTW (Table 7)	CIRAR	POLCO	SETVI	THLAR
P-W	4.7 a	1.20 b	1.10 ab	0.10 a	0.00 a
P-C	3.1 a	2.90 ab	0.20 b	0.00 a	0.00 a
P-C-W	1.3 a	0.00 b	0.20 b	0.10 a	0.10 a
P-O-W	11.1 a	0.10 b	4.50 a	3.30 a	1.70 a
P-W-C-W	5.4 a	5.00 a	0.10 b	0.10 a	0.00 a
P-C(A)-A-A	5.4 a	0.00 b	0.40 b	0.00 a	0.00 a
MEAN	5.2	1.53	1.10	0.60	0.30

CIRAR=Canada thistle; POLCO= wild buckwheat; SETVI=green foxtail; THLAR= stinkweed.

Table 9: Average density of major weeds for residual weed counts in Potatoes, 2002.

Rotation	TOTW (Table 7)	AMARE	POLCO	SETVI
P-W	0.5	0.00	0.00	0.00
P-C	0.1	0.00	0.1	0.00
P-C-W	0.4	0.00	0.00	0.4
P-O-W	0.3	0.1	0.00	0.1
P-W-C-W	2.5	1.4	1.0	0.1
P-C(A)-A-A	0.1	0.1	0.00	0.00
MEAN	0.7	0.3	0.2	0.1

AMARE= redroot pigweed; POLCO = wild buckwheat; SETVI= green foxtail.

Table 10. Average density of major weeds for residual weed counts in potatoes, 2003.

Rotation	TOTW (Table 5)	POLCO	SETVI	TRZAS
P-W	2.3	0.5	0.4	1.4
P-C	0.0	0.0	0.0	0.0
P-C-W	1.1	0.1	0.1	0.9
P-O-W	3.9	0.2	2.7	1.0
P-W-C-W	4.3	0.4	0.8	2.8
P-C(A)-A-A	2.8	1.0	0.0	0.1
MEAN	2.4	0.4	0.7	1.0

POLCO = wild buckwheat; SETVI= green foxtail; TRZAS=volunteer wheat

Table 11: Average density of all weeds (± SE) prior to in crop spraying, 2002.

	Total Weed Density									
Rotation	Potato	Whea	Wht/Pot	Wht/Can	Canola	Can/Alf	Oat	Alfalfa 1	Alfalfa 2	Mean
P-W	26.4 b	6.2 a								16.3
P-C	58.2 a				7.5 b					32.9
P-C-W	13.5 b	2.1 a			17.8 a					11.1
P-O-W	15.3 b	5.0 a					35.6			18.6
P-W-C-W	28.4 b		4.7	3.3	4.4 b					10.2
P-C(A)-A-A	53.9					27.0		19.0	4.9	26.2
Mean	32.6	4.4	4.7	3.3	9.9	27.0	35.6	19.0	4.9	

Table 12: Average density of all weeds (± SE) prior to in crop spraying, 2003.

	Total Weed Density									
Rotation	Potato	Wheat	Wht/Pot	Wht/Can	Canola	Can/Alf	Oat	Alfalfa 1	Alfalfa 2	Mean
P-W	18.2 bcd	35.7 b								27.0
P-C	2.6 d				43.7 a					23.2
P-C-W	13.1 cd	7.8 c			30.1 a					17.0
P-O-W	55.9 a	67.1 a					30.5			51.2
P-W-C-W	21.2 bc		62.2	14.0	5.9 b					25.8
P-C(A)-A-A	35.0 b					89.8		94.2	17.8	29.2
Mean	24.3	36.9	62.2	14.0	26.6	89.8	30.5	94.2	17.8	

Maintaining Soil Quality in an Irrigated Potato-Bean Crop Sequence

Principal Investigators: K.M. Volkmar, K. Buckley, B. Irvine, and A. Moulin, AAFC-Brandon Res. Ctr.

Co-investigators: D.J. Tomasiewicz and C.J. Jackson, MCDC

Funding: MCDC, AAFC (Matching Investment Initiative)

Progress: Year four of four-year study

Objective: To determine the effect of alternative residue management strategies on soil erodability and quality, and on crop yield in an irrigated potato-bean sequence

This study was undertaken to determine strategies to reduce the potential of soil erosion caused by soil disturbance, in combination with low plant residue input in a two-year potato-bean rotation. Erosion management treatments include:

1. Control (no soil amendment)
2. Fall rye after bean and potato
3. Cereal straw after bean and potato (rate based on long term cereal grain dry matter production rates on these soils);
4. Animal compost based on equivalent straw carbon, after bean and potato;
5. Animal compost based on recommended P, after bean and potato;
6. Polymer in the spring after bean and potato (this polymer will restrict soil erosion).

Treatments 1-5 are applied to both potato and bean fields in the fall. Treatments are replicated four times in randomized complete block design.

The study was initiated in 2000 with the planting of potato and bean in the two main plot areas. Treatments were imposed in the fall (fall sown rye, compost, and straw treatments), and spring (polymer treatment). The field season of 2004 marked the fourth year of this study.

Results and discussion

After a steady increase in yield up to 2003, both gross and marketable tuber yields decreased in 2004 (Figure 1). While main tuber yield in 2004 was comparable to that in previous years, small tuber yield was substantially higher and bonus tuber yield lower than in previous years (Figure 2).

Unlike 2003, treatments had no significant effect on marketable and gross tuber yield in 2004 largely reflected gross tuber yield (Figure 3). However, the Fall Rye-incorporated treatment tended to have a higher marketable yield than the other treatments. The tendency for lower gross and marketable yields of the plants receiving cattle compost observed from 2001 to 2003 was not apparent in 2004. The higher yield of potatoes following the Fall Rye-Incorporated in 2004 was related to a lower yield of small grade tubers and a higher yield of bonus tubers (Figure 4). Treatment effects on the components of tuber yield were not significant in 2004.

Tuber specific gravity ranged from 1.084 to 1.094 g/cm3 (Figure 5). Plots receiving compost produced tubers with significantly lower specific gravities, as in 2003. As in past years, tuber defects were negligible in 2004 (Table 1). There was some evidence of Blackleg (*Erwinia carotovora*) in several of the treatments, including the control. Fusarium dry rot was also observed at low levels in all treatments, and at higher levels in the Composted and Fall Rye -Incorporated treatments. Wire worm occurred in all but the Fall Rye-Cut treatment.

A killing frost prior to bean maturity prevented a measure of bean yield in 2004. A field survey of the bean crop at mid-season failed to detect evidence of foliar disease.

Conclusions

The current season represents the second year of the second two-year cycle of this study. Despite the tight rotation, there was no evidence of disease in either the potato or bean crops. Quantitative evaluation of treatment effects on soil erodability was undertaken to compare effectiveness of erosion control treatments. This information is not available at time of this reporting. Effort will be made to complete a third and final two-year cycle to ascertain longer-term impacts of these soil erosion control treatments in this study. A full report of the four-year study will be prepared for the 2005 CMCDC Annual Report.

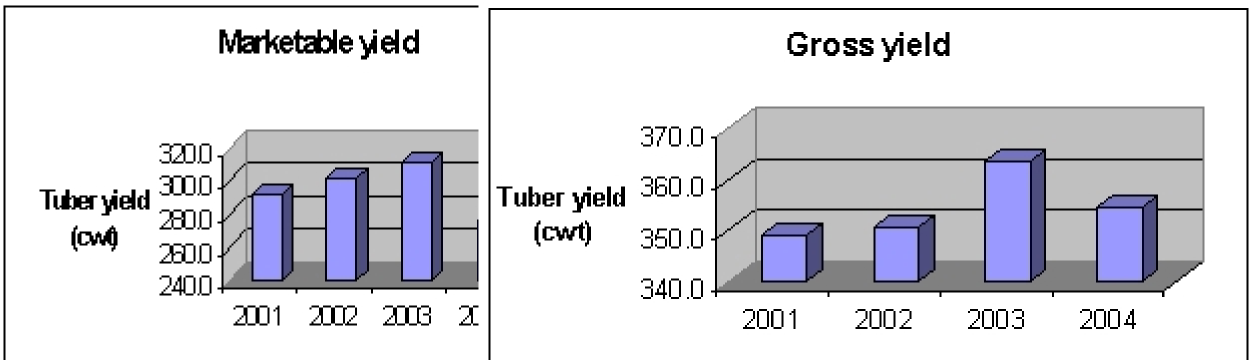


Figure 1. Marketable and gross tuber yields averaged over all treatments from 2001- 2004.

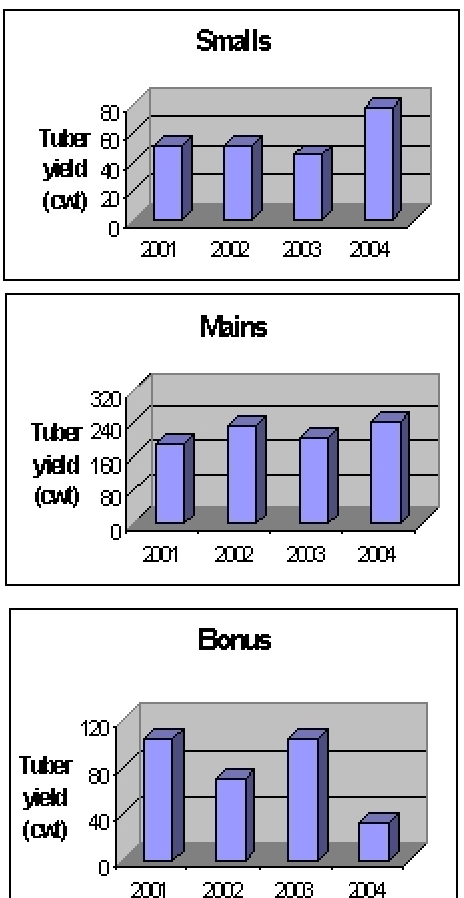


Figure 2. Change in small, main, and bonus tuber yield over time.

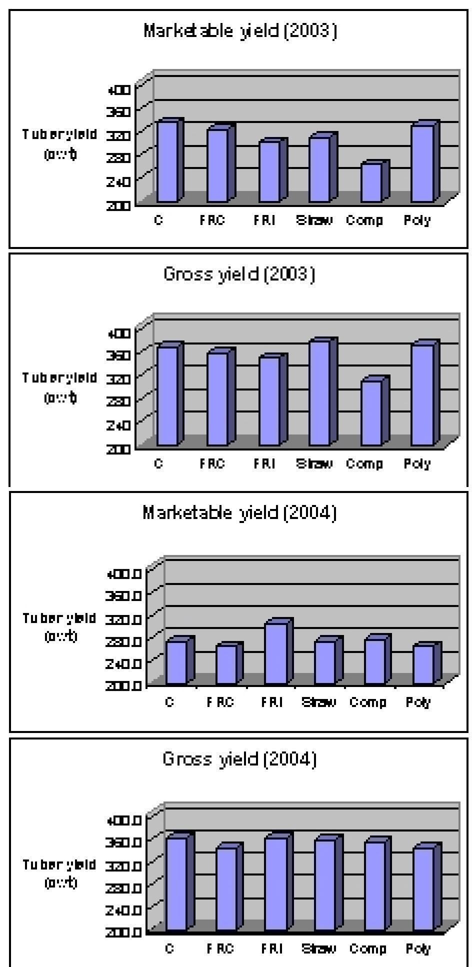
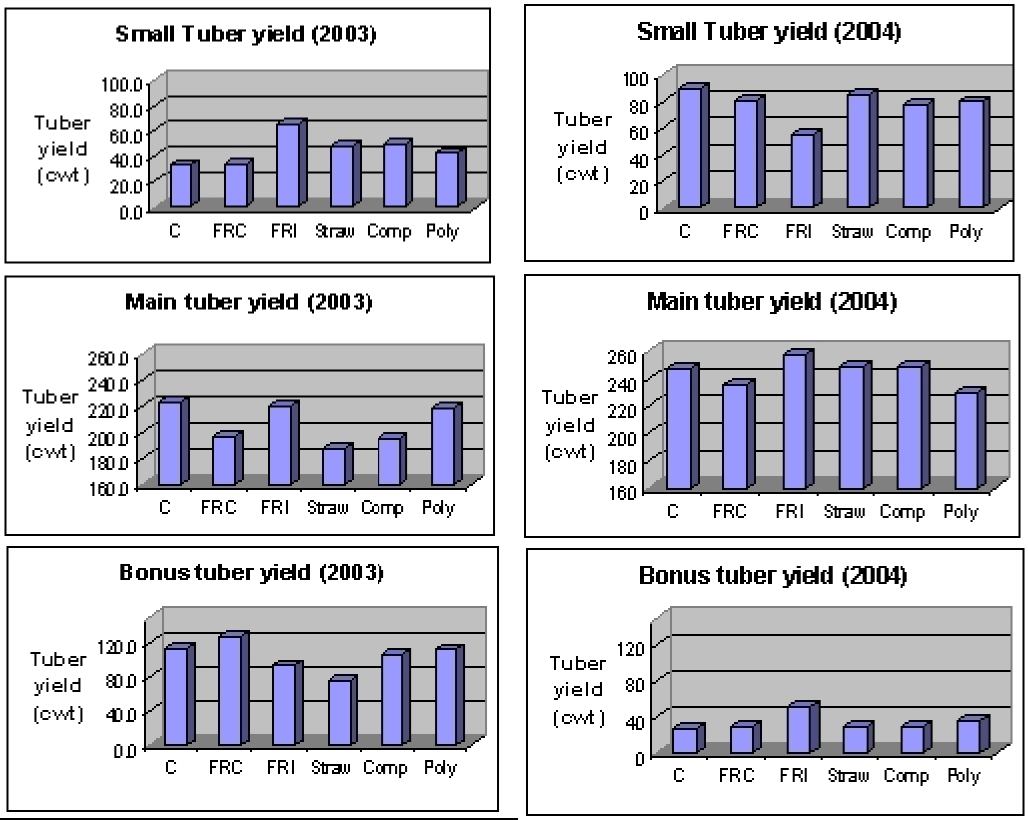


Figure 3. Treatment effect on marketable and gross tuber yield in 2003 and 2004.

Figure 4. Treatment effects on small, main, and bonus tuber yield in 2003 & 2004.



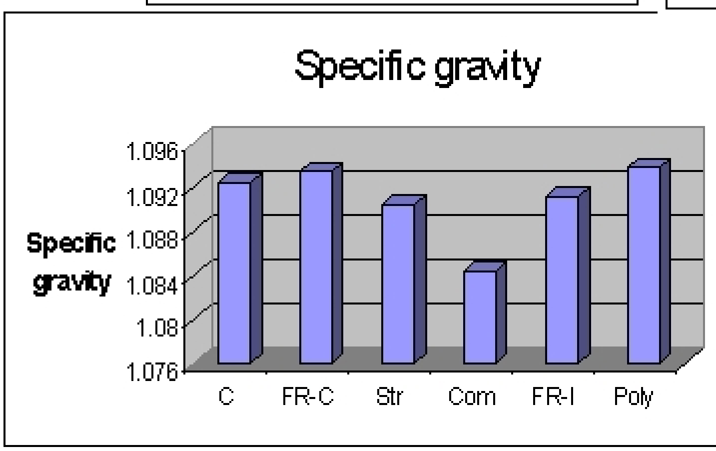


Figure 5. Treatment effects on tuber specific gravity.

Table 1. Disease incidence (%).

Treatment	Clean	Late Blight	Blackleg	Soft Rot	FDR (<5%)	FDR (>5%)	Rhizoc.	Scab	Hollow Heart	Wire Worm
Control	94.5	0.0	1.0	0.0	2.5	1.0	0.0	0.0	0.5	0.5
Fall rye cut	99.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
Cereal straw	96.5	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	1.0
Fall compost	91.5	0.0	0.5	0.0	2.5	1.5	0.0	0.0	0.5	3.0
Fall rye inc.	96.0	0.0	0.0	0.0	2.0	1.0	0.0	0.0	0.0	1.0
Spring polymer	96.0	0.0	0.5	0.0	3.0	0.0	0.0	0.0	0.0	0.5

Cumulative Effects on Crop Productivity of Swine Manure Used in Three-Year Potato Rotations

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Co-investigators: D.J. Tomasiewicz and C.J. Jackson, MCDC

Funding: Agri-Food Research and Development Initiative
AAFC Matching Investment Initiative

Progress: Year four of ongoing study

Objective: To determine the effect of the long-term use of animal manure on potato yield and quality.

Introduction

When considering a change in crop production practice, be it a new crop, a new pesticide, or a new cultivation method, consideration should be given to its impact on the whole cropping system. A switch from total reliance on commercial fertilizers to the use of animal bio-wastes such as swine manure to reduce input costs introduces issues concerning the long term rotation productivity. Assuming that nutrient use efficiency is optimized to limit the risk of surface or groundwater contamination, the main concerns relate to the long-term impact of the practice on potato and non-potato crop disease, on potato quality, and on issues of human health. The frequency of use of animal manure in the rotation is likely to have an influence, beneficial or otherwise, on all of these issues.

To address these concerns, a study was initiated in 2000, to look at several manure application options, from application of liquid swine manure or cattle compost yearly, to applying a manure amendment only in the non-potato year. These treatments will be monitored to determine their effect on disease, crop yield, and soil quality during the three year rotation cycle.

Methods

The following treatments were incorporated into a three-year potato-canola-wheat rotation:

1. Swine manure applied all years of rotation
2. Swine manure applied in fall preceding potato year
3. Swine manure applied in fall preceding non potato year
4. No manure applied (control)
5. Cattle compost applied all years
6. Cattle compost applied in fall before potato year

In 2000 the study was initiated on MCDC-Carberry field L4, and in 2001 on MCDC field P1, with potato the first crop in the rotation both years. The L4 field followed a Potato-Canola-Wheat-Wheat rotation, and P1 followed a Potato-Canola-Wheat rotation, so that both areas were sown to potato in 2004.

Plots are 6 x 12 m and laid out in a randomized complete block design with four replicates per treatment. Fertilizer rates are based on average soil test levels to achieve optimum yields while minimizing risk of nutrient leaching or run-off. Each plot was fertilized using manure or compost in combination with commercial fertilizer to obtain the required final fertility target according to treatment. Compost was applied to match phosphorus requirements. Compost treated plots therefore required additional N supplied as commercial fertilizer (46-0-0-), assuming that approximately 20% N was available in the current year of compost application. Liquid swine manure or compost was injected in the Fall, except in 2001, which was spring applied. Nutrient composition of the manure and compost are shown in Table 1. In treatments where manure was required, canola received an average of 4500 gal/acre as liquid manure, wheat 3200 gal/acre, and potato 7400 gal/acre on a per plot basis. The rates of applied manure, fertilizer, and compost are shown in Table 2.

Potato plots were sown using a four-row commercial potato planter with a between-row spacing of 0.95 m and an in-row spacing of 0.38 m. Fungicide sprays were applied as recommended by provincial blight forecasts.

Treatment yields were taken in the potato phase of each the rotations. Plants were destructively sampled from two-meter rows outside of the center two rows final harvest area for 1) above-ground biomass, 2) tuber number and 3) tuber mass, according to size. Tubers from the center two rows of each plot removed using a one-row digger at final harvest date, weighed and graded according to size classification, and assessed for quality based on shape, specific gravity, external blemishes, and disease.

Table 1. Mean nutrient composition of liquid swine manure and beef compost amendments applied to potato and non-potato crops during the past four years.

Nutrient	Manure	Compost
	(lbs/1000 gal)	(% dry wt)
N	22.4	0.61
P	8.2	0.23
K	17.8	0.52
S	1	0.15

Table 2. Mean nutrients added as manure, compost and commercial fertilizer on canola, wheat and potato crops in spring (pre-plant) 2001-2004 (kg/ha).

	N		P		K		S	
	Manure	Compost	Manure	Compost	Manure	Compost	Manure	Compost
Soil test	31	31	34	34	441	441	8.5	8.5
Manure	104		39		110		6	
Compost		22		37		148		11
Fertilizer	0	82	0	0	0	0	12	31
Final	135	135	73	71	551	589	34.5	50.5
Soil test	23	23	26	26	405	405	9.5	9.5
Manure	67		27		80		3	
Compost		17		27		115		8
Fertilizer	0	50	2	0	0	0	8.5	2.5
Final	90	90	55	53	470	520	21	20
Soil test	24	24	32	32	420	420	10	10
Manure	156		60		162		10	
Compost		52		93		336		23
Fertilizer	0	104	23	0	0	0	8	0
Final	180	180	115	115	582	756	28	33

Results and Discussion

Yields: There was a clear trend in both the three- and four-year rotations for increasing yields with decreasing amount of swine manure applied. In the four-year rotation, potato yields were significantly lower ($P<0.01$) where swine manure was applied annually, compared to all other treatments (Figure 1). Treatments in which manure was applied in the non-potato years, or only in the potato year had marketable yields similar to the No-manure treatment. Gross potato yield was reduced when swine manure was applied in the potato year only, compared to when it was applied only in the non-potato years. Treatment effects were similar in the three-year rotation, except the effect of swine manure on yield was more pronounced than in the four-year rotation (Figure 2). In both rotations, potato yields of treatments receiving cattle compost, either only in the potato year or only in the non-potato year, were not significantly different from the control treatment that received no manure. The tendency toward higher yields in response to cattle compost was evident in year-one (2001) of the three-year rotation. This early treatment response was not related to differences in available N or P in the cropping year. Fall soil samples from the 2004 cropping season were not available at time of this reporting.

