ABSTRACTS

from the

Canadian Society Of Agronomy Annual Meeting, July 20-23, 2004
University of Edmonton, Edmonton, Alberta

To be published in the Canadian Journal of Plant Science

CSA Graduate Students - Oral Presentations

Tannin Free Faba Bean Plant Population and Yield Response to Seeding Conditions

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Tannin free faba bean (*Vicia faba* L.) cultivars, Cresta and Snowbird, did not achieve target plant populations under the cool and wet spring seeding conditions found in north central Alberta, in 2002. Emergence of tannin free cultivars was reduced by 26%, which may be due to the increased susceptibility of tannin free seed to pathogen attack and imbibition damage. By comparison, emergence of tannin containing faba bean cultivars was reduced by 9%, under the same seeding conditions. In 2001, when spring seeding conditions were dry and warm, emergence appeared to be linked to seed size rather than the presence or absence of tannin in the seed coat. Despite reductions in the Snowbird plant populations, during the two years of the study, yields of this tannin free cultivar were significantly greater than the tannin containing cultivars ($P \leq 0.01$). Snowbird's high yields were achieved through an increased number of pods per plant and seeds per pod.

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CSA/SeCan Graduate Student Competition – 1st Place Oral

Influence of wild oat (*Avena fatua*) time of emergence and density on tame oat (*Avena sativa*)

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Wild oat (*Avena fatua* L.) is a serious weed in all cereal crops, but it is most problematic in tame oat (*Avena sativa* L.) because of the absence of herbicides to selectively remove the weed from the tame oat crop. Quantifying the effect of time of emergence on weed-crop interference is critical for the development of accurate crop yield loss models and weed density thresholds. Therefore, field experiments were conducted at 2 locations in Saskatchewan in 2002 and 2003 to determine the influence of wild oats emerging at different times and varying densities on tame oat yield and quality. Wild oat density and seedling emergence time relative to tame oat influenced tame oat yield loss. Estimated maximum tame oat grain yield loss ranged from 41 to 96%. Wild oat seed production also varied with seedling emergence time and density, with maximum wild oat seed production ranging from 7800 seeds m^{-2} to 28 000 seeds m^{-2}. In general, wild oat that emerged before tame oat caused considerably more crop yield loss and had significantly higher reproductive output than wild oat that emerged after tame oat. Wild oat emergence time relative to tame oat was determined to be more critical than weed density when describing the effect of wild oat on tame oat yield. The results of this study emphasize both the need to control early emerging wild oats, as well as the importance of time of emergence in the prediction of crop yield loss.

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CSA/SeCan Graduate Student Competition – 2nd Place Oral

Chromosomal regions of winter wheat participating in cold tolerance

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Low-temperature (LT) tolerance is a complex, multigenic trait associated with winter survival. In winter wheat as many as 15 out of 21 chromosomes participate in LT-tolerance. To identify and functionally characterize chromosomal regions participating in LT-tolerance, doubled haploid (DH) lines from a cross between Norstar (LT_{50} of -19°) and Cappelle-Desprez (LT_{50} of -11.5°) were developed. Molecular marker analysis using Simple Sequence Repeats (SSRs) were performed on 22 less-hardy (LT_{50} -12 to -13°C) and 20 hardy (LT_{50} -16 to -18°C) lines. A total of 318 SSR markers were screened for this study. One hundred and eighty-four (43, 55 and 40 to the A, B and D genomes, respectively) markers were mapped to different chromosomes. Four SSR markers were mapped to the vernalization region of chromosome 5A, with one marker showing strong linkage to LT-tolerance. Genomic mapping data in conjunction with a wheat BAC library will be used for the molecular characterization of LT-tolerance loci in wheat.

