

Abstracts of Technical Papers

Abstracts of papers presented at the Halifax 2006 joint meeting of the Canadian Society of Agronomy, the Canadian Society for Horticultural Science and the Canadian Society of Animal Science.

PLENARY SESSION

Reinventing agricultural research: Changing context and moving targets. Paul Struik, CWE, Haarweg 333, 6709 RZ Wageningen, the Netherlands.

Future food security for the rapidly increasing human population is at stake because farmers need to produce more food on less land and with less water and energy. Natural resources will be less and less available for agriculture due to economic development, which diverts these resources to non-agricultural uses. In many parts of the world, soil productivity is declining or agriculture is banned to marginal areas. Moreover, changes in diets in countries with the largest populations, given their booming economies, will increase the need for meat, fruit and vegetables, resulting in decreasing production of calories per unit of land. Future security of the food production will therefore depend on acceleration of yield gains for the major food crops at rates well above the historical trend of the past 50 yr. Agronomists have to make that happen with a shrinking research budget, while their license to investigate and educate is increasingly questioned and their main clients (the farmers) have lost most of their political clout almost all over the world. Moreover, their specific expertise is not highly valued by modern donors. Are agronomists becoming a rare species at the verge of extinction or a dying breed? This contribution illustrates five areas where agronomists can excel and can rightfully claim their share of research funds necessary to realize the rapid and continuous increase in productivity efficiency needed to feed the world in a way the western society is used to. First of all, agronomy should play a major role in the allocation and use of natural resources (including land, energy, nutrients, water, biodiversity), to wisely settle competing claims. In particular, agronomists should contribute to the development of a bio-based economy by designing production systems of raw materials that are resource efficient and do not jeopardize food production. Secondly, agricultural research should change landscape management by designing land use systems which capitalize on positive effects of processes acting over long periods and large areas (including co-existence of conventional and organic agriculture, spatial benefits of crop diversity, integration of arable farming and dairy farming). Thirdly, agronomy should contribute to steep increases in the efficiency with which natural resources, especially water and phosphorus, are used, for example by designing highly productive cropping systems with aerobic rice. Fourthly agronomy should play a much more dominant role in the efficient and knowledgeable use of the modern "omics". Only the agronomists are capable of asking the right questions to the molecular scientists thus making the latter less naïve and more effective. Finally, agronomy should pay much more attention to the reasons why the Western system of development of agricultural knowledge and technology has completely failed to play a role in the poorest continent Africa, despite enormous investments and in contrast to the successes of the Green Revolution in Asia and the Brown Revolution in South America. Agronomists are best equipped to draw the proper lessons from this failure in order to design an appropriate system of joint experimentation through a convergence of science and indigenous

knowledge, and thus a democratization of science for those who need it most, i.e., the subsistence farmers in Sub-Saharan Africa. This approach will not only be useful in Africa, but also elsewhere in the world.

Reinventing agricultural research. Mick Price, University of Alberta, Edmonton, Alberta, Canada T6G 2E1.

Agricultural science and technology have played, and continue to play, a pivotal role in the success of the human species; all human culture and technology has agriculture as its starting point. Agricultural research, whether the informal trial and error that were the origins of animal and crop husbandry, or the highly formalized, peer reviewed science of today, has allowed a continuous increase in both yield and efficiency of production. But modern agricultural researchers are increasingly dependent on granting agencies for their funding and consequently these agencies, rather than the scientists and their institutions, are now controlling the research agenda. This talk will explore the premise that production efficiency is reaching a plateau and should no longer be a research priority. Perhaps scarce research dollars would be better spent on other priorities. How can our research funding agencies best ensure that the needs of society are met through the research they fund?

Reinventing agricultural teaching? In search of a mission: Can colleges of agriculture stay afloat in a pluralistic sea? Keith Schillo, Department of Animal Sciences University of Kentucky, Lexington, KY 40546, USA.

Colleges of Agriculture are obsessed with change. Numerous journal articles, reports and conference proceedings highlight the fact that the demographics of agriculture have changed dramatically since the time these institutions were established over a century ago. The authors of these reports typically argue that Colleges of Agriculture have ignored these changes and as a consequence have become less relevant and credible. Administrators and faculty have responded to these criticisms by changing the names of their colleges and departments, creating new academic programs, employing new pedagogies, and recruiting non-traditional students. What has been the impact of such changes? Have they made colleges of agriculture more relevant; more credible? How can we be sure that the goals and strategic plans we develop today will remain relevant in the future? My experiences suggest that in spite of all these changes, nothing is different. In other words, I suspect that most of the changes adopted by the vast majority of Agricultural Colleges are superficial and, in the long run, will fail to improve the relevance and/or credibility of these institutions. Academic programs in the agricultural sciences will continue to lack relevance and credibility as long as they embrace a monistic world view which emphasizes the perspectives of experts who are detached from greater society and whose interests may not be compatible with those of a diverse democratic society. In order to achieve and sustain relevance and credibility we should construct programs based on an alternative world view which assumes that reliable and credible knowledge requires an appreciation for diverse experiences and perspectives. Long-term relevance and credibility can be achieved if we embrace a mission with fundamental importance to civic society. Such a mission is to help students understand who they are and how they can effectively participate in a diverse

democracy. Serving this mission will require faculty to place less emphasis on departmental and disciplinary priorities and become more engaged in activities that link public participation with knowledge development.

CANADIAN SOCIETY OF AGRONOMY Oral Presentations

The effects of land use intensification on soil biodiversity in the pasture. A. A. Mills* and M. S. Adl, Dalhousie University Department of Biology, 1355 Oxford St., Halifax, Nova Scotia, Canada B3H 4J1.

A long-term multidisciplinary study of pasture agroecology is currently being conducted in Nova Scotia, Canada. The objective is to examine the relationship between aboveground and belowground functional diversity, and the effects on agroecosystem productivity. The experimental design consists of four treatments of decreasing land use intensity, applied in the context of pasture management intensive grazing. Treatments include, 1) clipping and harrowing following each grazing rotation (intensive); 2) clipping following each rotation; 3) grazing every second rotation; 4) grazed only once a year (extensive). Quadrats were sampled from each treatment once during May, July, and September 2005. Edaphic characteristics and plant diversity were measured, as well as microarthropod, nematode, protist, and bacterial functional group diversity and abundances. Significant ($P < 0.05$) effects of treatments were observed on % bare soil, plant species and functional diversity, bacterial functional diversity, and oribatid mite abundance. There were also significant ($P < 0.05$) negative correlations observed between treatment, and both testate amoebae and flagellate abundances. The information obtained from this study will be used to test the relationship between biodiversity and land-use intensity, and how this relationship affects pasture productivity.

Effects of pasture sward diversity and composition on soil functional diversity. Michel McElroy^{1*}, Yousef Papadopoulos², and Sina Adl¹, ¹Department of Biology, Life Science Centre, Dalhousie University, Halifax, Nova Scotia, Canada B3H 4J1; ²Agriculture and Agri-Food Canada, Crops and Livestock Research Centre, Truro & Charlottetown, Canada.

The relationship between ecosystem diversity, productivity and stability are a central theme in current ecological research, and links between above-ground and below-ground ecosystems are becoming more apparent. These links are of particular importance in agro-ecosystems, where soil quality is vital to the success of plant growth. This study focuses on the link between plant and soil organism diversity in a newly seeded experimental pasture, when both plant and soil communities are establishing themselves. In an experimental pasture, 36 small plots were seeded with a combination of timothy (*Phleum pratense*), white clover (*Trifolium repens*), Canada bluegrass (*Poa compressa*), reed canary grass (*Phalaris arundinacea*) and meadow fescue (*Festuca pratensis*). Nine specific plant combinations, replicated 4 times, were used to test the effect of plant composition. Each plant combination was then grouped into a diversity treatment, based on the number of plant-species seeded in the plot (1 to 5). The experiment was rotationally grazed. Just before dairy cows enter the plots, samples were taken to estimate herbage biomass production. On three sampling dates (Jun. 30, Sep. 06, Oct. 15) herbage samples were analysed for botanical composition and soil samples were taken. Bacterial activity and functional diversity was assessed using the Biolog ECO-plate[®] sole carbon source utilization profile system.

Roots were cleared and stained to determine the percent colonized by root endophytes. Gymnamoebae, nematodes and microarthropods (mites and collembolans) were extracted from fresh soil samples using standard methods, and observed by microscopy. Functional diversity and evenness of all biological groups was assessed using the Shannon-Wiener index, while differences in diversity and abundance of soil groups over composition and diversity treatments were assessed using analysis of variance (ANOVA) and Tukey's post-hoc test. Multivariate methods (Principal Components, Canonical Correspondence and Discriminant Function Analysis) were used to further investigate plant-soil links. Results from the post establishment year (2005) indicate that plant biomass is significantly affected by both composition and diversity showing single species plots to be most productive. The abundance and diversity values of bacteria varied significantly over date but not over treatments. Patterns of bacterial substrate use, however, changed considerably with plant composition. Soil fauna (gymnamoebae, nematodes, microarthropods) abundances and diversity measures did not respond significantly to treatment effects, but changed markedly over sampling date.

Phosphorus management in poultry and dairy manures using mineral amendments. J.D. Wilson^{1*}, V.D. Zheljzkov^{1,3}, B. Rathgeber¹, D. Burton², and C.D. Caldwell¹. ¹Department of Plant and Animal Sciences; and ²Department of Environmental Sciences, Nova Scotia Agricultural College, PO Box 550, Truro, Nova Scotia, Canada B2N 5E3; ³Mississippi State University, North MS Research and Ext. Center, Verona, MS 38879, USA.

A two-stage project was conducted to assess the effect of six mineral soil amendments (alum, calcitic lime, dolomitic lime, ferric chloride, gypsum, and slaked lime) on availability of P from animal manures. An incubation study evaluated four application rates of the six amendments (0, 50, 100, 200 g amendment kg⁻¹ of manure), when combined with three manures (liquid dairy, laying hens, and broiler hens). It was found that the 200 g kg⁻¹ rate of alum and ferric chloride reduced Mehlich-3 extractable P by 86% and 93% respectively. A subsequent container experiment assessed the previously incubated manure that contained ferric chloride, alum, and slaked lime at 100 and 200 g kg⁻¹ of soil as a fertilizer for growing timothy (*Phleum pratense* L.). The 100g kg⁻¹ ferric chloride treatment and the 200g kg⁻¹ slaked lime treatment reduced timothy biomass by 25.7% and 28% respectively as compared to an N-P-K control. The concentrations of ortho-phosphate and total dissolved phosphate in the soil from Mehlich-3 and water extraction were not found to be statistically different for any treatment when compared to an N-P-K or unamended control.

Organic crop management decreases labile P, promotes mycorrhizal colonization, and increases spore populations. Catherine Welsh^{1*}, Terry McGonigle², Martin Entz³, Don Flaten¹, Cynthia Grant⁴, and Mario Tenuta¹. ¹Department of Soil Science, University of Manitoba, Winnipeg Manitoba, Canada R3T 2N2; ²Department of Biology, Brandon University, Brandon Manitoba, Canada R7A 6A9; ³Department of Plant Science, University of Manitoba, Winnipeg Manitoba, Canada R3T 2N2; ⁴Agriculture and Agri-Food Canada, Brandon Research Centre, Brandon Manitoba, Canada R7A 5Y3.

Arbuscular mycorrhizal fungi (AMF) are one of the most important soil organisms in relation to plant nutrition, particularly phosphorus (P). With interest in lowering soil P levels, promoting the activity of mycorrhizal fungi may be critical to maintaining crop yields. This study compares organic and conventional practices

and different crop rotations to determine the extent of their impact on AMF colonization. The research was carried out at the 14-yr study at Glenlea, in Southern Manitoba. This site consists of 3 different 4-yr rotations under organic and conventional management: Wheat–Alfalfa–Alfalfa–Flax with and without animal manure, Wheat–Pea–Wheat–Flax, and a restored prairie. The organic rotations had lower levels of labile P fractions than conventional and the native prairie grass had P levels similar to conventional systems. The annual rotation had higher labile P than the alfalfa rotations ($P = 0.05$). AMF colonization levels as either hyphae alone or arbuscules were significantly higher ($P = 0.05$) in organic than conventional systems; however crop rotations did not significantly differ in colonization. The same was true for spore populations ($P = 0.05$). Organic management therefore has a greater impact on increasing AMF colonization than differing crop rotations.

An assessment of the genetic diversity of soybean rhizobia endemic to the soil of western Canadian region using PCR-based Genomic fingerprinting Techniques: REP-PCR and ERIC-PCR. F. Farooq* and J.K. Kevin, 923 Robie Street, Science Building, Department of Biology, RM 308, Saint Mary's University, Halifax, Nova Scotia, Canada B3H 3C3.

Soybean is an important economical crop. Low heat-unit-requiring cultivars of soybean [*Glycine max* (L.) Merr.] were introduced few years ago in western Canada and are found to be well adapted to the edaphic and climatic conditions of this region. Rhizobia are defined as nitrogen-fixing soil bacteria capable of inducing the formation of root or stem nodules on leguminous plants and helps in biological nitrogen fixation (BNF). During the last few years, the assessment of diversity within rhizobial natural populations in various regions of the world has received increased attention. It has been recognized that an important requirement for agronomically useful rhizobium-soybean associations is the ability of inoculant strains to compete with very diverse indigenous rhizobial strains. Therefore, in order to improve the beneficial effect of soybean inoculation, it is important to determine the characteristics of rhizobial field populations. The aim of this study is to assess the genetic diversity of the soybean rhizobia endemic to the soil of western Canada, specifically in western Manitoba using PCR-based genomic fingerprinting techniques: REP-PCR and ERIC-PCR. Genomic fingerprints of 60 isolates have been obtained and preliminary analysis suggests that there is significant genetic diversity among the soybean rhizobial population in western Canada.

Symbiotic efficiency of *Bradyrhizobium japonicum* for development of a commercial soybean inoculant for western Canada. V.B. Kavanagh¹* and J.K. Vessey^{1,2}. ¹Department of Biology, Saint Mary's University, Halifax, Nova Scotia, Canada B3H 3C3; ²Department of Graduate Studies and Research, Saint Mary's University, Halifax, Nova Scotia, Canada B3H 3C3.

Soybean production has increased substantially in western Canada since the mid 1990s. To maximize the returns from this crop, inoculation with a commercial bacterial inoculant (*Bradyrhizobium japonicum*) has been recommended. This application bypasses the need for supplemental nitrogen fertilizer by providing the plant with fixed nitrogen on-demand. Both soybean and its microsymbiote are tropical species and are not able to persist through the cold temperatures of a prairie winter. Bacterial populations often undergo mutations that result in poor performance. However, some of these changes may result in a novel rhizobial genotype capable of performing better than its original progenitor. This experiment set out to identify a superior *B. japonicum* strain specifically for

western Canadian soils. Soybean nodules with suspected changed bacteria were cultured and tested in a greenhouse setting to analyze symbiotic efficiency. This efficiency could be measured by determining individual strain infectability – its ability to induce nodulation, and effectiveness – ability to fix nitrogen against popular commercial inoculants 532C and USDA110. From testing of 60 isolates, several have shown promise with one strain showing a considerable elevation in nodulation rates when compared with the commercial control.

Productivity, quality and diversity of a pasture sward in Atlantic Canada. G. Carignan¹*, N. McLean¹, A.H. Fredeen¹, J. Winter¹, and R.C. Martin^{1,2}. ¹Department of Plant and Animal Sciences, Nova Scotia Agricultural College, P.O. Box 550, Truro, Nova Scotia, Canada B2N 5E3; and ²Organic Agriculture Centre of Canada, Nova Scotia Agricultural College, P.O. Box 550, Truro, Nova Scotia, Canada B2N 5E3.

The experiment examined the effects of grazing intensity on forage weight, forage quality and plant biodiversity. The four pasture treatments in a randomized complete block design were: (A) defoliated every grazing cycle, clipping and chain harrowing after every grazing cycle; (B) defoliated every grazing cycle, one clipping only after the second grazing cycle; (C) defoliated only every second grazing cycle, no clipping or harrowing; (D) no grazing until late July, no clipping until the end of the grazing season. It was hypothesized that extensive pasture treatments C and D would exhibit more biodiversity, albeit with lower forage quality and yields, than intensive treatments, A and B. When the effect of grazing in alternate defoliations was evident, pre-grazing forage weights were higher in treatment C. Weights of forage removed during grazing were similar between treatments, though there were higher proportions in intensive treatments. As expected, forage quality was lower in the extensive treatments. Species richness was more pronounced in treatment D with unique plant species, which may be due to edge effects and/or a delayed grazing date. Other measures of plant biodiversity such as evenness and the Shannon-Wiener index showed few differences between grazing treatments.

Late maturing hay, forage quality, and grassland birds: Conservation you can chew on! S. LeMoine¹*, S. Bondrup-Nielsen¹, K. MacKenzie², and G. Parsons³. ¹Biology Department, Acadia University, 24 University Ave., Wolfville, Nova Scotia, Canada B4P 2R6; ²Atlantic Food and Horticulture Research Centre, Agriculture and Agri-Food Canada, 32 Main St., Kentville, Nova Scotia, Canada B4N 1J5; and ³Wildlife Division, Nova Scotia Department of Natural Resources, 136 Exhibition St., Kentville, Nova Scotia, Canada B4N 4E5.

Harvesting of conventional hayfields is done to maximize forage quality for beef cattle but often results in high mortality of grassland birds. Here we examine if a late maturing hay cultivar can provide adequate forage under a delayed cutting regime. Three hayfields were planted with the late cultivar Comtal[®] timothy and winter seeded with Altaswede[®] red clover. A delayed cut date of Jul. 07 was chosen as grassland birds fledge the majority of their young by the first week of July. Forage samples were collected weekly from late cultivar hayfields and adjacent conventional hayfields from Jun. 15 to Jul. 19. Crude protein (CP) levels from late maturing hayfields were higher than in conventional fields and were suitable for calves and pregnant females (>11%). No difference was found in acid detergent fibre (ADF) between field types. Calcium (Ca) levels in the late maturing cultivar were sufficient except for growing calves but phosphorus (P) levels were lower

than recommended, although a sufficient Ca:P ratio was observed for the three July samples. The findings support the concept that a late maturing hay cultivar, with some minor phosphorus supplementation, provides adequate forage for beef cattle, while improving habitat for grassland birds.

Fenugreek (*Trigonella foenum-graecum* L.) seed yield improvement using mutation breeding. S. K. Basu^{1*}, S.N. Acharya², and J.E. Thomas¹. ¹Department of Biological Sciences, University of Lethbridge, 4401 University Drive, Lethbridge, Alberta, Canada; ²Agriculture and Agri-Food Canada, Lethbridge Research Centre, PO Box 3000, Lethbridge, Alberta, Canada T1J 4B1.

Fenugreek forage cultivar Tristar, produces high biomass yield in western Canada. However, it does not produce high seed yield and high quality seed every year because of its indeterminate growth habit and late maturity. To produce early maturing and/or determinate type plants along with adaptation to western Canada, mutation breeding was initiated using Tristar as the base population. Seed pre-soaked in distilled water were treated with Ethyl Methane Sulphonate (EMS) using a range of concentrations (10–300 mM) and durations (2–24 h). Resulting plants from treated seeds were grown individually in pots in the greenhouse and selected for high seed yield and early maturity. Limited number of progenies from the M₁, M₂ and M₃ selected plants were grown in the greenhouse, desiccated after 90 d and then harvested for seed yield and size determination. In 2005, greenhouse grown seed of M₁, M₂, M₃ and M₄ generations were seeded at Lethbridge under irrigation using generations as main plots and the lines randomized as in a RCBD with two replications within the main plots. Variability for seed yield and maturity duration was observed among the mutant lines, a number of them having higher seed yield and early maturity compared to the untreated Tristar. This and identification of some superior mutant plants indicated that mutagenesis using EMS can be used for fenugreek improvement.

Effects of cultivar and nitrogen rate on the performance of *Camelina sativa* L. in the Maritime Provinces of Canada. S. Urbaniak^{1*}, C.D. Caldwell^{1,2}, D. MacDonald^{1,2}, V.D. Zheljzkov³, and R. Lada¹. ¹Department of Plant and Animal Sciences, Nova Scotia Agricultural College, PO Box 550, Truro, Nova Scotia, Canada B2N 5E3; ²Nova Scotia Crop Development Institute, PO Box 550 Truro, Nova Scotia, Canada B2N 5E3; and ³Mississippi State University, North MS Research and Ext. Center, Verona, MS 38879, USA.

Camelina sativa (L.) is an ancient oilseed crop that has not been exploited to its full potential; however, its unique properties have led to renewed interest in its production. A study evaluating the effects of nine cultivars and five nitrogen rates on plant growth and development, seed yield, oil content, protein content and oil quality was conducted in the provinces of NS, NB and PEI in 2005. Seed yields, in the cultivar trial, ranged from 1130 to 2570 kg ha⁻¹ in NS, 550 to 2050 kg ha⁻¹ in PEI and 320 to 1000 kg ha⁻¹ in NB. Calena had superior yield performance at all locations. Seed oil content ranged from 35% to 40%. Major fatty acids (%) found were: linolenic (35 to 42), oleic (13 to 17), linoleic (16 to 19), eicosenoic (14 to 16) and erucic (3 to 4). Higher N rates resulted in increased grain yields only in PEI. Crude seed protein levels increased with higher N rates; however, a significant decrease in seed oil content occurred as N rate increased. Seed protein content ranged from 23 to 28 %. Results indicate that camelina adapts well to growing conditions found in the Maritime Provinces.

Yield and quality responses of Sunola varieties to Nitrogen Fertilizer in the Maritime Provinces. L. Luan^{1*}, C.D. Caldwell^{1,2}, D. MacDonald², R. Lada¹ and V.D. Zheljzkov^{3,1}. Nova Scotia Agricultural College, Department of Plant and Animal Sciences, PO Box 550 Truro, Nova Scotia, Canada B2N 5E3; ²Nova Scotia Crop Development Institute, Nova Scotia Agricultural College, Department of Plant and Animal Sciences, PO Box 550, Truro, Nova Scotia, Canada B2N 5E3; ³Mississippi State University, North MS Research and Ext. Center, Verona, MS 38879, USA.

Various studies have shown that Nitrogen (N) fertilizer has a significant effect on sunflower yield and quality. Sunola (*Helianthus annuus*), however, as a novel type of sunflower, has not been explored sufficiently in terms of N requirement, especially under the cool, moist conditions of the Maritime Provinces of Canada. A field experiment was conducted in 2005 at Truro NS and Charlottetown PEI to evaluate yield and oil quality responses of Sunola varieties (AC Sierra and Pioneer 63A21) to N fertilizer application rates (0, 50, 100, and 150kg N ha⁻¹). The results showed that emergence, plant height, head diameter, and thousand kernel weight (TKW) were not affected by N application rate but were affected by variety. Yield of Sunola did not respond significantly to N application rate, but the oil content decreased and protein content increased with increased N application rate. Total dry matter of above ground biomass was not affected by N rate but tissue N concentration was increased with higher N fertilizer. Fatty acid composition of Sunola was not changed by N rate. The two Sunola varieties had similar fatty acid profile: about 10% of saturated fatty acid (palmitic and stearic), 17–25% of oleic acid, and 63–72% of linoleic acid.