Tuber specific gravity: Manure treatments had a significant effect on tuber specific gravity (Figure 3). Treatment effects were more pronounced in the three-year rotation. Among the treatments receiving swine manure, tubers that received no manure had the highest specific gravity. Tubers that received cattle compost were among the lowest in specific gravity.

Tuber disorders and diseases: The incidence of tuber disease was lowest in the cattle compost treatments in both the three- and four-year rotations (Tables 3 and 4). In both rotations, treatments receiving cattle compost had a lower percentage of diseased tubers than those which received swine manure annually. The incidence of Fusarium Dry Rot (<5%) appeared to be inversely related to tuber yield. Rhizoctonia or Potato Scab was not present in either rotation. Blackleg occurred in both rotations at very low levels.

Conclusions

After one complete rotation cycle the results suggest that the incorporation of liquid swine manure into one or more phases of a three- or-four-year potato rotation may be deleterious to tuber yield. This was more evident in the three-year rotation, where yield was more adversely affected when swine manure was applied in the fall prior to the potato year than when applied only in the non-potato years. This suggests that it is not necessarily only the cumulative effects of the manure that impact yield but both the proximity along with the cumulative effects.

A previous study indicated that swine manure had no significant effect on tuber quality or yield when applied during the potato cropping season (Volkmar, K.M., McLaren, D., and Irvine, B. 2002. *In-crop application of liquid hog manure in irrigated potato production.* ARDI Report 98-102.). The results of the present study do not contradict those findings, since there was no evidence of yield loss in response to swine manure application during the first year of the study. However, the current findings suggest that when swine manure is applied in the first year, and applied again after three or four years, potato yields will be negatively affected.

There is insufficient evidence to explain either the yield loss due to swine manure use, or the yield improvement in response to beef cattle manure. While the results suggest that suppression or promotion of pathogens may be partly to blame, given the low level of symptoms in the case of the Fusarium pathogen, it seems unlikely that this is the sole cause of the manure/compost effect.

Further work is necessary to determine if yield differences among treatments may be related to the differences in the rates of release of N and/or P during the cropping season. Analysis of soil samples collected immediately after potato harvest may help to provide answers. A complete report on these rotations will be provided in the 2005 CMCDC Annual Report.

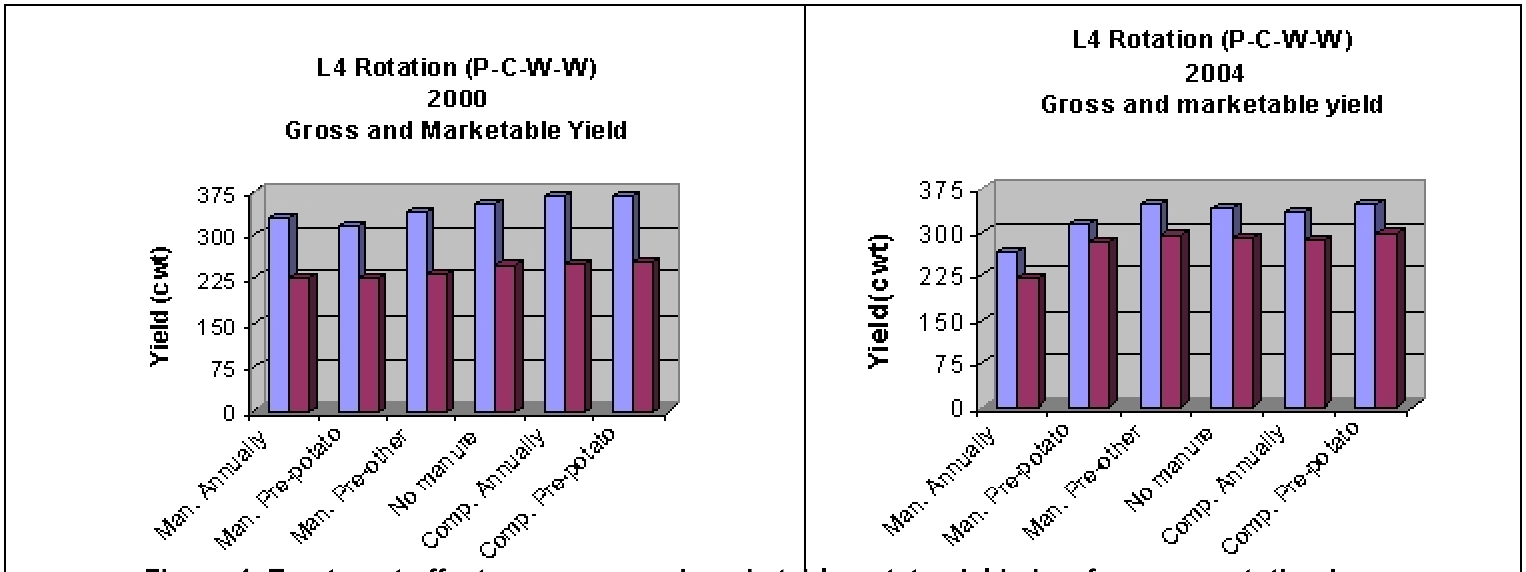


Figure 1. Treatment effects on gross and marketable potato yields in a four-year rotation in 2004.

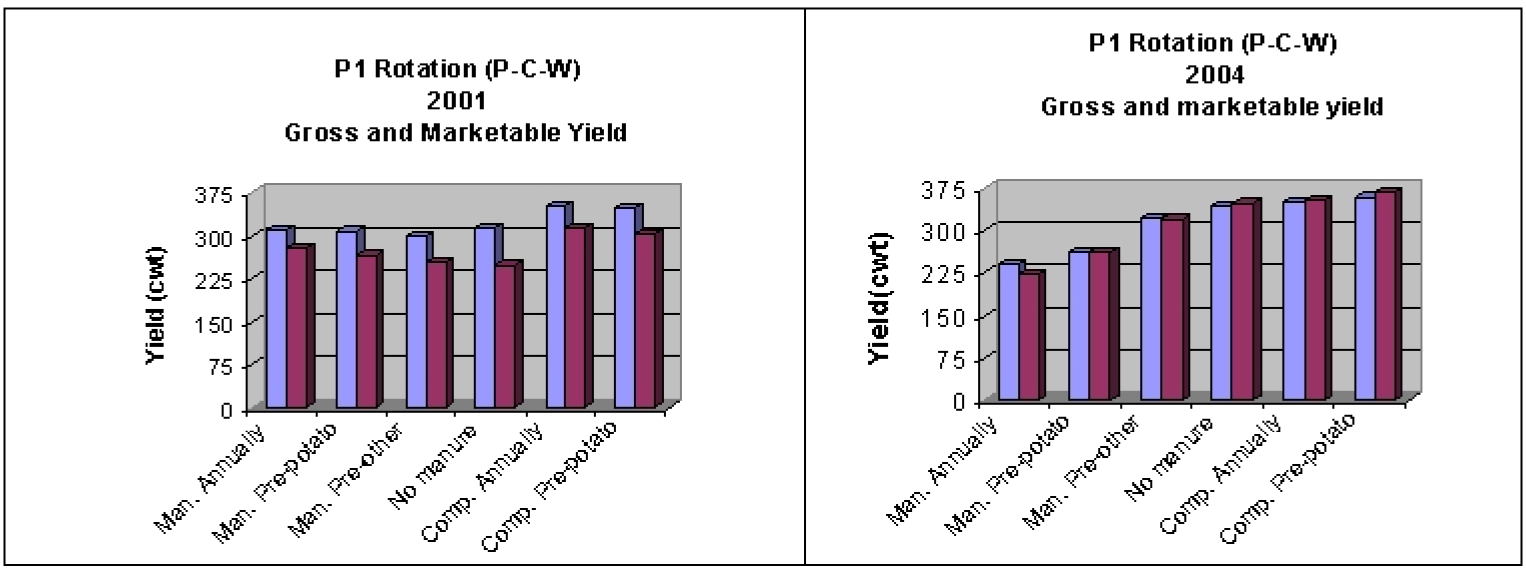


Figure 2. Treatment effects on gross and marketable potato yields in a three-year rotation in 2004.

Figure 3. Treatment effects on tuber specific gravity in 3- and 4-year rotations in 2004.

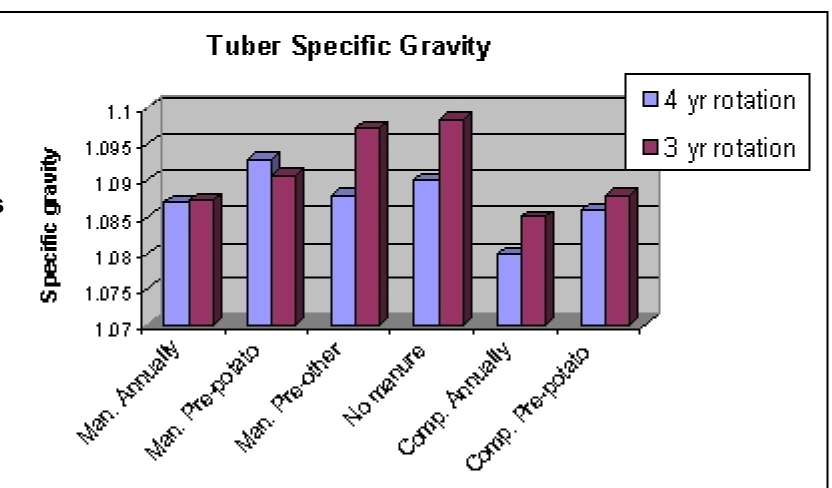


Table 3. Manure treatment effect on tuber disease in four-year rotation (P-C-W-W), expressed as percentage of total number of potatoes in sample.

Treatment	Clean	Late Blight	Blackleg	Soft Rot	FDR (<5%)	FDR (>5%)	Rhizoc.	Scab	Hollow Heart	Wire Worm
Man. Annually	84.0	0.0	0.0	0.0	8.7	2.0	0.0	0.0	1.3	2.7
Man. Pre-potato	85.0	0.0	0.0	0.5	8.0	3.5	0.0	0.0	1.0	1.5
Man. Pre-other	90.5	0.5	0.5	0.5	3.0	2.5	0.0	0.0	1.0	0.5
No manure	86.0	0.0	1.0	0.5	6.0	4.0	0.0	0.0	1.5	1.0
Comp. Annually	91.0	0.0	0.0	0.0	4.5	1.5	0.0	0.0	1.5	1.5
Comp. Pre-potato	90.0	0.0	0.0	0.5	3.5	3.5	0.0	0.0	0.0	2.5

Table 4. Manure treatment effect on tuber disease in three-year rotation (P-C-W), expressed as percentage of total number of potatoes in sample.

Treatment	Clean	Late Blight	Blackleg	Soft Rot	FDR (<5%)	FDR (>5%)	Rhizoc.	Scab	Hollow Heart	Wire Worm
Man. Annually	81.5	0.5	0.0	1.0	6.0	8.5	0.0	0.0	1.5	0.0
Man. Pre-potato	86.0	0.0	1.0	0.0	5.5	6.0	0.0	0.0	1.5	0.0
Man. Pre-other	92.0	0.5	0.0	0.0	3.5	4.0	0.0	0.0	0.0	0.0
No manure	92.5	0.0	0.0	1.0	2.5	3.5	0.0	0.0	0.5	0.5
Comp. Annually	89.0	0.5	0.5	1.5	3.5	3.0	0.0	0.0	0.5	1.5
Comp. Pre-potato	92.0	0.0	0.0	0.5	3.5	3.0	0.0	0.0	0.0	1.0

Potato Variety Development for Manitoba

Principal Investigator: B. Bizimungu, AAFC - Lethbridge Research Centre

Co-Investigators: H. Wolfe and C.J. Jackson, MCDC

Support: MHPEC Inc.
Keystone Vegetable Producers Association Inc.
Manitoba Chipping Potato Growers Association
Midwest Food Products Inc.
Peak of the Market
Simplot Canada Ltd.
AAFC Matching Investment Initiative

Progress: Year three of a three-year renewal of an ongoing project

Objective: To develop potato varieties with superior yield, quality and disease resistance for the Manitoba potato industry.

The major focus of the Western Canadian potato breeding program based at Agriculture and Agri-Food Canada Lethbridge Research Centre is the development of high yielding processing and fresh market varieties with superior quality and high levels of durable resistance to diseases prevalent in western Canada. The project at MCDC evaluates advanced selections developed by the AAFC program as well as material from US breeding programs based in the North Central and Pacific Northwest states.

Methods

Advanced selections from the western Canadian potato breeding program located at the Lethbridge Research Centre as well as promising clones and new varieties from US breeding programs located in the North Central and Pacific Northwest states are included in adaptation trials (randomised complete blocks design with four replications) and early (harvested at 80 days and 90 days after planting) and maincrop advanced trials (harvested 110 days after planting) (randomised complete blocks design with four replications). Data collected includes yield, tuber characteristics, internal and external defects and processing and culinary quality. The North Central (US) Breeders' Trial (nine US locations and three Canadian locations) is conducted at the MCDC-Winkler.

Results and Discussion

Maincrop Advanced Yield Trial (Tables 1 and 2)

The top performer among the french fry selections in the trial was CV1132-1. It considerably outyielded Russet Burbank while showing similar defect levels and fry color, but with slightly inferior specific gravity. The yield and fry color of CV1132-1 were equal to or better than Shepody while showing lower defect levels, but with slightly lower specific gravity. Other outstanding french fry selections in the trial that outyielded Russet Burbank include CV87101-2, FV12457-6, and V1062-1. CV87101-2 and V1062-1 also had superior fry color, and acceptable specific gravity similar to Russet Burbank, but with slightly higher hollow heart occurrence. FV12457-6 had equal or better fry color than Russet Burbank, but with lower specific gravity and higher hollow heart occurrence.

The two outstanding chip selections, with yields equal to or better than Snowden, were CV96105-2 and CV96053-4. CV96105-2 had chip color superior to both Atlantic and Snowden and lower level of defects, with acceptable specific gravity (similar to checks). CV96053-4 also had better chip color than both Atlantic and Snowden, with better specific gravity and hollow heart occurrence similar to Atlantic. It also has acceptable specific gravity, with levels similar to both checks.

The yields of the two red-skinned selections (CV89023-2 and V1076-1) were inferior to Norland and Sangre, but they had lower defects levels than both checks.

Table 1. Tuber yield and appearance - Main Crop Advanced Yield Trial at Carberry - 2004.

	Entry	Type	Overall Appearance[1]	Total Yield (t/ha)	Marketable Yield (t/ha) (>48mm)	Percent Marketable Yield	Percent Large (>88mm)
1	ATLANTIC	round, white	3.0	63.0	56.4	89.5	9.5
2	CV87101-1	oblong, russet	3.3	52.6	47.9	91.1	2.2
3	CV89023-2	oval, red	3.0	54.1	48.3	89.3	4.7
4	CV92028-1	oblong, russet	3.3	48.7	45.7	93.7	8.0
5	CV92056-4	oblong, white	3.0	51.8	46.5	89.6	15.5
6	CV95002-1	oblong, white/light russet	3.3	43.3	35.5	81.9	8.2
7	CV95070-3	round, white	3.0	33.6	29.5	87.9	5.4
8	CV95122-1	round, white	3.0	50.5	38.8	76.8	0.8
9	CV96022-3	oblong, light russet	3.3	46.0	39.8	86.1	4.2
10	CV96038-2	oblong, light russet	3.0	43.8	38.9	88.9	4.3
11	CV96040-1	oblong, light russet	3.0	45.6	40.7	89.5	9.0
12	CV96044-2	oval, white	3.0	36.3	29.4	80.8	0.0
13	CV96053-4	oval, white	3.0	53.7	50.6	94.2	5.1
14	CV96064-1	oblong, russet	3.0	45.3	38.3	84.4	2.0
15	CV96105-2	oval, white	3.0	57.4	51.6	90.0	2.7
16	FV12228-5	oval/oblong, white	3.0	50.2	43.5	86.7	4.0
17	FV12235-3	oblong, white	3.0	50.2	46.0	91.4	16.2
18	FV12272-3	oval, white	3.0	42.7	36.4	85.1	7.1
19	FV12291-10	oval, white	3.0	44.1	37.5	84.9	2.8
20	FV12457-6	oblong, white/light russet	3.0	58.0	51.1	88.0	5.9
21	NORLAND	oval, red	3.3	61.8	57.7	93.4	5.6
22	RANGER R	oblong, russet	3.5	53.3	46.9	87.8	4.7
23	RUSSET B	oblong, russet	3.0	50.6	34.8	68.7	2.1
24	RUSSET N	oblong, russet	3.5	59.7	51.8	86.8	13.5
25	SANGRE	oval, red	3.0	62.0	58.3	93.9	19.1
26	SHEPODY	oblong, white	3.0	58.8	53.5	90.8	15.6
27	SNOWDEN	round, white	3.0	53.0	47.4	89.3	0.0
28	V0865-1	oblong, russet	3.5	57.5	50.6	88.1	9.9
29	V0910-6	oval, white/light russet	3.0	57.4	49.9	86.8	0.0
30	V1062-1	oval/oblong, white	3.0	51.6	45.0	87.1	1.2
31	V1076-1	round, red	3.0	52.7	43.8	83.3	1.6
32	V1132-1	oblong, white	3.0	67.0	53.7	80.2	0.8
	CV%		-	10.8	12.1	4.0	78.5
	Prob.		-	0.0001	0.0001	0.0001	0.0001
	LSD (.05)		-	7.9	7.7	4.9	6.6

[1] Appearance- 1(very poor) -5 (outstanding)

Table 2. Tuber defects, fry color score and specific gravity - Main Crop Advanced Yield Trial at Carberry - 2004.

	Entry	Type	Hollow Heart %	Internal Necrosis %	Fry Quality[1]	Specific Gravity
1	ATLANTIC	round, white	15.0	2.5	50.3	1.091
2	CV87101-1	oblong, russet	17.5	0.0	47.7	1.082
3	CV89023-2	oval, red	0.0	0.0	27.9	1.074
4	CV92028-1	oblong, russet	10.0	0.0	33.2	1.078
5	CV92056-4	oblong, white	2.5	0.0	48.5	1.077
6	CV95002-1	oblong, white/light russet	7.5	0.0	53.5	1.088
7	CV95070-3	round, white	17.5	0.0	58.6	1.082
8	CV95122-1	round, white	20.0	0.0	56.8	1.086
9	CV96022-3	oblong, light russet	0.0	0.0	53.2	1.091
10	CV96038-2	oblong, light russet	25.0	0.0	39.3	1.080
11	CV96040-1	oblong, light russet	67.5	0.0	41.5	1.089
12	CV96044-2	oval, white	27.5	10.0	64.1	1.080
13	CV96053-4	oval, white	15.0	0.0	67.8	1.093
14	CV96064-1	oblong, russet	52.5	0.0	62.8	1.077
15	CV96105-2	oval, white	0.0	0.0	65.8	1.094
16	FV12228-5	oval/oblong, white	0.0	2.5	47.4	1.077
17	FV12235-3	oblong, white	12.5	5.0	36.3	1.076
18	FV12272-3	oval, white	15.0	0.0	52.5	1.095
19	FV12291-10	oval, white	0.0	0.0	59.7	1.082
20	FV12457-6	oblong, white/light russet	7.5	0.0	39.1	1.069
21	NORLAND	oval, red	5.0	0.0	34.8	1.069
22	RANGER R	oblong, russet	0.0	0.0	46.3	1.091
23	RUSSET B	oblong, russet	2.5	0.0	37.6	1.082
24	RUSSET N	oblong, russet	30.0	5.0	37.4	1.078
25	SANGRE	oval, red	5.0	2.5	27.3	1.072
26	SHEPODY	oblong, white	7.5	2.5	34.7	1.077
27	SNOWDEN	round, white	0.0	0.0	63.1	1.097
28	V0865-1	oblong, russet	0.0	0.0	35.8	1.088
29	V0910-6	oval, white/light russet	30.0	0.0	39.8	1.086
30	V1062-1	oval/oblong, white	5.0	0.0	52.1	1.081
31	V1076-1	round, red	0.0	0.0	30.7	1.071
32	V1132-1	oblong, white	2.5	0.0	36.7	1.070
	CV%		-	-	-	0.318
	Prob.		-	-	-	0.0001
	LSD (.05)		-	-	-	0.005

[1] Fry color measured using Agtron E15FP

Early Advanced Yield Trials (Tables 3 and 4)

The highest yielding selection at both harvest dates was a red-skinned clone, FV12486-2, with yield exceeding that of all the checks. The clone has also lower defects levels than Norland.

Among the chip selections, CV97065-1 and V1002-2 had yield similar to both Atlantic and Norvalley at both harvest dates, while showing a considerably higher chip color at both dates. The specific gravity of CV97065-1 was similar to that of Atlantic and superior to that of Norvalley. The specific gravity of V1002-2 was inferior to that of Atlantic but similar to that of Norvalley.

Table 3. Tuber yield and appearance - Early Advanced Yield Trial at Winkler - 2004.