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Agronomic Development of Triticale for Eastern Canada

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Triticale (*X Triticosecale* Wittmack) is a synthesized crop derived from crossing wheat (*Triticum*) and rye (*Secale*), and is a possible grain substitute for wheat in livestock diets. It was developed to combine the best features of wheat and rye; however, it has yet to develop into the staple cereal grain crop originally conceived. Nevertheless, certain cultivars of triticale have been shown to be more efficient in phosphorous extraction, nitrogen uptake, and its ability to tolerate both minor element deficiencies and low soil pH. Cultivars of spring and winter triticales from Europe, United States and Canada are being evaluated for grain production by testing their agronomic suitability, stability over different environments and their response to increasing rates of nitrogen at two sites in Nova Scotia. The variability among triticale cultivars to *Fusarium* infection and DON production are also being evaluated. This paper will present the results of two years of study in Eastern Canada. The spring triticale cultivars Wapiti and 92L021010 have had the highest grain yields, significantly higher than the Belvedere wheat check. The winter triticales SVWTR6, SVWTR7, SVWTR8, SVWTR9 and SVWTR10 had significantly higher grain yields than the AC Winsloe winter wheat check. AC Ultima and Sandro have had the best response to nitrogen for both grain yields and grain protein, even at a low soil pH (5.2-5.6) site. Some preliminary data will be presented on *Fusarium* infection and DON production of spring triticales.

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CSA Graduate Students – Poster Presentations

Caryopsis size and genotype effects on wild oat (*Avena fatua* L.) – tame oat (*Avena sativa* L.) competition

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The absence of herbicides to selectively remove wild oat (*Avena fatua*) from tame oat (*Avena sativa*) limits oat growers to using cultural weed control methods. Numerous studies have reported improved crop yield and competitiveness with the use of large seeds. Planting large seeds of competitive genotypes may reduce the negative impact of wild oat competition on tame oat. Therefore, a greenhouse experiment was conducted at in 2002 and 2003 to determine the relative importance of seed size and genotype in affecting wild oat – tame oat competition. Tame oats of three genotypes (AC Assiniboia, CDC Boyer, CDC Orrin) were classified into three size classes [large (35 mg), medium (25 mg), small (15 mg)] and grown in monoculture and in mixtures with wild oats (250 plants m^{-2}). Neither genotype nor seed size significantly influenced tame oat emergence. Nonetheless, tame oat plants established from large caryopses produced 18% more biomass and 15% more panicles m^{-2} than plants established from small caryopses. Wild oat produced 31% less biomass and fewer panicles m^{-2} when grown with tame oat plants established from large caryopses. CDC Boyer appeared to be the most competitive of the genotypes examined, having significantly higher biomass and panicle production both in the presence and absence of wild oat competition. The results of this study suggest that planting large seed of competitive cultivars may improve the competitive response of tame oat to wild oat interference. However, field studies are necessary to confirm these results.

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CSA/SeCan Graduate Student Competition – 1st Place Poster

Competitive ability of spring wheat varieties in conventional and organic management systems

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Height, tillering capacity, and seeding rate may influence the competitive ability of spring wheat (*Triticum aestivum* L.) cultivars. Field experiments were conducted in 2003 in Edmonton AB to determine the response of wheat variety and seeding rate on competitive ability under organic and conventional management. Nine spring wheat cultivars differing in height and tillering potential were planted at single (250 seeds m^{-2}) and double seeding rates, with and without tame oat (*Avena sativa* L.) competition, under both conventional and organic management. Doubling the seeding rate increased overall yield by 12% in conventional plots and 10% in organic plots. Tame oat grain yield was reduced by 27% in double seeded organic plots compared to single seeded plots. Competition from tame oats reduced grain yield by 15% under organic management, due to a 9% reduction in the number of wheat heads m^{-2}. Under conventional management, competition resulted in a 10% reduction in the number of heads m^{-2}, however this did not cause a yield reduction. These results may indicate that wheat grown under organic management may be more sensitive to additional weed competition.