The significance of competition: suppression of *Taraxacum officinale* populations by *Sclerotinia minor* and grass over-seeding. Mohammed H. Abu-Dieyeh* and Alan K. Watson. Department of Plant Science, McGill University, 21,111 Lakeshore Road, Ste.-Anne-de-Bellevue, Quebec, Canada H9X 3V9.

A successful long-term biocontrol strategy should not only suppress established plants, but should exert negative effects on seeds and prevent seedling establishment. *Sclerotinia minor* exerted strong detrimental effects on dandelion seeds, without negative effects on turfgrass seeds. In a greenhouse environment, pre- and post-emergence applications of *S. minor* significantly reduced dandelion emergence and survivorship to 17% and 2% respectively compared with 70–80% in the untreated control. There was no disease damage of direct *S. minor* contact on germination or emergence of turfgrass seeds or seedling establishment. Four weeks post application, the biocontrol treatment applied at sowing significantly increased the total biomass of perennial ryegrass and creeping bentgrass. In the field, grass over-seeding alone did not improve grass quality or reduce dandelion population densities. However, the application of *S. minor* with grass over-seeding resulted in 70–80% reduction of dandelion density in the first year and more than 95% in the following year. Densities of white clover and field bindweed were also significantly reduced when *S. minor* was applied with grass over-seeding compared with the fungus alone. The high susceptibility of dandelion seeds to *S. minor* broaden the potential of *S. minor* as an effective biocontrol agent for long-term reduction of the dandelion seedbank.

Gaseous N losses, nitrate leaching and corn yield from conventional tillage and no tillage systems following fall application of

semi-solid beef manure and inorganic nitrogen fertilizer. M. S. Mkhabela^{1*}, R. Gordon¹, D. Burton², A. Madani¹, and W. Hart³. ¹Department of Engineering, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada B2N 5E3; ²Department of Environmental Sciences, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada B2N 5E3; ³Process Engineering and Applied Science, Sexton Campus, Dalhousie University, Halifax, Nova Scotia, Canada B3J 2XA.

No-tillage (NT) systems have been suggested as better than conventional tillage (CT) systems because they improve soil structure, increase soil moisture, reduce soil erosion and subsequently increase crop yield and economic benefit to the producer. However, some reports show that NT may increase NH₃ and N₂O emissions as well as NO₃ leaching, while others report the opposite or no difference. The objectives of this study were to evaluate the impact of tillage method on NH₃, N₂O NO₃-N, denitrification, N₂O:N₂ ratios and corn yield. Semisolid beef manure was applied during the fall at 44 000 kg ha⁻¹ (168 kg N ha⁻¹) and inorganic N (50 kg N ha⁻¹) was applied at planting. Gas measurements started soon after manure application until harvest. On average, 0.24 and 2.76 kg N ha⁻¹ were lost through NH₃ volatilisation from the CT and NT plots. Denitrification rates and N₂O fluxes were 3 times higher in NT than CT. NO₃-N decreased with depth in both fields and both tillage systems. Generally, NO₃-N was significantly higher under CT than under NT management in all the soil depths. This may be attributed to higher denitrification rates in NT than CT. Interestingly, N₂O:(N₂O + N₂) ratios were lower under NT than in CT suggesting more complete reduction of N₂O to N₂ in NT system. NT management therefore, may be a viable strategy to remove NO₃-N from the soil, and thus, reduce NO₃-N contamination of ground water. However, it should be noted that the use of NT management to reduce NO₃-N leaching may actually increase NH₃ and N₂O emissions. Corn yields were slightly higher in NT than CT but the difference was not significant.

Fertilizer efficiency improvement in Canada. T.W. Bruulsema*, Potash & Phosphate Institute of Canada, 18 Maplewood Drive, Guelph, Ontario, Canada N1G 1L8.

Improved efficiency of fertilizer use is key to the social, economic and environmental sustainability of agriculture. More efficient use is motivated by recent increases in fertilizer:crop price ratios and the need to reduce nutrient impacts on the environment. Concepts and definitions of nutrient use efficiency vary widely. When they are defined clearly they can serve as indicators of sustainability, for accountability to the Canadian public. Recent soil test summaries and nutrient balances compiled by the Potash & Phosphate Institute indicate that both surplus and deficit areas exist across Canada. The wide-ranging distribution of soil test results in most provinces points clearly to the need for soil testing to determine fertility needs of specific fields as a guide to fertilizer and manure application. Fertilizer management strategies should be balanced with regard to achieving high short-term efficiency as well as maximizing the cumulative crop yield response over time. Long-term benefits accruing from residual fertilizer availability or increases in soil carbon and nitrogen storage should be included in evaluating fertilizer efficiency. Contributions of added nutrients to both crop uptake and soil nutrient supply must be accounted for in assessing the system level efficiency of applied nutrients.

The effects of soil nitrogen enrichment and management practices on plant diversity in a Nova Scotia dairy pasture. Andrew MacDonald*, Department of Biology, Cape Breton University, Sydney, Nova Scotia, Canada B1P 6L2.

Pasture plants supply the physical structure and food for complex communities of arthropods and vertebrates. Many studies of plant diversity estimate the cover of species in a community and qualitatively characterize physical structure. Both species diversity and structure are eroded by intensive management. Diversity of species and structure was measured, using a modification of the point quadrat technique, in a pasture located on the campus of the Nova Scotia Agricultural College in Bible Hill, Nova Scotia. The impact of intensification and nitrogen application on species richness, abundance and evenness of vascular plant species as well as the structure of vegetation was measured. Species richness and evenness were compared using rarefaction and ANCOVA, respectively. Structure was compared using rarefaction, and diversity was estimated using parametric diversity indices. Two experiments were examined, one a gradient of nitrogen fertilization and the other a gradient of management intensity with grazing, clipping and harrowing at various frequencies. In the summer of 2005, two common species (*Taraxacum officinale* and *Poa* spp.) became still more common with increasing rate of nitrogen application and decreasing management intensity, respectively. Species composition changed only slightly while structure was altered dramatically. It is recommended that structure be quantified alongside species diversity.

Organic potato and barley yield response to wild radish (*Raphanus raphanistrum* L.). Andrew M. Hammermeister* and Kathryn E. Punnett. OACC-NSAC, PO Box 550, Truro, Nova Scotia, Canada B2N 5E3.

Many conventional farmers have cited inability to control wild radish (WR) in organic management as a reason for not transitioning to organic agriculture. The objectives of this project were to quantify economic impacts of WR and identify management practices that for WR control. Two organic barley fields and two potato fields were selected where WR was expected to be a problem. Regression analysis was used to determine the relationship between WR population and biomass and yield of barley or potato. Barley yields at one site were negatively correlated with WR; the average population of 3.4 WR plants m⁻² reduced the barley yield by 36 kg ha⁻¹. At potato site 1, WR reduced the yield of small potatoes but not Canada No1 potatoes. A reduction of small potato yield of 1606 kg ha⁻¹ was estimated to occur for every WR plant found per 1 m of hilled row (with two WR plants m⁻¹ row on average). This equates to an estimated yield loss of 3212 kg ha⁻¹. At potato site 2, WR significantly decreased yield of Canada No. 1 and Small potatoes. Each additional WR plant m⁻¹ of hill reduced total potato yield by 425 kg ha⁻¹.

Weed and potato response to acetic acid used to control weeds. J.A. Ivany*. Agriculture and Agri-Food Canada, Crops and Livestock Research Centre, 440 University Ave, Charlottetown, PEI, Canada C1A 4N6.

Canada produces 175,300 ha of potatoes (*Solanum tuberosum* L.) with 59% of production in Eastern Canada and 41% in Western Canada and with 74% of total production being in Prince Edward Island, Manitoba, New Brunswick, and Alberta. The number of herbicides available to control weeds has decreased in recent years resulting in more interest in use of non-chemical and organic techniques. We evaluated the potential of the acetic acid products Ecoclear and glacial acetic acid for effects on potatoes and control of weeds. Ecoclear provided control of annual broadleaf weeds comparable to the standard herbicides metribuzin or linuron at 6wks after application. Ecoclear caused severe potato injury when

used post-emergence and reduced marketable yield in 1 of 2 yr. Glacial acetic at a concentration of 10% did not control weeds and 20% acetic acid was needed to reduce weed biomass to acceptable levels. A concentration of 30% was no more effective than 20% acetic acid. Glacial acetic acid applied post-emergence injured the potato foliage and reduced marketable yield below that of the standard herbicide metribuzin. No improvement in weed control was obtained by applying acetic acid twice in sequence compared to a single application at any of the three acetic acid concentrations.

The role of organic systems in reinventing agricultural research. Ralph C. Martin*. Organic Agriculture Centre of Canada at NSAC, Box 550, Truro, Nova Scotia, Canada B2N 5E3.

Profitable and sustainable agriculture is predicated on excellent management of soil, plants and livestock, within a systems framework. In particular, organic agriculture depends on excellent management because off-farm inputs cannot be used in sufficient amounts to mask poor agronomy and livestock husbandry. Organic research provides an opportunity for scientists to investigate unmasked systems under biological and climatic variability and to develop methods that will benefit all farmers. Research questions to be addressed in organic systems are within the context of expected interactions and multi-functionality. Fundamental agronomic and livestock research is crucial. Questions at the production level relate to others at the processing, distribution and marketing levels. A goal of organic systems is to supply products characterized by well-balanced nutritional content linked to healthy soil rather than by what might be applied or inserted to enhance products. Organic products also gain market share and premium prices because pesticides are not applied. Agricultural researchers in organic systems work most effectively in networks, including practitioners at all levels of the value chain. Reinventing agricultural research requires an awareness of meeting consumer demands for food quality now and in the long term.

The use of composted pulp fibre as soil amendment and its effect on crops of the second rotation in potato culture in New Brunswick, Canada, Sherif H. Fahmy*, Sheldon Hann and Tien Lien Chow. Agriculture and Agri-Food Canada, Potato Research Center, Fredericton, New Brunswick, Canada.

The residue waste from a thermo-mechanical pulping produced in New Brunswick, Canada was composted and used as soil amendment. A split application of the compost each of 22.5 tons ha⁻¹ (1F) and 45 tons ha⁻¹ (2F) dry weight basis, were used in the fall of the year 2001 and 2002 to amend a sandy loam soil, non-amended soil being (0F). Two irrigation protocols of rain-fed supplemented with drip irrigation (I) and rain-fed only (NI) were established. This soil was previously amended in the fall of 1998 with raw pulp fibre. The first crop of this second rotation was *Pisum sativum*, followed by *Zea mays* then *Solanum tuberosum* as final crop. Rotation crops responded differently. Supplemental irrigation and/or amended soils in the rain-fed system increased the total yield of pea and corn crops; dry pea weights were highest at higher rates of amendment application. As for potatoes, total yield of tubers obtained from rain-fed system was slightly higher than the supplementary irrigated system, and the marketable yield was significantly lower at the higher rates of compost application, especially under supplemental irrigation, this due to Common Scab infection that may have been caused by the use of infected tubers in the compost formula. Total-N in the amended soils of the 3-yr rotation crops at planting and after harvest was higher than non-amended soils in both irrigation systems. Total-N in pea seeds, corn kernels and potato tubers were

also at higher levels when composted pulp fibre was used as soil amendment in both irrigation systems. In order to enhance organic matter in soil, the application of pulp fibre waste or its mature compost as soil amendment may be a viable agronomic practice.

Water use and water use efficiency of chickpea and dry pea under conventional summerfallow and no-till stubble conditions. Y.T. Gan* and C.L. McDonald. Agriculture and Agri-Food Canada, P.O. Box 1030, Swift Current, Saskatchewan, Canada S9H 3X2.

Understanding water use characteristics can help improve crop productivity. A study was conducted in Saskatchewan, 1998–2000, to determine water extraction, water use efficiency (WUE) and postharvest residual soil water (PHRSW) in desi and kabuli chickpea (*Cicer arietinum* L.) and dry pea (*Pisum sativum* L.). The crops were grown at four population densities (PPD) under conventional summerfallow (CS) and no-till (NT) conditions. Desi and kabuli chickpea had a similar water extraction pattern; both extracting 28% more water than dry pea. Pulses grown on CS extracted 48% more water in the 60 to 90 cm soil depths than pulses under NT conditions. Dry pea had the greatest WUE (12.9 kg ha⁻¹ mm⁻¹), followed by desi (7.3 kg ha⁻¹ mm⁻¹) and then kabuli (6.6 kg ha⁻¹ mm⁻¹) chickpea. Increasing PPD increased WUE for dry pea and desi chickpea but not for kabuli chickpea. PHRSW was greater (9%) after dry pea compared to after chickpea under CS conditions, but no difference under NT conditions. Water was left unused by dry pea below 60 cm and by chickpea below 90 cm soil layers. A deep rooting crop grown after pulses may receive great benefits in utilizing the water conserved in the deep soil layers.

New directions for modified soybean oil. Gary R. Ablett*, Aron Weir, Guangyun Hou, Yarmilla Reinprecht, Peter Pauls, Istvan Rajcan. Department of Plant Agriculture, University of Guelph, Guelph, Ontario, Canada.

The University of Guelph has been working on modified fatty acid composition in soybeans for many years. The work initially focused on creating variability for various traits including low/high linolenic, low/high palmitic, high stearic and high oleic. The work has expanded over the years to include work on environmental stability, mapping of unique profiles, creating combinations of unique profiles and combining low linolenic with lipoxigenase nulls. We will provide a brief overview of past work and present additional information on this broad research area.

Seed coat integrity: Resistance to mechanical damage of seed coat in common bean (*Phaseolus vulgaris* L.). Soon J. Park* and Terry Rupert. AAFC Greenhouse and Processing Crops Research Centre, Harrow, Ontario, Canada N0R 1G0.

Seed coat integrity of navy beans is extremely important for processing of baked beans. Mechanical damage (MD) of bean seed also causes abnormal emergence and reduced seedling vigor. This prompted an initial study into seed coat integrity, resistance to MD and selection for resistant beans. Our initial study clearly demonstrated variety differences in response to direct combine harvest techniques (2001). The following study was conducted during 2000–2001 to determine genetic control of MD, to estimate heritability, and to apply these findings in development of MD tolerant bean cultivars. F4 and F4:5 RIL of two crosses between resistant and susceptible navy beans were tested. The results showed that MD was under quantitative genetic control by multiple minor genes. Heritability estimated by the parent-offspring regression

showed moderate heritability of MD (0.55 and 0.65 for two crosses). Correlations between the base population and selected progeny lines suggested that selection for MD tolerance would be moderately effective ($r = 0.58-0.78$) and breeding is possible. Seed characteristics measured by using digital image analysis system found that MD index is highly correlated with some of the seed characteristics like seed length and surface area in one of the two crosses. Some plant and seed characteristics may be used in selecting for resistance to MD. Seed coat tissues were examined by scanning electron microscopy to investigate micro-structural differences of seed coat tissue and the results showed some differences between MD susceptible and resistant parental lines. Air space below the parenchyma cells was significantly correlated with MDIc (0.32) as was between lower palisade and MDIs (0.36). Air space between seed coat layers and endosperm might have a cushioning effect to reduce seed coat damage.

The effect of soybean nodule hydrogen metabolism on the growth of rotation crops. Cheryl A. Dean^{1,2}, Wenchang Sun¹, Zhongmin Dong^{1*}, and Claude D. Caldwell³. ¹Department of Biology, Saint Mary's University, Halifax, Nova Scotia, Canada B3H 3C3; ²Present Address: Department of Microbiology and Immunology, Dalhousie University, Halifax, Nova Scotia, Canada B3H 1X5; ³Plant and Animal Sciences, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada B2N 5E3.

Soybean was inoculated with either a Hup- (JH47) or a Hup+ (JH) strain of *Bradyrhizobium japonicum*. These isogenic strains differ only in that JH47 has a Tn5 inserted in the gene coding for the small hydrogenase subunit which eliminates hydrogenase activity, thus releasing hydrogen into the rhizosphere. Inoculated alfalfa plants were used as the positive control as no hydrogenase activity has ever been found in alfalfa nodules. Soil adjacent to hydrogen releasing (Hup-) legume nodules had a significantly higher hydrogen uptake rate than that around the nodules containing the Hup+ strain. Barley grown following the Hup- soybean exhibited an increased rate of plant growth and grain yield under natural field conditions. The enhanced soil bacterial population is speculated to be responsible for the increased crop growth.

When is short-season soybean most susceptible to drought? M.J. Morrison*, N. McLaughlin, E. R. Cober, and G. Butler. AAFC, 960 Carling Ave, KW. Neatby Bldg, Ottawa, Ontario, Canada K1A 0C6.

Fourteen soybean (*Glycine max* L. Merr) cultivars were grown at Ottawa from 1993 to 2004 in a replicated design. Phenology, yield and seed quality data were collected. Climate data was merged into the data set. Seven key phenological growth stages were identified and the total precipitation (ppt) between stages calculated per cultivar for all possible durations. On a per cultivar basis, cumulative ppt among the growth stage durations was correlated with seed yield, thousand seed weight (TSW), seed protein and oil content. Variation in ppt prior to flowering did not influence yield. Yield and TSW was found to be most susceptible to drought from flowering to the end of seed development (R1 to R7). Further refining revealed that the most sensitive stage occurred during a 17 to 24 d period bracketing the beginning of seed development (R5). Seed protein in half of the cultivars was not influenced by ppt, while in the other half it was correlated with ppt from mid vegetative to the beginning of seed development. Seed oil content was not affected by variation in ppt. This data will be useful in designing strategies to breed for drought tolerance in soybean.

Weevil (Coleoptera: Curculionidae) diversity in a managed Nova Scotia dairy pasture. Sheena Townsend* and David McCorquodale. Department of Biology, Cape Breton University, Sydney, Nova Scotia, Canada B1P 6L2.

Agricultural intensification may lower biodiversity; a trend observed over a wide range of taxonomic groups. I look at the effects of management intensity on one group of herbivorous insects, weevils (Coleoptera: Curculionoidea), within a managed dairy pasture located in Colchester County, Nova Scotia. Like other Coleoptera, weevils may be less abundant and diverse when management intensity is higher. Weevils were collected by sweep-netting in the summer of 2005. An inventory that documented seasonal trends in the abundance of adult Curculionoidea was compiled. Twenty-eight species of Curculionidae and two Brentidae were collected. Of these, 22 are adventive. Eleven species were found in all management intensities. Seasonal abundance varied by species. The species richness, diversity and abundance of Curculionoidea in the pasture did not decrease as management intensity increased. Taxon sampling curves, rarefaction and diversity indices were used to examine the effect of management intensity on diversity. No differences in abundance among the four treatments were detected when data were analyzed using ANOVA. Caution should be used in both interpreting and gathering abundance data for Curculionoidea. Seasonal fluctuations varied among treatments and individual species' responses were not homogenous.

Posters

Evaluation of grass pea (*Lathyrus sativus*) landraces for drought tolerance indices. Ahmad Razban Haghighi^{1*}, Mohammad Moghaddam², Mostafa Valizadeh², and Aziz Javanshir². ¹Research Center of Agriculture and Natural Resources of Tabriz, Iran, ²Faculty of Agriculture, Tabriz University, Iran.

In order to determine suitable grass pea landraces for arid and semi-arid area, 12 landraces were evaluated in a split block design on randomized complete blocks with three replications under rain-fed and irrigated conditions in Botanical Garden of Research Center of Agriculture and Natural Resources of Tabriz. Six drought tolerance indices, Stress Susceptibility Index, Stress Tolerance Index, Mean Productivity, Tolerance, Geometric Mean Productivity and Modified Stress Tolerance Index were calculated based on biological yield and grain yield. STI was determined as index for selection of drought tolerant grass pea landraces. Ward's minimum variance cluster analysis was used to group grass pea landraces based on biological yield, grain yield and STI index. Landraces 3, 4, 6, 10, 11 and 12 were grouped in a drought tolerant cluster for both biological yield and grain yield.

Evaluation of Pb and Cu bioavailability from compost amended soils. A. Cooper^{1*}, V.D. Zheljzakov^{1,2}, B. Rathgeber¹, and D. Lynch¹. ¹Department of Plant and Animal Sciences, Nova Scotia Agricultural College, PO Box 550, Truro, Nova Scotia, Canada B2N 5E3; ²Mississippi State University, North MS Research and Ext. Center, Verona, MS 38879, USA.

Land application of organic composted wastes is economically valuable to agricultural systems. It would benefit the environment and agriculture if the content of municipal and industrial composted wastes were clearly defined. This research studied the bioavailability, mobility, and long-term effects of compost-born copper

(Cu) and lead (Pb) applied to agricultural soils on crop and poultry uptake. Specifically sewage sludge and municipal solid waste compost were applied to a no-till corn production system to determine the effects of industrial composts on soil quality through monitoring nutrient levels and speciation of Cu and Pb under varying soil pH. Poultry experiments assessed Cu bioavailability when compost amended soils were included in broiler diets. Redistribution and changes in mineral speciation of copper and lead were observed by varying compost type, application rate, and soil pH. Experiment results may be used for predicting crop and livestock uptake of Cu and Pb following industrial compost application and aid in fine-tuning compost quality guidelines.

Path analysis of yield and related characteristics for Grass pea (*Lathyrus sativus*) landraces under rainfed and irrigated conditions. Ahmad Razban Haghighi^{1*}, Mohammad Moghaddam², Mostafa Valizadeh², Aziz Javanshir². ¹Research Center of Agriculture and Natural Resources of Tabriz, Iran, ²Faculty of Agriculture, Tabriz University, Iran.

In order to determine relationships of biological yield and grain yield with some agronomical traits in grass pea landraces and contribution of most effective characters to biological yield and grain yield, an experiment with 12 landraces at rainfed and irrigated conditions was conducted as a based on randomized complete blocks at Botanical Garden of Research center of Agriculture and Natural Resources of Tabriz. In this study the phenotypic correlation coefficients of characters were calculated under irrigated condition significant correlation of number of pods per plant, number of grains per pod, number of grains per plant with biological yield and these characters plus plant height with grain yield were obtained. under rainfed condition correlations of number of pods per plant, plant height, number of grains per plant and root length with biological yield and plant height, number of grains per plant and root length with grain yield were significant. In order to determining characters that have considerable effect on biological yield and grain yield, forward ridge regression and then path analysis was done. Results showed that in the irrigated condition, number of grains per plant and in rainfed condition number of grains per plant and 100 grains weight had a positive and significant direct effect on biological yield and grain yield, and could be used as criteria to select for yield indirectly in irrigated and rainfed conditions.

Growth temperature affects yield and nutritive value of timothy. A. Bertrand*, Y. Castonguay, G. F. Tremblay, and G. Bélanger. Agriculture and Agri-Food Canada, 2560 Hochelaga Blvd. Québec, QC, Canada G1V 2J3.

Nutritive value of cool-season grasses is known to be affected by air temperature but there are few reports of this effect for timothy (*Phleum pratense* L.). We assessed the effect of growth temperature on dry matter (DM) yield and the concentration of water-soluble carbohydrates (WSC), neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL), and on the DM and NDF digestibility of timothy. Plants were grown in growth chambers under three day/night temperatures (17/5°C, 22/10°C, and 28/15°C) with a photoperiod of 15 h and harvested at the early heading stage. Timothy DM yield increased from 4.7 g DM/pot at 28/15°C to 7.9 g DM/pot at 17/5°C. Cool temperatures also increased DM (+ 51 g kg⁻¹ DM) and NDF (+ 96 g kg⁻¹ DM) digestibility of timothy but had no effect on ADF, NDF, and ADL concentrations. The WSC concentration (93 mg g⁻¹ DM) was highest in timothy grown at the warmest temperatures. The higher DM digestibility of timothy under cool growth temperatures was there-

fore not due to an increase in WSC or to a decrease in ADF, NDF, or ADL concentrations, but to an increase in NDF digestibility. Cool temperatures during growth favour the production of high-yielding timothy with a greater nutritive value.