	Entry	Type	Overall Appearance[1]		Total Yield (t/ha)		Marketable Yield (t/ha) (>48mm)		% Marketable (>48 mm)		Percent Large (>88mm)	
			E1[2]	E2	E1	E2	E1	E2	E1	E2	E1	E2
1	AC PTARMIGAN	oblong, white	3.0	3.0	19.5	40.4	14.6	37.8	74.0	93.5	0.0	0.7
2	ATLANTIC	round, white	3.0	3.0	13.5	35.9	10.3	32.2	76.5	89.8	0.0	0.7
3	CV96014-4	oblong, light russet	3.0	3.0	17.1	36.4	9.8	28.6	57.5	78.2	0.0	0.0
4	CV97054-8	oval, red	3.0	3.0	12.3	28.5	9.2	24.4	73.1	85.4	0.0	0.0
5	CV97065-1	round, white	3.0	3.0	20.1	32.9	14.7	27.3	72.1	83.1	0.0	0.0
6	CV97112-5	round, white	3.0	3.0	21.4	40.3	18.5	37.6	86.6	93.3	0.0	0.6
7	FV11983-1	oval, white	3.0	3.0	15.8	38.1	13.2	34.8	83.1	91.4	0.0	0.0
8	FV12246-6	oval, white	3.0	3.0	13.7	30.0	9.0	25.1	65.1	83.8	0.0	0.0
9	FV12469-1	oblong, light russet	3.0	3.3	19.4	36.6	13.9	32.3	71.6	88.0	0.0	2.2
10	FV12486-2	round, red	3.0	3.3	21.0	45.7	15.2	41.5	72.9	90.8	0.0	0.0
11	NORLAND	oval, red	3.3	3.0	22.2	38.7	18.9	35.1	85.5	90.8	0.0	2.0
12	NORVALLEY	round, white	3.0	3.0	21.2	44.6	13.8	37.6	64.9	84.4	0.0	0.0
13	RUSSET N	oblong, russet	3.3	3.3	13.7	33.8	8.3	28.4	60.2	84.0	0.0	4.9
14	V1002-2	round, white	3.0	3.0	17.3	36.8	8.9	28.2	51.6	76.3	0.0	0.0
15	V1102-1	oblong, white	3.0	3.3	18.0	40.1	14.2	36.9	78.4	92.0		1.3
	CV%		-	-	10.6	8.5	15.5	10.0	8.2	3.9	-	-
	Prob.		-	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-	-
	LSD (.05)		-	-	2.7	4.5	2.8	4.6	8.3	4.8	-	-

[1] Appearance- 1(very poor) -5 (outstanding)
[2] E1, E2- Harvested 80 and 90 days after planting, respectively

Table 4. Tuber defects, fry quality score and specific gravity - Early Advanced Yield Trial at Winkler - 2004.

Entry	Type	Deformed tubers (t/ha) (>48mm)		Hollow Heart %		Internal Necrosis %		Fry Quality[1]		Specific Gravity	
		E1[2]	E2	E1	E2	E1	E2	E1	E2	E1	E2
1 AC PTARMIGAN	oblong, light russet	0.0	0.0	0.0	0.0	0.0	0.0	25.5	45.2	1.064	1.071
2 ATLANTIC	round, white	0.0	0.0	0.0	0.1	0.0	2.5	34.9	47.2	1.079	1.086
3 CV96014-4	oblong, light russet	0.0	0.0	0.0	0.0	0.0	0.0	25.9	48.2	1.079	1.081
4 CV97054-8	oval, red	0.0	1.9	0.0	0.0	0.0	0.0	30.5	51.7	1.060	1.071
5 CV97065-1	round, white	0.0	1.4	0.0	0.0	0.0	2.5	43.8	57.1	1.075	1.084
6 CV97112-5	round, white	0.0	0.0	0.0	0.1	0.0	2.5	38.6	45.2	1.069	1.080
7 FV11983-1	oval, white	0.0	0.0	0.0	0.0	0.0	0.0	29.7	41.5	1.059	1.067
8 FV12246-6	oval, white	0.0	1.4	0.0	0.0	0.0	0.0	31.7	38.1	1.074	1.085
9 FV12469-1	oblong, light russet	0.0	0.0	0.0	0.0	0.0	0.0	26.4	43.5	1.065	1.071
10 FV12486-2	round, red	0.0	0.0	0.0	0.0	0.0	0.0	20.2	27.7	1.063	1.072
11 NORLAND	oval, red	0.0	2.3	0.0	0.0	0.0	2.5	29.6	38.7	1.061	1.068
12 NORVALLEY	round, white	0.0	0.0	0.0	0.0	0.0	0.0	26.8	43.7	1.066	1.076
13 RUSSET N	oblong, russet	0.0	3.2	0.0	0.0	0.0	0.0	22.2	29.4	1.072	1.079
14 V1002-2	round, white	0.0	3.7	0.0	0.0	0.0	0.0	37.8	53.0	1.064	1.075
15 V1102-1	oblong, light russet	0.0	0.0	0.0	0.0	0.0	0.0	27.7	36.1	1.065	1.071
CV%		-	-	-	-	-	-	-	-	0.176	0.373
Prob.		-	-	-	-	-	-	-	-	0.0001	0.0001
LSD (.05)		-	-	-	-	-	-	-	-	0.003	0.006

[1] Fry color measured using Agtron E15FP
E1, E2- Harvested 80 and 90 days after planting, respectively

The Effect of Potato Row Spacing on Processing Potato Yield and Quality

Principal Investigator: D.J. Tomasiewicz, MCDC

Funding: MCDC

Progress: One year only

Objective: To determine the effect of row spacing (34 vs. 38-inch) on yield and quality for processing of Russet Burbank potatoes grown under irrigation in Manitoba

Introduction

Irrigated processing potatoes in Manitoba are generally grown in rows spaced about 36 to 38 inches apart. Slightly closer rows are sometimes used for table or seed potato production. Row spacing is usually constant within a farm; it would be difficult to change field equipment or equipment settings to accommodate varying spacings. Perhaps also partly for this reason, few studies of the effects of potato row spacing have been conducted. Interest in effects of row spacing has arisen in recent years due to anecdotal reports of benefits from either closer spacings or other planting arrangements (e.g. in beds, paired rows), to increasing emphasis on controlling tuber size distribution, and to reports of closer row spacings in general use in other production areas. The effect of reducing row spacing is of interest both at constant planting density and at constant in-row seed piece spacing.

MCDC conducted a study of row spacing for irrigated Shepody and Russet Burbank in 2001. It included 24 to 48-inch row spacings (at constant planting density), and suggested little to no effect of row spacing within the 34 to 38-inch range of primary interest. Results of research trials in other potato-growing areas have generally shown the potato to adapt well to varying row spacings within the ranges of interest (i.e. little to no effect of spacing). At constant planting density, increasing row spacing has more often reduced tuber numbers than yield.

Methods

The study was conducted on a Ramada clay loam soil at MCDC-Carberry. All inputs (fertilizer, irrigation, pesticides) and operations were managed to be non-limiting for optimum production of irrigated processing potatoes. All pests were effectively controlled. Nitrogen fertilizer had been pre-plant incorporated at 186 kg ha^{-1} of N. Due to concern about possible leaching loss of nitrogen, additional fertilizer to provide 56 kg ha^{-1} of N was top-dressed on July 21.

Russet Burbank potatoes were planted on 21 May 2004, under wet soil conditions following ten days of very wet cold conditions (including heavy snowfall). Cut seed pieces averaging 64 g were used; seed was hand-screened prior to planting to eliminate most seed pieces not within the 40 to 100 g range. A two-row cup type planter was used, with riders preventing missing or multiple seed piece drops. Both the planter and hiller used allowed for the needed adjustment of row spacing to avoid having to use different implements for the two row spacings. Plots were four rows wide by 12.2 m long.

Treatments included two planting densities, each included at two row spacings (factorial), in a Randomized Complete Block layout with six blocks (Table 1). The in-row seed piece spacing in the high-density narrow-row treatment was the same as that in the low-density wide-row treatment.

Several days before harvest, at least two plants were hand-dug out from the end of each harvest row to eliminate edge effects, and the exact length of each remaining harvest row was determined for yield calculations (most were approximately 11 m). The centre two rows of each plot were top-killed by flail chopping on September 20, and harvested September 23. A harvest sample of approximately 23 kg was retained from each plot for grading (size distribution, defects, specific gravity, fry color).

Table 1. Treatments.

Treatment designation	Row spacing	In-row seed piece spacing	Planting Density	
	(in.)	(in.)	(pieces ac^{-1})	(lb ac^{-1})
34-L	34	16.2	11,384	1605
34-H	34	14.5	12,723	1794
38-L	38	14.5	11,384	1605
38-H	38	12.9	12782	1803

Results and Discussion

Yields were average for this site, limited by the extremely cool growing season. They may have been higher if topkilling/harvest had been delayed further, due to exceptionally warm late September weather. The several measures taken to reduce error resulted in very low CV's for the main components of yield, and for gross return.

Analysis of variance indicated only one significant (5%) effect of either row spacing or planting density (Table 2). The percentage of marketable size tubers by weight that were larger than 12 oz was greater for the lower planting density. More large tubers is not an unusual effect of lower planting density, though lower tuber numbers overall might have been expected as well. Tuber size distribution contributed to the trend to lower gross return for the higher planting density. The significant row spacing x planting density interaction for total tuber yield (only) shows opposing effects of increasing planting density at the two row spacings; the reason is not clear.

There were no significant effects of row spacing at constant in-row seed piece (treatment 34-H vs. 38-L); most trends favored the wider row spacing.

The frequencies of occurrence of all tuber defects were very low, and they were unrelated to treatment. Greening, rot, hollow heart exceeding contract specifications, and sugar ends were each present in $\leq$0.5% of tubers examined. No dark ends were found. Fry color was #0 in all except one of the 600 tubers tested. Hollow heart was observed in 1.2% of tubers examined.

Generally, neither closer rows nor higher planting densities significantly improved tuber yield or quality in this study, for the selected two spacings and densities used. This is consistent with earlier studies involving these variables at MCDC-Carberry, where excess production of small tubers has frequently occurred.

Table 2. Yield, number, size distribution, specific gravity, and value of tubers.

Treatment	Yield			Size distribution for >3 oz. tubers		Number of tubers	Specific gravity	Gross return
	Total	<3 oz.	>3 oz.	6-12 oz.	>12 oz.			
Means	- - - - cwt ac^{-1} - - - -			- - Percent - -		thousand ac^{-1}		\$ ac^{-1}
Row Spacing x Planting Density								
34-L	412	55	357	47	8	74	1.0805	2592
34-H	390	54	335	44	3	74	1.0806	2395
38-L	389	47	342	46	7	69	1.0808	2488
38-H	398	56	342	45	3	75	1.0800	2443
Row Spacing								
34	401	55	346	46	5	74	1.0805	2493
38	393	51	342	46	5	72	1.0804	2466
Planting Density								
Low	401	51	349	47	7	72	1.0807	2540
High	394	55	339	45	3	75	1.0803	2419
CV (%)	4.1	22.7	5.5	11.3	78.1	19.1	0.17	6.2
P-values (prob.)								
Row Spacing	0.29	0.52	0.61	0.94	0.59	0.72	0.86	0.68
Planting Density	0.33	0.49	0.20	0.43	**0.017**	0.59	0.65	0.08
Row Sp. x Plant. Dens.	**0.039**	0.37	0.20	0.63	0.85	0.57	0.59	0.26
Contrast 34-H vs. 38-L	0.96	0.33	0.56	0.61	0.15	0.52	0.84	0.31

Nitrogen Management for Irrigated Potato Production in Manitoba

Principal Investigators: R.M. Mohr, AAFC-Brandon Research Centre
D.J. Tomasiewicz, MCDC

Funding: J. R. Simplot Co.
Agriculture and Agri-Food Canada, Brandon
MCDC

Progress: Second year of three-year study

Objective: To assess the impact of nitrogen management in irrigated potato production systems in order to identify sustainable nitrogen management practices that optimize potato yield and quality while minimizing the potential for nitrogen losses from the plant-soil system.

Introduction

Manitoba's processing potato industry has undergone rapid expansion in recent years, contributing to significant increases in potato production in this province. In Manitoba in 2001-02, an estimated 12.8 million cwt of processing potatoes valued at $97.3 million were marketed.

Despite the growing importance of the processing potato industry in Manitoba, research directed at the development of agronomically and environmentally sustainable fertility management systems for irrigated potato production has been somewhat limited. As a result, much of the information currently available to Manitoba producers is based on research conducted in potato-producing areas outside of Manitoba. This information may not be directly applicable under local environmental conditions.

Methods

The study was conducted in 2004 at MCDC-Winkler on a site that contained relatively low soil test nitrate-N levels (Table 1). A randomized complete block design consisting of four replicates of the following treatments was established:

1) control (no N fertilizer applied, except 10 kg N ha^{-1} as the P fertilizer source)
2) 75 kg N ha^{-1}, pre-plant
3) 150 kg N ha^{-1}, pre-plant
4) 225 kg N ha^{-1}, pre-plant
5) 75 kg N ha^{-1}, split ½ as pre-plant (37.5 kg N ha^{-1}) and ½ topdressed just prior to final hilling (37.5 kg N ha^{-1})
6) 150 kg N ha^{-1}, split ½ as pre-plant (75 kg N ha^{-1}) and ½ topdressed just prior to final hilling (75 kg N ha^{-1})
7) 225 kg N ha^{-1}, split ½ as pre-plant (112.5 kg N ha^{-1}) and ½ topdressed just prior to final hilling (112.5 kg N ha^{-1})
8) 75 kg N ha^{-1}, split 1/3 as pre-plant (25 kg N ha^{-1}), 1/3 topdressed just prior to final hilling (25 kg N ha^{-1}), 1/6 hand broadcast midway between final hilling and final application (12.5 kg N ha^{-1}), 1/6 hand-broadcast at beginning of August (12.5 kg N ha^{-1})
9) 150 kg N ha^{-1}, split 1/3 as pre-plant (50 kg N ha^{-1}), 1/3 topdressed just prior to final hilling (50 kg N ha^{-1}), 1/6 hand broadcast midway between final hilling and final application (25 kg N ha^{-1}), 1/6 hand broadcast at beginning of August (25 kg N ha^{-1})
10) 225 kg N ha^{-1}, split 1/3 as pre-plant (75 kg N ha^{-1}), 1/3 topdressed just prior to final hilling (75 kg N ha^{-1}), 1/6 hand broadcast midway between final hilling and final application (37.5 kg N ha^{-1}), 1/6 hand broadcast at beginning of August (37.5 kg N ha^{-1})

Potato (cv. Russet Burbank) was planted on May 20 using a two-row research potato planter with a 1-m row spacing. In-row seed-piece spacing was 38 cm. Plots were 6 rows wide x 16 m long.

Table 1. Soil NO_3-N in each replicate of the plot area in the spring immediately prior to planting at Winkler in 2004

Soil NO_3-N measure		Rep 1	Rep 2	Rep 3	Rep 4	Mean
0-15 cm	(mg kg^{-1})	3.8	2.9	2.1	6.1	3.7
15-30 cm	(mg kg^{-1})	3.2	4.9	2.2	4.5	3.7
30-60 cm	(mg kg^{-1})	2.7	8.1	3.7	6.9	5.3
60-90 cm	(mg kg^{-1})	3.3	7.3	4.0	12.5	6.8
90-120 cm	(mg kg^{-1})	3.5	5.5	2.0	10.3	5.3
0-60 cm	(kg ha^{-1})	27	53	26	54	40
0-120 cm	(kg ha^{-1})	58	109	52	154	93

Nitrogen fertilizer (ammonium nitrate) was applied at the rate and time indicated by treatment. Dates of N application were: May 17 (pre-plant), June 29 (pre-hilling), July 28 (midway between hilling and final application) and August 9 (final application). To ensure adequate levels of P, K and S across the entire experimental site, a pre-plant blanket application of 46 kg P_2O_5 ha^{-1}, 46 kg K_2O ha^{-1}, 15 kg S ha^{-1} and 8 kg Mg ha^{-1} as monoammonium phosphate, potash, and K-Mg-sulphate was made. Monoammonium phosphate provided 10 kg N ha^{-1} to each treatment. As such, the control treatment received 10 kg N ha^{-1} rather than 0; in all other treatments, N rates were adjusted to account for this additional N.

All pre-plant fertilizer was applied approximately 1" below the soil surface using a Great Plains seed drill to meter the fertilizer. The soil was tilled the following day to incorporate fertilizer bands. In-crop N was applied by hand as required for each treatment.

Pesticide applications to the plot area were conducted to manage disease, insects and weeds. The crop was irrigated as required using the field irrigation system.

Soil samples in increments of 0-15 cm, 15-30 cm, 30-60 cm, 60-90 cm and 90-120 cm were collected from each replicate within the plot area prior to fertilization on May 17.

Plant stand in rows 3 and 4 of each plot was measured after emergence. Petiole samples were collected at approximately 10-day intervals throughout the growing season (June 29, July 9, July 19, July 28, August 10, August 20, August 30, September 9) from rows 2 and 5 within each plot. Petiole samples were oven-dried and ground. Nitrate-N in ground petiole samples was extracted with water, and the NO_3 concentration in the extract determined colorimetrically using an autoanalyzer.

Potato plots were harvested on September 20 by harvesting approximately 12 m of row from each of rows 3 and 4. The harvested area was measured and tuber yields were determined.

Following harvest, a subsample of potato tubers from each plot was graded. The weight of tubers was determined based on five tuber weight classes (<3 oz, 3-6 oz, 6-10 oz, 10-12 oz, >12 oz). In addition, the weight of small tubers was determined based on three tuber size classes (<1 ¾", 1 ¾" to 2" and <4 oz, 1 ¾" to 2" and >4 oz). The number and weight of green tubers, and tubers affected by rot and hollow heart/brown centre were determined. As well, specific gravity and fry colour were determined.

Soil samples in increments of 0-15 cm, 15-30 cm, 30-60 cm, 60-90 cm, and 90-120 cm were collected from two locations within each plot on September 22 following harvest. All soil samples were air-dried and ground. Soil NO_3-N was extracted with 2 M KCl, and the NO_3 concentration in the extract determined colorimetrically using an autoanalyzer.

Data were first analyzed as a randomized complete block design to determine the effect of treatment. Data, excluding the control, were then analyzed as a factorial of fertilizer N rate and timing of N application. Contrasts were used for specific comparisons among treatments.

Results and Discussion

Rate and timing of N application had limited effect on potato yield and quality in 2004, even though the experimental site contained a relatively low concentration of soil nitrate (40 kg NO_3-N ha^{-1} to 60 cm) and would have received a recommendation for N fertilizer (Table 1). Unusually cool, wet weather during the 2004 growing season may have contributed to the crop response observed.

Table 2. Effect of N fertilizer rate and timing of application on tuber yield for various size fractions, total tuber yield, and specific gravity in 2004

Treatment		<3 oz	3-6 oz	6-10 oz	10-12 oz	>12 oz	Total	S.G.
		---------------------------cwt acre^{-1}---------------------------						
Means								
Control	10 kg N ha^{-1}	38	120	147	45	37	387	1.0893
Rate	75 kg N ha^{-1}	44	135	151	38	31	399	1.0898
	150 kg N ha^{-1}	44	142	158	34	25	403	1.0863
	225 kg N ha^{-1}	42	138	151	34	27	392	1.0842
Split	1	49	150	155	34	24	413	1.0877
	2	38	135	153	36	32	395	1.0875
	4	43	129	152	36	27	387	1.0850
LSD $_{(0.05)}$ for fert. splits		8.3	19.8	16.6	14.9	17.3	13.4	0.002
P-values*								
Rate		0.77	0.78	0.61	0.81	0.82	0.26	**<0.0001**
Split		**0.04**	0.09	0.91	0.96	0.64	**0.002**	**0.03**
R*S		0.55	0.64	0.09	0.93	0.91	0.32	0.81
Contrasts								
Linear rate		0.58	0.73	0.99	0.62	0.67	0.34	**<0.0001**
Quadratic rate		0.66	0.54	0.33	0.69	0.65	0.18	0.43
CV (%)		22.0	22.5	19.4	17.5	21.1	4.54	0.23
P-values**								
Treatment		0.21	0.31	0.31	0.98	0.97	**0.05**	**0.0006**
Contrasts								
Control vs all fertilized		0.26	0.15	0.53	0.30	0.43	0.24	0.07

* Results presented are based on analysis of all treatments, excluding the control, as a factorial.
** Results presented are based on analysis of all treatments including the control, by treatment.

Plant N status varied during the growing season as a function of crop maturity and nitrogen management (Figure 1). Overall, petiole nitrate concentration tended to decline as the season progressed; however, comparatively greater fluctuations in petiole nitrate concentration within the growing season were evident in 2004 than in 2003. In part, cool and wet conditions during the 2004 growing season may have impacted both plant growth and N uptake, and thereby the petiole nitrate concentration at a given sampling time. For all sampling times, the petiole nitrate concentration of the control treatment was significantly (P= 0.056) lower than fertilized treatments. Petiole nitrate concentration increased significantly with increasing N rate; however, a significant effect of timing of N application on petiole nitrate concentration was evident only for the first sampling (June 29th) and the fourth sampling (July 28th). Petiole nitrate concentrations were: preplant > 2x split > 4x split, and preplant = 2x split > 4x split, for the first and fourth sampling periods, respectively.

