



**Canada/New Brunswick
Research and Innovation Program (RIP)**

2004/2005 Project Highlights

Introduction

The Canada/New Brunswick Research and Innovation Program (RIP) was developed to encourage the growth, prosperity and profitability of New Brunswick's agriculture, agri-food and agri-product sectors by supporting innovative pre-commercial strategic research.

This 2004/2005 Project Highlights report was compiled to provide a general overview of various strategic research projects funded through RIP. Examples of research projects supported included germplasm evaluation, molecular approaches to understanding potato diseases and insects, organic insect and disease control, post harvest quality, fertility, and reduced input technologies. These projects were all conducted in collaboration with industry partners who identified strategic research needs within their sectors.

The results of these projects provide valuable information to producers, producer groups and all those interested in New Brunswick agriculture. The New Brunswick Department of Agriculture, Fisheries and Aquaculture (NBDAFA) and Agriculture and Agri-Food Canada (AAFC) continue to be dedicated to building upon new and existing innovative opportunities to develop a prosperous New Brunswick.

Further Information

Anyone requiring further details on any of the articles presented in this report is encouraged to use the contact information associated with each project or contact NBDAFA at <http://www.gnb.ca/afa-apa>.

New Naturally Occurring Sprout Suppressants: Their Effects on Processing and Tablestock Potato Quality and Storage Diseases in New Brunswick

Partner: Potatoes New Brunswick

Essential oils and their components may be alternatives to the synthetic sprout inhibitor, CIPC, which prevents sprout growth in stored potatoes. For example, carvone, an essential oil component of caraway seed, is commercially available in Europe as a sprout inhibitor.

Agriculture and Agri-Food Canada researchers and NB provincial specialists tested peppermint oil, menthol (a component of peppermint oil), and carvone on non-dormant tubers. They found that sprout growth could be suppressed with peppermint oil or menthol. Carvone was not as effective as the mint oil. Coating the tubers with dry microencapsulated menthol or peppermint oil mixed with a food-grade carrier such as cellulose, starch or modified starch lead to consistent long-term sprout suppression. When used as an applied vapour, menthol or carvone were not effective in controlling sprout growth. However, applying the menthol/starch powder to individual tuber eyes resulted in complete inhibition of sprouting of the treated eye. There was no effect on non-treated adjacent eyes, which grew normally. Menthol may act topically and not be transported within the tuber. Laboratory tests with menthol, carvone or peppermint oil indicated each compound was also effective in controlling the growth of a wide range of potato pathogens. In addition, taste tests indicated that these compounds could be used for sprout suppression without significant effects on food quality.

Encapsulated menthol with a food-grade carrier was less toxic, cheaper and more effective than commercial applications of carvone.

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Development of a PCR Method to Identify Common and Powdery Scab from Potato Lesions

Partner: Potatoes New Brunswick

Powdery scab and common scab reduce potato quality by forming lesions on the tuber surface. The two soil-borne pathogens responsible for the diseases are the fungus *Spongospora subterranea* f. sp. *subterranea* causing powdery scab while the bacterium *Streptomyces scabiei* causes common scab. *S. subterranea* is the vector of Potato Mop-Top Virus (PMTV), a virus which causes tuber tissue necrosis. The virus can be introduced into new geographic areas by planting virus-infected tubers with powdery scab lesions. The pathogen causing common scab is not a vector of PMTV. Symptoms of powdery scab, in some disease stages, are very difficult to distinguish from common scab. This project was initiated to develop a Polymerase Chain Reaction (PCR) method to identify powdery and common scab pathogens from potato lesions. The DNA extraction and purification methods were optimized and the PCR method can identify both pathogens in one reaction. The PCR method will provide an accurate assessment of tuber contamination by the pathogens thus providing information on the epidemiology of the disease. This will help in disease management such as early harvesting, health levels of seed potatoes and fungicide treatments.