Long-term management intensive grazing of pastures shifts the soil food web. Ardhini Maharning* and Sina Adl, Biology Department, Dalhousie University, Halifax, Nova Scotia, Canada.

Abundance, diversity and community structure of soil organisms are mostly affected by the above-ground ecology and abiotic parameters. In turn, the decomposer food web and mycorrhizae can affect the plant community. In managed pastures, plants are exposed to intensified livestock grazing, fertilizer application, and machine traffic, that may alter the plant-soil communities and physical parameters. We hypothesized that long-term sustainably managed pastures would have a fungal-dominated soil ecology, in contrast to bacteria dominated soils which indicate frequent disturbance. Three pastures under Management Intensive Grazing (MIG) for 3, 10, and 50 yr (P3, P10, and P50) were selected. The soil organisms enumerated were fungi, naked amoebae, nematodes, collembolan, and mites. Other measured variables included root biomass, root weight loss, soil C and N, pH, soil moisture, and bulk density. Stepwise discriminant analysis showed that centroid distances between P3 and P10 was the shortest suggesting that the soil community of P3 and P10 were most similar (R-square of axis 1: 0.59, axis 2: 0.13). Canonical correspondence analysis (CCA) indicated that the soil communities in P3 and P10 were characterized by greater abundance of predatory and bacterivorous nematodes and earthworm casts suggesting the dominance of a bacterial-based energy pathway. The 50 yr pasture was associated with a higher abundance of fungi, fungal feeding, root feeding and omnivorous nematodes, collembolan, and oribatid mites indicating the dominance of a fungal pathway. CCA eigenvalues were 0.26 for axis 1 and 0.006 for axis 2 with species-environment correlation of 0.82 and 0.67 respectively. We conclude that long-term MIG promoted the fungal pathway suggesting sustainable low impact disturbance.

Effect of re-cropping infested wheat stubble on wheat stem sawfly survivorship. Brian Beres* and Héctor Cárcamo. Agriculture and Agri-Food Canada, Research Centre, 5403 1st Avenue South, Lethbridge, Alberta, Canada T1J4B1.

Conservation cropping practices have allowed producers in semi-arid regions to increase continuous cropped acres vs. the traditional half cropped/half fallow system. Most semi-arid regions of the southern prairies are prone to wheat stem sawfly attack. We were interested to determine what impact re-cropping infested wheat stubble with spring or winter wheat, as opposed to leaving the stubble as fallow, would have on wheat stem sawfly survivorship. Adult sawfly emergence from undisturbed stubble was compared to stubble that was harrowed with heavy tine or rotary drum harrows prior to re-cropping. Adult emergence from a control of no re-cropping was compared to re-cropping infested stubble with (1) air seeders configured with 23 or 30 cm row spacing and knife type openers, (2) an air seeder configured with a 23 cm row spacing and a high disturbance shovel type sweep opener and (3) a low disturbance John Deere disc type opener. Heavy harrow residue management significantly reduced the adult population compared to leaving the stubble undisturbed prior to seeding when spring tensions or drum angle was set at 5° and 45°, respectively. The pre-seed harrow treatment in the winter wheat system reduced grain yield, therefore, residue management for control of sawfly in a

winter wheat system may not sustainable. Re-cropping infested stubble significantly reduced sawfly populations compared to leaving the field as a chemical fallow. Sawfly survivorship results between seeding systems did not differ significantly but the high disturbance sweep opener consistently produced the lowest grain yield.

Effect of cultivar and alternative seeding strategies on wheat stem sawfly survivorship. Brian Beres* and Héctor Cárcamo. Agriculture and Agri-Food Canada, Research Centre, 5403 1st Avenue South, Lethbridge, Alberta, Canada T1J 4B1.

The wheat stem sawfly is a major production constraint in 10–14 million acres of wheat grown in the southern prairies of Canada. Our objective was to assess the potential of novel seeding strategies and to validate the negative impact of solid-stemmed cultivars on sawfly fitness. The solid-stemmed cultivar AC Eatonia was utilized in a trap crop system that consisted of a 20 m or 40 m border of AC Eatonia planted adjacent to a field of the susceptible hollow-stemmed cultivar AC Barrie. This strategy was compared to monoculture systems of AC Eatonia and AC Barrie, and to a 1:1 blend of these two cultivars. AC Eatonia was significantly more effective at reducing sawfly survivorship than any other treatment and had significantly higher grain yield than AC Barrie. The 20 m trap treatment did not stabilize yield and was not effective at killing sawflies. The 40 m trap crop was effective at stabilizing the yield of AC Barrie planted to the interior of field. However, this practice did not reduce the population of overwintering larvae and, therefore, should only be considered when sawfly pressure is low or there are inadequate supplies of solid-stemmed cultivars. Cultivar blends improved yield and reduced the sawfly population but the yield results were not significantly greater than AC Barrie. The study results demonstrate the agronomic attributes of solid-stemmed cultivars such as AC Eatonia are competitive if not superior to hollow-stemmed cultivars, and they reduce the sawfly population.

Effect of row spacing and seeding rate on hybrid corn silage yield in southern Alberta. Brian Beres^{1*}, Ken Coles¹, and Corny Van Dasselaar². ¹Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada, ²BenchMark Seeds (Alberta) Ltd.

Corn silage production is a relatively young practice in southern Alberta and continues to replace barley as the preferred crop for feedlot operators. This study was initiated in 2005 at Vauxhall, Alberta, and was designed to determine optimal seeding rates for irrigated hybrid corn silage production for 15 inch (38 cm) and 30 inch (76 cm) row spacing configurations. Five seeding rates ranging from 26 000 to 46 000 kernels per acre were planted in both 15 inch and 30 inch row spacings. Corn silage yield response to seeding rate was highly significant and consistent with a second degree polynomial curve. The highest attainable yield was reached with plant populations of 32 000 and 36 000 plants per acre, or, at the 30 000 and 34 000 kernels/acre seed rates. The maximum yield for the 15 inch row spacing was achieved at the 34 000 kernels per acre rate, whereas the 30 inch row spacing required 38 000 kernels per acre to achieve maximum yield. The 15 inch row spacing produced a mean dry matter yield across all seeding rates of 6.24 tons per acre vs. 5.75 tons per acre for the 30 inch row spacing. The preliminary results from year 1 of this experiment indicate that the 15 inch row spacing configuration produces higher plant populations and improved yield over the 30 inch row spacing.

Organic crop management reduces labile phosphorus. Catherine Welsh^{1*}, Martin Entz², Don Flaten¹, Sola Ajiboye¹, Cynthia Grant³, and Mario Tenuta¹. ¹Department of Soil Science,

University of Manitoba, Winnipeg Manitoba, Canada R3T 2N2; ²Department of Plant Science, University of Manitoba, Winnipeg Manitoba, Canada R3T 2N2; ³Agriculture and Agri-Food Canada, Brandon Research Centre, Brandon Manitoba, Canada R7A 5Y3.

Since phosphorus (P) is a non-renewable resource, there are concerns with agricultural practices that mine P from the soil. Many organic farm systems surveyed in the prairies showed a deficiency in soil test P. The purpose of this study is to determine if common organic management systems are mining P from the soil or changing the forms of P. The research was carried out at the 14-yr study at Glenlea, in Southern Manitoba. This site consists of 3 different 4-yr rotations under organic and conventional management: Wheat–Alfalfa–Alfalfa–Flax with and without animal manure, Wheat–Pea–Wheat–Flax, and a restored prairie planting. The modified Hedley procedure was used to determine levels of P in different P fractions. Crop yields and P additions throughout the 14 yr were used to calculate P removal. The organic rotations had lower levels of readily plant available P fractions than conventional (e.g., Alfalfa: organic $P = 27.1$, conventional $P = 53.13$ mg P kg⁻¹ soil) but the recalcitrant fractions were not significantly different ($P = 0.05$). The P budget of organic and conventional crops over the years shows that organic systems reduce labile P at a low rate due to low yields (e.g., Alfalfa rotation 2003: Organic flax yield = 481.9, conventional flax = 1328.5 kg ha⁻¹). This data suggests that many organic systems slowly reduce only labile P fractions.

Effectiveness of controlled release urea and split nitrogen applications in crop production on the Canadian Prairies. C.A Grant* and R. Wu. AAFC Brandon Research Centre, Box 1000A, R.R.#3, Brandon, Manitoba, Canada R7A 5Y3.

Efficiency of nitrogen fertilizer should be improved if the N supply is closely matched to crop uptake, both in terms of amount and timing. In many systems, split N applications are used to provide the N to the crop as it is needed. Another way of synchronising N supply with crop demand is by the use of controlled release fertilizers. Field studies were conducted in locations across the prairies to evaluate the effectiveness of split or controlled release urea applications as compared to traditional application of urea banded at the time of seeding. The sites were selected to provide a range of environments. Use of controlled release urea tended to improve plant biomass, grain yield, and N uptake under wet conditions, but had little benefit when conditions were dry. Applying half of the N at seeding and the other half at tillering also improved crop yield under wet conditions. Use of split applications or controlled release products may therefore improve N efficiency where wet conditions lead to a high risk of N loss by leaching or denitrification.

Split application of nitrogen in oilseed flax production. D. Pageau* and J. Lajeunesse. Research Farm, Agriculture and Agri-Food Canada, Normandin QC, Canada.

In the province of Quebec (Canada), oilseed flax (*Linum usitatissimum* L.) production is still uncommon. Until now, there is no fertilization recommendation for Quebec flax growers. Four nitrogen application rates (0, 15, 30, and 45 kg ha⁻¹) in one or two applications were evaluated during 3 yr (2003–2005). Fertilization was broadcasted at a single application at pre-seeding or a split application with half rate at pre-seeding and the other half at the plant height of 10 cm. In 2003, the application of 45 kg N ha⁻¹ significantly reduced grain yields compared to 0 kg N ha⁻¹. Lodging tend to be higher with high nitrogen fertilization. However, in 2004 and 2005, nitrogen fertilization had no significant effect on oilseed flax

production. Nitrogen fertilization as a single or split application had no significant effect on straw yield, lodging or seed oil content during the 3 yr. Cold and wet conditions prevailing in some areas in Northern Quebec could be beneficial for oilseed flax production. However, it seems that there is no advantage to apply high nitrogen fertilization for flax grown under cool conditions.

Nutrient distribution in tubers of *Solanum tuberosum* var. Shepody and Russet Burbank. E.L. LeRiche^{1*}, G. Wang-Pruski¹, V. Zheljzkov². ¹Department of Plant and Animal Sciences, Nova Scotia Agricultural College, PO Box 550, Truro, Nova Scotia, Canada B2N 5E3, ²Department of Plant and Soil Sciences, Mississippi State University, PO Box 1690, Verona, Mississippi, USA, 38879.

Many plant nutrients are associated with potato tuber processing quality. Some nutrients are difficult to measure *in-situ* using traditional chemical methods. In this study, scanning electron microscopy equipped with an energy dispersive X-ray microanalyzer was used to map elemental nutrients in potato tissue. Samples were taken from tubers of the cultivars Shepody and Russet Burbank from fertilized and non-fertilized plots. Each sample was divided into eight segments from stem to bud. Mapping showed a higher overall concentration of P, Mg, and Ca in fertilized plots compared to unfertilized plots for Shepody and Russet Burbank tubers. P content was correlated with Mg content in Shepody ($r = 0.851$) and Russet Burbank ($r = 0.748$). An increasing gradient of P and Mg from stem end to center of tubers and decrease again towards the bud end was observed in Russet Burbank, but not as noticeably in Shepody. Ca showed a steady decline from stem end to bud end of tubers and little or no correlation to P or Mg for both varieties. P, Mg, and Ca are directly associated with Fe intake, and therefore important for tuber development and storage quality. This study is the first reported attempt in this field.

Variability for non structural carbohydrates amongst alfalfa genotypes. G. F. Tremblay^{1*}, Y. Castonguay¹, A. Bertrand¹, G. Bélanger¹, R. Michaud¹, and R. Berthiaume². ¹Agriculture and Agri-Food Canada, Soils and Crops Research and Development Centre, Québec, QC, Canada G1V 2J3; ²Agriculture and Agri-Food Canada, Dairy and Swine Research and Development Centre, Lennoxville, QC, Canada J1M 1Z3.

Extensive degradation of proteins combined with insufficient readily fermentable energy in alfalfa results in poor forage N utilization by ruminants and substantial N losses to the environment. Our objective was to determine the extent of genetic variability for non structural carbohydrates (NSC) within an alfalfa population. Nearly 500 genotypes from the cultivar AC Caribou were grown under controlled conditions and a first harvest was taken on 2004 Apr 02. These genotypes were subsequently transplanted in a field and harvested a second time on 2004 Sep. 13. Forage samples were immediately dried at 55°C after each harvest and the NSC concentration was determined by NIR spectroscopy. The NSC concentration varied from 5 to 170 mg g⁻¹ DM (mean = 69) at the first, and from 73 to 230 mg g⁻¹ DM (mean = 136) at the second harvest. An additional harvest was taken on 2005 Jul. 28 to validate groupings of genotypes with contrasted NSC concentration. Although the ranking of genotypes changed with harvests, ten genotypes with consistently high (118, 171, and 101) or low (47, 96, and 67 mg g⁻¹ DM) NSC concentrations at the three harvests, respectively, were retained for further characterization. We conclude that extensive variability for NSC concentration exists within alfalfa populations.

Cow condition, milk yields and milk quality when grazing in a modified management intensive grazing system in Atlantic Canada. G. Carignan^{1*}, N. McLean¹, A.H. Fredeen¹, J. Winter¹, and R.C. Martin^{1,2}. ¹Dept. of Plant and Animal Sciences, Nova Scotia Agricultural College, P.O. Box 550, Truro, Nova Scotia, Canada B2N 5E3, ²Organic Agriculture Centre of Canada, Nova Scotia Agricultural College, P.O. Box 550, Truro, Nova Scotia, Canada B2N 5E3.

The experiment examined the effects of grazing intensity on cow weight and body condition score (BCS), milk quality and milk yield. Responses of lactating Holsteins were assessed in a paired t-test ($n = 8$). Grazing treatments were: (Intensive) management intensive grazing (MIG) treatments only; (Extensive) grazing a combination of MIG treatments and those permitted to mature through longer recovery periods with no post-grazing clipping. It was hypothesized that cows grazed intensively would produce more milk, with similar quality, than those grazed extensively due to higher forage quality available to the intensive group. By allowing extensive cows to have access to both intensive and extensive grazing treatments, it was expected that the trade-off would be minimized between: (1) lower forage quality and milk yields and (2) higher biodiversity. As predicted, forage quality was lower in the extensive grazing treatments and milk quality was not compromised in the extensive group. Interestingly, there were no significant differences in milk production in either year. For 2005, average seasonal milk production was 35.2 kg d⁻¹ cow⁻¹ and 33.6 kg d⁻¹ cow⁻¹ for the intensive and extensive group respectively (non-fat-corrected milk). Body weight and BCS did not differ. Biodiversity changes will continue to be studied over three additional field seasons.

Life cycle analysis of an environmental technology to better manage efficiency of nitrogen fertilizers in durum wheat. Goretty M. Dias^{1*}, Lindita Bushi¹, Steven B. Young¹, Carlos M. Monreal², Guy Lafond³, Judy McKell⁴, Chris Holzapfel. ¹GHGm.com, Guelph, Ontario, Canada N1H 4W8, ²Agriculture and Agri-Food Canada, Ottawa, Ontario, ³Agriculture and Agri-Food Canada, Indian Head, Saskatchewan, ⁴Indian Head Agricultural Research Foundation, Indian Head, Saskatchewan.

A Canadian agricultural life cycle analysis model was used to analyze the environmental performance of an environmental technology (ET) used to effectively manage N fertilizers across a wheat field. The ET uses a GreenSeeker™ sensor to determine an estimate of crop growth and N status. By linking the sensor to a liquid N applicator, the required amount of N is applied to the field. This technology was compared to the baseline situation, in which all the N is applied to wheat fields prior to seeding. Preliminary results from the life cycle analysis showed that the ET used less energy per 1000 kg wheat harvested than the baseline (916 MJ compared to 1012 MJ) and produced fewer greenhouse gas emissions (61 kg CO₂e compared to 71 kg CO₂e). The ET addresses the issue of spatial variability for N and precisely identifies field areas requiring nitrogen. Other environmental indicators that were measured include nitrous oxide emissions, ammonia emissions, and residual N in the soil, but these results are pending. The precise application of N should reduce the potential for N accumulation and the risks of leaching, denitrification, ground water contamination and nitrous oxide emissions.

Development of a life cycle analysis model for Canadian agriculture. Goretty M. Dias^{1*}, Lindita Bushi¹, Steven B. Young¹, Carlos M. Monreal². ¹GHGm.com, Guelph, Ontario, Canada N1H

4W8, ²Agriculture and Agri-Food Canada, Ottawa, Ontario, Canada.

The Environmental Technology Assessment for Agriculture (ETAA) Program was established to identify innovative and sustainable environmental technologies (ETs) that maintain/enhance the health of soil, water and air, and reduce adverse impacts on biodiversity. One method that is capable of assessing the environmental performance of ETs is life cycle analysis (LCA), a method originally developed to assess environmental impacts of products and services. The master LCA model framework, developed for application to Canadian agricultural systems, will be discussed. The model tracks energy/material inputs, and outputs (emissions to air, water, and land) through the agricultural system from source to their exit through the farm gate. Where possible, Canadian core data on energy, materials, transportation, and various processes were compiled from referenced sources. The model analyzes environmental performance based on ETAA-specific indicators, founded on Canadian policy priorities. These were net energy use, renewable energy, greenhouse gases, ammonia emissions, residual N, P loading, soil carbon, soil erosion, pesticide hazard, pathogen reduction, and biodiversity. The model framework is also discussed with respect to gaps in databases, and the need to develop impact categories and characterization models to fit Canadian agricultural requirements for comparing production system impacts.

Adaptation of Pulse Crops to a Changing Climate in the Northern Great Plains. Herb W. Cutforth^{1*}, Sean M. McGinn², and Kevin E. McPhee³. ¹Agriculture and Agri-Food Canada, P.O. Box 1030, Swift Current, Saskatchewan, Canada S9H3X2; ²Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, Alberta, Canada T1J4B1; ³USDA-ARS, 303 Johnson Hall, Pullman, WA 99164-6434.

Climate over the Northern Great Plains has generally warmed over the last 60 yr. The rate of warming has not been uniform over time and space, and this has confounded trend analysis for climate indicators such as increased length of the growing season and accumulated heat units. Similar to temperature, there has been a variable response in precipitation. Despite this variability, present-day trends in temperature and precipitation coincide with the predicted direction of climate change. The synchrony of current and future trends reinforces the need for investigating adaptation of agricultural regions to changing climate. Pulse crops are being rapidly accepted as alternative crops in the Northern Great Plains, especially on the Canadian semiarid prairie. Our review is focused on sustainability of pulse crops in the Northern Great Plains and the repercussions of climate change, focusing on the growth and yield response to temperature and water. The resilience of pulse crops to present-day weather extremes such as drought, excess water, heat, cool weather during grain filling, and early frost are considered to define adaptation to future climate change. Features discussed include changes to crop water-use efficiency brought on by increased CO₂ fertilization, accelerated growth rates resulting from higher air temperatures, and total crop failures caused by an increased occurrence and magnitude of weather extremes. Adaptation strategies that are considered include earlier seeding of pulse crops to coincide with warmer spring conditions and avoid mid to late summer droughts, and use of winter pulses to take advantage of milder winters and spring moisture conditions. Crop sequencing within crop rotations, and alterations to the microclimate such as direct seeding into standing stubble, are areas of research providing promise for adaptation of pulse crops to future climates.

Leaf appearance rate, double ridge and terminal spikelet initiation rates, and final leaf number for the main stem of spring wheat, fall rye and winter wheat varieties. Herb Cutforth* and Y. Jame. Agriculture and Agri-Food Canada, Box 1030, Swift Current, Saskatchewan, Canada S9H3X2.

We had conducted a series of growth chamber experiments at temperatures between 5 and 35°C to study the effects of temperature on the phenological response of spring wheat (cv. Barrie), and two winter cereals, fall rye (cv. Prima), and winter wheat (cv. Clair). We determined the effects of temperature on apical development, leaf appearance rate, and final leaf number. Spring and winter cereals respond very differently to temperature. Optimum temperature for leaf appearance rate was between 20 and 25°C for both spring and winter cereals. However, optimum temperature for apical development was about 10°C for the winter cereals and between 20 and 25°C for spring wheat. Below about 20°C Prima fall rye and Clair winter wheat responded very similarly to temperature, but responded quite differently at temperatures above 20°C. The main stem of spring and winter cereals produced similar leaf numbers for temperatures below 10°C. However, as temperatures increased above 10°C, the winter cereals produced more leaves at a faster rate than spring wheat.

Estimation of evapotranspiration on the Canadian prairies using simple models with limited weather data. Charles Maulé¹, Herb Cutforth^{2*}, Warren Helgalson², Sean McGinn³. ¹Dept of Agriculture and Bioresource Engineering, 57 Campus Drive, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N5A9; ²Agriculture and Agri-Food Canada/Agriculture et Agroalimentaire Canada, Semiarid Prairie Agricultural Research Centre, P.O. Box 1030, Swift Current, Saskatchewan, Canada S9H3X2; ³Center for Hydrology, 117 Science Place, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N5C8; ⁴Agriculture and Agri-Food Canada/Agriculture et Agroalimentaire Canada, 5403 - 1 Avenue South, Lethbridge, Alberta, Canada T1J4B1.

Potential evapotranspiration (PET) can be accurately determined with a Penman-Monteith model, however this model requires inputs that are not all measured at most climatic stations. The agricultural region of the Canadian Prairies is a large geographic region of dry continental climate (cold semi-arid to subhumid) and could benefit from simple, yet accurate empirical models for determination of evapotranspiration. We used daily weather data from 2003 and 2004 from ten stations across the agricultural region of the prairies to develop temperature, temperature-relative humidity, and temperature-relative humidity-wind models. Our models were developed by regression using the ASCE (2005) standardized reference model for calculating potential evaporation from a well-watered short crop surface (ET₀) as the "observed" variable. Models developed in this study, ET_t and ET_{tr}, provided increased accuracy for estimating evapotranspiration compared to the models of Baier and Robertson (1965) and Linacre (1977). ET_t and ET_{tr} are recommended for use within agricultural regions of the prairie provinces where daily weather data is limited to just temperature or temperature and humidity. The model of choice will depend upon the daily weather data collected. The most accurate and precise model was ET_{tru}, which used temperature, humidity and wind speed. However, we recognize that few weather recording sites measure wind speed and/or humidity (dew point temperature).

Genotypic variation in water use in wheat. H.Wang*, T.N. McCaig, R.M. DePauw, J.M. Clarke, and R. Lemke.