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CSA/SeCan Graduate Student Competition – 2nd Place Poster

Photoperiodic and vernalization response of selected Canadian spring wheat varieties

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We investigated the effect of photoperiod and vernalization on days to heading and anthesis, leaf and spikelet number on the main culm, and tillers per plant in selected Canadian spring wheat varieties. Five Canadian spring wheat varieties, representing differing maturity groups, were evaluated under two photoperiod (16 and 10 hours) and two vernalization (42 and 0 days) treatments. Shorter photoperiod delayed heading and anthesis in all varieties, increased final leaf number (FLN) in AC Barrie. Conversely, vernalization promoted both heading and anthesis in AC Foremost and AC Taber, decreased FLN on the main culm in AC Foremost and AC Taber, and decreased the number of spikelets per spike on the main culm in AC Taber. Fulfillment of vernalization requirements in AC Foremost and AC Taber caused them to flower earlier, or at the same time, as AC Intrepid and Cutler. AC Barrie exhibited the greatest response to photoperiod. Our results suggest that flowering time in AC Foremost and AC Taber is controlled by vernalization while AC Barrie, AC Intrepid and Cutler are affected by earliness *per se*. AC Foremost and AC Taber appear to possess different vernalization genes than the other varieties studied.

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Management of Four Spring Triticale Cultivars

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Increased rates of nitrogen tend to produce more lush vegetative growth which can increase the incidence of disease and lodging. Fungicides and plant growth regulators (PGR's) have been used to control certain diseases and lodging in wheat and barley. Triticale (*X Triticosecale* Wittmack), being a cross between wheat (*Triticum*) and rye (*Secale*) has obtained some tolerant traits from both parents; however, one concern with triticale is a lack of data on its susceptibility to *Fusarium*. Also certain cultivars, especially winter types, tend to be more prone to lodging. The objective of this experiment is to determine if grain yield and grain protein are affected by management inputs at different rates of nitrogen. Low, medium and high management inputs were used. Low management was a 50 kg ha^{-1} application of nitrogen at seeding; medium was a 50 – 50 kg ha^{-1} split application at seeding and ZGS 39, and high input was a 75 – 75 kg ha^{-1} split application at seeding and ZGS 39. The high input treatment also included the applications of the fungicides Bravo 500 and Tilt 250 EC (1.5 L ha^{-1}) at ZGS 39. Also the PGR ethephon was applied with the fungicide at the rate of 320 g.a.i. There were no interactive effects between nitrogen and management inputs for grain yields or grain protein; however, there was an individual effect on both. However, there was also a low disease pressure that resulted in very little infection on all cultivars in the trial.

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Comparison of spring triticale microspore pre-treatments to reduce doubled haploid production time

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Knowledge available for isolated triticale microspore culture is limited. Anther culture has been the most common focus of triticale androgenesis double haploid research. A commonly used pre-treatment for triticale microspore culture requires 21 – 28 days. Decreasing this time could increase the efficiency of the procedure to a level similar to barley and wheat isolated microspore culture. The focus of the study was to decrease the pretreatment time without significantly reducing the production of triticale microspore derived embryos (MDE). Five spring triticale cultivars AC Ultima, Sandro, AC Alta, Pronghorn and 94S001008 were examined for potential genotypic differences. The MDE yields of AC Ultima and Sandro, and the lack of yields from the other cultivars suggested definite genotypic differences. AC Ultima and Sandro were subsequently pre-treated at 4°C, 32°C, or 35°C temperatures and in water, 0.4M mannitol, or 25% w/v polyethylene glycol (PEG). The MDE yields of the shorter pretreatments under these conditions did not achieve similar yields as the 4°C humid 21 – 28 day pretreatment.

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Effect of Potassium Management on Yield and Potassium Uptake of Corn and Impact of Landscape on Corn Root Growth