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Carrot Variety and Tillage Trials 2004

Partner: NB Soil and Crop Improvement Association

Approximately 105 hectares of processing carrots were grown in Southeastern NB in 2004. Growing carrots in this region is a relatively new endeavor. As such, there are a number of questions that need to be addressed in terms of specific growing conditions and management techniques. Field scale trials of different tillage techniques and variety evaluations were conducted. The objective of this project was to evaluate and demonstrate various processing

carrot varieties and tillage techniques under Southeast NB conditions.

Varieties such as Tempo out-yielded Oranza and Carro-choice in terms of yield and premium grade in fancy. Magnum and Neptune had nearly 50% less yield compared to the first group of varieties mentioned. Producers observed at harvest that Tempo had more stock breakage which may result in Carro-choice as a true alternative variety.

Tillage treatments also resulted in improvements in yield either directly in t/ha and/or increased root length. Growers achieved yields of approximately 84 t/ha when using the chisel plow, equipped with 10 cm wide twisted shovel points. This treatment involved making two passes, the second off-set 30 degrees to the first and at a depth of 5cm below traditional plowing depth. Chisel plowing with 40 cm sweep teeth and conventional plow treatments resulted in yields in the 52-60 t/ha range.

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2004 Organic Agriculture Research

Partner: Organic Agriculture Centre of Canada (OACC)

1) Organic potato producers have access to a limited number of options to control Colorado potato beetles in their crop. Entrust (Spinosad), a newly registered insecticide approved for organic agriculture, was evaluated as a potential replacement insecticide for Novodor (*Bacillus thuringiensis*) which is currently prohibited by most certifiers. It is also important in organic production to understand the potential interactions between nitrogen fertility, plant development and insect population dynamics with their potential consequences for the use of insect control products. The effects of three levels of organic fertilization on potato yield were evaluated. Results indicated that Entrust was similar or better than Novodor at controlling low density populations of Colorado potato beetle. It was possible to produce three levels of potato crop/plant health by manipulating fertilization levels.

2) The high cost of purchased organic protein supplements negates improving options for on-farm production of livestock protein supplements. In Atlantic Canada there are currently no recommended pea varieties, having been replaced largely by soybeans, which

remain difficult to produce organically. As such, the performance of pea/cereal mixtures with respect to protein and feed quality as affected by rate and pea variety under organic management was evaluated. Select pea varieties were grown in trials in monocrop or in two- or three-way intercrop mixtures. Results indicated that a significant increase in overall yield and percent protein can be achieved by using peas alone or in mixtures as compared to barley and oat monocrops. An optimal pea/cereal ratio may be suggested which results in approximately 20% or less of the final crop stand as peas.

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Identification of DNA Markers Associated with Potato Resistance to Common Scab

Partner: Potatoes New Brunswick

Common scab is a frequent tuber disease that occurs throughout the potato growing regions of New Brunswick. Although common scab does not usually affect total yields, significant economic losses result from reduced marketability of the tubers for both the table stock and processing industries. There are no adequate control methods for common scab. Improvement of resistance of commercial potato cultivars to common scab is a valid option to reduce damages caused by the disease. This project's objective was to identify DNA markers named SSR (simple sequence repeat) that are associated with resistance to common scab in potato. Several genomic DNA extraction methods were evaluated and the most efficient method was chosen to extract DNA from parental potato lines and their progeny (approximately 120 potato lines). The first step to identify DNA markers associated to common scab is to screen selected SSR primers on the parental lines using PCR. To date, 114 SSR primers belonging to 12 potato chromosome groups were screened on the parental lines and 31 primers amplifying DNA fragments showed a polymorphic pattern. In the next step, primers generating polymorphic patterns will need to be screened on a population of potato lines segregating for resistance and susceptibility to common scab to identify DNA markers associated with common scab resistance. SSR markers can be used to improve resistance of potato by accelerating the development and

release of new potato varieties using marker-assisted selection. The SSR markers can also be used as a tool to test existing potato varieties for resistance to common scab.