SPARC/AAFC, Box 1030, Swift Current, Saskatchewan, Canada S9H 3X2.

The moisture condition is often not favourable to wheat growth in the Canadian semiarid prairie. Some research suggested that droughts are likely to become more frequent and severe with climate change. It is, therefore, important to optimize water use by means of improving cropping management. A 3-yr (1998–2000) study conducted on a Swinton loam soil in the experimental farm of Semiarid Prairie Agricultural Research Centre, AAFC at Swift Current, Saskatchewan showed that in the Canada Western Red Spring (CWRS) class, AC Intrepid consistently used more water every year (averaged 15.5 mm more in 3 yr), but did not yield more grain or biomass compared with AC Elsa. In the Canadian Western Amber Durum (CWAD) class, genotypic difference in water use was relatively small. Compared with CWRS, the CWAD class used more water, which was associated with more yield and more biomass. Genotypic differences in water use were mainly caused by different water extractions at the soil depth deeper than 55 cm during in the late part of the growing season. The information can be used for making management decisions. We can use low-water use cultivars to conserve soil water for the continuous cropping system or use high-water use cultivars to reduce drainage and nitrogen leakage.

Patterns of AFLP variation in *Festuca hallii* as revealed by tiller and seed samplings. Jie Qiu^{1*}, Yong-Bi Fu², Yuguang Bai¹, and John Wilmshurst³. ¹Department of Plant Sciences, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 5A8; ²Plant Gene Resources of Canada, Saskatoon Research Centre, Agriculture and Agri-Food Canada, 107 Science Place, Saskatoon, Saskatchewan, Canada S7N 0X2; ³Western and Northern Service Centre, Parks Canada, 145 McDermot Avenue, Winnipeg, Manitoba, Canada R3B 0R9.

Sampling plant materials from natural stands is an important component in plant diversity studies and germplasm conservation but its effectiveness in capturing genetic variation is poorly known. Three types of samples, reproductive tillers, vegetative tillers and seeds, were collected from six natural populations of plains rough fescue [*Festuca hallii* (Vasey) Piper] in Manitoba and Saskatchewan. Three AFLP primer pairs were employed to screen 529 samples representing about 30 samples for each sample type collected in each location, and 330 polymorphic AFLP bands were scored for each sample. Analysis of these scored bands revealed that 90–93% of the total AFLP variation was presented within tiller populations reproductive and vegetative tillers and within seed populations. Comparisons of AFLP profiles among sample types indicated that the reproductive and vegetative tillers revealed fewer polymorphic bands and greater inter-population distances (Phi statistic) than seed samples. Larger genetic variation among the six PRF populations was found in the reproductive and vegetative tillers than in the seed samples. These findings indicate tiller samples are more effective than seed samples in capturing genetic variation of PRF populations and are useful for determining the appropriate strategies for conservation and management of PRF in Fescue Prairie.

The genetics of earliness in Canadian spring wheat. M. Iqbal^{1*}, A. Navabi¹, D. Salmon², R-C. Yang^{1,3} and D. Spaner¹. ¹Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, Alberta, Canada T6G 2P5; ²Field Crop Development Centre, Alberta Agriculture and Rural Development, Lacombe, Canada; ³Policy Secretariat, Alberta Agriculture and Rural Development, Edmonton, Canada.

Due to the short growing season in western Canada, the development of early maturing spring wheat (*Triticum aestivum* L.) cultivars is important to avoid frost damage which can adversely affect production and quality. We investigated earliness in five randomly selected western Canadian spring wheat cultivars differing in maturity, and their F₁ and F₂ crosses made in a one-way diallel mating design. Flowering time in parental genotypes was found to be controlled by both vernalization response and earliness per se genes. Additive gene effects accounted for 77% of the total phenotypic variation in flowering time. General combining ability effects were positive for Taber and Foremost and negative for Barrie, Cutler and Intrepid. The estimate of narrow-sense heritability of flowering time was relatively high (78%). Analyses of the F₂ populations conformed to the segregation of two vernalization response genes in six of the ten crosses. Selection for early flowering in early generations would help in the development of early maturing spring wheat cultivars for western Canada.

Productivity, persistence and nutritive quality of deep-rooted forage mixtures under a first-cut harvest and subsequent grazing system. M. de Graaff^{1*}, N. McLean², A. H. Fredeen², and R. C. Martin². ¹Soil & Crop Improvement Association of Nova Scotia, Agrapoint International, 199 Innovation Drive, Truro, Nova Scotia, Canada B2N 6Z4. ²Department of Plant and Animal Sciences, Nova Scotia Agricultural College, P.O. Box 550, Truro, Nova Scotia, Canada B2N 5E3.

Productivity of naturalized pastures in Maritime Canada has been limited in recent years due to mid-summer droughts. Naturalized pastures in the region contain shallow-rooted species, but forages with greater drought tolerance and deeper roots may be able to supplement naturalized pastures during periods of drought. Persistence, productivity and quality of 10 deep-rooted, binary grass-legume mixtures were evaluated under a first-cut harvest and subsequent grazing system. The two legumes were red clover and alfalfa and the five grasses were smooth and meadow bromegrass, orchardgrass and two varieties of tall fescue. No chemical fertilizer was added. There were no differences in yield between mixtures in any year. Total seasonal yields (kg ha⁻¹) for 2001, 2002 and 2003 were 6403, 8029 and 7123, respectively. Red clover mixtures yielded more in the first production year, while alfalfa mixtures outyielded red clover thereafter. Smooth and meadow bromegrass mixtures were of highest quality, contained the highest quantity of legume and persisted under grazing. Quality of orchardgrass mixtures varied. Many tall fescue and orchardgrass plots were winter-damaged during 2002–2003. All mixtures performed well in the trial and are a viable option in a management intensive grazing system.

Characterization of the genetic diversity of cotton cultivars by AFLP markers. Naveed Murtaza*, Bahauddin Zakaryia University, Multan Pakistan.

Amplified fragment length polymorphism (AFLP) markers were used to evaluate the genetic diversity for heat resistance among cotton (*Gossypium hirsutum* L.) cultivars. AFLP markers could easily distinguish uniquely all the cultivars as is evident from the dendrogram of combined profiles of eight primer-pairs. All the cultivars could also be discriminated from one another by way of producing cultivar-specific unique markers using this set of eight primer-pairs. Primer-pair M-CTT/E-ACT identified as many as eight cultivars by way of producing unique markers, which was followed by primer-pairs MCAG/E-ACT and M-CTC/E-ACT each of which identified six cultivars. No single primer-pair, however,

could produce markers specific to all the cultivars included in the study. The relative genetic distance was estimated using the complement of Jacquard's coefficient and grouping analyses were derived from UPGMA cluster analysis. This grouping analysis confirmed the broad genetic diversity among the cotton germplasm, which was divided into two main groups. These groups correspond to the Pakistan origin cultivars and US origin cultivars. The relative genetic diversity was greater among the US cultivars than that of the Pakistani cultivars.

Grain amaranth production potential in Southwestern Québec. B. Gélinas and P. Seguin*. Department of Plant Science, McGill University - Macdonald Campus, Sainte-Anne-de-Bellevue, QC, Canada H9X 3V9.

Grain amaranth (*Amaranthus* spp.) is a pseudocereal with interesting nutritional properties. It is gluten free, high in protein and lysine, and has potential industrial uses. The crop was successfully introduced in the northern United States. However, its potential in eastern Canada is currently unknown. Field experiments were conducted at two sites in southwestern Québec to assess grain amaranth potential and identify management requirements. The following factors were evaluated in three split-plot experiments: (i) seeding rate and row width, (ii) nitrogen rate and cultivar, and (iii) seeding date and cultivar. A fourth experiment consisted in the evaluation of 30 different genotypes. Grain yield and phenological development were determined in all experiments. The crude protein and oxalate contents of the 30 genotypes were also determined to assess whether genetic variability exists for these traits. Grain yields ranged between 350 and 1627 kg DM ha⁻¹ and averaged 820 kg DM ha⁻¹. Yields were affected by sites and cultivars only. Variations of 45 and 133% in crude protein and total oxalate concentrations were observed among genotypes evaluated. These preliminary results thus indicate that grain amaranth could be grown in southwestern Québec and demonstrate that there is significant variation among genotypes for grain quality characteristics.

Yield, nutritive value, and persistence of autumn-harvested tall fescue. R. Drapeau^{1*}, G. Bélanger², G.F. Tremblay², and R. Michaud². ¹Agriculture and Agri-Food Canada, Soils and Crops Research and Development Centre, Normandin, QC, Canada G8M 4H3, ²Agriculture and Agri-Food Canada, Soils and Crops Research and Development Centre, Québec, QC, Canada G1V 2J3.

Autumn-harvested tall fescue is an interesting source of forage but little is known on the effect of a third harvest taken in autumn on yield and nutritive value in areas with around 1400 growing degree-days. Three cultivars were submitted to five dates of third harvest (early September to late October) combined with two dates of second harvest in the Lac-St-Jean area of Quebec. Cultivars Courtenay and Kokanee were more productive and persistent than Montebello. Third-harvest DM yields of around 4.0 Mg ha⁻¹ in the first two production years and 2.8 Mg ha⁻¹ in the third production year were obtained. Third-harvest DM yields were also less when the second harvest was delayed to 35 d rather than 28 d after the first one. Annual DM yields decreased in the second and third production years; this decrease was greater with a third harvest in early October. The concentration of CP decreased to 120 g kg⁻¹ DM, that of water soluble carbohydrates increased to 150 g kg⁻¹ DM, while that of ADF changed very little with the delay of the third harvest. The third harvest should not be taken around the first killing frost to ensure good persistence and spring regrowth the following year.

Common bunt resistance gene B-10 located on chromosome 6D. J.G. Menzies¹, R.E. Knox^{2*}, Z. Popovic¹, J.D. Procnunier¹. ¹Cereal Research Centre, Agriculture and Agri-Food Canada, 195 Dafoe Road, Winnipeg, Manitoba, Canada R3T 2M9; ²Semi-arid Prairie Agricultural Research Centre, Agriculture and Agri-Food Canada, Box 1030, Swift Current, Saskatchewan, Canada S9H 3X2.

The chromosomal location of disease resistance genes assists in identification and classification of those genes. Determination of the chromosomal location in wheat of the common bunt (*Tilletia caries* and *T. laevis*) resistance gene Bt10 was the goal of this study. Doubled haploid lines were developed from the F₁ seed of the cross between bunt susceptible Glenlea and Bt10 resistant AC Taber using the maize pollen method. The doubled haploid lines were inoculated with *T. caries* race T19, grown in the greenhouse, and rated for bunt near maturity. DNA was extracted from lines of the population, and a series of wheat microsatellite (WMS) primers were tested on the DNA. The doubled haploid population gave a 1:1 segregation for bunt reaction with clear separation between resistant and susceptible classes. A 1:1 segregation occurred for a DNA polymorphism generated by gwm469 located in chromosome 6D. Combined segregation of bunt resistance and the gwm469 polymorphism differed significantly from a 1:1:1:1 ratio with a preponderance of parental types, indicating linkage of gwm469 with Bt10. The map distance was about 18 cM. The linkage between gwm469 and Bt10 indicates Bt10 is located in chromosome 6D.

A quantitative trait locus for leaf spot reaction in durum wheat. R.E. Knox^{1*}, F.R. Clarke¹, J.M. Clarke¹, S. Houshmand². ¹Agriculture and Agri-Food Canada, Semiarid Prairie Agricultural Research Centre, P.O. Box 1030, Swift Current, Saskatchewan, Canada S9H 3X2, ²University of Shahrekord, Faculty of Agriculture, P.O. Box 115, Shahrekord, Iran.

Leaf spotting diseases can be a serious problem on durum (*Triticum turgidum* L. var *durum*) grown in the semiarid wheat production area of western Canada. The present study was undertaken to identify loci associated with leaf spot resistance. A set of 155 doubled haploid lines was developed from the cross (Kyle*2/Biodur)/Kofa using the maize pollen method. The Kyle*2/Biodur parent (an F9 line) had a moderate level of resistance to leaf spot, and Kofa was susceptible. Leaf spots were rated in field trials near Swift Current, Indian Head and Regina, Saskatchewan in 2001 and 2002. The parents were tested for polymorphism with wheat microsatellite (simple sequence repeat) markers. Primers that were polymorphic on the parents were tested on the whole population. The computer program MQTL was used to perform QTL analysis with the polymorphic markers and the leaf spot results. Loci associated with leaf spot resistance were located on chromosomes 1B, 2A and 2B. The 1B locus was significant for the Regina environment in 2001. The 2A locus was significant for the 2 yr at Regina. The 2B locus was significant at Indian Head and Swift Current in 2002.

Barley and oat performance as sole crops and in mixture with peas. A.G. Todd^{1*} and D. Spaner². ¹Agriculture and Agri-Food Canada, P.O. Box 39088, St. John's, Newfoundland and Labrador, Canada A1E 5Y7; and ²Department of Agricultural, Food and Nutritional Science, 4-16D Agriculture/Forestry Centre, University of Alberta, Edmonton, Alberta, Canada T6G 2P5.

Growing a mixture such as peas, oats and vetch on land that has been recently cleared is an agronomic practice adopted by some

farmers in marginal growing regions to stabilize and build soil structure. We examined the potential for yield and nutritive value of pea, barley and oat when grown in pure stand or combinations of pea and cereal and harvested for ensiling, over three site-years at the AAFC research centre in St. John's, NL. Our treatments consisted of peas planted at two seeding rates, barley and oat at one rate, as sole crops, and peas and the cereals at two rates each in mixture. Barely produced greater yield, lower percent ADF and NDF than oat as a sole crop and in combination with peas. Combining peas with a cereal increased percent protein over pure stand cereal and increased it greater in barley than oat. Growing barley in combination with peas would be a better choice than either barley or oat alone or a mixture of peas and oat.

High yielding and Winterhardy Kayak orchardgrass cultivar for western Canada. Surya Acharya^{1*}, Yeves Castongey², and Doug Friebel¹. ¹Agriculture and Agri-Food Canada, Research Centre, 5403-1st Ave. S., Lethbridge, Alberta, Canada T1J 4B1; ²Agriculture and Agri-Food Canada, Research Centre, 2560 Boul. Hochelaga, Ste-Foy, QC, Canada G1V 2J3.

Kayak orchardgrass (*Dactylis glomerata*) was developed by the Agriculture and Agri-Food Canada Research Centre, Lethbridge, Alberta. This cultivar, tested as OG 96-1 in Western Forage Trials (WFT) is a synthetic cultivar derived from selections of 600 lines tested for winterhardiness, dry matter yield and forage quality. In 1995, 23 lines were selected and 10 grams of seed from each line was bulked and seeded in 1996 for seed increase. Seed from this population was evaluated across western Canada in 1997 through 2002 for forage yield. Seed yield was evaluated at Lethbridge and in Oregon (USA). Kayak produced more forage (t DM ha⁻¹) than Kay (check cultivar in western Canada) on both irrigation and dryland, 9.4 vs. 8.9 and 6.3 vs. 6.1, respectively and more seed (t ha⁻¹) than the check under irrigation at Lethbridge, 0.49 vs. 0.44 and 1.3 vs. 0.9 in Oregon. Kayak is more winterhardy than Kay and can be grown both under dryland and irrigated conditions in western Canada. Seed multiplication and distribution rights for Kayak orchardgrass have been granted to Terralink Horticulture, BC. Seed for the new cultivar will be available for commercial production in the fall of 2006.

Interspecific variation in cadmium phytoextraction, growth, and nutrient uptake in C3 grasses. S. Sabreen*, S. Sugiyama. Department of Bioproduction, Faculty of Agriculture and Life Sciences, Hirosaki University, Hirosaki 036-8561, Hirosaki, Japan.

A history of Itai Itai incident, soil properties and extensive use of phosphate fertilizers generally draw the attention for phytoavailability of cadmium (Cd) in Japanese agriculture. Phytoremediation can be a cost effective alternative for the treatment of contaminated soils. Moreover, extensive research is necessary to screen for Cd hyperaccumulating plant from high biomass species. Grass has advantage of higher biomass, higher growth rate, as well low management requirement, and thus can be valuable source for phytoremediation. This study was conducted to observe the interspecific variation in cadmium tolerance among the grass species adapted to cool-humid region. The populations of ten cool season grass species, namely *Agrostis alba*, *Anthoxanthum odoratum*, *Dactylis glomerata*, *Festuca arundinacea*, *Festuca ovina*, *Festuca pratensis*, *Festuca rubra*, *Lolium multiflorum*, *Lolium perenne*, *Poa pratensis*, were evaluated for their response to different concentrations of Cd (0, 5, 10 and 50 µM) in hydroponic culture. Generally, Cd application inhibited shoot biomass, uptake of potassium (K),

calcium (Ca), magnesium (Mg), zinc (Zn), iron (Fe) and manganese (Mn). There were differential species responses in the uptake of Cd, and Cd accumulation in plants was proportional to Cd availability. Cadmium treatment was positively correlated with percent inhibition (PI) of nutrient elements and relative rate of growth reduction (RGR), while negatively correlated with tolerance index (TI) of the species. Moreover, Cd treatment significantly affected efficiency ratio (ER) and uptake of nutrient elements. The species can be arranged for Cd accumulation as *L. multiflorum* > *D. glomerata* > *F. pratensis* = *L. perenne* > *A. odoratum* > *F. arundinacea* > *F. rubra* = *P. pratensis* > *A. alba* > *F. ovina*. Results indicated that Cd may be uptake and transported by the plants by sharing Ca channel and/or transporters for Fe/Mn. Among the species, *L. multiflorum* showed highest Cd accumulation for all Cd treatments. Comparison among species for TI and RGR, showed that *L. multiflorum* has higher potential for phytoremediation. Results inferred that selecting genotypes from different cultivars and ecotype of *L. multiflorum* can benefit developing genotypes for higher Cd phytoextraction.

Use of phosphate fertilizer and swathing improves fenugreek (*Trigonella foenum-graecum* L.) seed and forage yield under western Canada prairie conditions. S. K. Basu^{1*}, S. N. Acharya², D. R. Friebel² and J. E. Thomas¹. ¹Department of Biological Sciences, University of Lethbridge, 4401 University Drive, Lethbridge, Alberta, Canada T1K 3M4; ²Agriculture and Agri-Food Canada, Lethbridge Research Centre, PO Box 3000, Lethbridge, Alberta, Canada T1J 4B1.

Fenugreek (*Trigonella foenum-graecum* L.) is an annual legume crop being introduced to North America for its high quality, yield and medicinal properties. Tristar, the first North American forage cultivar, has shown inconsistent seed production in western Canada. Cultural practices for improvement in seed and forage production of this cultivar were evaluated at Lethbridge under rainfed and irrigated conditions over two growing seasons. A highly significant effect ($P < 0.001$) of growing conditions and rate of phosphate fertilizer application (0, 30, 40, 50 and 60 kg ha⁻¹) for forage and seed yield were observed. For seed production 40 to 50 kg ha⁻¹ of phosphate application was found to be most effective while for forage production 50 to 60 kg ha⁻¹ P was best. Cutting the plants and leaving them in a swath before combining the seed yielded significantly ($P < 0.001$) more seed compared to direct combining of the seed from a standing crop sprayed with desiccant. For improved seed production under western Canada prairie conditions a fenugreek crop should be fertilized with an appropriate amount of phosphate and, swathing should be practiced.

Genotype × environment interaction effects observed in fenugreek (*Trigonella foenum-graecum* L.) grown on the Western Canada prairies. S. K. Basu^{1*}, S. N. Acharya², D. Friebel², M. Bandara³, and J. E. Thomas¹. ¹Department of Biological Sciences, University of Lethbridge, 4401 University Drive, Lethbridge, Alberta, Canada T1K 3M4; ²Agriculture and Agri-Food Canada, Lethbridge Research Centre, PO Box 3000, Lethbridge, Alberta, Canada T1J 4B1; and ³Crop Diversification Centre South, S. S. No. 4, Brooks, Alberta, Canada T1R 1E6.

Fenugreek (*Trigonella foenum-graecum* L.) is being developed as a forage legume for the western Canada prairies. Tristar fenugreek, the first North American forage cultivar, does not produce good quality and quantity of seed every year as it requires about 120 d to produce mature seed in western Canada. The objective of the present study was to determine if genotype × environment interac-

tions have an impact on yield parameters. For this purpose two experiments were conducted: (1) 45 accessions originating from different parts of the world were grown under dryland and irrigated conditions at Lethbridge, Alberta; (2) five genotypes selected for high dry matter yield were grown at seven different locations (environments) in western Canada. The location effect in the world accession study was significant for forage yield. For seed yield, year, genotype, year \times location and, year \times genotype interactions were significant. Seed yield of this crop is influenced by environment more than forage yield and in this study, the interaction effect of year \times genotype for seed yield was significant ($P = 0.05$). The multi-environment study also indicated a highly significant effect of environment on both forage and seed yield while, only genotypic effects were significant for forage yield ($P = 0.05$). This study indicates that improvement in seed yield will be difficult and, will require selection using multiple locations and years due to very strong genotype \times environment interactions.

Medicinal plants may affect plant parasitic nematodes in Nova Scotia soil. Valtcho D. Zheljazkov^{1*}, Claude Gallant², and Joe Kimpinski². ¹Mississippi State, North Mississippi Research and Extension Center, 5421 Highway 145 South, Verona, MS 38879, USA; ²Crops and Livestock Research Centre, Agriculture and Agri-Food Canada, 440 University Ave. Charlottetown, PE, Canada C1A 4N6.

The hypothesis of this study was that some medicinal plants may suppress and perhaps eliminate plant parasitic nematodes in soil. In a field experiment in Nova Scotia, we studied the effect of forty seven (47) plant species and varieties on soil-inhabiting nematodes. We found that a number of medicinal plants harboured low populations of plant-parasitic nematodes. Specifically, hyssop, hollyhock, thorn apple, marshmallow, valerian, gypsophylla, St. John's wort, winter savory, elecampane, clary sage, garden sage, feverfew, tarragon, yellow poppy, foxglove, marigold, and dill supported low levels of root-knot nematodes. Also, the numbers of root-knot nematodes in soil under hollyhock, marshmallow, valerian, savory, dragonhead, clary sage, feverfew, tarragon, and foxglove were below 500 nematodes kg^{-1} of soil. In addition, root lesion nematodes were not detected in gypsophylla and yellow poppy. Result from this study may be useful for both conventional and organic cropping systems, though more research is needed to confirm these results.

Comparison of five digestion procedures for recovery of nutrients and trace elements in plant tissue. Valtcho D. Zheljazkov^{1*} and Paul McNeil². ¹Mississippi State, North Mississippi Research and Extension Center, 5421 Highway 145 South, Verona, MS 38879, USA; ²Department of Plant and Animal Science, Nova Scotia Agricultural College, P. O. Box 550 Truro, Nova Scotia, Canada B2N 5E3.