Based on the target range for petiole nitrate reported in the *Guide to Commercial Potato Production on the Canadian Prairies* (Western Potato Council, 2003), both the control and all 75 kg N ha^{-1} rates, regardless of timing of application, contained less than sufficient concentrations of petiole nitrate for most of the growing season. In all other treatments, petiole nitrate concentrations were within or above the range considered sufficient.

A comparison of all treatments revealed no significant effect of N fertilizer treatment on tuber size distribution, only on total tuber yield (Table 2; Figure 2). Analysis of fertilized treatments as a factorial revealed that total tuber yield was not affected by N rate, but varied depending on when during the growing season N fertilizer was applied. Regardless of N rate, total tuber yield was higher in treatments where all N fertilizer was applied pre-plant, than in those treatments where N was applied as a split application. In contrast, in 2003, total tuber yield increased with increasing N rate across the range of N rates applied, but was not influenced by the timing of N application.

The yield of small, maingrade, bonus, and marketable tubers was also assessed (Table 3). A comparison of all treatments indicated that N management tended (P=0.07) to influence maingrade tuber yield only, with fertilized treatments producing a higher maingrade yield overall than the control treatment. Based on analysis of individual timing treatments, increasing N rate resulted in a significant quadratic increase in maingrade and marketable yield across the range of N rates applied (including the control) only where all N fertilizer was applied preplant (data not presented). Analysis of fertilized treatments as a factorial showed no overall effect of N rate on small, maingrade, bonus, and marketable tuber yield. However, timing of N application influenced the yield of small and maingrade

Table 3. Effect of N fertilizer rate and timing of application on yield of selected tuber size fractions in 2004.

Treatment		Small (<3 oz)	Maingrade (3 to 10 oz)	Bonus (>10 oz)	Marketable (>3 oz)
		--------cwt acre^{-1}--------			
Means					
Control	10 kg N ha^{-1}	38	267	82	349
Rate	75 kg N ha^{-1}	44	286	69	355
	150 kg N ha^{-1}	44	300	59	359
	225 kg N ha^{-1}	42	289	61	351
Split	1	49	306	58	364
	2	38	289	68	357
	4	43	281	63	344
LSD $_{(0.05)}$ for fert. splits		8.3	18.8	26.1	16.8
P-values*					
Rate		0.77	0.31	0.74	0.61
Split		**0.04**	**0.03**	0.74	0.06
R*S		0.55	0.61	0.95	0.58
Contrasts					
Linear rate		0.58	0.71	0.57	0.64
Quadratic rate		0.66	0.14	0.60	0.38
CV (%)**		22.0	7.4	48.5	5.8
P-values**					
		0.21	0.07	0.95	0.40
Treatment					
Contrasts					
Control vs all fertilized		0.26	**0.04**	0.27	0.61

* Results presented are based on analysis of all treatments, excluding the control, as a factorial.

** Results presented are based on analysis of all treatments including the control, by treatment.

tubers. Pre-plant application of N fertilizer resulted in a higher yield of small tubers than where N was applied as a split at pre-plant and at hilling (Table 3). Similarly, the yield of maingrade tubers (3 to 10 oz) was higher where N was applied pre-plant, than where N was applied as a split four times during the growing season (Table 3). A similar trend was evident for marketable yield (P=0.06).

Interestingly, although soil nitrate levels were relatively low in the spring prior to crop establishment (averaging 40 kg NO_3-N ha^{-1} to 60 cm), and only 10 kg N ha^{-1} as fertilizer N was applied to the control treatment, total tuber yield was nearly 91% that obtained in the highest-yielding treatment (Figure 2). In 2003, similar results were obtained, with the control treatments yielding approximately 84% that of the highest N rate treatment. Previous studies in Manitoba have similarly pointed to the potential for significant contributions of N in irrigated potato production systems through mineralization of soil organic matter during the growing season (Tomasiewicz, 1996).

Specific gravity was strongly influenced by N fertilizer management in 2004 (Table 2). Increasing N rate resulted in a significant linear decline in specific gravity. Timing of N application also influenced specific gravity with a higher specific gravity obtained where N was either applied all pre-plant, or as a split application at pre-plant and at hilling, than where N was applied at four times throughout the growing season.

Preliminary results suggest that N fertilizer treatments had no effect on fry colour (data not presented). Preliminary analysis indicates that the occurrence of hollow heart and brown centre was greater in the control treatment than in N-fertilized treatments, and that increasing N rate tended to reduce the occurrence of hollow heart and brown centre. However, N treatment appeared to have no effect on the actual yield loss resulting from hollow heart and brown centre (data not presented).

Where N had been applied, post-harvest soil nitrate content to 120 cm increased linearly with increasing N fertilizer rate (Figure 3). Splitting the fertilizer applications did not have a statistically significant effect on post-harvest soil nitrate content, which ranged among treatments from approximately 36 to 103 kg NO_3-N ha^{-1} to 120 cm. Because soils were sampled immediately after tuber harvest, nitrate arising from post-harvest mineralization of crop residue was not accounted for in these analyses. In the spring prior to plot establishment, the soil nitrate content to 120 cm had ranged from 52 to 154 kg NO^3-N ha^{-1} to 120 cm when averaged across replicates (Table 1).

In fertilized treatments, soil nitrate concentration increased linearly with increasing N rate for all soil depths; however, no significant effect of timing of N application was evident (Figure 4).

Summary

Nitrogen management had limited effects on potato yield and quality in 2004. While timing of N application influenced the yield of some size fractions and total tuber yield, and tended to influence marketable yield, few effects of N rate on tuber yield or size distribution were evident. With the exception of decreases in specific gravity associated with increasing N rate, and the application of N as a 4x split, N management appeared to have little or no effect on quality parameters in 2004.

Petiole nitrate concentration was strongly influenced by N rate; however, impacts of timing of N application were inconsistent. In part, cool and wet growing season conditions may have impacted petiole nitrate concentrations in 2004. Based on published critical nutrient concentration criteria, the control treatment and all treatments receiving 75 kg N ha^{-1} would have been categorized as insufficient in N.

At potato harvest, the influence of fertilizer N application on soil nitrate content remained evident, with higher soil nitrate levels present where higher rates of N had been applied.

Field experiments are planned for 2005 in order to collect additional information regarding the impact of rate and timing of N application on crop and soil parameters.

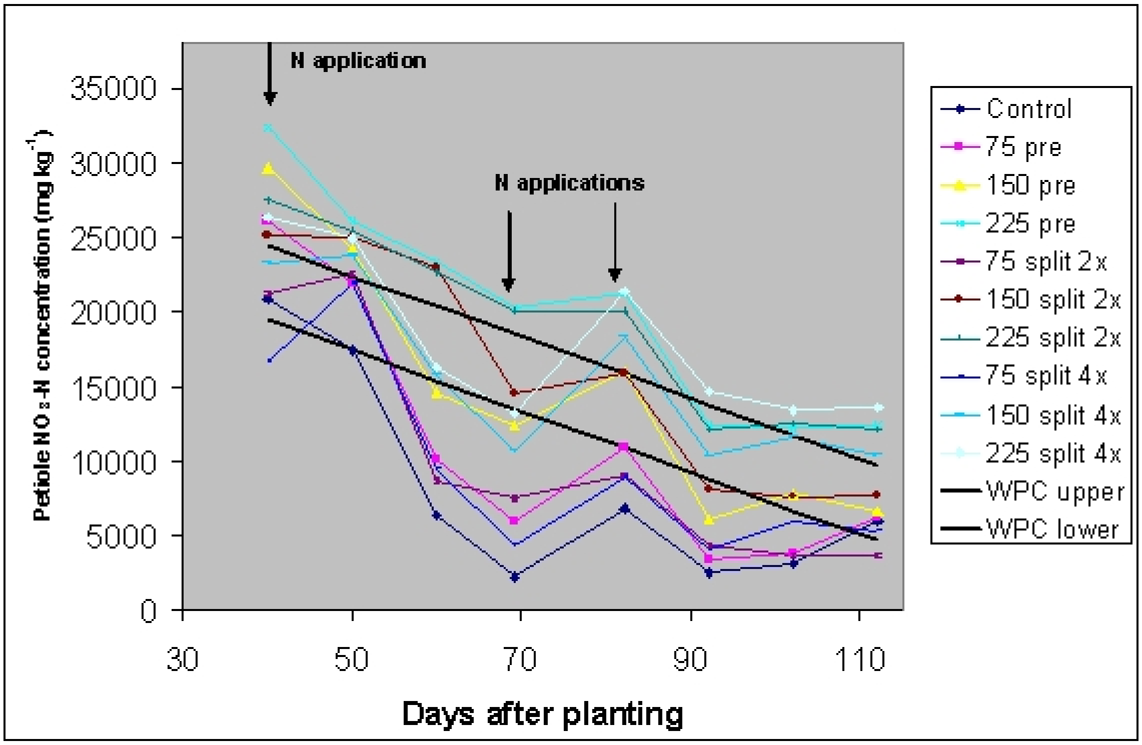


Figure 1. Effect of N fertilizer application rate and timing on petiole nitrate concentration of potato (cv. Russet Burbank) throughout the 2004 growing season. "WPC" indicates the upper and lower limits of the target range for potato petiole nitrate based on the *Guide to Commercial Potato Production on the Canadian Prairies* (Western Potato Council, 2003).

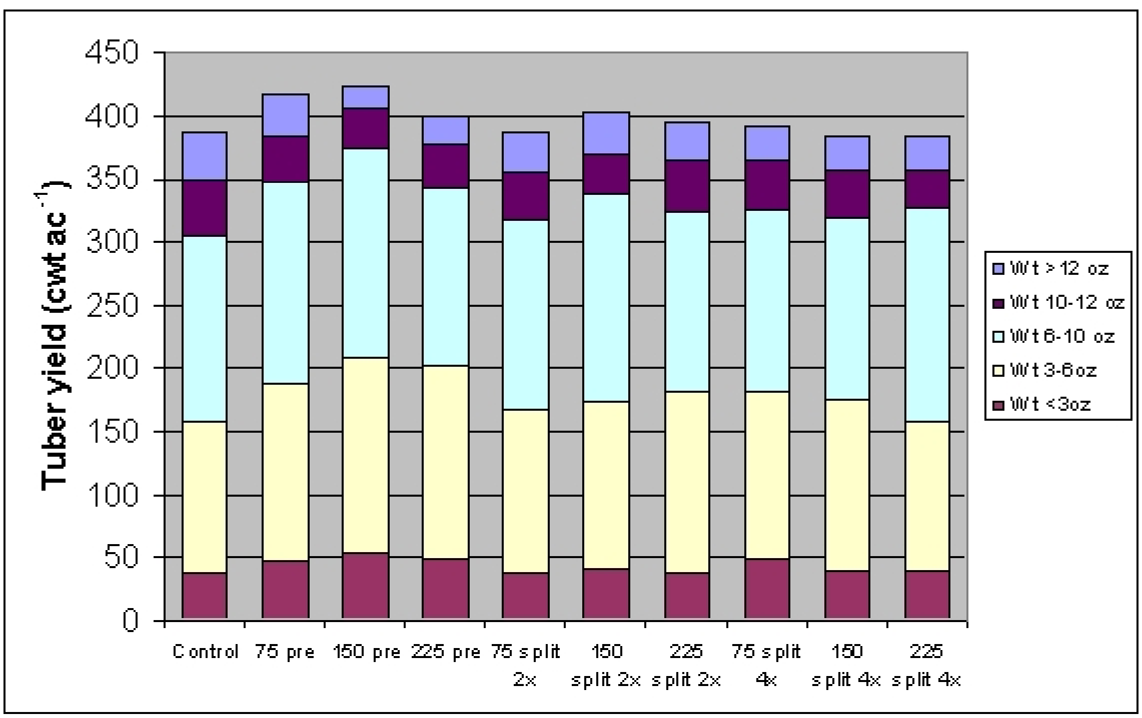


Figure 2. Effect of N fertilizer application rate and timing on yield of various tuber size fractions in 2004.

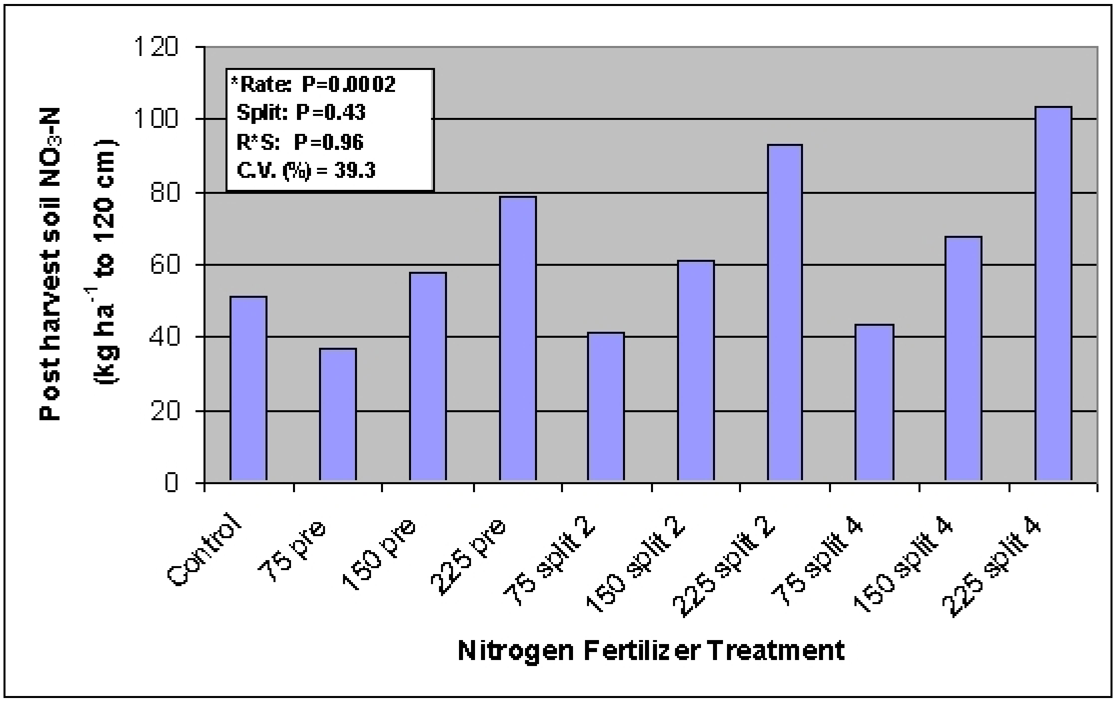


Figure 3. Effect of N fertilizer application rate and timing on post-harvest soil nitrate content in 2004. (*All fertilized treatments, excluding the control, were analyzed as a factorial. Post-harvest soil nitrate content increased linearly with increasing N rate (P-value<0.0001)).

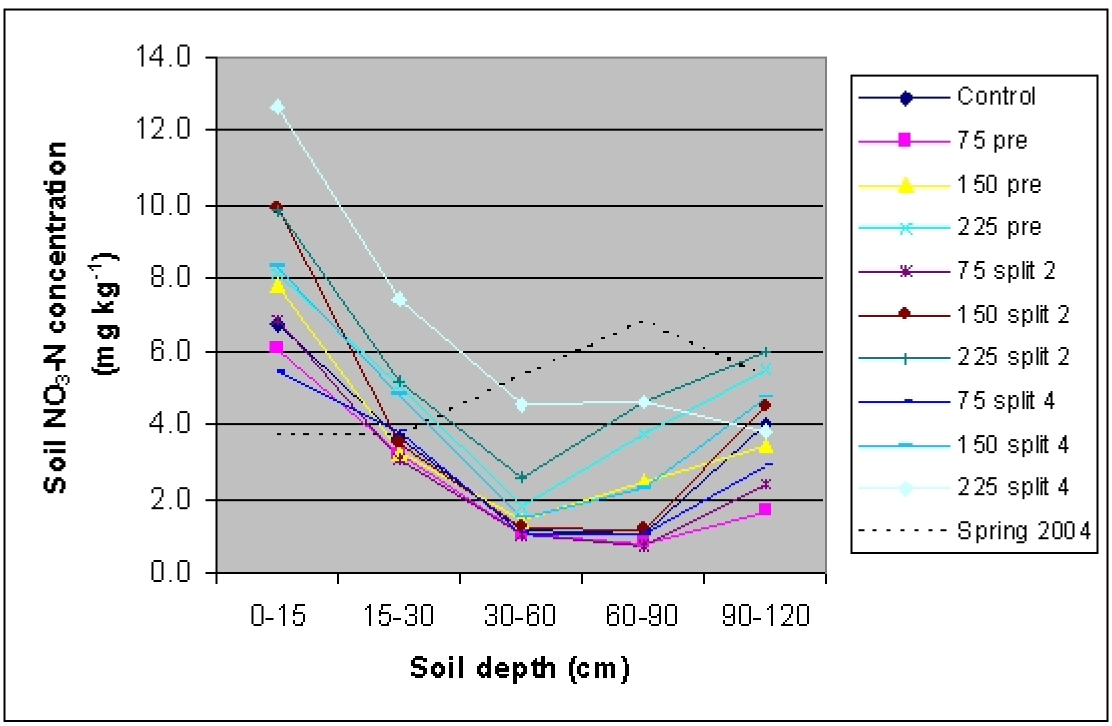


Figure 4. Effect of rate and timing of fertilizer N application on soil nitrate concentration in the soil profile immediately following potato harvest in 2004. "Spring 2004" indicates the spring soil nitrate concentration averaged across the experimental area prior to crop establishment.

The Effect of Gibberellic Acid on the Performance of Progeny Tubers

Principal Investigator: B. Geisel, Gaia Consulting Ltd.

Support: Keystone Vegetable Producers Association
MCDC

Objective: To determine the effect of Gibberellic acid (GA_3) treatment on the performance (yield and grade) of progeny tubers.

Abstract

There are several potato markets where a smaller tuber size profile is desirable. These include:

1. Seed. The most productive seed pieces originate from mother tubers weighing between 2 and 8 oz. Seed pieces originating from large mother tubers have fewer eyes and may result in blind seed pieces (no eyes), causing a reduction in stand, yield and quality.
2. Table. A premium price is paid for potatoes less than 1⅝ inches in diameter called "little potatoes" or "creamers".
3. French Fry Processing: Certain varieties (e.g. Shepody) have a low tuber set resulting in an undesirable size profile with a large percentage of tubers greater than 10 oz. Large tubers are not ideal for making French fries.

An application of gibberellic acid (GA) will increase tuber set and reduce the tuber size profile. Gibberellic acid, specifically the GA_3 isomer, is a naturally occurring plant hormone, which is used to modify plant growth in the fruit and vegetable industry. Previous research (2001, 02 & 03) conducted by Keystone Vegetable Producers Association, McCain Foods and Midwest Foods Products demonstrated that applying a 1,500 to 4,500 µg GA_3 in 150 ml water/100 kg of seed at plant will increase tuber number and decrease the tuber size profile by 20-30% in Shepody potatoes. The effect was the same for a pre-cut (14 days before plating) or fresh-cut (one day before planting) application of GA. GA_3 applied at the 3,000 and 4,500 µg/100 kg of seed rate caused slight phytotoxicity, which resulted in a reduction in total yield, but an increase in the premium seed size tubers (2-10 oz) compared to the untreated check.

Potato growers expressed concerns about the potential effect of GA on the performance of the progeny or daughter tubers. Two trials studying the residual effect of GA were conducted in 2003 and 2004. The application of GA to mother tubers had no effect on the performance of the daughter tubers in terms of total yield, marketable yield (tubers >2" in diameter), specific gravity, hollow heart and fry colour. In 2003 and 2004 there were no phytotoxic symptoms observed. In 2004, the application of GA to mother tubers affected the performance of the daughter tubers by reducing the yield and percentage of tubers greater than 10 oz. This effect was likely due to the smaller size profile of the seed and not due to a physiological difference between the GA treated and untreated seed lots. Research has shown that the size profile of the seed will affect the size profile of the resulting crop. In this case, treatments produced using GA had a smaller seed tuber profile resulting in a daughter tuber crop with fewer 10 oz tubers than the untreated check.

Gibberellic acid, which is marketed as Activol and Falgro by Norac Concepts is not registered for use on potatoes. Norac Concepts has applied to the Pest Management Regulatory Agency for registration.

Methods

Shepody potatoes were planted June 4 at MCDC-Portage la Prairie (Neuhorst clay loam; irrigated), at a 1-m row spacing. Plots were 2 rows by 12 m long, laid out in a randomized complete block design with four replicates. They were top-killed September 8, and harvested the next day. GA_3 had been applied to the mother tubers planted in 2003, at 2250 and 4500 µg GA_3 in 150 ml water per 100 kg of seed.

The progeny collected from the 2003 trial was then used as the seed source in the 2004 trial (Table 1).

Table 1. Treatments.

Treatment no.	GA Concentration	Rate of active ingredient
	ppm	µg ai/100 kg
1	sham - water only	0
2	15	2250
3	30	4500

Results and Discussion

Stand and Stem Count

Stand counts were conducted 24, 32 and 39 days after planting (DAP). There were no differences in stand or stem number between treatments (Table 2).