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A field study was conducted in Ontario in 2002 to determine the effect of deep-placed potassium fertilizer on corn potassium uptake and grain yield, and land slope impact on the distribution of corn roots and yield. Deep-placed, high-potassium dose (200 Kg K_2O ha^{-1}) with high management (100,000 seeds ha^{-1}, 280 Kg N ha^{-1} and 200 Kg P_2O_5 ha^{-1}) was compared with grower's practice (150-70-30 N-P_2O_5-K_20 Kg ha^{-1}, 75,000 seeds ha^{-1}). Corn earleaf, grain and stover were analyzed for potassium concentration. Significantly higher ear-leaf potassium concentration was found with deep-placed high potassium dose with high management compared to growers' practice. However, corn grain and stover potassium concentration and corn grain yield did not differ significantly from other treatments. Corn root distributions were studied at corn harvest at 10, 25, 40 and 55 cm soil depth using a soil core method at upper, middle and lower land-slope positions. No significant differences in root distribution at various depths between three slope positions were found, which coincided with non-significant corn-yield differences between these three slope positions (upper:10.6 t ha^{-1}, middle: 9.7 t ha^{-1} and lower: 10.8 t ha^{-1}).

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Agronomic and genetic approaches for improving seed quality and yield of fenugreek in western Canada

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Fenugreek (*Trigonella foenum-graecum* L.) is a new annual forage legume in western Canada. Tristar, a fenugreek cultivar developed at the Lethbridge Research Centre, has good potential to replace some traditional forage legumes as it has the ability to produce high yield and high quality forage. It is however, difficult to produce high quality seed for this cultivar under short Prairie growing conditions. The main objective of this study is to develop a suitable seed production protocol for the crop and/or to select genotypes with high seed yield. The agronomic approach includes seeding high dry matter producing lines at different dates, locations and with different levels of phosphate. Genetic investigation includes a search for genotypes in the world collections for high yielding, early maturing types and generation of mutants that would combine determinate growth habit with high seed yield.

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CSA Cropping Systems Symposium - Oral Presentations

Reducing greenhouse gas emissions from farms – how and why?

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Worries about a changing climate have sparked a search for ways to curb greenhouse gas emissions. My objectives in this paper are to contemplate *how* we might reduce emissions from farms, and *why* we might want to do that. Agriculture can help mitigate greenhouse gas concentrations in two ways: by reducing its own emissions (mostly CH_4 and N_2O), and by withdrawing atmospheric CO_2 by storing more C in soils ('C sequestration'). Both strategies rely on managing better the flows of C and N into and through our agroecosystems. We can do that, for example, by the crops we plant, the way we apply nutrients, the degree to which we connect our crops and livestock, and the extent to which we disturb the soil. And *why* reduce emissions? To help mitigate greenhouse gases in the air, of course. But also (and this may be even more important) to keep our ecosystems productive, healthy, and without undue harm to water and air. From this perspective, our ability to curtail greenhouse gas emissions becomes, not a goal in itself, but a measure of how well our ecosystems are performing on a changing earth.

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Soil Texture Effects on Soil C Sequestration Rates in North Central Montana

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The Century model employs equations developed from extensive field studies to model the biogeochemical processes that govern soil carbon dynamics in various ecosystems. Field studies have been inconclusive in determining if soil texture has an effect on soil carbon storage rates in no-till management systems. Soil organic carbon (SOC) gains induced by no-till management were measured at 6 sites in north central Montana. Soil clay contents across six sites ranged from 16 to 47% (0-20 cm). Implied annualized soil C sequestration rates ranged from 0.13 to 0.85 t C ha^{-1} yr^{-1} (0-20 cm). Regression of soil texture (i.e. % clay) on annualized C sequestration rates showed no meaningful relationship (r^2 = 0.19). Century model estimates of SOC for the same 6 sites showed higher predicted SOC values with increasing clay content; however, the predicted change in SOC with the elimination of tillage was not related to soil clay content.

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Alternative Cropping System and Economics of Greenhouse Gas Emission of a High and Low Input System

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In recent years increased attention has been given to alternative farming practices in order to decrease fossil fuel use, to enhance nitrogen fertilization efficiency, and to increase the implementation of conservation tillage practices. Farmers are recommended to include pulse crop into their rotation since legumes form symbiotic associations with bacteria that can fix atmospheric N_2 reducing the need of nitrogen fertilizer application and the emission of greenhouse gases (GHG). The objective of this study was to evaluate the economics of greenhouse gas mitigation for different cropping systems and management practices. Data from a 5-year study of a wheat-pea rotation was used to examine economic and greenhouse gas performance. Comparison of IPCC estimations of nitrous oxide (N_2O) emissions to measured values indicated that the measure emission rate was significantly lower than estimated values for the site. Results for a low-fertilizer rate/low-disturbance system, suggests there is greater net carbon fixed as compared to the high-disturbance practices in both wheat and pea. Overall, the decreased use of fertilizer (50% to 75% of recommended rates) under a low-disturbance seeding-system was preferable, based upon environmental-economic indicators.