The objectives of this study was to compare five digestion procedures: AOAC (dry ashing), two nitric acid (NA1, a commonly used and NA2, our modification), and two *aqua regia* (AR1 and AR2) procedures for recovery of 15 plant nutrients and trace elements in corn, swiss chard, thorn apple, and barely flour (certified material). Generally, the recovery of various elements depended on the digestion procedure used and the plant species. NA2 recovered more P, K, S, and Mn than the AOAC or the two AR procedures. In most instances, NA2 recovered more K and Mg than NA1. AR1 and AR2 recovered more Fe than the two NA procedures, and the same as the AOAC. AR2 procedure recovered very similar concentrations of nutrients to the AOAC, and in corn tissue, AR2 procedure

recovered more Zn, Cr, Ni, Cu, and B than the AOAC. AOAC recovered less K and S than any of the other procedures tested. Overall, the three important findings are: (1) NA procedures may be used for recovery of most elements in plant tissue; (2) AR2 procedure is comparable to the official AOAC method for nutrients and trace elements in plant tissue, (3) the official AOAC method used in Canadian plant testing laboratories may underestimate the concentration of K, S, Mn, Cr, and B in plant tissue.

Preemergence and postemergence herbicides for use in dill, fennel, coriander and basil. Valtcho D. Zheljazkov^{1*}, Kelly M. Bowes², Kevin Patterson³, and Glen Sampson⁴. ¹Mississippi State, North Mississippi Research and Extension Center, 5421 Highway 145 South, Verona, MS 38879, USA; ²SeCan Association, 201-52 Antares Drive, Ottawa, Ontario, Canada K2E 7Z1; ³Department of Environmental Science, Nova Scotia Agricultural College, P. O. Box 550 Truro, Nova Scotia, Canada B2N 5E3.

One of the limiting factors in essential oil crop production in Canada is the lack of registered herbicides for weed control. Greenhouse and field experiments were conducted to screen 30 postemergence and nine preemergence herbicides for weed control in the essential oil crops dill, coriander, basil, and fennel. It was found that crop tolerance was acceptable for the following herbicides: pyridate, linuron, trifluralin, pendimethalin, metolachlor, pronamide, and oxyfluorfen in dill, sethoxydim, isoxaben, linuron, trifluralin, pendimethalin, napropamide, linuron, metolachlor, pronamide, and oxyfluorfen in coriander, sethoxydim, fluzafop-p-butyl, napropamide, pronamide, and oxyfluorfen in basil, and ethofumesate, fluzafop-p-butyl, sethoxydim, linuron, trifluralin, pendimethalin, napropamide, metribuzin, metolachlor, pronamide, and oxyfluorfen in fennel.

Node development of chickpea in a semiarid environment. Y.T. Gan* and L.B. Poppy. Agriculture and Agri-Food Canada, P.O. Box 1030, Swift Current, Saskatchewan, Canada S9H 3X2.

Node development of a crop plant can be used as a reference in timing of foliar fungicide application in control of fungal diseases. A study was conducted in Saskatchewan, 2001–2002, to characterize the node development and their thermal time requirements on the main stem (MS) and on the branches of chickpea (*Cicer arietinum* L.). Large (9.1–11.0 mm) and small (8.1–9.0 mm) diameter seeds were planted at early-, normal-, and late-seeding dates. The MS nodes were numbered upwards from the base, with the 1st node being the one immediately above the hypocotyls. Branches were identified and named in correspondence with their positions on MS. Delay in seeding decreased the total number of branches per plant and of nodes on the late-emerging branches. Nodes on MS ranged from 20 (2001) to 24 (2002), and their appearance was a linear function of growing-degree-days (GDD) when GDD was <650 and was a quadratic relationship when GDD was ≥ 650 . Nodes on higher positioned branches had greater GDD requirements than the earlier branches. The higher positioned branches also required more thermal time units to emerge than the earlier branches. To use node development as a reference for timing of foliar fungicide application in chickpea, one should consider that the GDD requirements vary with node and branch positions on the culm.

Genetic variability of main isoflavones in red clover. Yousef Papadopoulos^{1*}, R. Tsao², K. B. McRae³, A. E. Mellish¹, and S. A. E. Fillmore³. ¹Crops and Livestock Research Centre, Agriculture and Agri-Food Canada, 440 University Ave., Charlottetown,

Prince Edward Island, Canada C1A 4N6; ²Food Research Program, Agriculture and Agri-Food Canada, 93 Stone Road West, Guelph, Ontario, Canada N1G 5C9; ³Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Center, Kentville, Nova Scotia, Canada B4N 1J5.

Isoflavones, known for their health benefits, are found in high amounts in red clover (*Trifolium pratense* L.). The total isoflavone content in red clover was found to be as high as 30 times that of soybean, indicating that red clover can be a good source of nutraceutical and functional food ingredients. Leaf tissue of 13 red clover cultivars were sampled at two growing stages (late bud stage and late flowering stage) and the concentration of individual isoflavones were determined by HPLC. Different varieties were found to differ significantly in concentration of total and various isoflavones. Biochanin A and formononetin were the two predominant isoflavones. However, with the aid of LC-MS, at least eight isoflavones were positively identified and quantified. The results from these cultivated varieties show significant genetic variability for total isoflavone concentrations and for levels of specific isoflavones and these differences were not related to ploidy levels of studied cultivars. Broad-sense heritability ($H = \text{genetic variance}/\text{total variance}$) was shown to range from 0 to 80%. This range was influenced both by type of isoflavone and by the sampling date for isoflavone assessment. Little information on the heredity of various isoflavone concentrations has been reported for red clover. The results of this study suggest that significant genetic variance exists within currently available cultivars.

The Halifax experimental pollen and spore monitoring and forecast program: 5-yr results and trends. Benjamin J.A. Moulton¹, David H.S. Richardson¹, David L. Waugh², and Ann A.L. Miller^{1,3*}. ¹Department of Biology, Saint Mary's University, 923 Robie St, Halifax, Nova Scotia, Canada B3H 3C3; ²Atmospheric Science Division, Meteorological Service of Canada – Atlantic Region, Environment Canada, 45 Alderney Drive, Dartmouth, Nova Scotia, Canada B2Y 2N6; ³marine g.e.o.s., 1003 Peter St., Apt. 1, New Minas, Nova Scotia, Canada B4N 3L7.

This pollen and spore monitoring programme has been in operation since 2000. Pollen levels are monitored in Halifax, Beaverbank, and Noel, urban, suburban and rural sites, respectively. Pollen forecasts are made based on the pollen found and the expected weather. Here trends in the 5-yr pollen records are reported. Pollen and spores are allergenic to sensitive individuals, causing hay fever symptoms to chronic asthma. The forecasts can help predict high-risk periods of allergic reactivity, allowing individuals to modify their daily activities, minimizing the need for medical treatment, reducing the risk of developing serious or chronic respiratory illness, and decreasing the demands on the health care system. Plant reproductive behaviour, weather, and climate are complexly inter-related with the incidence of hay fever/asthma. Vegetation patterns (composition, seasonality, ranges) are changing, as temperatures increase, precipitation becomes more variable, and atmospheric carbon dioxide levels rise, all the result of global warming. Plants are flowering sooner, flowering seasons may be longer, and some produce more pollen. Plants at more inland sites in Nova Scotia tend to flower and release pollen earlier. Long-term monitoring may reveal early indications of vegetation responses to global warming.

Temporal, compositional, and density characteristics and differences of airborne pollen and spore records from Halifax, Kentville and Sydney, NS. Erin Pitman^{1*}, Ann A. L. Miller^{1,2},

David H.S. Richardson¹, and David L. Waugh³. ¹Department of Biology, Saint Mary's University, 923 Robie St, Halifax, Nova Scotia, Canada B3H 3C3; ²marine g.e.o.s., 1003 Peter St., Apt. 1, New Minas, Nova Scotia, Canada B4N 3L7; ³Atmospheric Science Division, Meteorological Service of Canada – Atlantic Region, Environment Canada, 45 Alderney Drive, Dartmouth, Nova Scotia, Canada B2Y 2N6.

Since 2000, the Saint Mary's University-Environment Canada Experimental Pollen and Spore Monitoring Programme has been operating in Nova Scotia. Airborne pollen and spore levels have been recorded at three equi-latitudinal sites. This year one sampler remains situated in Halifax, and the others are located at Agriculture Canada's Kentville Research Station and Cape Breton University, allowing monitoring over greater geographical and climatic ranges. Halifax and Sydney are exposed to cool coastal elements, whereas Kentville is inland at the eastern end of the Annapolis Valley, in the lee of the North Mountain. The Kentville sampler is adjacent to Environment Canada's automatic weather station, allowing correlation of pollen species and densities with local weather conditions. The temporal differences in pollen release by natural vegetation, and the compositional differences and densities of the pollen assemblages have been measured. Some differences appear to be due to biannual reproductive behaviour and to local weather conditions, but others can be attributed to the latitudinal differences and prevailing climatic conditions. It has been possible to examine records of fruit tree and agricultural crop pollen release and correlate this with that from natural vegetation.

CANADIAN SOCIETY OF HORTICULTURAL SCIENCE Oral Presentations

Environmental losses of soil applied nitrogen in wild blueberry production. Gloria Thyssen*, David Percival, and D. Burton. Nova Scotia Agricultural College, Truro, Nova Scotia, Canada; Kevin Sanderson, Agriculture and AgriFood Canada, 440 University Avenue, Charlottetown, PE, Canada C1A 4N6.

Environmental losses of soil applied N-fertilizers through ammonia volatilization, ammonium and nitrate leaching, and greenhouse gas emissions (GHG) were examined in a wild blueberry production system. Volatilization trials were established in the vegetative phase of production in Nova Scotia (NS) and Prince Edward Island (PE) in 2004 and 2005. A controlled environment, leaching experiment was conducted in 2005 using intact soil cores collected from Debert, NS. The GHG experiment examined the loss of soil applied N through nitrous oxide (N₂O), carbon dioxide and methane emissions, using a static non-steady state chamber. Treatments used in the volatilization trial consisted of no fertilizer (control) and N applications (35 kg N ha⁻¹) of ammonium sulphate (AS), urea (U), diammonium phosphate (DAP) and sulfur coated urea (SCU). The leaching trial consisted of the aforementioned treatments, and the addition of isobutylidene diurea (IBDU) and Nitroform (NF). The GHG trial consisted of a control and AS. Results from the volatilization trials indicated significant treatment effects with U (NS in 2004, PEI in 2005) and DAP (NS in 2005) being significantly greater than the control. Significant results from the leaching trial were present, with IBDU having the highest nitrate leaching rate, and AS having the highest rate of ammonium leaching. N₂O emissions were found to be minimal, with no significant treatment effects. Therefore, these results indicate that volatilization and leaching losses are significant and site specific and can provide the basis of inadequate growth.

Compost teas and their effects on raspberry and strawberry fruit quality. Jennifer Hargreaves^{1*}, Phil R. Warman², Sina Adl³.

¹Dalhousie University/Soil Ecol, LSC 5130, Dept of Bio. Life Sciences, 1355 Oxford Street, Halifax, Nova Scotia, Canada B3H 4J1; ²Dalhousie University/NSAC, ³Dalhousie University.

Compost teas are new products in the organic agriculture industry typically being used to control plant disease. However, organic farmers are also experimenting with this product as a “stand alone” product, one that may be beneficial because it impacts a plant more quickly than nutrients applied to the root zone. This research will investigate these claims by directly comparing the effects of non-aerated compost teas from different compost sources, composts, and fertilizer on the nutrient content and fruit quality of strawberries and raspberries grown in the field. Furthermore, recommendations on compost tea production methods have been debated for some time and so other experiments will focus on comparing compost tea nutrient content of aerated and non-aerated compost teas made from difference compost sources and their ability to provide nutrients to plants. Finally, it is claimed that compost tea properties begin to shift within 24 h after production, so compost tea properties, including nutrient content and microbial community structure, will be monitored in aerated and non-aerated compost teas made from different sources for 6 wk after production. The findings of this project will greatly aid in filling data gaps in compost tea research and help determine the suitability of these amendments for practical farming purposes. Preliminary results will be presented, specifically, the effects of storage on compost tea properties and results from the first harvest.

Effect of mulch applications on nitrogen fertility and the growth and productivity of organically managed highbush blueberry plants. N.E. Burkhard^{1*}, D.H. Lynch¹, D.C. Percival².

¹Nova Scotia Agricultural College, Department of Plant & Animal Sciences, P.O. Box 550, Truro, Nova Scotia, Canada B2N 5E3; ²Nova Scotia Agricultural College, Department of Environmental Sciences, Truro, P.O. Box 550, Nova Scotia, Canada B2N 5E3.

Weed management is a significant challenge in organic highbush blueberry (*Vaccinium corymbosum* L.) production due to an inability of existing registered herbicides to control within-row weeds. Mulch application may be a promising alternative; however, it can greatly influence soil nitrogen (N) dynamics. In 2005, a study was initiated at a commercial highbush blueberry operation in Nova Scotia to: 1) test the ability of 20 cm-thick mulches to suppress weeds and 2) assess their influence on N fertility, plant growth and crop yield. A split-plot experimental design was used with five blocks, six treatments and five plants (cv. Duke) per split plot. The whole plot factor consisted of mulch/fertility treatments and included: (i) control (no amendment), (ii) ammonium sulphate fertilizer (30 kg N ha⁻¹), (iii) pelletized poultry manure (60 kg N ha⁻¹), (iv) pine needles (80 t ha⁻¹), (v) horse manure and sawdust compost (550 t ha⁻¹), and (vi) seafood waste compost (360 t ha⁻¹). The split plot factor consisted of level of hand weeding (\pm). Preliminary results of mineralizable soil N (monitored *in situ* using PRSTM anion/cation exchange membranes), seasonal changes in soil mineral N (NO₃⁻-N and NH₄⁺-N), and plant response (leaf N, crop yield, plant canopy index) will be presented.

Associations of citrus tree decline, soil variability and *Diaprepes abbreviatus* (L.) root weevil: two-case study in Florida. Hong Li^{1*}, Stephen H. Futch², Robin J. Stuart², James P. Syvertsen², and Clay W. McCoy². ¹Nova Scotia Agricultural College, Department of Plant and Animal Sciences, Truro, Nova Scotia, Canada B2N 5E3; ²University of Florida, IFAS, Citrus Research and Education Center, Lake Alfred, Florida 33850, USA.

The hypothesis of associations of environmental soil heterogeneity with citrus tree decline and *Diaprepes abbreviatus* (L.) root weevil variability was tested in two flatwoods citrus groves in Florida. Studies were conducted on a loamy, poorly drained Mollisol in Osceola County, central Florida in 2002, and on a sandy, poorly drained Spodosol in DeSoto County, south-west Florida during 2001–2003. Adult weevils were monitored using 50 Tedders traps arranged in a 34 × 25 m grid at the Osceola site, and using 100 identical traps in a 30 × 15 m grid at the DeSoto site. Soil water content (SWC), texture, pH, Ca, Mg, Fe, Cu and other nutrients were measured at each trap. Soil was strongly acidic (pH 4.9 ± 0.4) at the Osceola site but near neutral (pH 6.6 ± 0.4) at the DeSoto site. The Mehlich-I extractable soil Mg and Ca were correlated to soil pH and SWC in both soils, and extractable Fe was related to pH, SWC and Mg in the Spodosol (0.30 < R² < 0.65, P < 0.01). The weevil density was high in areas low in soil Mg and Ca in the acidic Mollisol, but high in areas with high soil pH, and Mg and low sand content in the near neutral Spodosol (P < 0.05). Tree decline was associated with soil Fe concentrations > 40 mg kg⁻¹ in the Mollisol (P < 0.01), and weevil density was low at soil pH between 5.7 and 6.2. The range of spatial dependence of weevil population, soil pH, SWC, Fe, Mg and sand varied between 60–100 m in the Mollisol and the Spodosol. Soil-weevil-tree simple and multivariate linear models were established to put into practices for predicting and controlling the weevil population and tree decline in the future. Differences in site characteristics suggested the need for site-specific weevil and citrus tree management.

Use of plant growth regulators to increase bioactive compounds in the wild blueberry. Joanna MacKenzie* and David Percival., Nova Scotia Agricultural College, Truro, Nova Scotia, Canada.

With increasing awareness of the antioxidant properties of the wild blueberry (*Vaccinium angustifolium* Ait.), more emphasis has been placed on developing cultural management practices to enhance fruit polyphenolic levels and use processing byproducts as potential polyphenolic sources for the nutraceutical market. Trials were initiated in 2004 and 2005, with four plant growth regulators (methyl jasmonate, abscisic acid, riboflavin and Retain[®]) applied to maturing berries of the select clone Fundy at the Wild Blueberry Research Centre (Debert, NS). Berries were harvested approximately one month after treatment applications, with collections of green leaf tissues at harvest and red leaf tissues 2 wk after harvest in 2005. Assessment of polyphenolic and anthocyanin levels within the berry and leaf tissues followed the Folin-Ciocalteu and pH differential methods, respectively. Overall, substantially higher levels of polyphenolic compounds were found within the leaf tissues, although anthocyanin content was highest in the berries. The application of methyl jasmonate elevated levels of bioactives within the harvested berry and leaf tissues. This increase in bioactives occurred, however, at the expense of harvestable yields, with lower yield in plots treated with methyl jasmonate in 2004. Results thus suggest that the use of some PGRs may effectively increase bioactives, but their value must be assessed against a possible yield reduction. In addition, these studies indicate that leaf debris may provide a superior polyphenolic source for the nutraceutical market.

The impact of “surround” on leaf gas exchange of Ginger Gold apple trees in New Brunswick. J.P. Privé*, L. Russell, and A. LeBlanc. Agriculture and Agri-Food Canada; Atlantic Food and Horticulture Research Centre, Bouctouche, New Brunswick, Canada.

A field trial was conducted over two growing seasons in a Ginger Gold apple orchard in Bouctouche, New Brunswick, Canada to examine the impact that "Surround" (95% kaolin clay), had on leaf gas exchange [net photosynthesis (Pn), stomatal conductance (gs), intercellular CO₂ (Ci) and transpiration (E)]. In 2004, a greater rate of Pn and gs was achieved at the higher than at the lower rate of 'Surround'. This was particularly the case at leaf temperatures exceeding 35°C. However, in a more detailed experiment in 2005, fewer significant ($P = 0.05$) results from Surround, at leaf residue rates of up to 3.7 g m⁻², and leaf temperatures ranging from 25 to 40°C were found for any of the leaf gas exchange parameters. Seasonal differences make it difficult to predict the leaf gas exchange responses from this reflective particle film material.

Root weevils and strawberry – Just how many are too many?

Kenna MacKenzie*, Julia Reekie, Micheal Binns, and Beata Lees. Agriculture and Agri-Food Canada, Kentville, Nova Scotia, Canada B5N 1J5.

Root weevils are a concern for strawberry production across the world. Yet, no damage threshold has been determined for root weevils in commercial strawberry production. Two experiments were run where individual 6-wk-old strawberry plants were inoculated with known numbers of black vine weevil eggs. Two cultivars, Kent and Annapolis (rated as susceptible and tolerant to root weevil feeding respectively), were used. In the first experiment treatments of 0, 6, 12, 24, 48, 96 and 192 eggs per plant were used, while 0, 3, 6, 12, 24 and 48 were used in the second experiment. Live and dead leaves, crown and roots were weighed and the number of larvae per pot were counted. Plants at the higher doses (48 and up) in experiment one showed high mortality and poor growth. In the second experiment, there was no effect of root weevil feeding seen with Annapolis while Kent plants at 48 eggs per plant treatment had smaller root systems. These results demonstrate that root weevil feeding has little, if any, effect on strawberry growth at least under ideal conditions. Interactions between root weevils and other stresses such as root diseases may be responsible for major losses seen in field situations.

Chlorophyll fluorescence as an indicator of physiological change in plants. John M. DeLong*, Robert K. Prange. Atlantic Food and Horticulture Research Centre, Agriculture and Agri-Food Canada, 32 Main St., Kentville, Nova Scotia, Canada B4N 1J5.

Chlorophyll fluorescence (CF) has been termed a rich, but ambiguous signal. Since Kautsky's observations of leaf fluorescence in the 1930s, the development of theoretical aspects of fluorescence have paralleled advances in understanding the mechanisms involved in the light reactions of photosynthesis. The development of pulse amplitude modulated (PAM) fluorometry in the 1980s facilitated a boom in the use of CF as standard methodology for detecting plant stresses in their myriad forms. CF is popular because it is rapid and non-destructive, facilitates repeated observations on the same experimental unit and provides direct measurements of fundamental photosynthetic reactions. CF techniques have been used for measuring plant responses to: excess and UV light, herbicides, water stresses, low oxygen environments and high and chilling temperatures, to name a few. CF methods have been developed to monitor in vivo excitation energy distribution, oceanic photosynthesis, adaptation of plants to changing light regimes, senescence, insect damage and even fruit ripening and quality! This presentation will highlight application of CF as an indicator of physiological change in plants due to alterations in growth or storage

environments (stress responses) and normal senescence metabolism (non-stress responses).

The effects of handling and postharvest dehydration on grape berry chlorophyll fluorescence, mass loss and visual colour.

Harrison Wright^{1,2*}, John DeLong¹, Robert Prange¹, and Rajasekaran Lada². Atlantic Food and Horticulture Research Centre, Agriculture and Agri-Food Canada, Kentville, Nova Scotia, Canada B4N 1J5; ²Department of Plant and Animal Sciences, Nova Scotia Agricultural College, PO Box 550, Truro, Nova Scotia, Canada B2N 5E3.

Two experiments were designed to test the effects of handling on primary chlorophyll fluorescence parameters (F_o , F_m , F_v/F_m), colour change and dehydration dynamics in a green seedless table grape cultivar. In experiment 1, the effect of barehanded, gloved and pedicel-handled grapes and a high intensity light saturation pulse was compared with an untouched control. Experiment 2 investigated the effects of handling grapes at different stages in dehydration. Non-significant differences in "% mass loss" were observed among the different handling protocols. Handling grapes increased senescent-like browning of the berries when touched with bare or gloved hands compared with pedicel-handling. Exposing grapes to the saturation pulse of the fluorometer did not change berry colour or any fluorescence parameters. Fluorescence measurements indicated that the control grapes (no handling) senesced less than the three handled treatments and that the pedicel-handled grapes senesced less than the glove and bare-hand treatments. The senescence-promoting effect of handling on the fluorescence measurements and berry colour was significantly less on grapes treated immediately after they were brought into the lab compared with those that sat out (7 d +) before they were handled. This study shows that postharvest handling influences grape berry chlorophyll fluorescence, mass loss and visual colour.

Biochemical characteristics of selected advanced lines and commercially grown raspberry cultivars.

Shahrokh Khanizadeh¹, Behrouz Ehsani-Moghaddam¹, and J. Alan Sullivan^{2*}. ¹Agriculture and Agri-Food Canada, Horticultural Research and Development Centre, 430 Gouin Blvd., St-Jean-sur-Richelieu, QC, Canada J3B 3E6; ²Department of Plant Agriculture, University of Guelph, Guelph, Ontario, Canada N1G 2W1.

Three advanced raspberry lines from University of Guelph (88–18, 88–117, 88–134) and one from Quebec fruit breeding programs (SJR942-7) were tested in Quebec for their winter hardiness, fruit quality and performance, and compared to four commercially grown cultivars (Festival, Boyne, Nova and Killarney). The selected lines were evaluated for their total antioxidant capacity, soluble solid contents, and acidity. The crude, hydrophilic and lipophilic antioxidant content of fruit were measured using the Trolox Equivalent Antioxidant Capacity (TEAC) method. Significant variation was observed for crude, hydrophilic and lipophilic antioxidant values among the advanced raspberry selections. The highest crude, hydrophilic and lipophilic activities were found in 88–18 with 24.06 ± 0.87 , SJR942-7 with 16.80 ± 0.13 , and Boyne with $0.53 \pm 0.06 \mu\text{mol TE g}^{-1} \text{FW}$, respectively.