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Cereal Crop and Bio-fuel Development Trials

Partner: NB Soil and Crop Improvement Association

Several cereal grain trials were conducted in 2004 to evaluate the field performance and quality of feed barley, malt barley, spring wheat, winter wheat, feed oat and milling oat. A new bio-diesel trial was conducted involving 5 species of *Brassica* investigating their growth under NB's climate and evaluating seed yield, oil content and quality for potential bio-diesel production. In addition, 6 cultivars of herbicide-tolerant soybeans and 10 cultivars selected for a Maritime soybean test were evaluated.

All barley, oat and wheat trial performance data were collected, compiled, analyzed and used to publish the "2005 Cereal Guide to Cultivar & Herbicide Selection". This included a total of 95 oat, 117 barley, 62 spring wheat and 44 winter wheat cultivars involved in screening, registration and recommendation trials. A special emphasis was placed on cultivar susceptibility to *Fusarium* Head Blight and DON (deoxynivalenol) level.

Results of the bio-diesel trial determined that although this climate has been considered inadequate for maturity, there is a high potential to produce all *Brassica* species in NB and further investigations should continue. All tested soybean cultivars received sufficient heat units to mature and produced reasonable yields with a high quality.

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Biological Control of Hairy Chinch Bug

Partner: NB Hort Trades Association (NBHTA)

Hairy chinch bugs, *Blissus leucopterus hirtus Montandon*, are destroying lawns in New Brunswick and elsewhere. The literature and our preliminary research have identified certain

"entomopathogenic" fungi (*Beauveria* and *Metarhizium spp.*) in some soils that can kill chinch bugs. Other fungi, known as endophytic fungi (*Neotyphodium* and *Acremonium spp.*), form a beneficial association with healthy grass plants and make compounds that repel or inhibit chinch bugs. Grass seeds containing the latter fungi are being marketed as "Endophyte-Enhanced" seed.

A series of trials and tests were conducted to determine if certain fungi have the potential to be used as effective biological controls for chinch bug infestations in lawns.

Soils from New Brunswick lawns, with and without chinch bug problems, were collected and assessed for entomopathogenic fungi. They were not detected in many soils tested, including the manufactured topsoils. However, the fungi were present in soil from a site where chinch bugs have never been found. Methods for growing the fungi and collecting their spores were developed and the spores were added to various soils. This increased the amount of entomopathogen in the soils for several months. In lab experiments, some isolates of the fungi killed all the insects that were added to the soil in just over one week. Work is underway to identify better strains and methods for formulating the fungi to increase their efficacy.

Grass seeds that contained endophytes were obtained from various sources, including commercial suppliers. The amount of endophyte in plants from these seeds was measured. It was found that the endophyte was only present in a small percentage (<10%) of many allegedly positive seeds. Hairy chinch bugs were observed to feed on some plants in which endophyte were present. Further work is underway to identify endophyte-grass associations that are more stable and better able to inhibit hairy chinch bug activity.

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Compost and Compost Tea for the Improvement of Yield and Quality of Spring Cereal Crops, and its Effect on Soil Chemistry and Biology

Partner: NB Soil and Crop Improvement Association

In 2004, a trial to evaluate the effect of compost and aerobic compost tea on three spring cereals

(barley, triticale and wheat) was established in Northampton, N.B. Pre-plant soil applications of compost, or compost + compost tea, or compost tea alone, increased cereal yields by 34.9, 24.6, and 19.3 percent, respectively, over the untreated control. Soil application of compost and compost tea significantly increased test weights and thousand kernel weights compared to the control for all three cereals.

Although this trial did show a trend of disease reduction with compost tea foliar applications in barley and wheat and a reduction of DON concentration in barley, more work is required to further assess the efficacy of compost tea treatments.

Trends observed indicated that multiple compost tea foliar applications positively influenced soil fungal populations. Mycorrhizae populations were also enhanced by compost and compost tea applications. Compost tea applied to the soil in the spring did appear to improve several soil parameters over the growing season including; soil pH, CEC, phosphorus, potassium, calcium and magnesium.