Table 2. Stand and stem counts

Treatment		Plants in 12 m of row			
No.	µg GA_3/100 kg	24 DAP	32 DAP	39 DAP	Stems/plant
1	0	25.5	31.8	31.8	2.6
2	2,250	21.3	30.0	30.8	2.8
3	4,500	22.3	31.0	32.3	2.6
	Prob.	0.0736	0.2841	0.4506	0.1934
	CV %	9.5	4.5	5.1	4.9
	LSD = 0.05	NSD	NSD	NSD	NSD

Yield, Grade, and Tuber Profile

The application of GA to mother tubers had no effect on the performance of the daughter tubers in terms of total yield, marketable yield (tubers >2" in diameter), specific gravity, hollow heart and fry colour. In 2004, the application of GA to mother tubers affected the performance of the daughter tubers by reducing the yield and percentage of tubers greater than 10 oz. This effect was likely due to the smaller size profile of the seed and not due to a physiological difference between the GA treated and untreated seed lots. Research has shown that the size profile of the seed will affect the size profile of the resulting crop. In this case, treatments produced using GA had a smaller seed tuber profile resulting in a daughter tuber crop with fewer 10 oz tubers than the untreated check.

Fry Colour and Sugar Ends

Fry colour was determined using the USDA fry colour chart. The colour scale ranges from "0" (light) to "4" (dark). There were no differences in fry colour or number of sugar ends between the GA treated and untreated check (Table 4).

Table 3. Yield, grade and tuber profile

Treatment No.	Treatment µg GA_3/100 kg	Specific Gravity	Tuber yield (cwt/acre) 0-2 oz	2-6 oz	6-10 oz	>10 oz	>2 oz	Total	Tubers >10 oz (%)	Hollow Heart (%)	Mean tuber size (oz)
1	0	1.076	1.0	40	91	146	276	277	52.8	0.0	8.7
2	2250	1.075	1.9	49	95	123	266	268	45.9	3.9	8.1
3	4500	1.074	0.6	39	96	136	271	271	50.2	6.9	8.6
	Prob.	0.745	0.682	0.312	0.649	0.009	0.618	0.706	0.000	0.530	0.459
	CV %	0.294	175.5	21.5	8.6	5.0	4.9	5.3	2.5	228.8	7.6
	LSD = 0.05	NSD	NSD	NSD	NSD	11.7	NSD	NSD	2.2	NSD	NSD

Table 4. Fry colour and sugar ends.

Treatment No.	Treatment µg GA_3/100 kg	Mean Fry Colour [1]	Sugar Ends
1	0	2.2	0.8
2	2250	2.0	1.3
3	4500	2.1	0.8
	Prob.	0.794	0.579
	CV %	11.3	81.3
	LSD = 0.05	NSD	NSD

[1] Value indicates the weighted mean for fry colour from ten tubers per sub sample.

Effect of Soil Applied Surfactants on Water Infiltration and Sugar Ends

Principal Investigator: B. Geisel, Gaia Consulting Ltd.

Support: Keystone Vegetable Producers Association
McCain Foods (Canada)
Simplot Canada Limited
MCDC

Objective: To assess the effects of non-ionic surfactants, and of the timing of their application, on infiltration of water into soil and on yield and quality in potato.

Abstract

Sugar-end (also called translucent end) affects the stem end of tubers. The affected tissue has a lower dry matter content and a higher reducing sugar (glucose and fructose) content. The reducing sugars react with free amino acids during frying to form dark fry ends. For processors, sugar-ends result in reduced processing efficiency and economics and in extreme cases an unusable product. Several factors contribute to this problem, including moisture stress, high temperature stress, high ratio of tops to tubers, and over-fertilization. The formation of excess reducing sugars may not occur until weeks or even months after the stress. Sugar-end tubers are typically irregularly shaped with pointed stem ends. However, ideally shaped tubers may also have sugar-ends. Cultivars with long tubers, such as Russet Burbank, are particularly prone to this disorder. If the plant is not able to maintain a high growth rate due to high temperature and low moisture stress, the plant becomes stressed and sugar ends may result. Soil surfactants may be used to increase water penetration into the hill, reduce the formation of a dry root zone, and therefore reduce the development of sugar-ends.

In 2004, three surfactants and two application timings were tested at MCDC-Portage la Prairie under irrigation. Some phytotoxicity was measured for some of the pre-hill treatments. No differences were found in yield or grade. Fewer sugar ends were found in the Wet-Sol pre-hill treatment and the NCF-059A pre-hill treatment. As sugar ends were not a significant problem during the 2004 season, more testing may be needed.

Methods

Russet Burbank potatoes were planted May 29 at MCDC-Portage la Prairie (Neuhorst clay loam), at a 1-m row spacing. Plots were four rows by 12 m long, laid out in a randomized complete block design with four replicates. Assessments were conducted on the two centre rows. Plots were top-killed by flailing September 17, and harvested the same day.

Treatments (Table 1) were applied either July 1 (pre-hill) or July 2 (post-hill), with a tractor-mounted CO_2 sprayer with a TurboDrop TD 015 venturi and a 110-04 nozzle. Solutions were applied at 225 l/ha and 550 kPa pressure, with nozzles 45-cm above ground spaced 50 cm apart.

Results and Discussion

<u>Phytotoxicity</u>

A phytotoxicity assessment was conducted on July 2. NCF-057-A (a pre-hill; Trt 2) and Wet-Sol (pre-hill; Trt 4) had significantly worse phytotoxicity symptoms (Table 2). Treatment 2 showed the strongest phytotoxic symptoms.

Table 1. Treatments.

No.	Surfactant	Company	Rate	Application Timing
1	Untreated Check			
2	NCF-057-A	Norac Concepts Inc.	5 L/ha	Emergence (pre-hilling)
3	NCF-057-A	Norac Concepts Inc.	5 L/ha	Post-hilling
4	Wet-Sol	Schaeffer Manufacturing Co.	5 L/ha	Emergence (pre-hilling)
5	Wet-Sol	Schaeffer Manufacturing Co.	5 L/ha	Post-hilling
6	NCF-059-A	Norac Concepts Inc.	5 L/ha	Emergence (pre-hilling)

Table 2. Phytotoxicity assessment.

Treatment	Application Timing	Phytotoxicity Rating*
1 Untreated Check		9.0 a
3 NCF-057-A	Post-Hill	9.0 a
5 Wet-Sol	Post-Hill	8.8 a
6 NCF-059-A	Pre-Hill	8.8 a
4 Wet-Sol	Pre-Hill	7.8 b
2 NCF-057-A	Pre-Hill	5.5 c
Probability		0.0000
CV %		5.6
$LSD_{0.05}$		0.7

* 0-9 scale; 9 indicate no symptoms and 0 is complete death.

Yield

No significant differences were measured between treatments for undersize, marketable, or total yield Table 3). Similarly, no differences were found for tubers over 10 oz.

Table 3. Effect of surfactant treatment on yield and grade.

Treatment	Timing	Yield (cwt/ac) <2"	>2"	Total	>10 oz (%)
1 Untreated Check		29.4	304.2	333.7	31.6
2 NCF-057-A	Pre-Hill	40.5	268.5	309.0	26.9
3 NCF-057-A	Post-Hill	38.5	278.2	316.7	28.8
4 Wet-Sol	Pre-Hill	35.7	295.6	331.3	24.0
5 Wet-Sol	Post-Hill	45.0	287.6	332.5	25.7
6 NCF-059-A	Pre-Hill	36.2	283.1	319.3	35.4
Probability		0.401	0.113	0.083	0.4693
CV %		26.5	6.0	4.0	9.4
$LSD_{0.05}$		NSD	NSD	NSD	NSD

Processing Quality

No differences were measured between treatments for specific gravity (total solids), hollow heart or fry colour (Table 4). Significantly fewer sugar ends resulted from Wet-sol pre-hill (#4) and NCF-059-A pre-hill (#6) treatments. As sugar ends were not a significant problem during the 2004 season, more testing may be required to determine if surfactants applied to soil will be an effective strategy for reducing sugar ends.

Table 4. Effect of surfactant treatment on processing quality.

Treatment	Timing	Specific Gravity	Total Solids (%)	Hollowheart (%)	Fry Colour	Sugar Ends (%)
2 NCF-057-A	Pre-Hill	1.080	20.9	4.6	2.10	15.0 a
1 Untreated Check		1.084	21.7	3.8	1.73	10.0 a
5 Wet-Sol	Post-Hill	1.082	21.2	1.2	1.63	10.0 a
3 NCF-057-A	Post-Hill	1.083	21.4	2.5	2.00	7.5 ab
4 Wet-Sol	Pre-Hill	1.081	21.0	1.0	1.77	0.0 b
6 NCF-059-A	Pre-Hill	1.083	21.4	3.1	1.77	0.0 b
Probability		0.566	0.566	0.542	0.185	0.034
CV %		3.2	3.2	76.4	14.8	93.8
$LSD_{0.05}$		NSD	NSD	NSD	NSD	10.00

Potato Virology Research

Impact of seed source, host crops and an early warning system on PVY disease management in potato

Principal Investigator: D. L. McLaren, AAFC-Brandon Research Centre

Co-Investigators: T. Shinners-Carnelley and Brent Elliott, Manitoba Agriculture, Food and Rural Initiatives
R.P. Singh, AAFC-Potato Research Centre (Fredericton)
R. Mohr, AAFC-Brandon Research Centre

Funding/support: Manitoba Rural Adaptation Council
Seed Potato Growers Association of Manitoba
Keystone Vegetable Producers Association
Midwest Food Products Inc.
McCains Foods Ltd.
MCDC

Objectives:
To determine the prevalence and incidence of PVY isolates in the Manitoba potato crop.
To compare seed source (domestic versus imported) of PVY infested potato fields.
To assess other susceptible crops for infection by PVY isolates.
To assess the potential of an early warning system, based on virus spread, to predict expected virus levels within the fall tuber crop.
To assess aphid populations in the Manitoba potato production regions, using suction and pan traps, for species that are important in the spread of these viruses.

Potato virus Y and potato leafroll virus are the two most important aphid-vectored viruses in Manitoba in terms of yield and quality reduction in the potato crop. A strain of PVY that differs from the common PVY strain has been found in Manitoba potato crops and is of great concern.

Methods

In 2004, 19 fields from the main potato producing area in Manitoba were selected and were assessed (preplanting) for the presence of PVY isolates. Prior to planting, tubers from these fields (imported and domestic seed source) were tested for the different PVY isolates to provide information on current source and incidence of virus isolates in seed to be used in Manitoba fields. Selected sampling from other susceptible crops/plants present in the vicinity of these fields was also conducted to determine if such virus-susceptible crops/plants are a source of PVY or PLRV.

Commonly grown potato cultivars were assessed in replicated field studies to provide information on virus spread and when it occurred.

Assessment of aphid populations and species identification is important as virus spread is associated with aphid flight activity and the presence of efficient and less efficient but abundant vectors. The establishment of the trapping network provided information on aphid identification and flight activity, to assist growers in making pest management decisions. Such a system may ultimately reduce costs to Manitoba potato producers through improved timing and judicious use of insecticides.

Results and Discussion

Aphid trapping network within potato fields in Manitoba

In June of 2004, aphid traps were located in 11 fields in Manitoba with sites at Bagot, Carberry (3), Gretna, Holland, Miami, Gladstone, Portage, Shilo, and Winkler (Figures 1 and 2). Regular weekly monitoring began in late June and continued until September 15. Aphids, collected from suction and pan traps as well as from leaf samples, were counted and identified. Weekly aphid data were compiled and posted on the Manitoba Agriculture, Food and Rural Initiatives website. Weekly reports were sent to all growers participating in the study and to the SPGAM (D. Lidgett) for distribution to other seed potato growers.

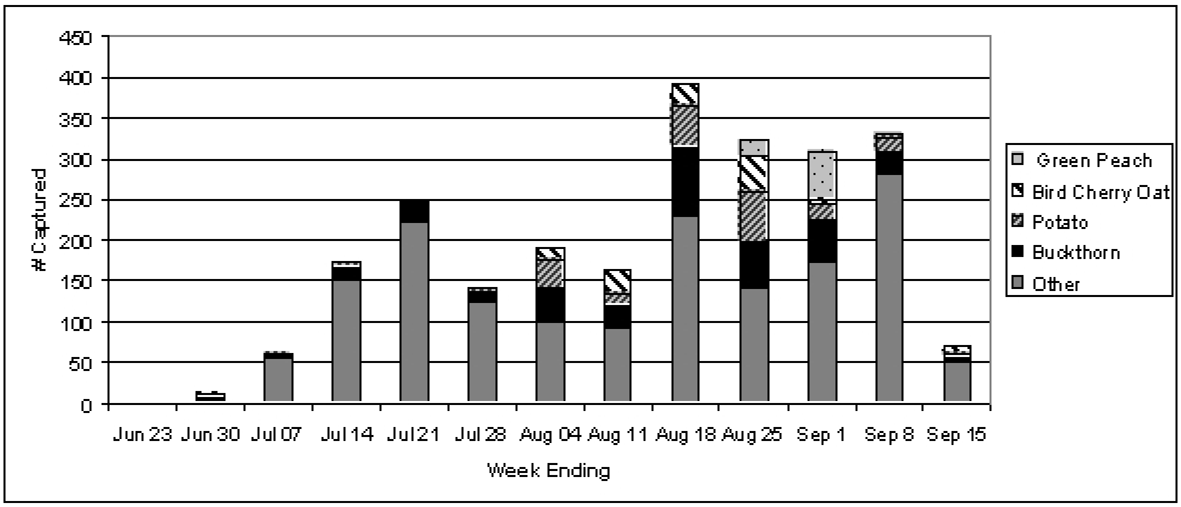


Figure 1. Total aphids captured from late June to September 15 over all Manitoba trap sites in 2004.

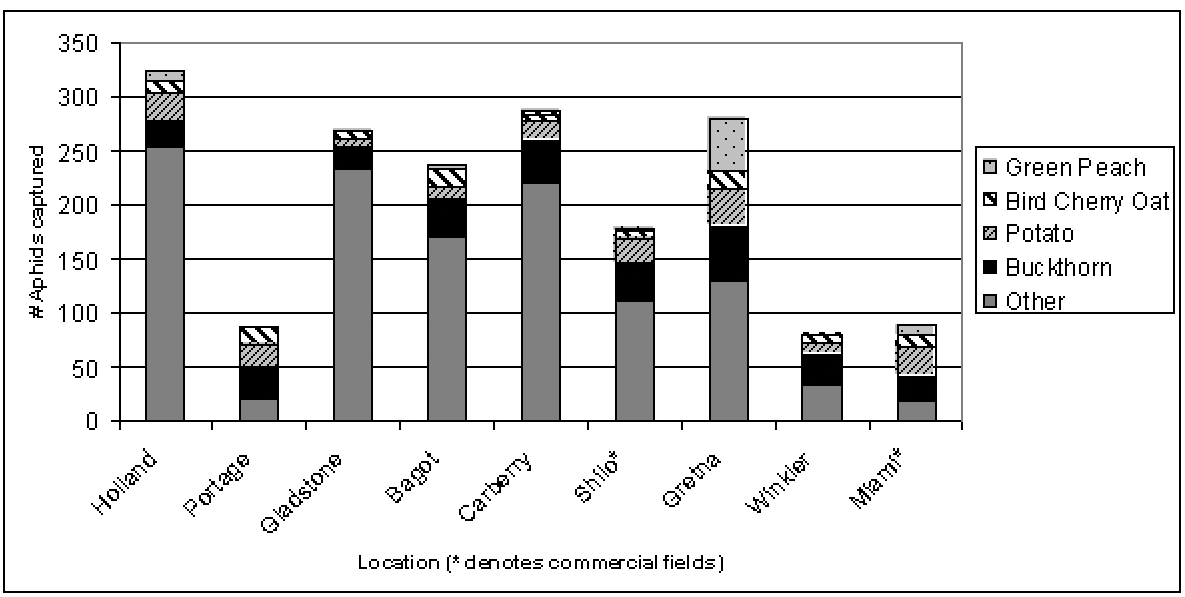


Figure 2. Aphids captured over the 2004 trapping season by location.

Preplanting Tuber Collection

Tubers were collected from 6 producers during May 14-26, 2004. These tubers represented 19 potato fields and included varieties such as Russet Burbank, Shepody, Ranger Russet, Sangre, Nordonna, and Dakota Pearl. Imported seed sources included Saskatchewan, British Columbia and Montana. One hundred tubers from each of the 19 seed lots have been or are in the process of being evaluated for the presence of PVY and strain identification. Preplanting tuber testing in 2003 indicated that only three of 4200 tubers tested were PVY positive; two were PVY^{O} and one was $PVY^{N:O}$.

Prevalence and Incidence of PVY and PLRV in the Potato Crop

Twelve commercial and seed fields were assessed for the incidence of viruses in early July, 2004. PVY and PLRV were found in 33% and 25% of surveyed fields, respectively. Overall, disease incidence was low and averaged 0.07% PVY and 0.04% PLRV.

Other Crops/Plants Susceptible to PVY

There are a number of weed species suspected of being susceptible to PVY. Potato virus Y has a relatively narrow host range, affecting plants in the Solanaceae family (that is, tomatoes, potatoes, and peppers). There are a number of weeds within this family including wild tomato and nightshade. In 2003, we often found these weeds associated with corn fields and potato fields within the vicinity of the corn fields. In 2004, a number of potato and corn fields were surveyed for these weeds. Wild tomato, black nightshade and hairy nightshade were collected with a total of 62 plants sampled from 4 fields. Of these plants, 12 were sampled over two collection dates (August 6 or 11 and October 6). All plant samples were analyzed for the presence of PVY and PLRV to determine if they were acting as wild reservoir hosts for virus. In 2003, of the 32 plants sampled in early September, no PVY was detected but PLRV was found in black nightshade and wild tomato. These weeds do not overwinter here. In 2004, no viruses were detected in the hairy nightshade, black nightshade or wild tomato samples. Weed management strategies are critical in and around corn fields where many of these weeds were found, and in all potato fields, especially those found in the vicinity of corn fields. Although the weeds do not overwinter, they can still act as reservoir for virus during the growing season.

Time of Virus Spread

A replicated trial was established at MCDC-Carberry to assess virus spread in Russet Burbank, Shepody, and Norland. All rows per plot contained healthy tubers except the center row, which was planted to tubers known to be infected with PVY. Leaf samples from all diseased plants were collected in early July. At each of the three tuber sampling dates, 240 tubers were collected from each cultivar for a total of 720 tubers. With three collection dates, approximately 2160 tubers were analysed for virus using RT-PCR. Analyses are ongoing with results available from the Russet Burbank leaves and tubers to date. Additional data will be available once testing is completed. Preliminary data indicates that spread of PVY from infected to healthy Russet Burbank potatoes was not evident over three tuber collection dates in 2004 (Table 1). However, in a similar study in 2002, tubers collected from healthy rows which were adjacent to diseased rows (PVY and PLRV) showed virus spread, as tubers from the August collection were clean but many collected in September were infected (Table 2). These data indicates that late spread of virus was occurring in 2002 as compared to the time of spread observed in the Maritimes in the same year. Little spread occurred in the current study in 2004 and this may be related to reduced aphid numbers and activity due to the cool, wet environmental conditions of the season. Similarly, in New Brunswick, little spread of virus was also observed in 2004 (Singh, pers. comm.).

Table 1. Spread of PVY and PLRV from infected to healthy potatoes under Manitoba field conditions (2002).

	July Leaves		August Tubers		September Tubers	
Row no.	PVY (%)	PLRV (%)	PVY (%)	PLRV (%)	PVY (%)	PVY (%)
3	0	0	0	0	23.1	23.1
4	0	0	0	0	6.7	13.3
5	0	0	0	0	5.9	20.0
10	0	0	0	0	0	5.6
11	0	0	0	0	0	6.7
12	0	0	0	0	0	5.6

Table 2. Spread of PVY and PLRV from infected to healthy Russet Burbank potatoes under Manitoba field conditions (2004).

	July leaves		August 17 tubers		September 2 tubers		September 21 tubers	
Row type	PVY (%)	PLRV (%)	PVY (%)	PLRV (%)	PVY (%)	PVY (%)	PVY (%)	PLRV (%)
Healthy N	0	0	0	0	0	0	0	0
Diseased	95	0	95	0	95	0	84	0
Healthy S	0	0	0	0	0	0	0	0

Effect of Irrigation Timing, Nitrogen Rate and Timing on Sugar-End Disorder

Principal Investigators: B. Geisel, Gaia Consulting Ltd.
D.J. Tomasiewicz, MCDC

Support: Irrigation Development Program
Keystone Vegetable Producers Association
Midwest Foods Products Inc.
McCain Foods (Canada) Ltd.
MCDC

Objective: To assess the effects of irrigation timing, nitrogen rate, and nitrogen timing on sugar-ends in potato.

Abstract

Sugar-end (also called translucent end) affects the stem end of tubers. The affected tissue has a lower dry matter content and a higher reducing sugar (glucose and fructose) content. The reducing sugars react with free amino acids during frying to form dark fry ends. For processors, sugar-ends result in reduced processing efficiency and economics and in extreme cases an unusable product. Several factors contribute to this problem, including moisture stress, high temperature stress, high ratio of tops to tubers and over-fertilization. The formation of excess reducing sugars may not occur until weeks or even months after the stress. Sugar-end tubers are typically irregularly shaped with pointed stem ends. However, ideally shaped tubers may also have sugar-ends. Cultivars with long tubers, such as Russet Burbank, are particularly prone to this disorder. Since this is the dominant variety grown in Manitoba, management practices might be implemented in order to minimize the effects of sugar-ends. Making adequate, uniform water applications, especially during tuber initiation, can cool plants and the soil, while providing moisture to the plants' roots. Over-fertilizing with nitrogen should be avoided. High nitrogen fertilization increases growth rates in the plant, resulting in an increased requirement for soil moisture. If the plant is not able to maintain a high growth rate due to high temperature and low moisture stress, the plant becomes stressed and sugar ends may result. In 2005, the soil moisture deficit was 70 mm for the growing season. Specific gravity was reduced by the application of irrigation water and nitrogen. Maintaining available soil water above 70% increased marketable yield. Sugar ends were affected by nitrogen rate and timing, however, a clear pattern was not evident. Sugar end incidence tended to be elevated at the higher rate of nitrogen application.