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CO2 evolution during crop residue decomposition in conventional and zero tillage systems

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Field experiments were conducted to determine how decomposition of red clover (*Trifolium pratense*) green manure (GM), field pea (*Pisum sativum*), canola (*Brassica rapa*) and wheat (*Triticum aestivum*) residues under zero tillage (ZT) and conventional tillage (CT) affected CO_2 evolution. When CO_2 evolution was measured in the season following residue placement, preceding crops had no effect, but evolution was greater under CT than under ZT. When CO_2 evolution was measured from the time of residue placement, tillage had no effect, but more CO_2 was emitted where legume GM residues had been added than from other residues because of a large peak in evolution immediately after GM residue placement. These results mean that measurements that do not include the initial flush of microbial activity, e.g., by sampling only in the season(s) following residue placement, probably (a) underestimate gas emissions from legume crop residues, and (b) overestimate the effect of ZT on reducing gas emissions.

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Spring application of manure on grass reduces nitrous oxide emissions

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Half of the annual manure on dairy farms in BC is applied between Feb. and May. Farmers usually apply this manure onto bare corn land for convenience although the grass can better use the nutrients. Applying manure in spring on grassland instead of bare soil, prior to corn planting, reduced emissions by 5-10-fold times. Emissions of N_2O were lower on the manured grass that the un-manured bare soil. Differences in emissions between grass and bare soil appeared to be related to nitrate levels in the upper 15 cm of soil, with less than 1kg NO_3-N ha^{-1} in manured grass plots compared to 10-20 kg NO_3-N ha^{-1} in manured bare-soil plots. Slightly greater soil temperature (0.5-1.0^oC) on bare soil might have contributed to the high N_2O emission rates. This study shows that the BMP for manure application on grass in spring reduces N_2O emissions.

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Strategic tillage - Evolution or Devolution of Zero Tillage?

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Producers who practice zero tillage are concerned that a single tillage operation will cause serious negative long-term impacts to their system. A study of **Strategic tillage**, "planned occasional tillage which occurs for a purpose other than seedbed preparation", was established in 1999 on a clay loam soil near Brandon Manitoba with 2 rotations: canola-wheat-pea and canola-wheat-flax. While all crops were sown each year and tillage occurred each yield the impact of tillage in subsequent seasons could not be measured until one or two years following the tillage operation. The objective was to determine the impact of tillage in a long term zero tillage system on crop yields, weed numbers, foliar disease and nutrient uptake. Tillage just prior to planting flax or pea resulted in lower yields of that crop in that season. While total weed numbers were up to 30% greater in the year of tillage weed numbers returned to near pretillage numbers the second season after tillage. In 2003 barley yields were greater on plots that had received tillage in any of the previous seasons however the mechanism, timing and frequency of this response is unclear. Since strategic tillage did not have long-term negative impacts on crop yields, or weed pressure it is possible to use tillage in the subhumid black soil zone to control difficult weeds or level a rough field without long-term negative impacts.

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The integration of crop management tools to enhance the sustainable production of winter cereals

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The sustainable production of winter wheat in traditional and non-traditional regions requires strategic integration of several agronomic tools. Two studies were initiated at Lacombe and Lethbridge, Alberta to A) measure the effect of cultivar and seeding rate on weed management and crop yield, and, B) investigate the productivity and competitiveness of winter and spring cereal classes in two weed management systems. Our results to date suggest that winter wheat can be just as productive without the added input of spring herbicide applications, particularly at higher seed rates. With respect to crop productivity, winter cereal yields at Lacombe in 2002 were similar to spring cereal yields, except for spring triticale, which produced higher yield than all other winter or spring cultivars. In 2003, winter cereals produced higher grain yield than all spring cereals at Lethbridge dryland and similarly at Lacombe with the exception of barley and spring triticale, which produced higher yields than winter wheat. Winter cereals matured 7-14 days earlier than the spring cereals and produced significantly more biomass than all spring cereals except triticale. Three station years of experimentation has shown that feed and milling types of winter wheat returned the greatest gross cash revenue of all classes tested.