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Development of Real-time PCR Technology For the Detection of Potato Viruses

Partner: Potatoes New Brunswick

Traditional detection of viruses in potato tubers involves sprouting of tubers and growing them in a warm climate that simulates infection during the summer. The most common viruses that are tested for are Potato Virus Y (PVY), Potato Virus X (PVX), Potato Leaf Roll Virus (PLRV) and Potato Virus S (PVS). Four different methods of nucleic acid extraction were tried to find a more efficient method for dormant tubers and allow for isolation of nucleic acid of several viruses in a single protocol. The Dot Blot Method was found to be the least time consuming, used the least amount of harmful chemical and gave reliable results. However, it does not appear to be as sensitive as the Sodium Sulfite RNA extraction procedure.

TaqMan probes may be used to visualize the presence of target molecules in a real-time diagnostic assay by fluorescing when the target is present. Researchers here synthesized several TaqMan probes based on gene

sequences from the four viruses of interest, and labelled each with a different colour fluorophore. The probes were successfully tested using field and greenhouse grown tubers in simplex, duplex and multiplex format for all combinations of PVY, PVX, PLRV and PVS. Once fully tested, the extraction protocol and visualization technology being developed here will allow for rapid, reliable and cost effective testing for several viruses from one sample.

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Development of Oil and Border Crop Technology Specific to NB to Reduce the Spread of Viruses in Seed Potatoes

Partner: Potatoes New Brunswick

Oil spray and crop borders are two reduced chemical input technologies that may be used instead of insecticides to reduce the spread of Potato Virus Y (PVY) in NB seed potatoes. Field plots were established to determine what combination of border type and oil spray would provide maximum protection from PVY transmission to the potato crop.

Field layouts included fallow border, short grass border, or potato plant border in combination with oil sprayed on the border crop or potato crop or both.

The principle of using a border crop is that the aphids land on the border first and lose the virus particles they carry while probing so they are not infectious as they move into the crop itself. The application of oil to plant foliage acts as a barrier to aphid probing. Oil applied to the border crop should prevent the aphids from transmitting any remaining virus particles as they move to the main crop and thereby reduce further the PVY transmission rate. Aphid catches in traps and aphid counts on plants did not indicate more aphids landing on the border crop. The implication is that the efficacy of the border crops results mostly from the loss of virus particles by aphids probing the crop border before they move from the border to the centre of the plots. Two oil formulations were compared and found to have the same efficacy in protecting the potato plants.

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Evaluation of RT-PCR Technology in the Detection of Potato Mop Top Virus and a Controlled Facility for the Assessment of the Virus in New Brunswick Potatoes

Partner: Potatoes New Brunswick

Potato Mop Top Virus (PMTV) can persist in the soil for several years and infect any tubers that are planted there. Potato Research Centre researchers have established a greenhouse chamber where conditions may be controlled to determine what environmental conditions promote PMTV growth and symptom expression. Infected tubers planted in a field and potting soil mixture supplied the virus inoculum. Tobacco plants were used as bait plants for the fungal vector of the virus.

Tobacco seedlings became infected with PMTV when planted in the infested soil. This tobacco assay shows promise to provide information on the presence of PMTV in any field soil without planting tubers in the soil. Seventy percent of potato plants planted in the PMTV-infested soil were detected PMTV positive. PMTV detection increased with cool temperature tests compared with warm temperature tests. The optimum sampling tissue for virus detection was found to be the lower leaves on the plant and the lowest leaflets on the leaves. Identification of PMTV in the samples was based on Polymerase Chain Reaction test.

Plantlets of 13 potato cultivars were evaluated for PMTV susceptibility by growing in the infested soil in the chamber. Two cultivars developed foliar symptoms in the chamber and all 13 became infected with PMTV. Cultivars varied in the degree of infection. Shepody was the least susceptible.

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Field Performance of Small Seed Tubers in New Brunswick

Partner: Potatoes New Brunswick

Very small, nuclear stock tubers that are produced from tissue culture plantlets under a protected production method are said to be able to produce high yields of high generation class seed tubers in a shorter timeframe than conventionally produced nuclear seed stock.