Apple peels as a value-added food ingredient in a model muffin system. H.P.V. Rupasinghe*, L. Wang, G. Huber, and N.L. Pitts. Department of Environmental Sciences, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada B2N 5E3.

Apple fruit skin, a rich source of dietary fiber and many health-enhancing phenolics, is a by-product of apple processing. The aim

of this study was to investigate the feasibility of incorporating dried apple skin powder (ASP) as a value-added ingredient in bakery food products using a food model system of muffins. The blanched, dehydrated and ground ASP (2 mm particle size) was incorporated into muffins at 0, 4, 8, 16, 24, or 32% (wt/wt) levels by replacing an equivalent amount of wheat flour in a standard muffin mixture. The effect of ASP substitution on texture, color, volume, proximate composition, total phenolic content and antioxidant capacity of muffins was determined. The level of total phenolics and antioxidant capacity of muffins was directly correlated to the amount of ASP incorporated. A taste panel of 65 untrained panellists showed that the 16% replacement level of ASP produced the bakery product most acceptable for organoleptic attributes. The effect of baking on individual phenolic constituents was determined by liquid chromatography mass spectrometry. The present study has demonstrated the potential for the industrial exploitation of ASP as a health food ingredient for bakery industry.

Use of row covers and adapted cultivars for successful over-wintering of leeks for spring harvest in Atlantic Canada. Josée Owen¹*, Serge LeBlanc¹, Viliam Zvalo². ¹Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Centre, Senator Hervé J. Michaud Research Farm, Bouctouche, New Brunswick, Canada E4S 4J1, ²AgraPoint International Inc., Kentville, Nova Scotia, Canada B4N 1H7.

Vegetable growers in Atlantic Canada are at the mercy of long, harsh winters as they seek ways to diversify crops, gain access to early spring markets and capture price premiums. Over-wintering leeks is an opportunity to produce a high quality early vegetable. This study examined cropping system factors in over-wintering leeks in Southeastern New Brunswick and Nova Scotia's Annapolis Valley over three years. Experimental layout was a three by three cross design at each site, with each replicate containing all treatments. Treatments were combinations of eight cultivars and three row covers (bare soil, straw, non-woven polypropylene fleece). Data collected included winter and spring soil and air temperatures, yield of trimmed leeks and leek diameter. Results showed that over-wintering leeks is viable in both New Brunswick and Nova Scotia. Yields varied from less than 1.0 to 9.8 t ha⁻¹ in New Brunswick, whereas yields in Nova Scotia varied from 4.2 to 15.3 t ha⁻¹. Row covers improved yields compared with bare soil, although two cultivars yielded just as well on bare soil as under row covers. The high quality and small diameter of over-wintered leeks at the New Brunswick site suggests an opportunity for a niche market "New Brunswick Baby Spring Leek."

Potassium management for carrots in Prince Edward Island. K.R. Sanderson* and J.B. Sanderson. Agriculture and Agri-Food Canada, Crops and Livestock Research Centre, Charlottetown, PE, Canada C1A 4N6.

Nine field studies were conducted over a 3-yr period to determine the response of carrot (*Daucus carota* L.) to soil-applied K on sandy to loamy sand Orthic Podzol soils in Prince Edward Island. Sites were classified based on K rating as L-, L, and M (Mehlich-III extractant) according to the PEI Soil and Feed Testing Laboratory. Treatments consisted of broadcast applied muriate of potash at 0, 75, 150, 225 and 300 kg K ha⁻¹. Total carrot yields were 70, 90 and 98% of maximum yield when no K was applied, while 150, 75 and 0 kg K ha⁻¹ were required to achieve 95% maximum yield for the L-, L and M soil K ratings, respectively. Increasing rates of applied K linearly increased the K content of tissue and soil taken at harvest. Root K content increased linearly

with rate of applied K and parallel line analysis indicated separate lines were required for each K soil test rating.

Assessing different nitrogen use efficiency indices using field-grown green bell peppers. Laura L. Van Eerd*. University of Guelph, Ridgetown Campus, 120 Main St. E., Ridgetown, Ontario, Canada N0P 2C0.

Rising crop input costs and pressure to protect the environment has increased interest in improving nitrogen use efficiency (NUE), while maintaining crop yields and minimizing N losses. The aforementioned parameters were assessed in two green bell pepper field experiments per year. In 2 contrasting years (i.e., cool/wet vs. warm/dry), marketable yield response to N application was either positive or no response was observed. In most experiments, the quantity of N (0–210 kg N ha⁻¹), application timing (preplant vs. split) and N source (ammonium nitrate vs. urea with nitrification and urease inhibitor) did not influence total and marketable yield nor measured fruit quality parameters. Total percent N in the fruit and shoot was lower in non-fertilized plants compared to plants receiving 70 or 210 kg. N ha⁻¹. There were considerable differences between locations in soil mineral N, yield, NUE, and plant N uptake and removal. Moreover, NUE (i.e., apparent N recovery) and agronomic efficiency decreased as N application increased from 70 to 210 kg N ha⁻¹. However, this was not observed when physiological efficiency and N harvest index were quantified. Thus, the interpretation and applicability of NUE depends on the goals of the research and which index was used.

Potatoes transformed for enhanced tolerance of temperature stress. D.R. Waterer* and L.V. Gusta. Department of Plant Sciences, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 5A8.

Potatoes (*Solanum tuberosum*) are sensitive to temperature stress both in the field and during storage. This project evaluated the yield, quality and stress tolerance of potato (cv. Desiree) transformed with a range of genes involved in adaptation or resistance to environmental stress. The genes introduced via *Agrobacterium*-mediated transformation were; dehydrin 4 (Dhn4) isolated from barley, mitochondrial Mn superoxide dismutase (SOD) from wheat, CBF1 from canola and ROB5 from bromegrass cell culture. The genes were linked to either the constitutive 35S promoter or a stress-induced Arabidopsis COR78 promoter. In a series of controlled environment trials, the transformed lines were exposed to low or high temperature stress as developing plants or as harvested tubers. Transformation with SOD or ROB5 appeared to improve tolerance to low and high temperature stress both during development and in storage. Similar results were obtained in field trials if the crop was exposed to significant heat or drought stress. When the field trials were managed to minimize stress, none of the transformed lines produced higher yields or had any obvious quality advantage relative to the parental material. The COR78 promoter appeared to be as effective as the 35S promoter but without the metabolic cost of constitutive expression.

Effect of sowing depth on emergence, growth and yield of Okra (*Abelmoschus esculentus* L.) Moench in South West Nigeria. F.O. Odeleye¹*, O.M.O. Odeleye², J.K. Vessey³, Z. Dong³, F.B. Yakubu⁴, and A.O. Olaleye⁵. ¹Dept. of Crop Protection and Environmental Biology, University of Ibadan, Nigeria; ²National Horticultural Research Institute, Jericho, Ibadan, Nigeria; ³Dept. of Biology, St. Mary's University, Halifax, Nova Scotia, Canada; ⁴Federal School of Forestry, Jericho, Ibadan, Nigeria; ⁵Dept. of

Soil Science and Farm Mechanization, Olabisi Onabanjo University, Ago-Iwoye, Nigeria.

Pot and field trials were conducted to evaluate the effects of sowing depth on the performance of two varieties of Okra grown as sole crop. The trials involved factorial combination of 5 sowing depths (1, 2, 3, 4, and 5 cm) with 2 varieties of okra in randomized complete block with 4 replicates. The experiments were carried out in pots and the experimental plot of the Dept. of Crop Protection and Environmental Biology, University of Ibadan, Nigeria. The data taken on days to emergence, growth and yield parameters were subjected to ANOVA using SAS and means were separated using LSD and SE. Results showed that sowing okra 4 cm and 5 cm deep significantly reduced % seedling emergence and caused a significant decrease in the vegetative growth, dry matter accumulation and yield of okra in pots and on the field. The 5 cm depth is the most damaging in this regard. Good seedling emergence were obtained at 1, 2 and 3 cm sowing depths but the 3 cm depth appears to be the optimum sowing depth as highest yield and overall best performance of okra were attained at this depth. The two varieties of okra used in this study responded similarly to depths of sowing but NHAe 37-4 (medium maturing) out yielded LD88 (early maturing) apparently because of its longer life cycle and its larger leaf area which enabled it produced more fruits over time during its life cycle.

Response of cucumber to time of fertilizer application in South West Nigeria. F. O. Odeleye,^{1*} O.M.O Odeleye,² J.K. Vessey,³ Z. Dong³ and H.N. Ebuzome¹. ¹Dept. of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Nigeria; ²National Horticultural Research Institute, Jericho, Ibadan, Nigeria; ³Dept. of Biology, St. Mary's University, Halifax, Nova Scotia, Canada B3H 3C3.

A field trial was conducted on the experimental farm of the Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria, to determine the growth and yield response of cucumber to time of fertilizer application. The cucumber variety used was Poinsett. Applying N.P.K (20:10:10) fertilizer at the rate of 150 kg N ha⁻¹, the treatments comprised applications at: planting, 3 wk after planting (WAP), 6 WAP; split applications at planting + 3 WAP, at planting + 6 WAP, at 3 WAP + 6 WAP and control to which no fertilizer was applied. The experimental design was randomized complete block with 4 replications. Means were separated using Duncan's Multiple Range Test at the 5% probability level. Results from the experiment showed that cucumber plants that were fertilized at one time or the other generally performed better than control plants in terms of vegetative growth and yield. However, comparing the times of fertilizer application treatments, fertilizer applied entirely at 6 WAP was the least beneficial to cucumber plants, application of the entire fertilizer at planting or the split application of fertilizer at planting + 3 WAP engendered a high level of vegetative growth but lower fruit yield compared with split application at 3 WAP + 6 WAP. The split application of fertilizer at 3 WAP + 6 WAP was optimal for the performance of the crop in terms of vegetative growth and fruit yield in South West Nigeria.

Taming the wild rose. R. Barry^{1*}, K. Sanderson², and J. Kemp¹. ¹Department of Biology, University of Prince Edward Island, 550 University Ave., Charlottetown, PE, Canada C1A 4P3; and ²Agriculture and Agri-Food Canada, 440 University Ave., Charlottetown, PE, Canada C1A 4N6.

Roses of the genus *Rosa* are found growing wild throughout the Atlantic Provinces in a multitude of different habitats. Rose hips, the marketable product from these roses, are a rich natural source of bioactive compounds useful in the pharmaceutical industry. In 2004 a wild rose field trial was established at the Agriculture and Agri-Food Canada Harrington Research Farm on Prince Edward Island. Planting stock for this trial was propagated from wild rose populations throughout PEI. Treatments were applied at planting and included: in-row mulch (none, bark and straw), between-row (tilled and sod) and in-row fertility (none, compost and chemical fertilizer). In-row mulch and fertility treatments were reapplied in 2005. Straw mulch proved to be the most effective in-row mulch for promoting new shoots, increasing plant spread and shoot length. Between-row tilled treatment proved better than between-row sod for promoting plant spread, shoot length, shoot diameter, and rose hip yield. The most effective in-row fertility treatment was the chemical fertilizer which resulted in a greater plant spread, shoot length, and rose hip yield than the other two treatments. Outcomes from this experiment will be used to establish protocols for commercially growing wild roses as an agricultural crop for the Atlantic Provinces.

Predicting weekly yields of greenhouse-grown sweet peppers. W. C. Lin^{1*} and B. D. Hill². ¹Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada, P.O. Box 1000, Agassiz, British Columbia, Canada V0M 1A0; ²Research Centre, Agriculture and Agri-Food Canada, P.O. Box 3000, Lethbridge, Alberta, Canada T1J 4B1.

Sweet peppers (*Capsicum annuum* L.) grown in commercial greenhouses are harvested when they are fully coloured. The production season of greenhouse peppers is about 10 months each year. In this study, sweet peppers were grown in an experimental greenhouse to examine the irregular patterns of weekly yields. Peaks-and-valleys in weekly yield occurred in each of 5 yr with both red and yellow sweet peppers. Records of weekly yields and associated environmental data were used in formulating models with artificial neural networks (ANN). ANN models accommodated two different cultural practices: conventional one fruit per node and fruit-pruned to one fruit for every other node. It appears that red peppers yields can be predicted four weeks ahead, but yellow peppers only 1 wk in advance. ANN models may require validation with prevailing cultivars and cultural practices, when they are markedly different from the original data used in formulating the ANN models. Our results indicate that ANN models can be improved by continuously updating with data consisted of different cultural practices and cultivars. ANN models are superior or equivalent to regression models. The relationship between peak production week and environmental factors of greenhouse-grown sweet peppers will be discussed.

Shelf life of greenhouse peppers influenced by storage temperatures and pre-harvest conditions. W. C. Lin*. Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada, P.O. Box 1000, Agassiz, British Columbia, Canada V0M 1A0.

Greenhouse-grown sweet peppers (*Capsicum annuum* L.) are commercially harvested when fully colored. This study examined whether storage at temperatures lower than recommended 7.5°C for 4 wk would be possible. Red and yellow peppers were stored for 4 wk at 1°C, 2.5°C, 5°C, 7.5°C, 10°C, and 12.5°C, followed by a 3-d shelf life evaluation at 20°C. Each fruit was visually rated for decay from none (0) to severe (5). Fruit from commercial and experimental harvests were compared. With commercial harvests,

red peppers had low decay at 5°C, 7.5°C, and 10°C, while yellow peppers had low decay at 10°C or 12.5°C. A rapid increase in decay index (more than 2.5) upon return to room temperature after 4-wk storage at 1°C and 2.5°C indicated possible chilling injury. Storage at 5°C or higher did not result in a rapid increase in decay index (less than 1.0). With experimental harvests, red peppers were more tolerant to 5°C or 7.5°C than yellow. In general, sweet peppers harvested from the experimental greenhouse had less decay than those from a commercial source. This study indicated that fully colored sweet peppers could be stored at 5°C for 4 wk without indication of chilling injury.

Responses of a long greenhouse tomato crop to summer CO₂ enrichment. Xiuming Hao, Qingguo Wang*, and Shalin Khosla. Greenhouse and Processing Crops Research Centre, Agriculture and Agri-Food Canada, 2585 County Rd. 20, Harrow, Ontario, Canada NOR 1G0.

Responses of greenhouse tomatoes to CO₂ enrichment are strongly influenced by duration of the CO₂ enrichment and greenhouse climate. While CO₂ enrichment generally benefits tomato fruit production in winter its effects on summer tomato production (under high air temperature and strong ventilation) are still not clear, especially when the crop has been subjected to long-term of CO₂ enrichment in winter. Therefore, a study was initiated in 2005 to determine the feasibility of summer CO₂ enrichment in southwestern Ontario, a major greenhouse vegetable production area in North America with very hot summer. The long tomato crop (cv. Rapsodie) was planted into rockwool slabs in six greenhouse compartments in January. From January to the middle of June, the tomato plants in all six greenhouse compartments were subjected to the same standard CO₂ enriching practice. From the end of June to August, three CO₂ treatments (two compartments for each treatment) were applied: Control (ambient), Enrich1 (800 ppm when ventilation was less than 10% and 400 ppm when less than 50%) and Enrich2 (1200 ppm when ventilation was less than 10% and 500 ppm when less than 50%). The CO₂ enrichment was stopped when ventilation requirement was more than 50%. Leaf photosynthesis, as indicated by the CO₂ response curve, partially acclimated to the CO₂ enrichment. Stem dry weight was increased while fruit dry weight was reduced by the summer CO₂ enrichment. Marketable fruit yield was also reduced by the summer CO₂ enrichment. High air temperature might have affected fruit setting and thus limited the response to CO₂ enrichment. Further investigation on carbohydrate translocation is needed to clarify the mechanism limiting the response of greenhouse tomatoes to summer CO₂ enrichment.

Neural networks to predict harvest dates of greenhouse-grown sweet peppers. B. D. Hill* and W. C. Lin². ¹Lethbridge Research Centre, Agriculture and Agri-Food Canada, P.O. Box 3000, Lethbridge, Alberta, Canada T1J 4B1; ²Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada, Box 1000, Agassiz, British Columbia, Canada V0M 1A0.

Sweet peppers (*Capsicum annuum* L.) grown in the greenhouse display a pattern of irregular weekly yields. Modelling the colouration of individual fruit may help growers predict the number of harvestable (fully coloured) peppers in advance. We monitored the red, green and blue colour intensities of developing fruit via digital image processing. These colour measurements together with crop and environmental variables were used as inputs into neural network (NN) models to predict days-to-harvest (D-to-H) for individual fruit. When 18 inputs were evaluated, the 'best' model used

only five of the inputs to predict D-to-H for red peppers with a R^2 of 0.79 and root mean square error (RMSE) of 3.4 d. Predictions were more difficult for yellow peppers. The "best" model used eight inputs and achieved a R^2 of 0.69 and RMSE of 4.4 d. Light and temperature had only minor effects on predictability. Further testing indicated that equivalent NN predictions could be obtained using only three inputs (Julian day, nodal position of the target fruit, ratio of red:green intensities). The R^2 of NN models were higher than those of corresponding regression models. We concluded that NN have considerable potential to assist greenhouse operators predict the D-to-H of sweet peppers.

Developing strategies to propagate small fruit nuclear stocks of commercial interest for Canadian industry. Samir C. Debnath*. Agriculture and Agri-Food Canada, Atlantic Cool Climate Crop Research Centre, P. O. Box 39088, St. John's, Newfoundland and Labrador, Canada A1E 5Y7.

Small fruits are genetically heterozygous and characterized as "not coming true from seeds". The conventional methods, although successful for vegetative propagation of these fruits, are slow and labour-intensive and few propagules are produced from a selected clone or hybrid. Micropropagation techniques are important for clonal multiplication, germplasm improvement and gene conservation of Canadian small fruits: *Fragaria* (strawberries), *Rubus* (raspberries, cloudberrries) and *Vaccinium* (blueberries, cranberries, lingonberries, etc.) species. The in vitro propagation of these species using axillary bud proliferation and adventitious shoot regeneration has been investigated in a number of studies. The morphogenesis seems to be highly dependent on plant growth regulators and media used for culture, which is again genotype specific. The paper presents the progress in-depth of various aspects of Canadian small fruits species in vitro, on gelled and in liquid media using bioreactors, for their commercial production. It also discusses the relationship between molecular diversity and in vitro propagation, the production of apparently rejuvenated clones and the issues that still need to be addressed to utilize the full potential of plant tissue culture techniques in mass propagation of Canadian small fruit nuclear stocks.

Horticultural plant conservation: management and commercialization. John T. A. Proctor*. Dept. of Plant Agriculture, Bovey Bldg., University of Guelph, Guelph, Ontario, Canada N1G 2W1.

Most Canadian crop plants originated outside Canada, e.g., corn from Mexico, soybeans from China. Germplasm for these crops is retained in the Canadian Plant Germplasm System (CPGS) so that their genetic diversity, and that of their wild relatives, is preserved. A small number of Canadian crop plants are native to Canada, e.g., strawberry, raspberry and ginseng. Ginseng is one of Canada's oldest crop plants and featured in the early fur trade. It is Canada's most important pharmacological crop. The CPGS preserves some native crops, but not ginseng. In this review the history, genetic diversity, crop management and commercialization of ginseng will be described. Worldwide the ginseng genus (*Panax* L.) has 11 species, 9 from Asia and 2 from North America, *P. quinquefolius* and *P. trifolius*. The genus is genetically diverse and the crop plant basically undomesticated. Wild ginseng is listed as endangered in the 1999 list of Canadian species at risk.

Fresh-cut apples: Challenges and opportunities for multi-disciplinary research. Peter M.A. Toivonen*. Agriculture and Agri-Food Canada, Summerland, BC, Canada V0H 1Z0.

The fresh-cut apple industry has just become established in North America. Much of this development has been a result of multi-disciplinary work to find integrated and reliable solutions to problems. The future looks very bright for this fruit product, however growth and improvement in the quality and relative production costs will require further work. The existing industry has grown from concept to reality in response to research activities in package technology, sensory analysis, postharvest physiology, postharvest pathology and food microbiology. Several examples of how these critical research inputs impacted and continue to impact on the industry practice. The next generation of questions and challenges posed by the industry will require some new inputs. One example is that the dip used to control cut-edge browning in fresh slices is reported to be the most expensive component. New cultivars of apples which do not brown can potentially remove this cost of production. However, these new cultivars will also create challenges in regards to postharvest storage research to optimize their condition and availability to the fresh-cut processor over a storage season. Another issue which continues to plague the industry is secondary browning, a problem caused by fungi. Sporadic occurrence during the storage season and between lots in a storage has required research to develop predictors of lot to lot variation in susceptibility. More recently, a new technology involving 1-MCP may hold promise as a final solution to this insidious and unpredictable problem. The very nature of fresh-cut fruit has and continues to require a coordinated multi-disciplinary research strategy.

Developing cultivars for organic production systems. Andrew Jamieson*. Agriculture and Agri-Food Canada, Kentville, Nova Scotia, Canada.

The amount of fruit and vegetables produced under organic production systems, irrespective of how "organic" is delimited, has been steadily increasing. Organic production is largely based on cultivars that were originally developed for conventional production systems. The prospects of breeding specifically for organic systems are intriguing. One approach is identifying the major constraints with which organic growers must contend (often diseases or insect pests) and then incorporating stable genetic resistance. A more complex approach is to define an organic crop ideotype and derive an index of traits as a selection criterion. How effective are these methods expected to be in improving clonally propagated fruit crops? In addition to the importance of the breeding goals, the technologies employed are also of concern. The topic will be examined with special reference to breeding strawberries and apples.

The current status of organic horticulture research in Canada and recent linkages with international scientists in organic apple and pear production research. Charlee G. Embree, Research Scientist, Study leader for Organic Horticulture, Agriculture and Agri-Food Canada, Kentville, Nova Scotia, Canada B4N 1J5.

Organic horticulture research has been conducted by Agriculture and Agri-Food Canada (AAFC) Scientists throughout the Nation for a number of years. The research projects have in all cases been conducted in conjunction with or complimentary to the scientists primary focus. Extensive research reports have therefore been few. Often results are made available directly to the industry producers, through the popular press or in technical publications. There is evidence that this is changing as horticultural research scientists learn of the industry's need to produce more certified organic produce to meet expanding market opportunities. The greenhouse vegetable

industry is a good example. Research in organic tree fruit production in Canada is also in its early stages of development. In Feb. 2006 it received a strong stimulus however, when a group of AAFC, ISHS and the Organic Agriculture Center for Canada scientists joined with the regional organic network (ACORN) to host the First International Apple and Pear Symposium in Nova Scotia. This paper will attempt to document the current status of organic research in Canadian Horticulture and to report the highlights of the International Apple and Pear Symposium.

Wendy, a new early season strawberry. Andrew R. Jamieson*. Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Centre, 32 Main Street, Kentville, Nova Scotia, Canada B4N 1J5.