Methods

Russet Burbank potatoes were planted at MCDC-Carberry (Wellwood clay loam), at a 1-m row spacing. Plots were four rows by 12 m long, laid out in a split plot design with four replicates.

Three irrigation treatments were assigned to the main plots, and six N rate/timing treatments to the subplots (Table 1), as follows:

		Irrigation (mm)	Total rainfall + irrig. (mm)
Irrigation (Factor A):	1 - Rainfed	0	318
	2 - Grower Standard 1	38	356
	3 - Maintain 70% ASW	70	388

Nitrogen Rate and Timing (Factor B):
1 - Recommended at planting
2 - Recommended (1/3:2/3 split) early hilling
3 - Recommended (1/3:2/3 split) late hilling
4 - Recommended + 75 lb N/ac at planting
5 - Recommended + 75 lb N/ac (1/3:2/3 split) early hilling
6 - Recommended + 75 lb N/ac (1/3:2/3 split) late hilling

Table 1. Irrigation and nitrogen treatments.

		- - - - - - - Nitrogen Application (lbs N/acre) - - - - - - -			
Factor A,B	Precipitation plus irrigation (mm)	Total	Sideband at plant	Early split applied June 30	Late split applied July 15
1,1	318.4	120	120		
1,2	318.4	120	30	90	
1,3	318.4	120	30		90
1,4	318.4	195	195		
1,5	318.4	195	30	165	
1,6	318.4	195	30		165
2,1	356.4	120	120		
2,2	356.4	120	30	90	
2,3	356.4	120	30		90
2,4	356.4	195	195		
2,5	356.4	195	30	165	
2,6	356.4	195	30		165
3,1	388.1	120	120		
3,2	388.1	120	30	90	
3,3	388.1	120	30		90
3,4	388.1	195	195		
3,5	388.1	195	30	165	
3,6	388.1	195	30		165

For the at-plant sideband applications, ammonium nitrate was applied in a band 5 cm to the side and 5 cm below the seed piece. For the split applications, ammonium nitrate was broadcast over the plot and incorporated with a tillage implement comprised of s-tine shanks and hilling discs.

Petioles samples were collected (July 8, August 9, and September 9) from each treatment on each date. Each sample was a composite of petioles from each replicate. Plots were harvested October 4.

Results and Discussion

Petiole Analysis

There were few differences in petiole nitrate concentrations between treatments on the July 8th sample date (Figure 1). Differences between treatments began to develop by the August 9 sample date and were greatest by the September sampling date - petiole nitrate concentration increased with increasing rates of N application (Figure 2). Fertilizer treatments 4, 5, and 6 had higher petiole nitrate concentrations than treatments 1, 2, and 3.

The rainfed treatment had higher petiole nitrate concentrations in September than the irrigated treatments (Figure 1). Treatment #3, which received the highest amount of precipitation and irrigation water had the lowest petiole nitrate concentrations.

The treatments with all N applied at planting (1 and 4) had lower petiole nitrate concentrations in September than the split application treatments (2, 3, 5, and 6). This was especially true for the highest N rates (4, 5 and 6). In this case, split applying N caused higher nitrate levels in September. There were no difference in petiole nitrate concentrations between the early and late split applications.

Figure 1. Petiole nitrate concentrations all sampling dates.

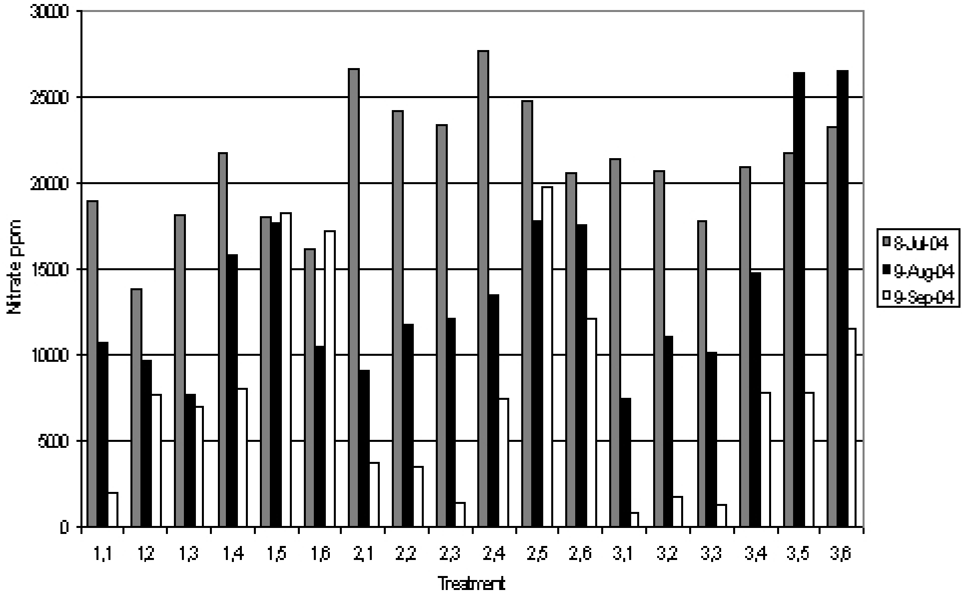
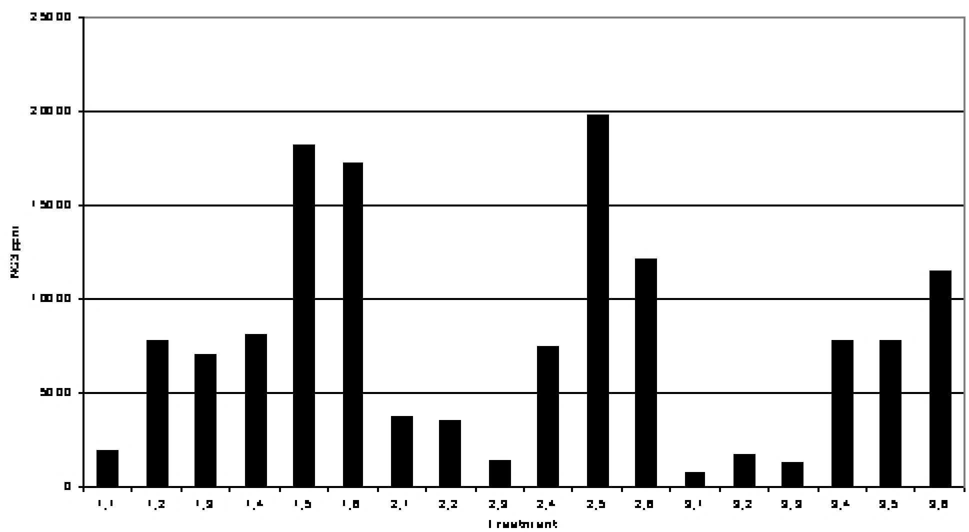


Figure 2. Petiole nitrate concentrations on September 9.



Yield and Grade

The addition of irrigation water reduced specific gravity compared to the rainfed (Table 2). There was no difference in specific gravity between the grower standard irrigation regime and the treatment where soil moisture was maintained above 70% available soil water. Increasing the rate of N reduced specific gravity.

Maintaining available soil water (ASW) above 70% produced a marketable yield greater than the grower standard and rainfed treatments (p=0.08). There was no difference in yield between the grower standard and rainfed treatments.

Sugar ends were affected by N rate and timing; however, a clear pattern was not evident. Sugar end incidence tended to be elevated at the higher rate of N application with the exception of treatment #6 the late split application. It was speculated that the late application of N (#6) became available to the plant after the sugar ends had developed thus having no affect on this condition.

Table 2. Yield and grade.

Factor A	Factor B		Yield cwt/ac						
Irrigation Trt. No.	Nitrogen Trt. No.	Specific Gravity	Undersize <2"	Marketable >2"	Total	Bonus >10 oz (%)	Hollow Heart (%)	Fry Colour	Sugar Ends %
1		1.088 a	44.7	275.0 b	319.7	24.5	6.8	1.36	1.7
2		1.085 b	37.7	287.6 b	325.3	27.4	3.9	1.48	4.2
3		1.085 b	36.9	307.2 a	344.1	25.6	3.5	1.56	4.2
	Prob.	0.0219	0.4209	0.0807	0.3035	0.5732	0.2614	0.3786	0.1644
	CV %	0.230	31.9	10.6	10.4	29.6	92.4	21.40	163.30
	LSD=0.05	0.001	NSD	NSD	NSD	NSD	NSD	NSD	NSD
	LSD=0.10		NSD	14.9	NSD	NSD	NSD	NSD	NSD
									0
	1	1.090 a	35.0	269.5	304.5	23.9	6.5	1.49	2.5 abc
	2	1.087 b	40.5	287.1	327.6	26.4	6.5	1.48	0 c
	3	1.088 b	44.5	291.6	336.2	26.0	5.3	1.33	3.3 abc
	4	1.087 b	37.6	300.5	338.1	25.1	3.8	1.53	5.8 ab
	5	1.082 d	38.2	304.0	342.2	28.0	2.8	1.57	6.7 a
	6	1.084 c	42.9	286.9	329.8	25.6	3.3	1.39	1.7 bc
	Prob.	0.0000	0.5161	0.1128	0.1239	0.8353	0.1589	0.4963	0.0396
	CV %	0.230	31.9	10.6	10.4	29.6	92.4	21.40	163.30
	LSD=0.05	0.001	NSD	NSD	NSD	NSD	NSD	NSD	4.48
									0
1	1	1.091	38.8	249.3	288.1	21.7	11.4	1.33	2.5
1	2	1.090	51.5	269.2	320.7	24.6	8.3	1.42	0
1	3	1.089	46.2	279.9	326.0	23.2	5.9	1.43	2.5
1	4	1.090	45.0	285.9	330.8	19.1	3.4	1.27	2.5
1	5	1.082	38.1	311.2	349.2	32.9	5.9	1.48	2.5
1	6	1.087	48.8	254.6	303.4	25.5	5.8	1.25	0
2	1	1.088	30.6	254.5	285.0	27.9	5.3	1.55	0
2	2	1.085	41.9	282.9	324.8	28.3	6.1	1.40	0
2	3	1.088	42.7	288.0	330.7	26.8	4.8	1.23	2.5
2	4	1.086	33.7	306.6	340.2	30.2	2.2	1.65	7.5
2	5	1.082	39.2	293.9	333.1	25.5	1.4	1.67	10
2	6	1.083	38.3	299.8	338.1	25.8	3.5	1.35	5
3	1	1.090	35.6	304.7	340.3	22.1	2.8	1.60	5
3	2	1.087	28.3	309.0	337.3	26.3	5.1	1.60	0
3	3	1.086	44.7	307.0	351.7	28.1	5.3	1.35	5
3	4	1.085	34.1	309.1	343.2	25.8	5.9	1.67	7.5
3	5	1.082	37.3	306.8	344.2	25.7	1.2	1.58	7.5
3	6	1.082	41.7	306.4	348.0	25.6	0.6	1.58	0
	Prob.	0.2640	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
	CV %	0.230	31.9	10.6	10.4	29.6	92.4	21.40	163.30
	LSD=0.05	LSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD

Phosphorus Management for Irrigated Potato Production in Manitoba

Principal Investigators: R.M. Mohr, AAFC-Brandon Research Centre
D.J. Tomasiewicz, MCDC

Funding: Potash and Phosphate Institute
Agriculture and Agri-Food Canada, Brandon
MCDC

Progress: Second year of three-year study

Objective: To determine the effect of P fertilizer rate on tuber yield and quality, petiole P concentration, and post-harvest soil extractable-P levels for irrigated processing potato.

Introduction

In 2001-02, Manitoba produced an estimated 12.8 million cwt of processing potatoes valued at $97.3 million. While phosphorus is routinely applied to most potato fields in Manitoba, much of the research regarding potato responses to P in Manitoba was conducted in the 1960's. More recently, Geisel (1995) and Tomasiewicz (1994) conducted field trials to assess P response in irrigated potato. In five field trials conducted from 1991 through 1994, Geisel (1995) reported significant yield increases with P application in two of five trials, with yield increases evident only where soil test P levels were less than 40 lbs acre-1 (45 kg ha^{-1}). In a one-year study, Tomasiewicz (1994) found no effect of P application on potato yield or quality for a site that, based on the soil test P level, would have been expected to respond to P fertilization most of the time.

Materials

The field experiment was conducted at MCDC-Carberry (soil nutrient test levels in Tables 1 and 2). A randomized complete block design consisting of four replicates of four P fertilizer rates (0, 34, 67, 100 kg P_2O_5 ha^{-1}) was superimposed on a potato production field. Phosphorus fertilizer in the form of monoammonium phosphate was pre-plant broadcast incorporated at the rates indicated by treatment. Nitrogen fertilizer in the form of urea was applied to each treatment in order to balance N provided by the monoammonium phosphate, such that each treatment received a total of 21 kg N ha^{-1} as monoammonium phosphate and/or urea. In addition, for all treatments, a total of 174 kg N ha^{-1} as urea and 61 kg K_2O ha^{-1} as potash was pre-plant broadcast incorporated. All pre-plant fertilizer was broadcast using a Great Plains seeder to meter the fertilizer, then tilled prior to seeding.

Table 1. Soil test levels for 2004 experimental site (sampled spring 2004).

Soil nutrient	Soil depth (cm)	Concentration (kg ha^{-1})
NO_3-N	0-60	34
$NaHCO_3$-extr. P	0-15	27
$NaHCO_3$-extr. K	0-15	271
SO_4-S	0-60	58

Table 2. Soil test P content in each replicate of 2004 experimental site (sampled spring 2004)

Replicate	Soil depth (cm)	$NaHCO_3$-extractable P (kg ha^{-1})*
1	0-15	23.4
2	0-15	29.0
3	0-15	31.2
4	0-15	32.6
Mean	0-15	29.1

* based on analysis of a composite sample from 12 hand-sampled cores per replicate

Fertilizer was applied to plots measuring 8.5 m wide x 16 m long, except for plots in replicate 4 which were 30 m long to accommodate the wheel track of the centre pivot.

The potato crop in the plot area was managed the same as the surrounding production field. Potato (cv. Russet Burbank) was planted using a field-scale planter on May 28th. A row spacing of 96.5 cm, and in-row spacing between seed pieces of 38 cm was used. Pesticide applications to the plot area were conducted by MCDC using recommended products at recommended rates. The crop was irrigated as required using the field irrigation system.

Soil samples in increments of 0-15 cm, 15-30 cm, and 30-60 cm were collected on April 29th prior to plot establishment. Two methods of sampling were used: 1) 12 cores/rep were collected from the 0-15 cm depth using a hand-held probe; 2) 10 cores/experiment were collected from the 0-15, 15-30, and 30-60 cm depth using a mechanized soil probe.

Plant stand in the harvest rows of each plot was measured after emergence. Petiole samples were collected at approximately 10-day intervals throughout the growing season (July 8, July 19, July 29, August 12, August 23, September 2, and September 20) from rows 4 and 7 within each plot. Petiole samples were oven-dried and ground, and will be analyzed to determine total P concentration. Whole plant samples were also collected prior to harvest, and the total P concentration of the components will be determined. On September 20th, potato tops in harvest rows were removed using a flail mower. Potato plots were harvested on September 21 by harvesting approximately 12 m of row from each of rows 5 and 6. The harvested area was measured and tuber yields were determined.

On September 29th, soil samples were collected from each plot, air-dried and ground. Two methods of sampling were used: 1) 10 cores/plot were collected from the 0-15 cm depth using a hand-held probe; 2) 2 cores/plot were collected from the 0-15, 15-30, and 30-60 cm depth using a Giddings hydraulic probe. Soil P concentration was determined colorimetrically following extractions with 0.5 M $NaHCO_3$.

Following harvest, a subsample of potato tubers from each plot was graded. The graded sample for each plot was equivalent to approximately 25% of the harvested yield. The weight of tubers was determined based on five tuber weight classes (<3 oz, 3-6 oz, 6-10 oz, 10-12 oz, >12 oz). In addition, the weight of small tubers was determined based on three tuber size classes (<1 ¾"; 1 ¾" to 2" and <4 oz; 1 ¾" to 2" and >4 oz). The number and weight of green tubers, and tubers affected by rot and hollow heart/brown centre were determined. As well, specific gravity and fry colour was determined.

Preliminary analysis of the yield and quality data has been completed. Chemical analysis of petiole samples and whole plant samples was not complete at the time this reporting.

Results and Discussion

In 2004, total tuber yield averaged 306 cwt acre^{-1}. Gross yield was somewhat lower than in 2003 (380 cwt acre^{-1}). In part, a later seeding date and cool growing season conditions, including an August frost, may have contributed to lower yields in 2004.

Phosphorus application had little effect on tuber yield. Phosphorus fertilizer rate did not have a statistically significant effect on the yield of various tuber size fractions measured, nor on total tuber yield (Table 3). Interestingly, however, P rate tended (P=0.10) to influence the yield of tubers <3 oz as well as total tuber yield. Closer investigation of the data using contrasts revealed that application of 34 kg P_2O_5 ha^{-1} increased the yield of tubers <3 oz (P=0.03) and decreased total tuber yield (P=0.01) compared to the other P treatments. Although P rate appeared to have some influence on the yield of small (<3 oz) tubers, P rate had no significant effect on the yield of either maingrade or bonus tubers (Table 4). However, marketable yield (the sum of maingrade and bonus tuber yield) was significantly affected by P rate. The application of 34 kg P_2O_5 ha^{-1} resulted in a significantly (P=0.005) lower marketable yield than other treatments, based on contrast analysis. The reason for the apparent increase in small tuber yield and decrease in marketable tuber yield with the application of 34 P_2O_5 ha^{-1}

is unclear, and not characteristic of a P response. The observed response appeared to be relatively consistent across replicates. Overall, marketable and total yield data were quite consistent in this study (C.V. = 6.1 and 5.3%, respectively).

Table 3. Effect of P fertilizer rate on tuber yield for various size fractions, total tuber yield, and specific gravity in 2004.

Treatment		<3 oz	3-6 oz	6-10 oz	10-12 oz	>12 oz	Total	S.G.
		----------------------------cwt acre^{-1}----------------------------						
Means								
P Rate	0 kg P_2O_5 ha^{-1}	23.5	89.0	106.5	29.7	63.3	312.0	1.0845
	34 kg P_2O_5 ha^{-1}	33.0	93.5	93.9	31.1	32.0	283.5	1.0848
	67 kg P_2O_5 ha^{-1}	28.6	101.2	112.3	32.1	37.7	311.8	1.0855
	100 kg P_2O_5 ha^{-1}	26.1	85.5	112.5	37.3	54.9	316.3	1.0893
P-values								
Rep		**0.02**	0.16	0.47	0.97	0.41	0.19	0.53
P Rate		0.10	0.57	0.17	0.76	0.23	0.07	0.10
Contrasts								
Linear rate		0.78	0.94	0.21	0.34	0.71	0.29	**0.03**
Quadratic rate		**0.03**	0.24	0.32	0.73	0.06	0.07	0.22
Control vs fertilized		0.07	0.65	0.97	0.55	0.13	0.41	0.22
CV (%)		17.4	17.3	11.4	32.3	47.5	5.3	0.24

Table 4. Effect of P fertilizer rate on yield of small (<3 oz), maingrade (3 to 10 oz), bonus (>10 oz) and marketable (>3 oz) tubers in 2004.

Treatment		<3 oz	3 to 10 oz	>10 oz	>3 oz
		----------------------cwt acre^{-1}----------------------			
Means					
P Rate	0 kg P_2O_5 ha^{-1}	23.5	195.5	93.0	288.5
	34 kg P_2O_5 ha^{-1}	33.0	187.4	63.2	250.5
	67 kg P_2O_5 ha^{-1}	28.6	213.4	69.8	283.2
	100 kg P_2O_5 ha^{-1}	26.1	198.0	92.2	290.2
P-values					
Rep		**0.02**	0.68	0.50	0.58
P Rate		0.10	0.49	0.29	**0.03**
Contrasts					
Linear rate		0.78	0.53	0.94	0.34
Quadratic rate		**0.03**	0.76	0.07	**0.03**
Control vs fertilized		0.07	0.77	0.25	0.19
CV (%)		17.4	11.7	32.1	6.1

Soil samples collected from the plot area in spring 2004 contained an average of 27 kg $NaHCO_3$-extractable P ha^{-1} (Table 1). Based on detailed hand sampling (12 cores per replicate) in spring 2004, soil test levels ranged from 23 to 33 kg $NaHCO_3$-extractable P ha^{-1} across replicates. As such, this field would have received a recommendation for P fertilizer, and a yield response to P would have been expected in most cases. Based on the *Guide to Commercial Potato Production* (Western Potato Council, 2003), a soil test P level of 25 to 50 lb P $acre^{-1}$ to 6" is considered medium and would result in a fertilizer recommendation for 40 to 70 lbs P_2O_5 $acre^{-1}$ based on a banded fertilizer application. In previous studies in Manitoba, Geisel (1995) found yield responses with P application only where soil test P levels were less than 40 lbs $acre^{-1}$.