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Crop Heat Units and Corn Maturity in a Changing Environment

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Estimation of corn (*Zea mays* L.) development rate is needed to market hybrids of specific maturity and to schedule stage-sensitive operations such as silage harvest. Field experiments included growing hybrids with a wide range of maturities and cultural practices for several growing seasons. During the growing season, phenological events of silking and physiological maturity (0 milk line and black layer) were observed on a minimum of 3 replications per treatment. For most hybrids, additional 100 to 300 crop heat units (CHU) were required to reach physiological maturity. Compared with historical norms, there were large fluctuations in air temperatures coupled with periods of drought during these growing seasons. Such trends may have affected the rate of crop development and caused differences between actual CHU requirement and CHU reported by the companies for most hybrids tested. Implications of variations of hybrid maturation in a changing environment on corn improvement and production system will be discussed.

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Preliminary evaluation of Jerusalem artichoke as an alternative, multipurpose crop for Alberta

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Jerusalem artichoke (*Helianthus tuberosus)* is a tuberous perennial plant native of the North American plains. It can produce 30 tonnes of tubers and 70 tonnes of aboveground biomass per hectare and can serve as a multipurpose raw material for food, forage and industrial products. We have tested the field performance of 2 registered varieties (Rubik and Albik) and 8 breeder's lines of different European origins. The crop appeared to be free of pests and diseases and it out-competed weeds. Varieties differed considerably in production of above- and belowground biomass. Cattle manure applied at a rate of 40 tonnes/ha increased aboveground biomass of Albik and Rubik by 19 and 38%, respectively. Manure application increased tuber yield in Rubik by 57%, but had no significant effect in Albik. Rubik and Albik have the potential to yield as much under Alberta conditions as they do in Poland where they were bred.

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Differential response of industrial hemp (*Cannabis sativa* L) cultivars to drought stress

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Industrial hemp needs 500-600 mm of precipitation per year to produce yields of 15-20 tonnes/ha in Alberta. Soil moisture deficit can reduce yields of stalks and seeds particularly when it occurs in the seedling establishment phase. Improper nutrition can exacerbate the problem. We have compared the water use efficiency (WUE) of five cultivars of industrial hemp (Anka, Carmen, Felina, Ferimon and Uniko B) grown under high and low nutrient regimes. Under conditions of high soil moisture and nutrient supply, Uniko B was approximately 25% more efficient in producing stalks than other cultivars. However, stalk yield decreased by approximately 30% in this cultivar when moisture and/or nutrients were limiting. Yields of the other cultivars decreased to a lesser extent under limited water and nutrient conditions. These results demonstrate the importance of selection of industrial hemp cultivars based on water and nutrient availability.

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Wheat genotype × environment interaction in long-term regional variety trials in Alberta

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Genotype × environment interaction (GEI) refers to the differential response of genotypes to differing environments. If GEI is associated with genotypic rank-change it complicates the identification of superior genotypes in breeding programs. We studied grain yield of hard red spring wheat varieties in multi-location regional variety trials in Alberta, Canada from 1981 to 2002. A shifted multiplicative model (SHMM) was used with a cluster method to identify subsets of sites in each year with reduced numbers of genotypic rank-change. Also, genotype main effect plus GEI biplots were constructed by the use of least squares solution of the site regression (SREG) model, to identify high-yielding and stable genotypes across locations. Application of SHMM model did cluster locations into subsets with smaller frequencies of crossover interaction in each. However, this clustering did not generally follow a repeatable pattern over years. Neither did the clustering follow the provincial soil or geographical classification patterns. Therefore, it seems unrealistic to classify the sites studied in this research into different wheat-growing mega-environments, mainly because of a highly variable and unpredictable year effect in Alberta. Selection of generally adapted varieties would be the most reliable breeding strategy. Such varieties were repeatedly selected across years by SREG model in our study.