Wendy is a productive, short-day cultivar adapted to matted-row culture in eastern Canada. Harvest of Wendy is in early season, concurrent with Evangeline. Primary fruit are wedge-shaped; subsequent fruit are conic. Fruit are larger than for Evangeline with similar color and firmness. Berries of Wendy have excellent fresh flavor. Plants are vigorous and productive in matted rows. Plants are moderately resistant to powdery mildew but susceptible to Verticillium wilt. The reaction to red stele root rot has not been defined. Wendy is introduced as an early season alternative to Evangeline and Veestar with improved fruit size and yield.

Certain natural and synthetic compounds act as anti-transpirants. Rajasekaran Lada¹, B. Theakston², A. Adams^{1*}, T.J. Blake². ¹Department of Plant and Animal Science, Nova Scotia Agricultural College, P.O Box 550 Truro, Nova Scotia, Canada B2N 5E3; ²Earth Science Centre, Faculty of Forestry, University of Toronto, 33, Wilcocks Street, Toronto, Ontario, Canada M5S 3B3.

Water is a scarce resource and nearly 75% of the underground water has already been depleted, mostly through agriculture. Controlling stomatal opening without any phytotoxic effects on plants is advantageous under water limiting conditions and to conserve soil moisture. A study was conducted to screen potential anti-transpirant compounds for their ability to reduce stomatal conductance and leaf transpiration in carrot seedlings. Carrot seeds var. Oranza were sown in 6" pots containing PromixTM and grown under greenhouse conditions (21°C day, 14°C night) for 3 wk. Each pot received 250 mL of water per day. Twenty compounds were applied as a foliar spray. Each treatment was replicated 4 times with untreated and water treated controls for each. Sprays were applied at 1000 and allowed to dry on the leaves before measurements were taken between 1045 and 1145 using a LI-1600 Steady State Porometer (LiCor, USA). Our previous studies revealed that stomata in carrot seedling are most active during that time. Of the 20 compounds screened, WiltprufTM, LeafsheildTM, N-Methyl-L-Proline, and BIOPROTECTTM were all effective at reducing stomatal conductance (Cs) and leaf transpiration (Tl). Compounds such as Potassium chloride, 1-2-4 Triazole, Trans-4-Hydroxy-L-Proline, Spermine and Spermidine all increased Cs and Tl.

Regulation of superoxide dismutase isoforms in resistant strawberry cultivar subjected to leaf spot disease. Behrouz Ehsani Moghaddam* and Shahrokh Khanizadeh. Agriculture and Agri-Food Canada, Horticultural Research Development Centre, 430 Gouin Blvd., St-Jean-sur-Richelieu, Québec, Canada J3B 3E6.

Two June bearing strawberry cultivars, Joliette (resistant) and Kent (susceptible) were inoculated with *Mycosphaerella fragariae*

pathogen. Macroscopic symptoms characterized by red spots were observed on leaves 30 d after inoculation. Comparison of the Superoxide dismutase isoform profiles obtained by gel electrophoresis in all samples extracted from both resistant and susceptible cvs indicated one constant sharp band identified as Mn-SOD with 19 kD molecular mass. The intensity of this band in all samples derived from resistant cv. was greater than that of susceptible. Another SOD isoform was also disclosed as a CuZn-SOD with 16 kD molecular mass, detected in all soluble proteins derived from resistant cv. This isoform was not observed in susceptible cv, however, with an increment of the amount of loaded protein, it was illuminated as a faint band in sample collected 3 d after inoculation, indicating insufficient production of CuZn-SOD isoform in susceptible cv. during oxidative burst induced by the *M. fragaria* pathogen. Several bands were also characterized in both cv containing jointly Fe and Mn as their co-factors (Fe, Mn-SOD). In the resistant cv. the activity of Fe, Mn-SOD isoforms gradually and regularly increased and reached to their highest level during the third day after inoculation. In comparison, the activity of the isoforms changed irregularly over the 20 d of the survey after inoculation.

Spatial variation of wild blueberry N, P and K levels using hyperspectral techniques. Camille Bourguignon^{1*}, David Percival¹, Jean-Pierre Privé², Robin Robinson¹. Nova Scotia Agricultural College, P.O. Box 550, Truro, Nova Scotia, Canada B2N 5E3; ²AFHRC, Senator Hervé J. Michaud Research Farm, P.O. Box 2069, Bouctouche, New Brunswick, Canada E4S 2J2.

Current wild blueberry leaf macronutrient assessment analyses are costly and time consuming and generally provide an overview for blanket fertilizer applications. Hyperspectral techniques using wavelengths in the visible and near-infrared spectra have been considered as an alternative for various crops. Nutrient assessment research at the site (CASI 550) and plot (FieldSpec Pro radiometer) levels were used to determine if spatial variations of wild blueberry leaf N, P and K contents could be determined in commercial fields. In May 2004, a multiple location N-P-K experiment (16 treatments, 4 replications) was established in Mount Thom, Nova Scotia. Nitrogen (0–80 kg N ha⁻¹, as (NH₄)₂SO₄), phosphorus (0–220 kg P₂O₅ ha⁻¹, as TSP) and potassium (0–80 kg K₂O ha⁻¹, as MOP) were applied to induce variations in corresponding leaf nutrients contents. Leaves were sampled in August 2004 and 2005, as well as in June 2005. Foliar N (LECO auto-analyzer), as well as foliar P and K (ICAP), were determined. CASI 550 data was acquired at Mount Thom (833 m altitude) at dates similar to those of leaf sampling. Radiometer data was collected in 2005 (2 m above ground) at dates corresponding to CASI data collections. Stepwise regressions and NDVI comparisons on CASI reflectances were done to estimate leaf N content. Preliminary analyses were completed on radiometric raw DN_s to observe possible trends of foliar N, P and K variations.

Current status of elderberry research in eastern Canada. Denis Charlebois* and Claude Richer. Horticultural Research and Development Centre, Agriculture and Agri-Food Canada, 430 Gouin Blvd., St-Jean-sur-Richelieu, Quebec J3B 3E6.

American elderberry (*Sambucus nigra* ssp. *canadensis*) is a perennial shrub native to Eastern North America. Aside from being used as wind break or ground stabilizer there has been an increasing demand for its fruits mainly from the food colorants industry. To satisfy the demand of this industry alone more than 100 hectares would have to be planted. However little is known about this

plant's cultivation. We report preliminary results from a long-term study evaluating field performance, yield, fruits characteristics of the wild species and 5 selected cultivars (Kent, Nova, Scotia, Victoria and York). Under proper care all cultivars showed excellent winter survival from zone 5a to zone 2b. Branches are only moderately resistant to snow and ice load and can easily break if left unattached. Rapid growth (up to 1.5 m a year) can compensate for losses following bad winter conditions. Fruit production starts the second year in the field and can vary between 2 and 3 kg per plant. It reaches between 5 and 8 kg per plant the second year of production. Pigment content differs between cultivars; those producing larger fruits containing less pigment. Results obtained so far can be used to assist potential producers selecting the appropriate cultivars to suit their need.

Potential to double crop vegetables on plastic mulch. T. Simms, J. Bantle, W. Hrycan, and D. Waterer*. Department Plant Sciences, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 5A8.

Double-cropping plastic mulches may increase cost-effectiveness while reducing the environmental impact of this method for enhancing growth of vegetable crops. In regions with a short growing season, double-cropping of mulches involves leaving the plastic in the field over winter. This extended exposure to the elements may negatively effect the physical and optical characteristics of the mulch. In 2005, black, clear and IRT mulches were used to produce pepper (*Capsicum annuum*) or cucumber (*Cucumis sativus*). Clear mulch produced the highest yields of both crops, followed by the IRT and black mulch. Light transmission characteristics of the mulches were noticeably altered after the first growing season. Part of this change was due to soil and debris on the surface of the mulch: when the mulches were washed, their light transmission characteristics more closely resembled new mulch. The light transmission characteristics of the IRT mulch changed more than the clear or black mulches. All the mulches were physically sound at the beginning of the second growing season. The light transmission characteristics of the mulches and the performance of tomatoes cropped on the mulch in the second season will be reviewed.

Determination of flavonols in apple genotypes by liquid chromatography mass spectrometry. G.M. Huber^{1*}, C. Embree², and H.P.V. Rupasinghe¹. ¹Department of Environmental Sciences, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada B2N 5E3; ²Atlantic Food and Horticulture Research Center, Agriculture and Agri-Food Canada, Kentville, Nova Scotia, Canada B4N 1J5.

Growing evidence has been reported on the specific health benefits of flavonols. Apple skin is one of the richest sources of flavonols, particularly quercetin glycosides. The objective of this research was to determine the distribution of flavonols among the fruit skin tissues of selected 27 apple genotypes comprised of 11 commercial cultivars, 10 new breeding lines, and 6 crab species. An ultrasound-assisted method was optimized for extraction of flavonols from freeze-dried apple skin tissues. The identification and quantification of six known flavonols was performed using ESI-MS/MS in multiple reaction monitoring mode. The major flavonols identified in apple skins were quercetin-3-galactoside, quercetin-3-rhamnoside, quercetin-3-glucoside, and quercetin-3-rutinoside. Quercetin-3-galactoside, the most abundant flavonol, represented 46% of total flavonols in the skin. The commercial cultivar group had higher total flavonols (121 to 363 mg 100 g⁻¹ DW) than the new breeds and crab apple groups ($P < 0.0001$). Empire (363 mg

100 g⁻¹ DW), Novamac (356 mg 100 g⁻¹), and Royal Gala (303 mg 100 g⁻¹ DW) cultivars had the highest total flavonols content among the tested apple genotypes. Precursor ion scan of the quercetin aglycone (m/z 301) revealed the presence of an additional quercetin glycoside in some apple genotypes. Further analyses are being performed to elucidate the structure of this unknown quercetin glycoside.

Life cycle analysis of environmental technologies to improve wild blueberry production. G. Dias^{1*}, L. Bushi¹, S. Young¹, C. Monreal², D. Percival³, G. Thiessen³. ¹GHGm.com, Guelph, Ontario, Canada N1H 4W8; ²Agriculture and Agri-Food Canada, Ottawa, Ontario, Canada K1A 0C6; ³Department of Environmental Sciences, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada.

A Canadian agricultural life cycle analysis model was used to analyze the environmental performance of leading edge environmental monitoring and precision farming techniques to optimize fertilizer, pesticide, and water use in wild blueberry production. These techniques could provide sustainable technologies to reduce the risk of soil and water contamination and increase the competitiveness of the blueberry industry. The baseline industry practice involves standard fertilization and pesticide application at a single rate (i.e., blanket application) and limited use of irrigation. The life cycle analysis compared the environmental performance of the new technology and the baseline based on a reference unit (RU) of 1000 kg blueberries harvested. The use of precision farming techniques and environmental monitoring to determine the needs of the blueberry crop resulted in environmental savings of 1744 MJ/RU of energy, 127 kg CO₂e/RU of greenhouse gases, and 580 µg/RU of ammonia emissions, compared to the baseline practice. Other environmental indicators that were measured include residual N, P loading reduction, pesticide hazard reduction, soil carbon, soil erosion reduction, and biodiversity, but these results are pending. Precision farming technologies should improve yields, fruit quality and composition and enhance environmental stewardship.

Delineation of within-site terroir effects using soil and vine water measurement. Investigation of Cabernet Franc. Javad Hakimi Rezaei* and Andrew G. Reynolds. Cool Climate Oenology and Viticulture Institute, Brock University, St. Catharines, Ontario.

The influence of soil, climate, and water status were studied in commercial vineyard blocks of *Vitis vinifera* L. 'Cabernet Franc' in Niagara Peninsula, Ontario. Vine performance, berry, must and wine composition of nonirrigated grapevines were compared in ten vineyard blocks containing different soil types. The influence of climate was assessed using maximum and minimum temperature, degree days (base of 10°C) and rainfall for 2005. Preliminary results showed that within each vineyard block water stress zones can be identified on GIS generated maps using leaf water potential and soil moisture measurements. Some of the variables correlated with the intensity of vine water stress. Wines made from high and low water stress zones in each vineyard block were tasted by a panel that could be differentiated in terms of water stress levels as well as geographic location.

Effect of plant growth regulators on tomato plug plant production, field establishment, maturity, yield & quality. John Zandstra^{1*}, Jim Dick², John Lang³. ¹Ridgetown College, University of Guelph, Ridgetown, Ontario, Canada N0P 2C0; ²Tomato Solutions, 23264 Mull Rd., Chatham Ontario, Canada N7M 5J4; CanGro, 759 Wellington St., Dresden, Ontario, Canada N0P 1M0.

Managing transplant development in a greenhouse can be challenging in certain years, and techniques to help control plant growth would be useful. Given the limited growing season in southwestern Ontario, processing tomato transplants which establish and begin to grow quickly after transplanting are also desired. Triazoles are a group of agricultural chemicals which were initially developed as fungicides but were also found to regulate plant growth. The most typical plant growth response to triazoles is a reduction in stem length, but they also have been found to increase leaf thickness, stem thickness, and root development. Triazoles have also been reported to protect plants from environmental stresses, including drought and temperature extremes. When applied to processing tomato transplants as a soil drench at the 2 leaf stage, the triazoles paclobutrazol (Bonzi) and uniconazole (Sumagic) reduced plant development resulting in the need to fertilize heavily (up to 5 times the normal rate) to achieve the desired plant height at transplanting. These treatments resulted in increased vigour in the field (measured as plant dry and fresh weight), advanced plant development (earlier bloom), and advanced fruit maturity.

Evaluation of fresh and aged clam processing wastes as agricultural liming agents for coastal vegetable production fields. Josée Owen^{1*}, Serge LeBlanc¹, Patrick Toner², and Erica Fava¹. ¹Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Centre, Senator Hervé J. Michaud Research Farm P.O. Box 2069, Bouctouche, New Brunswick, Canada E4S 4J1; ²New Brunswick Department of Agriculture, Fisheries and Aquaculture, 850 Lincoln Road, Fredericton, New Brunswick, Canada E3B 9H8.

Clam processing in Atlantic Canada generates 4000 metric tons of clamshell wastes annually. Twenty-year stockpiles of shells must now be remediated to satisfy environmental regulations. This study examined fresh and aged clamshells as agricultural liming agents for sandy, acidic, coastal vegetable production soils. Clamshell wastes fresh from processing and aged stockpiled shells were analysed for coliform bacteria, plant nutrients, calcium carbonate equivalent, and organic matter. The shells met New Brunswick's guidelines for wastes as soil additives. Clamshells were ground to three size fractions (<0.250 mm, 0.250 to 1.00 mm, 1.00 to 2.00 mm). These were mixed with two soils at four rates, and placed in a control-plus-factorial (commercial agricultural lime as control) pots experiment. During an 8-wk incubation, soil water pH and electrical conductivity (EC) were monitored biweekly. At 4 and 8 wk, a soil extract germination test was conducted using watercress (*Lepidium sativum* L.), a species sensitive to water quality, as an indicator plant. The pH and EC data were used to develop prediction graphs of the soil reactions which can be used as a basis for guidelines for rates of land application for liming. Clamshell amendment did not negatively affect germination of watercress seeds.

Leaf removal and prohexadione-calcium can modify Camarosa strawberry nursery plant morphology for plasticulture fruit production. J.Y. Reekie^{1*,3}, P. R. Hicklenton¹, J. R. Duval², C. K. Chandler², and P. C. Struik³. ¹Atlantic Food and Horticulture Research Centre, Agriculture and Agri-Food Canada, Nova Scotia, Canada B4N 1J5; ²Gulf Coast Research and Education Center, University of Florida, 14625 County Road 672, Wimauma, FL 33598, USA, USA; and ³Department of Plant Sciences, Crop and Weed Ecology Group, Wageningen University, Wageningen, the Netherlands.

Mowing and the application of a new gibberellin biosynthesis inhibitor, prohexadione-calcium (ProCa), were studied as methods to modify the bare-root transplant morphology of Camarosa strawberry (*Fragaria × ananassa* Duchesne) in a Nova Scotia nursery. The effect these nursery practices had on fruit production in annual hill plasticulture was also determined. In one experiment Camarosa plants were sprayed with ProCa at an active ingredient concentration of 62.5 mg L⁻¹ on Aug. 22, Sep. 05, or Sep. 19, 2001 and 2002, corresponding, respectively, to growing degree days (10°C base) of 800, 894 and 965 in 2001 and 726, 821 and 908 in 2002. Application on Aug. 22 increased production of daughter plants, especially those of marketable size, by increasing the number of daughters per meter of runner and allocating more dry matter to marketable daughters. In a second experiment, field plots were mowed and/or treated with ProCa at an active ingredient concentration of 62.5 mg L⁻¹ on Sep. 05 or Sep. 19, 2001 and 2002. All plants were dug in early October, shipped to Dover, Florida, and transplanted into plasticulture for fruit production. At digging, plants that had been mowed or treated with ProCa on Sep. 05 were reduced in plant height and total leaf area compared with untreated plants. Plants that were treated both with ProCa and mowed were the shortest. Fruit yield was higher from treated than from untreated plants. In 2001, the treatments increased early fruit production.

Time to emergence (ATE) and stem number of potato plants grown from seed tubers treated with ethylene and 1-methylcyclopropene (MCP) during storage. K. Pruski*, B. Daniels-Lake, and R. Prange. Nova Scotia Agricultural College, 50 Pictou Rd., Truro Nova Scotia, Canada B2N 5E3; Atlantic Food & Horticulture Research Centre, Kenville, Nova Scotia, Canada B4N 1J5.

A 3-yr study (2002/2004) was undertaken to determine the effects of low concentrations of ethylene in storage atmosphere and MCP (1-methylcyclopropene) treatment on physiological responses of seed tubers. Seed tubers (cut and uncut) of the three cultivars, Atlantic, Russet Burbank and Shepody, were stored at 4°C, 80–85% humidity, with air ventilation of 15 L min⁻¹ for two 6-h periods daily, either under continuous ethylene supplement at 4 ppm alone (either from November or February) or with MCP, applied as a gas, for 48 h, only once in early December. In growth-room studies, once a month (January–May), six uncut tubers were taken from each of the storage treatments, planted to pots and grown for one month at 16 h photoperiod, 22/18°C d/n temp. In field studies, cut (stem and rose end) and uncut tubers were planted. In the growth-room, shoot emergence from the ethylene-treated seeds of all three cultivars occurred significantly earlier (up to 5 d), producing higher number of stems per tuber and stolons per stem, compared with control and MCP treatments. ATE decreased further with the increased length of storage. MCP in combination with ethylene was particularly effective in Shepody after 190 d of storage. Similar in the field, plants grown from ethylene-treated whole and cut rose end seed emerged earlier (2–3 d) compared to plants from untreated and cut stem end seed. In the field, however, the differences between cultivars were more pronounced than in growth-room studies.

Do photo-physical-mechanical (PPM) pre-treatments induce defense against carrot blights (*Alternaria dauci* and *Cercospora carotae*) through endogenous hormonal signals? Kathryn Pickle¹*, Rajasekaran R. Lada¹, Sam Asiedu¹, Claude Caldwell¹, Jeffrey Hoyle², and Jeffrey Norrie³. ¹Department of Plant and Animal Science, Nova Scotia Agricultural College, PO Box 550,

Truro, Nova Scotia, Canada B2N 5E3, ²Department of Environmental Science, Nova Scotia Agricultural College, PO Box 550, Truro, Nova Scotia, Canada B2N 5E3, ³Acadian Seaplants Limited, 30 Brown Avenue, Dartmouth, Nova Scotia, Canada B3B 1X8.

Plants have evolved many different and ingenious strategies to defend themselves against environmental and biotic stresses. The impact of examining and understanding these natural defense mechanisms may lead to the modification of conventional farming practices, and reduce our dependency on chemical disease control. One of the most promising methods is to trigger plant defenses by exposing them to an abiotic stress prior to infection, thereby increasing the plants resistances to diseases and/or pests. In this model study, UV-C radiation, leaf brushing and canopy trimming were applied to field-grown carrots and the degree of blight and white mold infection was measured. Preliminary analyses showed that UV-C radiation at 4 wk post-emergence or brushing at 4 or 8 wk significantly reduced carrot blight and/or white mold. This implies that UV-C radiation and brushing may induce plant defenses, allowing the crop to better defend itself against future biotic stress. This hypothesis that photo-physical and mechanical (PPM) pre-treatments induce plant defenses through increasing endogenous salicylates and/or jasmonates is being investigated under controlled conditions.

Prince Edward Island growers can reduce soil phosphorus buildup while maintaining carrot crop yield. K.R. Sanderson* and J.B. Sanderson. Agriculture and Agri-Food Canada, Crops and Livestock Research Centre, Charlottetown, PE, Canada C1A 4N6.

Producers continually manage the application of nutrients relative to economic crop returns while remaining sensitive to environmental issues such as increasing soil phosphorus. To address this issue in carrot production, we studied the effect of soil applied P on yield and soil P content in PEI. Six field studies over a 3-yr period were evaluated to determine the yield response of carrot (*Daucus carota* L.) on sandy to loamy sand Orthic Podzol soils. Treatments consisted of broadcast P at 0, 33, 66, 99 and 132 kg P ha⁻¹. When total yield of carrots was fitted to a quadratic response curve and solved for maximum yield, 110 kg P ha⁻¹ would be required to achieve this yield. By applying P to achieve 95% of maximum yield, soil test P was only increased by 25% compared to when P was applied to achieve maximum yield. Carrot growers can significantly reduce environmental contamination caused by the buildup of soil P while maintaining excellent crop yield.

Assessing nitrogen use efficiency and potential nitrogen losses in field-grown cucurbits. Laura L. Van Eerd*. University of Guelph, Ridgetown Campus, Ridgetown, Ontario, Canada N0P 2C0.

With nutrient management legislation, it may be more critical to optimize nitrogen use efficiency (NUE) in order to maintain crop yields and minimize off-field N losses. The aforementioned parameters were assessed over 2 yr in three field experiments of processing winter squash and machine-harvested processing cucumbers. Preplant ammonium nitrate or UMAXX[®] (a urea-based fertilizer containing nitrification and urease inhibitor) was broadcast applied at five doses between 0 and 220 kg N ha⁻¹, and a split application of 70 plus 40 kg N ha⁻¹. In two contrasting years (i.e., cool/wet vs. warm/dry), marketable cucurbit yield response to N application was either positive, negative, quadratic, or no response. There was no difference in marketable yield between dif-

ferent application timings nor N source. Generally, NUE decreased as N rates increased from 110 to 220 kg N ha⁻¹ for both cucurbits. Squash NUE was considerably higher than cucumber, which was likely due to the stage of plant development at harvest. The quantity of mineral N remaining in the field at harvest varied greatly with location and cucurbit crop. Preliminary results indicate an opportunity to reduce N rates and thus increase NUE and decrease potential N losses.

Effects of summer and fall applications of foliar boron on wild blueberry fruit bud winter injury. L.J. Eaton¹*, H-Y. Ju¹ and K.R. Sanderson. ¹Nova Scotia Agricultural College, Truro, NS, Canada B2N 5E3; ²Agriculture and Agri-Food Canada, Crops and Livestock Research Centre, Charlottetown, PE, Canada C1A 4N6.