The field performance of these small tubers (average weight 1.3 grams), greenhouse minitubers (average weight 26.5 grams) and transplanted plantlets were compared in 2004 at Florenceville. Standard seed tuber production practices were followed for the minitubers and transplants. The small tubers were grown according to protocols specific for the planting of these propagules.

Plants that developed from the minitubers produced an average yield of 208 cwt/acre, almost twice the total tuber yield as the small tubers and 35% more than the transplants. The same trend was seen with seed tuber yield, yield of those tubers between 40 and 70 mm. Minitubers yielded the largest average tuber size (109 grams), the greatest yield on a per plant basis (650 grams) and 6.4 tubers per plant, similar to transplants and over twice that of the small tubers.

It appears that the 2004 production year favoured the use of minitubers. Soil and air temperatures during plant establishment were less than ideal and may have set the small tubers back more than the other propagules. Research is on-going.

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Plant Growth Regulator Effects on Seed Potato Crop Quality

Partner: Potatoes New Brunswick

Gibberellic acid (GA) is a naturally occurring plant hormone that has many applications in the fruit, vegetable and ornamental plant industries as a modifier of plant growth. On potato, GA can alter stem and tuber numbers and influence tuber size profile. By reducing overall tuber size, GA may increase value of the seed crop of potato cultivars that tend to produce few or large tubers. Field trials with seven potato cultivars during 2002-2004 assessed the effects of spraying seed pieces with 0-15 ppm GA solution before planting.

With GA concentrations up to 10 ppm, stem number per plant increased by 1 or 2 stems and in some cases was doubled. Total tuber yield (measured as cwt/acre) was unaffected by GA treatment up to 10 ppm while at the same time, yield of tubers suitable for seed (40 mm-64 mm diameter) increased from 10% -40% depending

upon cultivar. GA treatment also reduced yield of tubers too large for seed (>64 mm diameter) by one-half to two-thirds. With GA treatment, a larger proportion of the crop could be used for seed. Because GA also resulted in more tubers produced per acre, average weight of each tuber was reduced by about 25 grams. There was no carry over effect of GA on plant growth or tuber producing ability from tubers produced from seed treated with GA, except at the highest GA concentration. Fifteen ppm GA is not recommended as it reduced tuber yield significantly and the effects were carried over into the following production year.

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Development of Molecular Tools to Identify Insecticide Resistance in Colorado Potato Beetle Populations

Partner: Potatoes New Brunswick

Colorado Potato Beetle (CPB) is a major insect pest of potato. If not controlled, adult beetles and larvae will totally defoliate potato plants. CPB has a remarkable ability to develop resistance to most insecticides that have been used to control it. Gene point mutations have been related to CPB's quickly acquired resistance to some insecticides used in commercial production. In several other insect species cytochrome P450-dependent monooxygenases (P450 enzymes) are involved in insecticide activation and detoxification. Does the same hold true for CPB where insecticide resistance can be acquired rather quickly?

Researchers have isolated and sequenced gene fragments from CPB that control P450 enzymes similar to those conferring resistance in other insect species. Of the 6 groups of P450 enzyme gene fragments discovered in CPB, two have been completely sequenced. Work continues to build a complete bank for P450 enzyme genes for CPB.

Researchers have also developed a rapid and inexpensive CPB DNA extraction protocol. Typical yield from one CPB was 35000ng of DNA/ beetle with an A260/280 of 1.9. Streamlining the protocol to reduce the 2 hours needed per sample is on-going.

The work will continue to increase the number of detoxification genes sequenced, and to develop a rapid method to detect insecticide resistance.

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Carbon Dioxide Levels in Potato Storage

Partner: Potatoes New Brunswick

Carbon dioxide (CO₂) can build up in potato storages when outside temperatures prevent ventilating the pile due to risk of freezing the tubers. High CO₂ levels are detrimental to tuber processing quality by causing reducing sugars to accumulate. CO₂ concentrations greater than 2000 ppm in a potato storage will adversely affect tuber quality. It is unknown if high CO₂ levels influence seed tuber performance.