Specific gravity tended to be influenced by P application (P=0.10), with preliminary contrast analysis revealing a significant linear increase in specific gravity with increasing P fertilizer rate. In contrast, in 2003, specific gravity was significantly (P=0.02) lower in the highest P treatment than in the other treatments. Preliminary analysis for 2004 indicated no effect of P rate on defects, hollow heart and brown centre, or fry colour (data not presented).

Post-harvest soil sampling of the surface 0-15 cm demonstrated a significant linear increase in $NaHCO_3$-extractable P concentration with increasing rates of spring-applied P fertilizer (Table 5). This was evident for both sampling methods used, whether soil analyses were conducted on a composite of 10 hand-sampled cores per plot or on a composite of 2 cores per plot collected with a Giddings probe. The coefficient of variation was similar for both sampling methods. In contrast, in 2003, the hand-sampling method more effectively identified treatment differences than did the mechanized sampling method which involved the collection of fewer cores per plot.

Table 5. Effect of fertilizer P rate on extractable P content of soil following harvest.

Treatment		Hand sampled (10 cores/plot)	Giddings samples (2 cores/plot)
		$NaHCO_3$-extractable P content in soil (kg ha^{-1}, 0 to 15 cm)	
Means			
P Rate	0 kg P_2O_5 ha^{-1}	34.7	34.1
	34 kg P_2O_5 ha^{-1}	48.1	45.1
	67 kg P_2O_5 ha^{-1}	64.8	65.9
	100 kg P_2O_5 ha^{-1}	82.4	80.3
P-values			
Rep		0.21	0.34
Rate		0.0001	0.0003
Contrasts			
Linear rate		0.0001	0.0001
Quadratic rate		0.64	0.73
CV (%)		15.0	16.9

References

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Tomasiewicz, D.J. 1994. *Effects of phosphorus fertilization on potato production and petiole test levels.* P. 31-33 in Manitoba Crop Diversification Centre Annual Report 1994.

Western Potato Council. 2003. Guide to Commercial Potato Production on the Canadian Prairies.

Evaluation of Nitrogen Uptake in the Potato Plant

Principal Investigators: B. Zebarth, AAFC – Potato Research Centre (Fredericton)
B. Geisel, Gaia Consulting Ltd.

Support: Agriculture and Agri-Food Canada
Keystone Vegetable Producers Association
McCain Foods (Canada)
MCDC

Objective: To determine the effects of N rate at planting, timing of N application (pre-plant vs. split), and fertilizer placement (pre-plant broadcast vs. banded at planting), on tuber yield, size distribution, and specific gravity, and on plant dry matter and N accumulation and partitioning.

Methods

The trial was conducted on a non-saline Neuhorst clay loam soil at MCDC-Portage la Prairie. The surface (0- 6" depth) soil had a pH of 8.0, 7.1% organic matter, and the following soil test nutrient levels (all in lb/ac; Enviro-Test Laboratories): NO_3-N – 16, P – 16, K – 314, SO_4-S - >41, Cu – 1.9, Mn – 6.2, Zn – 2.3, B – 3.8, Fe – 27, and Cl – 21. The 6-12" depth soil contained 14 lb/ac NO_3-N.

Russet Burbank potatoes were planted June 9 at a 1-m row spacing and 15-inch in-row seed piece spacing. Plots were four rows by 12 m long, laid out in a randomized complete block design with four replicates. A blanket fertilizer application of 50 lb/ac P_2O_5 and 100 lb/ac K_2O was made to all plots. Assessments were conducted in the two centre rows.

Ammonium nitrate was used for all treatments (Table 1). For the pre-plant broadcast applications it was broadcast and then incorporated with an s-tine cultivator prior to planting. For the banded applications it was applied in a band 5 cm to the side of and 5 cm below the seed pieces at planting. For the split applications it was broadcast and then incorporated at hilling using a tillage implement with s-tine shanks and hilling discs.

Petioles were sampled on July 20, August 3 and 16, and September 1 and 16. Thirty petioles were collected from each of the 48 plots for analysis. Whole plant samples were collected from all plots just prior to top kill. Samples consisted of four adjacent plants in one of the assessment rows. Pruning shears were used to partition whole plant samples into tubers, vines, and roots plus stolons. Dry weight and mineral content of the whole-plant samples were determined after drying. For each plot at final harvest, gross yield was recorded and a 50-lb sample was submitted to McCain Foods-Portage for yield and grade analysis.

Analysis of variance was used to assess the results for petiole nitrate concentrations and yield. Means

Table 1. Nitrogen Treatments.

	Lbs N/ac Applied as Ammonium Nitrate			
Trt No.	N Broadcast Pre-Plant 06/08/05	N Banded at Planting 06/09/05	Split N 07/15/09	Total N Applied
1	0	0	0	0
2	50	0	0	50
3	100	0	0	100
4	150	0	0	150
5	200	0	0	200
6	250	0	0	250
7	100	0	50	150
8	50	0	100	150
9	0	0	150	150
10	0	100	0	100
11	0	150	0	150
12	0	200	0	200

separation used the least significant difference (LSD) test. Orthogonal contrasts were used to compare nitrogen application methods at the treatment rate.

Results and Discussion

All treatments receiving nitrogen (#2-12), with the exception of #2 after early August, had higher petiole nitrate concentrations than the check (Table 2, Figure 1). Petiole nitrate concentrations increased with increasing rates of N application. Sidebanding all N at planting (#10–12) produced higher petiole nitrate concentrations (p=<0.000 for the 09/01 sampling date) than broadcasting all nitrogen at plant (#3–5). Broadcasting all of the N 36 days after planting (#9) produced higher petiole nitrate concentrations (p=0.090 for the 09/01 sampling date) than broadcasting all N at planting (#4).

Table 2. Petiole Nitrate Analysis.

	NO3 ppm				
Trt. No.	20-Jul	3-Aug	16-Aug	1-Sep	16-Sep
1	12490	1128	424	645	379
2	21303	5885	1071	1495	824
3	23548	11022	3105	2934	1651
4	25383	15211	8582	5861	4178
5	24372	15645	10049	9276	7993
6	25466	17035	12061	12517	9524
7	24861	14616	8718	7793	4062
8	22776	13284	9556	7391	3720
9	19849	12959	11175	9411	4688
10	25957	13576	6171	5401	1804
11	24200	15216	10840	9215	6677
12	26639	16696	12118	13024	10013
Prob.	0.0000	0.0000	0.0000	0.0000	0.0000
CV %	7.53	6.46	15.05	25.57	19.45
LSD = 0.05	2500	1180	1694	2604	1294

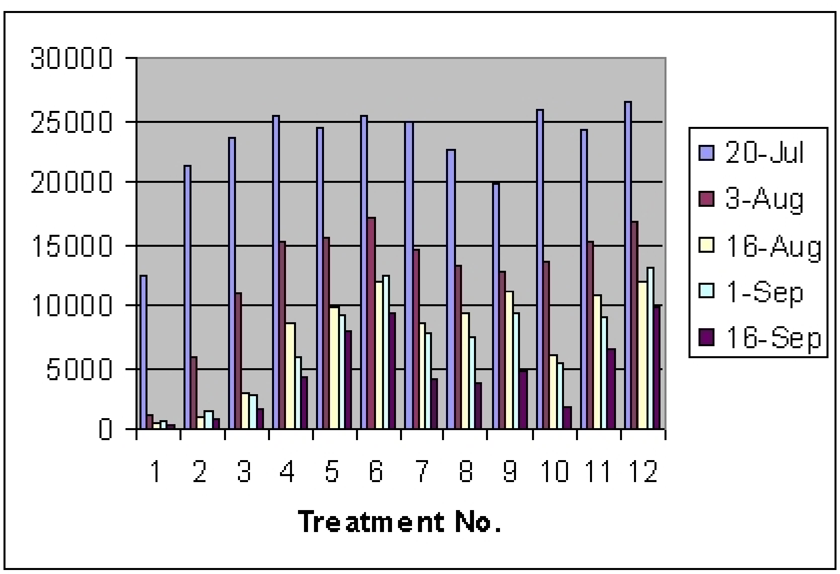

Figure 1. Petiole Nitrate Concentration.

Due to the late planting date and wet soil conditions, the plot yields were below average (Table 3). Under better growing conditions the results may be different. All N rates increased yield compared to check. Highest yields were achieved by applying 100 to 150 lbs N/acre. Due to the denitrification resulting from saturated soil conditions, the late application of nitrogen (treatment #9) produced the best yield. Application rates in excess of 150 lbs N/acre tended to produce lower yields than lower rates of application. For all application methods, increasing the rate of nitrogen decreased the specific gravity.

Table 3. Tuber Yield and Grade.

Trt. No.	Tubers No. per Plot	Average Tuber Wt. oz.		Total Yield cwt/ac		Marketable Yield Tubers >2" cwt/ac		Specific Gravity	
9	560.79	11.96		318.16	a	291.06	a	1.088	cd
3	602.58	11.39		313.76	ab	282.15	ab	1.090	bc
8	518.53	12.30		301.95	abc	269.44	abc	1.085	de
7	506.49	12.34		295.92	abc	267.49	bc	1.087	de
10	519.08	11.90		293.36	abc	266.39	bc	1.087	de
4	508.02	12.19		293.57	abc	265.88	bc	1.085	de
11	564.85	11.15		297.55	abc	264.25	bc	1.086	de
2	554.28	11.08		290.76	bc	260.54	bc	1.093	b
6	523.71	11.61		287.79	c	257.73	c	1.082	f
5	521.99	11.49		284.48	c	257.03	c	1.084	ef
12	562.80	11.03		294.83	abc	254.61	c	1.085	de
1	541.35	9.94		255.16	d	222.41	d	1.099	a
Prob.	0.2637	0.0062		0.0042		0.0006		0.0000	
CV %	9.414	6.756		5.908		6.137		0.2103	
LSD = 0.05	73.27	1.12		24.98		23.24		0.00	

Results of analysis of soil and whole plants were not available when this report was submitted.

Other Crops

Manitoba Oriental Vegetable Research Project

Principal Investigators: G. Loeppky and D. Bouchard, MCDC

Project Support: MCDC
T&T Seeds

Progress: Ongoing study

Objective: To introduce new varieties, evaluate pest control products, and commercialize oriental vegetables in Manitoba.

Introduction/Abstract

Manitoba already grows a diverse variety of vegetables commercially. Since the oriental vegetable project began in 1997, there has been a substantial increase in acres grown in Manitoba, devoted to oriental vegetables. Producers see when they visit their local supermarket produce section, that today consumers want a greater variety of fresh (locally grown) vegetables. While oriental vegetables may seem unusual and exotic to some consumers, there are more and more people either, because of cultural preferences or the wide availability of cookbooks or television shows devoted to using oriental vegetables, now looking for them in their local area.

Results from this and previous years field trials indicate that a wide range of oriental vegetables can be produced in Manitoba, and have strong market potential as locally grown produce. Even with the less than ideal growing conditions this year, certain Bok Choy, cabbage, zucchini, tomato, Yuchoy and pepper varieties had average yields.

Further testing of new crops and new varieties of existing crops, new options in pest control management and production techniques will help solidify oriental vegetable production, in the commercial producers future seeding plans.

The remainder of this report is summarized from a detailed 28-page 2004 report on the project, which is available through CMCDC

Site

Location:	MCDC-Portage la Prairie, Manitoba
Soil Texture:	Clay loam
Soil test level:	N - 65, P - 40, K - 647, and S - 142 (all in lbs /acre); pH - 8.3
Weather:	Refer to MCDC-Portage site meteorological data in the introductory section of this report. The first fall frost of the 2004 growing season occurred on October 1 (136 frost free days).

Alternative Pest Control Evaluation Trial

The objective was to evaluate alternative pest control and conventional products on selected Oriental crops and varieties for irrigated commercial production under Manitoba conditions.

Many conventional pesticides are not registered for use on Oriental vegetable crops in Canada. For this reason, this trial was conducted to determine the effectiveness of alternative or "organic" pest control products, especially for the control of insect pests

Plot size: 4 rows, 1.5m wide, 6m long, replicated 3 times, in-row spacing (15cm bok choy & yu choy) (20 cm Gai Lon seeded). Between row spacing 30cm, seeding depth approx. 1cm

Crops Evaluated and Dates planted:

1. Bok Choy Varieties Joi Choi (June 8) Gracious (June 30) White Toy(July 14)
2. Gai Lon Variety-Kailaan (June 8 & 30)
3 Yu Choy Variety-Jiangxi#2 (July 14)

Treatments:
1) End-All (a type of pyrethrum, the natural form of pyrethroid insecticides)
2) Garlic (liquid and powder; derived from commercial garlic produce)
3) Conventional product - Success 480SC - a naturalyte insect control product
4) Control - Untreated

All were applied at recommended rates when insect populations reach estimated economic thresholds, based on weekly pest inspections.

Due to poor germination in some crops, intense insect pressure at germination and then low insect pressure later in the season no significant data was collected from this year's trials. They will be continued in coming years to further test existing and new products as they become available.

Mulch - No Mulch Cabbage Trials

The objective was to compare maturity, insect damage, plot maintenance (labour), and yield of cabbage varieties grown on bare ground versus grown on black embossed plastic mulch.

Cabbage 98 and *Winner 85* varieties of cabbage were seeded in the greenhouse on March 18, and transplanted by hand to the field on May 28. Plot size was 3 rows (1.5 m) wide by 6 m long; within-row plant spacing was 45cm. The trial design was a Randomized Complete block with three replicates.

Both varieties of cabbage grown on bare (no mulch) plots produced higher yields than on mulch plots. The bare ground plots also had 100 &102 viable heads harvested from 108 transplants per variety. The mulch plots had 83 & 79 viable heads harvested from 108 transplants. Cabbage 98, which is a typical round headed green cabbage, was observed throughout growing season with sudden head cracks and splits. This observation was made only on Cabbage 98 growing on mulch. Considering the cost of plastic mulch, the insignificant difference in weed growth in mulch plots as compared to bare ground plots, the higher yields and no great differences in maturity, we would not recommend the use of plastic mulch in cabbage.

Variety Trials

<u>Bok Choy</u>

Varieties:	First seeding:		Second seeding:	
		(1) Choi Joi (check)		(1) Gracious (check)
		(2) Yellow Heart		(2) Green Farm
		(3) Yellow Heart		(3) White Toy
		(4)Shencai #1		(4) Shencai #1
		(5) Shencai #2		(5) Shencai #2
		(6) Shanghai		(6) Shanghai

The combination of many negative factors including unseasonably cool and wet conditions, poor germination and high flea beetle activity at plant emergence influenced the results of this year's trial. All varieties were harvested on Aug.19. White Toy, Shencai#1 and Sanghai were the 3 highest producers in the first seeding. Joi Choi was used as the check variety, but it, along with all the other varieties had very poor germination. The entire trial was reseeded with Gracious as the check variety and once again germination was very poor. Future field studies are recommended for Bok choy. Interest in this crop is good. Being one of the more recognizable of the oriental crops and the most widely used, future variety trials are important to producers. As we continue to refine our production techniques, our success in finding varieties suitable for Manitoba growing conditions will increase.

Diakon and Lo Bok

Varieties: (1) Omni (Stokes 278) - check
(2) Early Spring Diakon
(3) Red Fleshed Lo Bok

The Lo Bok variety Red Fleshed bolted early in the season and did not produce any marketable produce. Diazinon insecticide was applied (as a drench) to protect against root maggots as well as 3 applications of Success insecticide to control flea beetles (July 1, July 8, July 14). All varieties suffered minor flea beetle damage early after emergence, however most varieties recovered to produce marketable fruit. Omni and Early Spring performed quite well, with Omni yielding higher than all other varieties.

Based on 3 years of in field data, Red Fleshed should not be grown in the Portage area due to early bolting. Omni has preformed well in the past two years trials and has produced 12% higher yield than Early Spring. The tubers of both varieties are of good quality. This crop fits in well with existing carrot production and has good potential for expanded commercial production in Manitoba. At present there is limited commercial production being carried out in the province. Interest from both the wholesale and retail sectors, as well as market information gathered over past years, indicates there is a demand for this crop. Future field trials with new varieties are recommended.

Oriental Cucumber

Varieties: (1) Orient Express (check), (2) Sitia, (3) Jing Jan, (4) Shen Fenge #3, and (5) Zhongnong.

All of the varieties performed poorly in this year's trials. Yields of the check variety and 3 other varieties tested in previous year's trials were on average 50 to 60% lower than in previous trials. Sitai had the highest overall yield in what was a very cool summer (the coldest in 133 years). Zhongnong (first year in trials) had lower yields but had exceptionally good tasting and good shaped cucumbers. Based on the four years of field trials, and the positive comments received from individuals who have sampled the different varieties, it is recommended that the testing of cucumber varieties continue.

Baby Corn

Varieties: (1) Little Indian (check), (2) Baby Corn #1, and (3) Seenoog #1.

Because of extremely poor growing conditions (cool weather) all varieties were harvested only twice. All yields that were substantially lower than anticipated because of poor growing conditions. Little Indian and Seenong#1 were #1&2 in cobs harvested, with Seenong #1 having the highest average cob weight. All data entered in the variety performance summary is from unhusked ears of baby corn.

Two years data indicates that Seenong#1 and Little Indian have very similar yield. Both years Seenong#1 has had double the individual cob size to Little Indian. Both varieties produced good marketable cobs. Baby corn, although very labour intensive because of multiple harvests required, has potential in smaller scale commercial production. Pest and disease problems usually encountered with corn production are not an issue because of the earlier harvest dates. Further field studies with new varieties are recommended.

Oriental Watermelon

Varieties: (1) Early Harvest (check), (2) Chen Len, (3) Yellow Skin, (4) Jing Ling, (5) Zhengzhou Juquan, and (6) Hua La #9

All varieties had been progressing well, but due to very poor growing conditions in the second half of August and all of September and disease problems in September, we were unable to harvest any marketable watermelon in any of our check or new test varieties. Although no data was gathered this year, we believe future field tests are warranted, because of the interest shown by producers and consumers who have sampled previous years fruit.

Oriental Muskmelon

Varieties: (1) Yellow Gold (check), (2) Chang Nong, (3) Ging Feng, and (4) New Sweet Long.

Due to very poor growing conditions and a early season frost no marketable muskmelon were harvested. There is at this time in Manitoba some small-scale production of muskmelons. Muskmelon has good potential for expanded commercial production. Variety trial research and promotion of these new varieties are key factors in large scale production possibilities.

Taiwanese Cabbage

Varieties evaluated: (1) Winner 85 (check), (2) Jangxi #8, and (3) Jangxi #1

There were no disease problems detected on these varieties. All seemed well adapted to our growing conditions. All were harvested from July 24 to Sept 22. Flea beetles caused minor damage in mid-June and July; imported cabbage worm caused damage to the outer leaves in mid August. All varieties performed quite well, with Jiangxi#1 having the heaviest weight per head. All have typical oblong/oval (oblate) Taiwanese cabbage head shape.

The results from two years of field testing indicates that Jiangxi #1 has a 24% yield advantage over Jiangxi #8. Quality of the two varieties is very comparable. Taiwan cabbage has unlimited potential for commercial production in Manitoba. With the expertise Manitoba vegetable growers already have in green cabbage production, the addition of oblate headed (Taiwanese) cabbage varieties with their different tastes and uses will increase producer cropping options. Future field tests with new varieties will only increase these options.

Oriental Pepper

Varieties evaluated: (1) Shen Jiao, (2) Xan Jiao, and (3) Zidan.

There were no pest or disease problems in this year's test. Due to cool mid-season growing temperatures, Zidan and Xan Jiao were slow to set fruit. Yield for Shen Jiao, which we have used in previous years in our mulch trials, was also lower this year. There is quite a size variation in the three varieties. Shen Jiao closely resembles a bell pepper, but has a medium to hot flavour when fully mature. Zidan resembles a Jalapeno pepper, with a very hot flavour when fully mature. Xan Jiao resembles a Cayenne pepper, with a hot flavor when fully mature.

This crop has excellent potential for expanded commercial production. Consumer comments have been very positive when variety specifics are explained. Future field studies with these and other new varieties are recommended.

Demonstration plots

A number of new crop varieties were planted this year to evaluate their potential as alternatives to known lettuce, radish, zucchini and tomato varieties. The goal of seeding new varieties is to find a better variety for our unique growing conditions.

Tomato

Varieties: (1) Delifu, and (2) Langren.

Although this growing season was less than ideal for tomatoes, these varieties did produce fruit. Future field studies are recommended with tomato varieties to be included in our vegetable variety trials for next year.

Oriental Radish

Variety: Hong Ding

On July 29 we harvested 33 lbs of radish. They ranged in size from 3 to 6 cm in length and 3 to 4.5 cm in diameter, with an average weight of .06 lbs. Taste and appearance was similar to traditionally seeded varieties. No further field research is recommended at this time.

Oriental Lettuce

Variety: Yida

No data was gathered for this demonstration. Based on observations of this demonstration during the growing season, it is recommended that if seed can be acquired from Chinese sources, lettuce be again included in future variety trials.