Boron is a micro nutrient that is important in small fruit production, and plays a role in fruit bud development and possibly in tolerance of harsh winter conditions. Boron is applied to a few wild blueberry (*Vaccinium angustifolium* Ait.) fields in Nova Scotia, but little is known of its effects. This study reports the effects of single and multiple applications of foliar boron to two commercial wild blueberry fields, particularly the effects on tissue B concentrations and winter injury to developing fruit buds. Foliar boron (Bortrac[®]) was applied in single and multiple applications over a 4-yr period. Multiple foliar boron applications, summer + fall, resulted in increased tissue boron levels in first crop fruit buds compared to untreated controls, but the increases were not observed in second crop fruit buds. Only multiple applications of foliar boron (summer + fall) applied in two successive cycles at the Fern Walker field reduced winter injury compared to untreated controls. It is possible that multiple foliar applications of boron to blueberry fields may reduce winter injury to developing fruit buds in some years.

Influence of introduced living mulches in lowbush blueberry fields on soil microclimatic conditions. Lynda I. Stewart*, David C. Percival, and Bonna L. Jordan. Department of Environmental Sciences, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada B2N 5E3.

Increased herbicide use has led to an increase in the size and number of bare spots in fields and soil erosion creating an unfavorable environment for wild blueberry growth and development. Vegetative cover, in the form of living mulches, is a feasible method of improving soil quality and lowbush blueberry coverage. Two experiments were conducted in commercial blueberry fields to determine the effects of introducing living mulches on the soil microclimatic conditions, and the competition for light between the blueberry and living mulches. Both experiments were established in the vegetative phase of production and each consisted of three vegetative treatments. The first experiment consisted of 1) an unseeded control, 2) creeping red fescue and perennial ryegrass, and 3) birdsfoot trefoil (BFT) and tall fescue. The second experiment consisted of 1) an unseeded control, 2) BFT, perennial ryegrass, tall fescue, and 3) nordic hard fescue, sheep's fescue, creeping red fescue, perennial ryegrass. Following two growing seasons, the living mulches significantly retained soil moisture and decreased soil temperature when compared to the bare soil samples. The introduction of the living mulches did not affect the soil hydraulic activity, infiltration rate, or soil aggregate stability. BFT and fescue species significantly increased the % organic matter and the soil nutrients K, Ca and Mg. LAI and PAR results suggest the fescue species compete less for light, and may be more suitable as living mulches in lowbush blueberry fields.

Microbial growth control of fresh-cut apples by cinnamon extracts. S. Muthuswamy*, H.P.V. Rupasinghe, and G.W. Stratton. Department of Environmental Sciences, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada B2N 5E3.

The consumer demand for convenient and nutritious minimally processed produce like fresh-cut apple has been steadily increasing. Identification of natural antimicrobial agents that are acceptable to consumers is a challenge to the fresh-cut industry. We have investigated the potential for natural antimicrobial products extracted from cinnamon (*Cinnamomum cassia*) to use as a food additive to extend the shelf life of fresh-cut apples. Five extracts were prepared from cinnamon bark and powder to evaluate their antimicrobial activity on two common food borne microorganisms, *Escherichia coli* and *Listeria innocua*. An ethanolic extract of cinnamon bark inhibited the growth of *E. coli* and *L. innocua* by 67 and 68%, respectively, as determined by the optical density (turbidity) of the Trypticase soy broth (TSB) culture medium (24 h at 32°C) inoculated with the microorganisms separately. When incorporated in a commercial anti-browning dipping solution FreshExtendTM, the cinnamon extract reduced significantly ($P < 0.05$) the microbial growth of apple slices stored for 12 d at 6°C in comparison to the control. The cinnamon extract had no influence on the antibrowning properties of FreshExtend. Liquid chromatography mass spectrometry analysis showed that the major component of this extract is cinnamaldehyde.

Ambiol enhances drought tolerance in flacca tomato mutant with wilt phenotype. Mason T. MacDonald*. Ecophysiological Research Group, Department of Plant and Animal Science, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada B2N 5E3.

Ambiol is a synthetic antioxidant well established to possess plant growth regulating properties. In addition, Ambiol is capable of alleviating drought stress in a variety of dicots and conifers, including tomatoes (*Lycopersicon esculentum*). As such, it is expected that Ambiol may require ABA, a phytohormone associated with stomatal closure, to alleviate drought stress. A 2-sample t-test was constructed to test the effect of a 10 mg L⁻¹ and 0 mg L⁻¹ Ambiol seed treatment on an ABA deficient tomato mutant, flacca. It was found that the 10 mg L⁻¹ treatment was able to significantly increase plant height (10%), membrane stability (10%), and photosynthetic rate (60%). These preliminary results suggest that there is some benefit from Ambiol regardless of the presence of ABA, perhaps due to promotion of cytokinins or auxins, which would help explain increased growth and stability of the photosynthetic apparatus. Confirmatory studies are needed using ABA inhibitors.

Impact of morphological and physiological variations in strawberries (*Fragaria*) on resistance to the tarnished plant bug, *Lygus lineolaris*, and the efficacy of the egg parasitoid, *Anaphes iole*. Nader Koohpayehzadeh¹*, Guy Boivin², Yves Desjardins¹, Shahrokh Khanizadeh². ¹Université Laval, Département de Phytologie, ²HRDC, Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu QC, Canada J3B 3E6.

The strawberry is one of the most important small fruit culture in Canada. There are hundreds of strawberry varieties which were developed based on morphological traits as well as physiological factors. Moreover, these varieties vary in their susceptibility to some diseases and pests. The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) (Hem.:Miridae) is an important pest of strawberries causing fruit deformation "catfaced" and abortion. In this study, we will assess the importance of morphological and physiological characteristics of strawberry in the resistance of this plant

to the tarnished plant bug. However, in order to use resistant cultivars of strawberries in integrated pest management programs, it is important to determine the effectiveness of natural enemies on these cultivars. To verify this hypothesis in the strawberry system, we will use *Anaphes iole* Girault (Hym.: Mymaridae), an egg parasitoid of tarnished plant bug. These results will help plant breeders to produce cultivars that are both resistant to this pest and amenable to the use of egg parasitoid.

SuperMac, a new winter hardy scab resistant apple cultivars. Shahrokh Khanizadeh^{1*}, Yvon Groleau¹, Audrey Levasseur¹, Odile Carisse¹, Jennifer DeEll², Jean-Pierre Privé³, Campbell Davidson⁴, Intiaz Ali⁵, Jenk Kemp⁶.¹Agriculture and Agri-Food Canada, Horticultural Research and Development Centre, 430 Gouin Blvd., St-Jean-sur-Richelieu, QC, Canada J3B 3E6; ²Ontario Ministry of Agriculture and Food, Box 587, 1283 Blueline Rd & Hwy #3, Simcoe, Ontario, Canada N3Y 4N5; ³Agriculture and Agri-Food Canada, Food and Horticulture Research Centre, Senator Hervé J. Michaud Research Farm, 1045 St. Joseph Rd. Bouctouche, New Brunswick, Canada; ⁴Agriculture and Agri-Food Canada, Cereal Research Centre, Unit 100-101 Route 100; Morden, Manitoba, Canada R6M 1Y5; ⁵Department of Food Science, Macdonald Campus of McGill University, 4,111, Lakeshore Rd. Ste Anne de Bellevue, Quebec, Canada; and ⁶Praktijkonderzoek Plant & Omgeving B.V., Postbus 167, 6700 AD Wageningen, the Netherlands.

SuperMac is being released as a replacement for Spartan, which is presently being grown in Eastern Canada for its excellent shelf life but susceptibility to scab the most common apple diseases. This new cultivar produces larger fruit than Spartan and is resistant to apple scab [*Venturia inaequalis* (Cke) Wint.]. It is very attractive, has a pleasant taste and an excellent shelf-life and keeps very well and longer compare to the 'Spartan'. SuperMac is a 'McIntosh' type apple (*Malus × domestica* Borkh. The tree is hardy to -30°C, and the fruit and leaves are resistant to the common races of apple scab (*Venturia inaequalis* (Cke) Wint.) due to the presence of the Vf gene derived from *Malus floribunda* 821.

EdenTM, a non-browning apple cultivar. Shahrokh Khanizadeh^{1*}, Yvon Groleau¹, Audrey Levasseur¹, Rong Tsao², Raymond Yang², Jennifer DeEll³, Cheryl R. Hampson⁴, and Peter Toivonen⁴. ¹Agriculture and Agri-Food Canada, Horticultural Research and Development Centre, 430 Gouin Blvd., St-Jean-sur-Richelieu, QC, Canada J3B 3E6; ²Agriculture and Agri-Food Canada, Food Research Centre, 93 Stone Road West, Guelph, Ontario, Canada N1G 5C9; ³Ontario Ministry of Agriculture, Food and Rural Affairs, 4890 Victoria Ave N, Box 8000, Vineland Station, Ontario, Canada L0R 2E0; ⁴Agriculture and Agri-Food Canada, 4200 Hwy. 97, Summerland, British Columbia, Canada V0H 1Z0.

EdenTM is a dessert apple (*Malus × domestica* Borkh.) type with improved firmness, crispness, high quality flesh and much longer shelf life than McIntosh and Cortland. The fruit have superior flavor and do not fall from the tree at maturity. The flesh is juicy, firm, crisp and resistant to bruising. No browning occurs after cutting, making it an excellent candidate for fresh fruit slices, fruit salad, dried apple chips and processing (juice, cider). EdenTM also tested as 'SJCA38R6A74' and 'A38R6A74', originated from a cross made in 1971 between Linda and Jonamac, at the Agriculture and Agri-Food Canada (AAFC), Horticultural Research and Development Center (HRDC). EdenTM fruit are susceptible to bitter pit, especially if the season is dry and no irrigation is provid-

ed. The yield is very similar to Macspur and the fruit are resistant to water core. Contrary to Macspur, the fruit of Eden do not drop at maturity and stay on the tree several weeks after, even at -20°C, which make it a good candidate for Ice Cider production.

Antioxidant capacity in June-bearing and day-neutral strawberry. Shahrokh Khanizadeh^{*}, Behrouz Ehsani-Moghaddam, and Audrey Levasseur. Agriculture and Agri-Food Canada, Horticultural Research Development Centre, 430 Gouin Blvd., St-Jean-sur-Richelieu, Québec, Canada J3B 3E6.

The present study was carried out to estimate the crude, hydrophilic and lipophilic antioxidant content of known and new advanced selections among June-bearing and day-neutral genotypes using Trolox equivalent antioxidant capacity method. Crude, hydrophilic and lipophilic extractions were prepared using 25g samples of frozen fruits. In June-bearing strawberries, significant differences were observed among crude, hydrophilic and lipophilic antioxidant values of different selected genotypes. Mean of crude, hydrophilic and lipophilic antioxidants in June-bearings were estimated 20.382, 13.444 and 0.474 µmol TE g⁻¹ FW, respectively, which were higher than those of the day-neutral genotypes (i.e., 13.167, 9.387 and 0.281 µmol TE g FW). The present study revealed the importance of genetic background for determining the antioxidant potential in selected June-bearing genotypes and the possibility of production of new strawberry cultivars with higher levels of antioxidant capacity through breeding programs.

Clé des Champs strawberry. Shahrokh Khanizadeh^{1*}, Martine Deschênes¹, Audrey Levasseur¹, Odile Carisse¹, Jennifer DeEll³, Rong Cao², Raymond Yang², J. Alan Sullivan⁴, Jean-Pierre Privé⁵. ¹Agriculture and Agri-Food Canada, Horticultural Research and Development Centre, 430 Gouin Blvd., St-Jean-sur-Richelieu, QC, Canada J3B 3E6; ²Agriculture and Agri-Food Canada, Food Research Centre, 93 Stone Road West, Guelph, Ontario, Canada N1G 5C9; ³Ontario Ministry of Agriculture and Food, Box 587, 1283 Blueline Rd & Hwy #3, Simcoe, Ontario, Canada N3Y 4N5; ⁴Department of Plant Agriculture, University of Guelph, Guelph, Ontario, Canada N1G 2W1; ⁵Agriculture and Agri-Food Canada, Food and Horticulture Research Centre, Senator Hervé J. Michaud Research Farm, 1045 St. Joseph Rd. Bouctouche, New Brunswick, Canada.

Clé des Champs is a new June bearing strawberry cultivar (*Fragaria × ananassa* Duch.) bred for Eastern Central Canada and climates similar to Quebec conditions. Clé des Champs was released for pick your own and shipping because it has very attractive light red, glossy and firm fruit, which have an excellent shelf life of several days. Clé des Champs, tested as LL9324-24, is a progeny resulting from a cross between 'SJ89244-6E' and 'SJ8518-11' made in 1993 by S. Khanizadeh. Clé des Champs has been tested at the Agriculture and Agri-Food Canada (AAFC) sub-station in L'Acadie, Quebec since 1994, and during 1995-2002 by our partners Association des producteurs de fraises et framboises du Québec - (APFFQ) and Réseau d'Essais de Petits Fruits, CPVQ (Quebec Regional small fruit trials, Conseil des productions végétales du Québec) in Quebec. It has been also tested by other AAFC research centers (Atlantic Food and Horticulture Research Centre, Bouctouche New Brunswick), as well as in Ontario. Clé des Champs is presently being tested in another AAFC research center (Manitoba) and also in Europe by Meiosis (Bradbourne House, Stable Block, East Malling, Kent ME19 6DZ).

Phenolic composition and antioxidant activity of selected apple genotypes. Shahrokh Khanizadeh^{1*}, Rong Tsao², Djamilia

Rekika¹, Raymond Yang³, and Jennifer DeEll⁴. ¹Horticultural Research and Development Centre, Agriculture and Agri-Food Canada, 430 Gouin Blvd., St-Jean-sur-Richelieu, Quebec, Canada J3B 3E6; ²Food Research Program, Agriculture & Agri-Food Canada, 93 Stone Road West, Guelph, Ontario, Canada N1G 5C9; ³Ontario Ministry of Agriculture and Food, Box 587, 1283 Blueline Rd & Hwy #3; Simcoe, Ontario, Canada N3Y 4N5.

The phenolic composition of eleven apple genotypes was determined in the flesh and peel by high performance liquid chromatography (HPLC), total phenolic content (TPC) by the Folin-Ciocalteu method, and antioxidant capacity using ferric reducing antioxidant power (FRAP). HPLC analysis identified and quantified several groups of phenolic compounds: procyanidins, hydroxycinnamic acids, anthocyanins, flavonols, and dihydrochalcones. Procyanidins were the most predominant group in both flesh and peel and contributed 52.4% and 44% of the total phenolic index (TPI), respectively. Quercetin glucosides were almost exclusively found in the peel, while cyanadin 3-galactoside was found only in red apple peel. The profile of phenolic compounds varied among the eleven genotypes and the peel showed higher concentrations than the flesh. Among the studied genotypes Reinette Russet and 'SJCA38R6A74' had the highest and the lowest concentrations, respectively. The total phenolics (TPI/TPC) of both flesh and peel extracts correlated well with antioxidant capacity as estimated by the FRAP assay ($R^2 = 0.87, 0.76, 0.92$, respectively), with the exception of TPC from the apple peel determined with FC ($R^2 = 0.52$). The low chlorogenic acid and zero total flavanol content in flesh of 'SJCA38R6A74' genotype tended to be associated with no browning compare to other cultivars.

Fresh market sweet corn production under clear and solar mulch films. T.Q. Zhang*, C.S. Tan, and J. Warner. Harrow Research Center, Agriculture and Agri-Food Canada.

Earliness of fresh market sweet corn is vital important to increase production profitability and maintain market occupancy. The maturity of fresh market sweet corn may be advanced by various mulch films, which however have to be screened to select the one that maximizes the earliness and productivity. We conducted an experiment to determine the effects of clear (CMF) and solar mulch films (SMF) on soil temperature and moisture during the growing season and the performance of fresh market sweet corn in a Granby sandy loam soil with and without N fertilization in south-west Ontario from 2000 to 2001. Regardless of N fertilization, both mulch films increased soil temperature and moisture, compared with the bare soil. Increases of soil temperature were greater under CMF than SMF, with an average of up to 2.2°C across the entire growing season in both 0–10 and 10–20 cm soil depths. However, increases of soil moisture (0–20 cm) were up to 4.4% less under CMF than SMF. Both CMF and SMF advanced sweet corn maturity by 6–7 d. Marketable yield increased by 25 to 63% without N addition and by 72 to 114% with N addition under CMF. Under SMF, marketable yield increased by 97 to 98% without N addition and by 120 to 200% with N addition. SMF is significantly superior to CMF for fresh market sweet corn production.

Protocol for explant disinfection and in vitro shoot multiplication in rhubarb. U. Rayirath^{1*}, R. Lada¹, C. Caldwell¹, S.K. Asiedu¹, and K. Sibley². ¹Department of Plant & Animal Sciences, ²Department of Engineering, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada B2N 5E3.

Rhubarb (*Rheum rhubarbarum* L.) is an emerging commercial vegetable having great potential or the frozen food industry in

North America. However, the exorbitant propagule cost and low rate of in situ propagule production limit expansion of rhubarb industry. Rhubarb is propagated vegetatively by rhizome divisions. Identifying rhizome growth accelerating signals and their application will increase propagule production. Experiments are being conducted to identify the rhizome inducing signals in rhubarb in vitro. Experiments were conducted to standardize protocols for explant disinfection and rapid in vitro shoot multiplication from meristem tips. The results showed that treating lateral bud explants with 30% bleach (sodium hypochlorite) for 10 minutes significantly reduced culture contamination. The culture medium containing MS basal salts and 1 mg L⁻¹ each of benzyl aminopurine (BAP) and indole 3-butyric acid (IBA) was found to be ideal for rapid shoot multiplication from meristem tips. The protocol is successfully used for inducing multiple shoots from meristem tips obtained from lateral buds.

Polyphenol profiles of apple processing by-products. H.P. Vasantha Rupasinghe*. Nova Scotia Agricultural College, Department of Environmental Sciences, Truro, Nova Scotia, Canada B2N 5E3.

There is a strong body of scientific evidence indicating the role of plant polyphenols in fruits and vegetables for their potential benefits in human health. Processing of apples for juice, pie and sauce results in significant volumes of by-products such as pomace, skins, cores, and seeds. The purpose of this study was to investigate whether the processing waste streams of apple are a promising source for biologically active polyphenols. Liquid chromatography coupled to electrospray ionization and triple quadrupole mass spectrometry (ESI-MS/MS) was used to determine the polyphenols present in apple by-products collected from commercial juice and pie manufacturing plants. Apple pomace contained total phenols content of 43 mg 100 g⁻¹ dry weight (DW). The most predominant phenolic compound present in apple seeds and cores was phloridzin (64 and 24 mg 100 g⁻¹ DW, respectively). The total phenolic contents of skin tissues of 'Northern Spy' and 'Idared' cultivars were 322 and 402 mg 100 g⁻¹ DW, respectively. Among the major polyphenols of 'Idared' skins were: cyanidin-3-galactoside (114 mg 100 g⁻¹ DW); quercetin-3-galactoside (90 mg 100 g⁻¹ DW); phloridzin (56 mg 100 g⁻¹ DW); chlorogenic acid (40 mg 100 g⁻¹ DW); and epicatechin (33 mg 100 g⁻¹ DW). These findings demonstrate the potential nutraceutical and other uses of apple by-products upon the investigation of efficient extraction technologies.

Preemergence weed control in ornamental perennials. Valtocho D. Zheljzkov^{1*}, Kevin Patterson², Kim Parsons², and Glen Sampson². ¹Mississippi State, North Mississippi Research and Extension Center, 5421 Highway 145 South, Verona, MS 38879, USA; ²Department of Environmental Science, Nova Scotia Agricultural College, P. O. Box 550 Truro, Nova Scotia, Canada B2N 5E3.

In recent years, the market for ornamental perennials (such as *Astilbe japonica*, *Astilbe arendsii*, *Astilbe chinensis*, *Sedum* spp., *Hosta fortunei*, and *Hemerocallis* spp.) in Canada expanded. Weed competition is a major limiting factor to production of these new cash crops. The objective of this two-seasons field study was to evaluate pre-emergence and post-emergence herbicides for weed control in the above ornamentals. It was found that: (1) Pre-emergence herbicides: (1.1) Napropamide, linuron, mebribuzin, pendimethalin, metolachlor, pronamide, and oxyfluorfen may be used in *Hosta*. (1.2) For weed control in *Astilbe*, napropamide, pendimethalin, metolachlor, pronamide, and oxyfluorfen may be

suitable. Linuron at 2.25 kg a.i. ha⁻¹ can be used in *A. japonica* and *A. arendsii*, but no in *A. chinensis*. (1.3) Herbicides napropamide, linuron, pendimethalin, metolachlor, pronamide, and oxyfluorfen may be suitable for weed control in both *Herocallis* and *Sedum*. (2) Post-emergence herbicides: (2.1) Bentazon, fluazifop-P, pendimethalin, pronamide, thifen sulfuron, rimsulfuron, dithiopyr, and isoxaben can be used. Chlorimuron should be tested further at lower rates. (2.2) Fluazifop-P, pendimethalin, pronamide, chlorimuron, thifensulfuron, rimsulfuron, dithiopyr, and isoxaben can be used for weed control in all three *Astilbe* species. (2.3) Bentazon, fluazifop-P, pendimethalin, pronamide, chlorimuron, rimsulfuron, dithiopyr, and isoxaben can be used in *Hemerocallis*. (2.4) Bentazon, pendimethalin, pronamide, chlorimuron-ethyl, nicosulfuron, nico-rimsulfuron, thifensulfuron, dithiopyr, and isoxaben can be used in *Sedum*.

Incubation PRSTM-N flush on organic highbush blueberries (*Vaccinium corymbosum* L.) soils with and without mulches. Zhiming Zheng^{1*}, Derek H. Lynch¹, David Percival² and Nicole Burkhard¹. ¹Department of Plant and Animal Sciences, ²Department of Environmental Science, Nova Scotia Agricultural College, P.O. Box 550 Truro, Nova Scotia, Canada B2N 5E3.

Previous studies have indicated a poor relationship between standard soil N tests and highbush blueberry plant N uptake. Standard leaf N tests are conducted too late in the season for making current

season N recommendations, and this is especially true for organic highbush blueberries where supplemental fertilization is reliant on slowly mineralizing organic amendments. Ion exchange membranes may provide an alternative tool to assess the N supply power of these soils. The study was designed to assess the mineral N flush on unfertilized highbush blueberries soils under laboratory incubation. In the Spring of 2005, soils were taken from 2 sites varying in texture of Nova-Agri/Blueberry Acres, a commercial organic highbush blueberry farm, in Centreville, NS. Both mulched and un-mulched mineral soils were recovered, sieved to pass 6 mm sieve and air-dried. In the Spring of 2006, a pot study was conducted using mulched and unmulched mineral soils under a controlled air temperature (25°C) and a soil moisture of 60% field capacity. A pair (cation/anion) of Plant Root Simulator (PRSTM) probes, an ion-exchange membrane encapsulated in a plastic probe was inserted into soils in each plot. The probes were replaced at intervals of 3d at first, followed by 4 successive 7d periods thereafter over a total of 31d. The mineral N sorbed on probes (PRS-NO₃ and -NH₄) was eluted with 0.5 M HCl and determined colorimetrically by a hydrazine-reduction method. A subsample of soil (~50 g) was also taken at day 0 and 31 for determination of soil mineral N (NO₃-N and NH₄-N) content by chemical extraction. The relationships between the flush of mineralized soil N over a defined summative burial period and soil mineral N measured by chemical extraction as affected by soil texture and mulches will be examined.