To investigate the effect of CO₂ on seed tubers, Russet Burbank, Shepody, Snowden and Yukon Gold were stored at 4C in closed containers with 6000-10,000 ppm CO₂ for 4 months before planting. When planted in the field, growth from tubers stored under high CO₂ levels was no different than that from tubers stored in ambient CO₂ levels (340 ppm). Stem number per plant, tuber number per plant, tuber yield and average tuber size were not affected by storage atmosphere CO₂ concentration. It appears that CO₂ concentrations up to 10,000 ppm in storage air do not affect seed performance.

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Corn Germplasm and Fertilizer Evaluation Trials

Partner: NB Soil and Crop Improvement Association

There were two main components in the project, the evaluation of new corn germplasm for grain and silage corn production and evaluating liquid and dry starter fertilizers in corn production.

For the corn germplasm component, the NB contribution to the 2004 Atlantic Corn Hybrid Evaluation trials was conducted in Sussex. The results were compiled along with data collected at Charlottetown, PEI, Truro, NS and Kentville, NS. A total of 42 silage corn hybrids and 31

grain corn hybrids were evaluated. As a result of these trials the "2005 Corn Guide to Hybrid Selection for the Maritimes" was published. Four new grain hybrids and two new silage hybrids were added to the list of recommended hybrids.

In conjunction, two starter fertilizers were evaluated in fields that had received high application rates of manure. It is unclear whether fields receiving manure on a regular basis have sufficient levels of phosphorous and potassium to produce grain corn without the addition of these two nutrients in a fertilizer program. Four variables were tested; no fertilizer, 3-18-18 seed-applied liquid fertilizer, 30-10-0 starter fertilizer and both 3-18-18 and 30-10-0 fertilizer together. There was a significant increase in yield for plots receiving 3-18-18 seed-applied liquid fertilizer, 30-10-0 starter fertilizer and both 3-18-18 and 30-10-0 fertilizer together compared to plots with no starter fertilizer. No significant difference in grain corn yield was found with 3-18-18 seed applied liquid fertilizer when compared with 30-10-0 starter fertilizer alone and in combination with 3-18-18 seed-applied liquid fertilizer.

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Yield or dry matter produced, nutrient quality, winter hardiness, re-growth potential and tolerance to poor soil drainage are rated for each forage cultivar to best assess the suitability for use under a maritime climate. Those cultivars which consistently show potential or out-perform the current recommended cultivars are included in the annual publication. Composite trial results including the 2004 trials led to the removal of 3 cultivars from the recommended list.

The second production year harvest of 14 different grass/legume mixtures established in 2002 showed that alfalfa mixtures performed better than and were more persistent than red clover mixtures. The 60% Alfalfa/ 40% Timothy mixture yielded the highest dry matter (3.97 t/ha from two cuts). The poorest performing mixture was 20% Red Clover/ 80% Timothy, which produced 2.37 t dry matter/ha from two cuts. When a seed mixture contained more than 50% legume, there was no substantial difference in performance.

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Forage Germplasm Testing, Forage Cultivar Evaluation in Atlantic Canada 2004

Partner: NB Soil and Crop Improvement Association

Yield, quality and winter hardiness are important when selecting perennial forage crop cultivars suitable for pasture and stored feed production in the Maritimes. New Brunswick participates in the Atlantic Region Field Crop testing system along with Nova Scotia and Prince Edward Island. Each year, forage cultivar evaluation trials are conducted in each province and the collective data are published in an annual Forage Guide to Variety and Mixture Selection. The New Brunswick 2004 regional forage trials evaluated the performance of established plots of perennial ryegrass, timothy, alfalfa, white clover and red clover representing 32 forage crop cultivars as well as, the establishment of three new trials including timothy single cut hay, timothy fertility and perennial ryegrass/*Festolium*. The yield, forage quality and persistence of 14 grass/legume mixtures were also rated.