Long Bean

Variety: King

Long bean trials should be re-introduced to the variety trials, as there is excellent potential for them as a locally grown crop. Market gardeners should find long beans an excellent addition to their produce mix.

Zucchini

Varieties: (1) Boda, and (2) Jade Green

This crop has excellent potential as a locally grown crop, and should also be re-introduced into the variety trials.

Shelterbelt Centre Nursery Stock Field Performance Trial

Principal Investigator: W. Webster, AAFC-PFRA Shelterbelt Centre, Indian Head, SK

Co-Investigator: B. English, AAFC-PFRA-Brandon

Objective: To assess the performance of nursery stock produced and distributed by the Shelterbelt Centre located in Indian Head, SK.

In previous years this trial was limited to one site located at the Shelterbelt Centre at Indian Head, SK. In the spring of 2004, an additional monitoring site was set up at MCDC-Carberry to verify findings at Indian Head. When available, seedling stock from sources other than the PFRA Shelterbelt Centre are compared to stock produced by the Centre.

In the Spring of 2004, 50 seedlings each of stock type tested were randomly chosen and outplanted into trifluralin-treated soil at the Shelterbelt Centre and at CMCDC. The study was arranged in a Randomized Complete Block Design with ten replications of five-plant plots for each treatment. The treatments were stock types (20) and various harvesting season (fall or spring lift), storage conditions (heeled-in outdoor or controlled indoor), and other species-specific handling effects (Table 1). The planting was kept weed free, and was not irrigated.

Results

Emergence from bud dormancy was monitored throughout the growing season. In late fall, a final assessment was used to determine survival rates for all species, a rating of overall vigour was made for deciduous species and new growth measurements were taken on the conifers (Table 1).

Mean survival rates of the 31 deciduous and 5 coniferous stock types are illustrated (Table 1). Mean survival overall was 87%, ranging from 40% for both 'Indian Summer' sea buckthorn (-4˚C indoors, not bagged, not stripped) and 'Lindquist' Siberian larch (source: Shand Greenhouse, Estevan, SK) to 100% for 'Arnold' hawthorn (-4˚C indoors), chokecherry (-4˚C indoors), chokecherry (1-0 Research trial), hedge rose (-4˚C indoors), 'Plains' green ash (-4˚C indoors), 'Ross' caragana (heeled-in), villosa lilac (-4˚C indoors, early lift) and villosa lilac (heeled-in, fall-lifted). Of the species that were both freezer-stored and heeled-in, only green ash and caragana showed differences between over-wintering methods. 'Ross' caragana had much higher survival when heeled-in compared to freezer-stored (100% vs. 56%), whereas 'Plains' green ash survival appeared to be negatively affected by heeling-in the stock (85% vs. 100%). Other data show a marked decrease in survival (40% vs. 94%) for 'Indian Summer' sea buckthorn when senescent leaves are not removed and bins are not lined with polyethylene bags prior to storage.

Survival rates are used in conjunction with bud break and vigour ratings to reflect seedling quality and to predict seedling performance of distributed stock. Delay in bud break and poorer vigour may corroborate lower survival rates or, when survival rates are similar, may indicate qualitative differences. For example, heeled-in green ash rated 85% survival (vs. 100%) and exhibited both a bud break delay (7 days) and a slight decline in rated vigour. Whereas heeled-in chokecherry showed no decline in survival but was delayed in emerging from dormancy and was rated as somewhat less vigorous. Manitoba maple and Ussurian pear were on average relatively late to break bud, but vigorous by year end. Overall, seedling vigour ratings corresponded closely to survival ratings.

Growth of conifers at season's end was satisfactory, however a delay in the onset of active growth was noted for Scots pine that was fall-lifted and stored indoors at -2˚C. Earlier emergence from dormancy could improve annual growth rates for this stock.

Table 1. 2004 Plant Quality - Carberry, Manitoba

Deciduous Species	Storage Method	Days to Max Bud Break	Overall Seedling Vigor (0-5)	% Survival
Arnold Hawthorn	-4°C indoors	14	5	100%
Buffaloberry	-4°C indoors	14	4	89%
Buffaloberry	-4°C indoors, not bagged, not stripped	16	3.4	78%
Burr Oak	Shand Greenhouse	16	3.2	62%
Choke cherry	-4°C indoors	14	5	100%
Choke cherry	Heeled in	23	4.9	98%
Choke cherry	Heeled in, fall lifted	20	4.7	96%
Choke cherry	1-0 Research trial	17	4.9	100%
Dogwood	-4°C indoors	14	4.8	92%
Hedge rose	-4°C indoors	19	4.9	100%
Indian Summer Sea buckthorn	-4°C indoors	17	4.4	94%
Indian Summer Sea buckthorn	-4°C indoors, not bagged, not stripped	14	2.4	40%
Lindquist Siberian Larch	Shand Greenhouse	14	5.5	40%
Manitoba Maple	-4°C indoors	20	4.8	98%
Mongolian cherry	-4°C indoors	16	5	98%
Pincherry	-4°C indoors	14	4.8	96%
Plains Green Ash	-4°C indoors	17	5	100%
Plains Green Ash	Heeled in	21	4.2	85%
Plains Green Ash	Heeled in, fall lifted	17	4.6	88%
Plains Green Ash	1-0 Research trial	14	5	98%
Red Elder	-4°C indoors	14	2.6	46%
Ross Caragana	-4°C indoors	17	3.1	56%
Ross Caragana	Heeled in	14	5	100%
Ross Caragana	Heeled in, fall lifted	16	4.7	92%
Trembling Aspen	-4°C indoors	16	4.7	88%
Ussurian pear	-4°C indoors	22	4.3	84%
Villosa lilac	-4°C indoors	14	4.9	96%
Villosa lilac	-4°C indoors, early lift, F-11	14	4.9	100%
Villosa lilac	Heeled in	14	5	96%
Villosa lilac	Heeled in, fall lifted	14	4.9	100%
Villosa lilac	-4°C indoors, late lift, L-3	14	4.7	98%

Coniferous Species	Storage Method	Days to Max Bud Break	New Growth (cm)	% Survival
Colorado spruce	-2°C indoors	42	4.12	94%
Colorado spruce (SL)	Spring lifted	36	4.79	98%
Prairie Green Scots pine	-2°C indoors	60	11.48	82%
Prairie Green Scots pine	Spring lifted	46	10.22	88%
White spruce	-2°C indoors	36	4.21	94%

Plant quality data relating to storage and handling treatments of certain species will impact on decisions made during harvest operations in future years. Stock sources showing poor ratings will be further investigated to determine causes.

All species tested in 2004 had excellent over-wintering success through the 2005 growing season and data obtained from Carberry compared favourably to those obtained at Indian Head. Overall, the quality of plant material, as determined by these methods, for stock distributed in 2004 was excellent.

Southwest HRSW Yield and Quality Variety Trial

Principal Investigator: Lionel Kaskiw, Manitoba Agriculture, Food and Rural Development

Progress: Second year of project

Objective: To compare yield and quality of four hard red spring wheat varieties grown under field scale conditions.

The trial was conducted on nine farms in southwest Manitoba region in 2004, at the following locations:

- Hamiota (2)
- Killarney (2)
- Carberry (2, including MCDC-Carberry)
- Souris (2)
- Dand

Varieties were selected by using *Yield Manitoba* risk areas 1-7 (MCIC) and through discussions with producers. Each producer planted five acres of each variety. Producers were responsible for seeding, spraying, and harvest. Yield data was collect through yield monitors or weigh wagons. Samples were collected and graded at local elevators for protein, test weight, and Fusarium. Mean grain yield and protein for all sites for 2003 and 2004 are presented, as well as for the MCDC 2004 site (Table 1).

Table 1. Yield and protein.

	AC Superb	AC Domain	AC Barrie	CDC Bounty
Yield (bu/ac)				
Mean - 2003	61	54	55	53
Mean - 2004	55	54	54	51
MCDC - 2004	74	62	57	55
Mean - 2003 & 2004	58	54	54	52
Protein (%)				
Mean - 2003	13.4	13.8	13.3	13.5
Mean - 2004	13.6	14.4	13.8	14.2
MCDC - 2004	12.6	14.2	14.0	14.0
Mean - 2003 & 2004	13.5	14.1	13.6	13.8

The yield of CDC Bounty was 95% of the yield of AC Barrie (the *check* variety used by Seed Manitoba) in 2004, and 96% for 2003 & 2004 combined. The corresponding relative yields of AC Superb were 102 and 106%, and for AC Domain were 101 and 99%.

The protein concentration of CDC Bounty was 103% of that of AC Barrie in 2004, and 96% for 2003 & 2004 combined. The corresponding relative protein concentrations for AC Superb were 99 and 100%, and for AC Domain were 104 and 104%. For AC Barrie the test weight (lb/bu) and Fusarium level (%) were 58.5 and 0.4, respectively. The corresponding values for CDC Bounty were 57.0 and 0.7, for AC Superb were 57.0 and 1.0, and for AC Domain were 58.5 and 0.3. AC Domain graded #2 Red, compared to #3 Red for the other three varieties.

Energy Crop - Sugar Beet Trial

Principal Investigator: T.S.C. Li, AAFC-Summerland, BC

Progress: First year of study

Objectives: To select a new crop suitable and more efficient for ethanol production to replace currently used crop material, conduct variety trials in at least two regions in Canada to select varieties with high sugar content and yield, develop a sustainable production system for this chosen crop, and determine ethanol production rates of selected varieties.

In 1993, FAO reported that by the turn of the century approximately one thousand million hectares of arable land will not be needed for food production. If half of this land was used to grow plants with high sugar or starch content, and the crop was used to produce ethanol, 30-40% of crude oil consumption could be substituted and the carbon-dioxide emission would decrease by one-third. Leaders in utilizing ethanol as a fuel are Brazil, United States, and European countries. Advantages of ethanol as a fuel are high in octane number, there is no need for lead in the fuel, and it doesn't contain sulfur. With the growing environmental concerns in Canada, ethanol and other alternative fuels are receiving increased consideration and biomass ethanol derived from agricultural residues has gathered great interest.

The potential of producing energy from biomass is considerable and that the possible contribution of biomass in energy production may be between 10 and 15%. This will offer an essential alternative for agriculture, environment and industry. More efforts should be implemented in order to increase the efficiency of biofuel production.

There are various possibilities which agriculture offers as a contribution to resolving the energy crisis by producing material as a source of biofuel. With respect to the need to find new ways of using surplus agricultural crops outside the food industry, utilization of sugar beet for liquid fuel production is a valuable alternative. In a study of the cost of potential ethanol from fodder beet, sweet sorghum, sugar beet, and corn in relation to the requirements of these crops for fertilizer nitrogen and irrigation sorghum and sugar beet required 36%, and fodder beet 68%, of the fertilizer N needed for corn. When fertilized and irrigated adequately, fodder beet produced 13.4; sugar beet 11.9, sweet sorghum 10.0 and corn 8.15 Mg hexose per hectare. Ethanol yield varies with the source of different plants - 36.3, 35.0, 22.0, and 7.7 hl/ha produced from sugar can, sugar beet, corn and wheat, respectively.

Overproduction of sugar causes a dramatic reduction in the acreage under sugar beet. New non-food technologies for exploitation of agricultural products are sought. Utilization of sugar beet for biofuel production could be a valuable alternative approach, and it is a choice plant for ethanol production in France. There are protein-rich byproducts, such as centrifuged solids, and stillage solubles, from sugar beet stillage after alcohol distillation, which contained crude protein of 47 and 24%, respectively.

Sugar beet quality factors essential for sucrose crystallization (e.g. high sucrose concentration and low amino N, Na and K concentration) are not important in the fermentation process. Increases in total sugar production might be more easily and rapidly achieved if selection were for fermentable sugars rather than for sucrose crystallization. Higher fermentable sugar yields must be sufficient to offset the cost of handling the additional root yields to be economically practical. High ethanol production is correlated with high sugar content; root weight and yield and ethanol capacity varies with variety.

Thirty five varieties of sugar beet were collected in the spring of 2004. Variety trials were planted in Manitoba (MCDC-Portage la Prairie), Saskatchewan, and British Columbia in May-June, and harvested in Sept-Oct. Yield, individual root size, sugar and ethanol contents will be determined in the winter. The top 5 varieties will be selected and trials will be repeated in 2005.

Demonstration of Herbs, Nutraceuticals, Oriental Vegetables, and Fruit Crops

Small-scale demonstrations of the following were conducted at MCDC-Carberry in 2004.

Herbs, Spices, and Nutraceuticals

Angelica	Lavender	St. John's Wort
Chamomile	Lovage	Stinging Nettle
Chives	Monarda	Summer Savory
Comfrey	Oregano	Sweet Basil
Echinacea	Parsley	Tarragon
Elecampane	Pyrethrum	Triple Curled Parsley
English Thyme	Red Clover	Valerian
Garden Sorrel	Rosemary	Wild Chicory
Grain Amaranth	Roses	Wormwood
Horehound	Rue	Yarrow
Hyssop	Spearmint	

Fruits and Vegetables

Apple	Cranberry
Apricot	Pear
Asparagus	Plum
Black Currant	Raspberry
Cherry	Red Currant
Chokecherry	Rhubarb
Crab Apple	Saskatoon

Oriental Vegetables

Bok Choy (varieties Gracious, Joi Choi, Shanghai, Shencai #1, Shencai #2, Yellow Choi)
Broccoli (Gailan Kailoon)
Cabbage (98, Jiangxi #2)
Carrots (Dajinag)
Chives (Huaxai 98)
Corn (Yanong #6, Seenong #1, Baby)
Cucumbers (Jing Yan, Orient Express, Shongnong, Sita)
Daikon (Early Spring, Omni, Red Fleshed,)
Lettuce (Yida)
Long Bean (King)
Muskmelon (Changnong, Ging Feng, New Sweet Long, Yellow Golden)
Onion (Dachong #1)
Peppers (Shen Jiao, Xanjiad, Zidan)
Radish (Hong Ding)
Snow Peas (Ho Lan Dow, Red Flower)
Tomatoes (Delifu, Lang Ren)
Watermelon (Early Harvest, Zhengzhou Juguan, Jing Ling, Hua Lu, Chen Len, Yellow Skin)
Zucchini (Jade Green, Boda)

Cereal Research Centre Wheat and Oat Breeding Trials at MCDC - Portage la Prairie

Principal Investigators:	Doug Brown	Canada Prairie Spring wheat
	Gavin Humphreys	Canada Western Hard White wheat
	Stephen Fox	Canada Western Red Spring wheat
	Jennifer Mitchell-Fetch	Oats
	Benoit Bizimungu	Oats

The breeding programs of the AAFC Cereal Research Centre have been evaluating material at the Portage MCDC site since the mid 1960's. Portage personnel first ran a Co-operative Oat Test as part of the variety registration process in 1938. This spirit of cooperation continued in 2004. In 2004, various classes of wheat (CPS, CWHW, CWRS) and oats were evaluated in early generation disease nurseries and in advanced generation yield trials.

In a seven acre screening nursery, approximately 50,000+ plots of early generation wheat and oat lines were evaluated for agronomic performance and resistance to various diseases of economic importance. Plot size varied from a short 0.6m row to a 5.0 square meter plot. Disease infection relied upon naturally occurring inoculum plus application of inoculum developed from locally occurring races/strains of leaf rust, stem rust, bunt and Fusarium Head Blight. Use of the mist irrigation system in this screening nursery ensured that the environment required for good infection, in the absence of genetic resistance, was provided. Seeds from selected heads, rows or plots were harvested for further evaluation and subsequent planting in New Zealand winter nurseries as part of the CRC cereal germplasm development program.

Approximately 8 acres were planted to 2,500+ advanced generation yield plots and 6 breeder seed isolation increases. Lines in the yield plots were evaluated for yield, straw strength and height, maturity and resistance to naturally occurring diseases. Harvested seed was used to measure seed quality (test weight, kernel weight and flour quality) as well as providing the seed source for future year's yield trials. Each breeder seed isolation, derived from 200+ heads collected in a previous year, was part of the pedigree seed production process required to put pure seed into the hands of seed growers and farmers. These 8 acres were part of the CRC cereal cultivar development program.

Dry Bean Breeding Program

Principal Investigators: Parthiba Balasubramanian, Dry Bean Breeder
Ferdinand Kiehn, Dry Bean Breeder
Robert Conner, Pulse Pathologist

<u>Trials at MCDC-Portage la Prairie</u>

Four Dry Bean Regional Trials and two Cooperative Registration Recommending Trials were grown in MCDC - Portage la Prairie. In total, 53 dry bean cultivars of 11 market classes (navy, pinto, black, small red, pink, great northern, bayo, flor de mayo, cranberry, and light red, dark red and white kidney bean) were grown in four wide row (24 inch) plots in the Regional Trial. The experimental design was a randomised complete block with three replications. Agronomic traits were determined - days to flowering, plant height, plant growth habit, days to maturity, lodging and pod clearance. Dry bean plots were also evaluated for field resistance to common bacterial blight, anthracnose, white mould and rust. In the Dry Bean Cooperative Registration Trials, 24 dry bean genotypes including check cultivars were grown in four wide row plots and 34 bean genotypes including the check cultivars were grown in five narrow row (8 inch) plots. The experimental design was a randomised complete block with three replications. Agronomic and disease resistance traits noted above were evaluated in each plot.

Trials at MCDC-Winkler

The four Dry Bean Regional Trials and two Cooperative Registration Trials conducted at MCDC-Portage la Prairie (see above) were also conducted at MCDC-Winkler. The advanced generation dry bean yield trials were also conducted in Winkler. Sixty-nine dry bean genotypes including check cultivars were evaluated in the Preliminary Yield Trials in two wide row plots for agronomic and disease resistance traits. Thirty-six dry bean genotypes including check cultivars were evaluated in the Pre-Cooperative Registration Trials in two wide row plots, and 14 genotypes including check cultivars were evaluated in the Pre-Cooperative Registration Trials in 5 narrow row plots for agronomic and disease resistance traits. In all trials, the experimental design was a randomised complete block with three replications.

The yield trials were successfully completed at both MCDC - Portage la Prairie and Winkler. Data from the trials will be used to advance elite lines in the dry bean breeding program and to request support for registration of lines as cultivars for commercial production.

Pulse Crop Pathology Projects

Principal Investigators: R.L. Conner, D.W. McAndrew, P. Balasubramanian, and F.A. Kiehn (Morden Research Station).

Anthracnose Seed Infection Trial

Seed lots containing either healthy seed or 10% anthracnose-infected seed of six different cultivars was tested in wide and narrow plots at MCDC-Portage la Prairie. The study was arranged in a split-plot design that used row spacing as the main treatments and cultivar/seed infection rate as the subplot treatments. The treatments were replicated four times and there was a total of 96 plots in this study. Emergence counts and the number of seedlings showing anthracnose symptoms was determined early in the growing season. Throughout the growing season, anthracnose severity was visually assessed as the percentage of plant tissue covered by anthracnose lesions on the bottom, mid, and top one-third of the plant canopy, and pods of 10 plants. White mould severity also was evaluated at the end of the season. Each plot was harvested for a yield measurement and the extent of seed discolouration was determined.

Effect of Seed Infection on the Rate of Anthracnose Transmission to Bean Seedlings

We examined the effect of six rates of seed infection (i.e., 0-20%) in two dry bean cultivars on anthracnose development, yield and seed quality, at MCDC-Portage la Prairie. The experiment consisted of 12 treatments that were arranged in a randomized complete block design with four replications for a total of 72 plots. Emergence, disease development and yield were determined as outlined above.

Improving Phosphorus Nutrition in Wheat

Investigators: C. Grant, M. Monreal, and D. McLaren, AAFC-Brandon Research Centre
G. Clayton and K. Turkington, AAFC-Lacombe Research Centre
N. Lupwayi, AAFC-Beaverlodge

Field trials were conducted at two locations in Manitoba (including MCDC-Carberry) and one location in Alberta in 2004 to evaluate the effect of placement and source of phosphate fertilizer, with and without mycorrhizal inoculation, on wheat yield and mycorrhizal colonization. Zinc applications were also evaluated. Controlled release monoammonium phosphate (CRP) increased stand density and early-season biomass production as compared to uncoated monoammonium phosphate (MAP) or ammonium polyphosphate (APP). There were generally no differences between APP and MAP or with placement of MAP or APP in effects on stand or wheat yield. Analysis of the mycorrhizal colonization from 2003 showed that the inoculant increased colonization, but location had the greatest impact on colonization. The investigators can be contacted for detailed project reports.

Multi-Use Shelterbelt Demonstration

The use of fruit-bearing shrubs can make a shelterbelt attractive to wildlife as well as helping to control wind erosion and trapping snow. The following tree species were established in 1995 at MCDC-Carberry to demonstrate this kind of multiple-use forest belt:

Basswood	Colorado Spruce
Black Walnut	Dogwood
Black Ash	Manitoba Maple
Buffaloberry	Rose
Butternut	Scots Pine
Caragana	Siberian Crab
Chokecherry	White Spruce

The use of shelterbelts as an alternate source of home heating fuel was considered when establishing a large poplar planting demonstration in 1995 at MCDC-Carberry. It includes the following varieties:

Walker Poplar
Prairie Sky Poplar
Raverdeau Poplar
Imperial Poplar
Robusta Poplar