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Effect of rotation and short-term tillage on soil quality after long-term zero tillage

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A field study was conducted from 2000 to 2002, near Brandon Manitoba, to determine the effect of low and high-intensity tillage on soil quality following 9 years of zero tillage. Tillage intensity affected dry-aggregate size distribution, but had no effect on bulk density, penetration resistance, and wet-stable aggregates. Mineralizable nitrogen measured with the amino-sugar test, was not affected by tillage management or crop. Total organic carbon and nitrogen were also not affected, due to the short period when tillage was imposed. Wet aggregate stability was directly correlated with soil organic carbon, though there was no significant effect of tillage and rotation. Tillage intensity (high and low levels) and preceding crops (peas or canola) had no significant effect on phosphate phosphorus (0-10 cm). However nitrate nitrogen (0-10 cm) was higher in high disturbance tillage and following canola. High levels of nitrate nitrogen and ammonium are attributed to residual nitrogen fertilizer. Results of this study differ from those reported in the literature, due the brief duration of tillage following long-term zero tillage.

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Effect of nitrogen, phosphorus and KCl management on oat yield and quality

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Recent expansion of oat (*Avena sativa*) production in Manitoba has created a need for a better understanding of fertilizer management practices that optimize oat yield and quality. A three-year field study was conducted to determine the effect of a factorial combination of four N rates (0, 40, 80, 120 kg N ha^{-1} as urea), three P rates (0, 30, 60 kg P_2O_5 ha^{-1} as monoammonium phosphate), and two KCl rates (0, 40 kg K_2O ha^{-1} as KCl) on oat. Results suggest that careful N management is required to ensure that sufficient N is present to optimize oat yield, but that over-application of N and resulting declines in yield and quality are avoided. Results further suggest that P may play an important role in enhancing early-season growth and, under some conditions, may increase grain yield. Small improvements in grain yield and quality may also occasionally be associated with KCl application on soils with adequate soil test K levels.

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Alfalfa/winterfat mixture – A sustainable forage source in southwestern Saskatchewan

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Winterfat *(Krascheninnokovia lanata*) is a palatable and nutritious native shrub of interest to beef producers. Its high protein concentration in the fall makes it valuable for fall grazing and suggested that it would benefit from a legume companion species in a mixture. Our objectives were to examine the productivity and forage quality of winterfat and alfalfa (*Medicago sativa*) as a mixture and to monitor the changes in soil quality caused by growing a legume and shrub together. A trial was seeded in the fall of 2001 with the following treatments: alfalfa monoculture, winterfat monoculture, alfalfa/winterfat mixture and summerfallow (control). Forage yields were higher in 2003 than in 2002 for both alfalfa (5.31 vs. 0.32 t ha^{-1}) and winterfat (0.11 vs. 0.06 t ha^{-1}) monocultures. Contrary to our expectations, N concentration of winterfat was similar in mixture with alfalfa or grown in monoculture. Soil organic carbon increased similarly for alfalfa monoculture (2.96 t ha^{-1}) and alfalfa-winterfat mixtures (2.72 t ha^{-1}) than under winterfat monoculture (3.04 t ha^{-1}). Winterfat plants appear to allocate carbon to below-ground growth during the first two years after seeding.

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SP08 Long term marketable yields of vegetable crops are a potential indicator of climatic changes

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Average annual yields of field crops and vegetables in Ontario were examined in relationship to seasonal climatic variables over a 30 year period (1970-2000). Standard climatological variables such as mean temperature and precipitation showed little correlation with yield. Yield of the cool season vegetable crops, cabbage, rutabaga, cauliflower and potato, decreased with increasing number of hot days (maximum > 30°C) per season, while yield of cabbage, rutabaga and onion increased with increasing number of days with precipitation. Conversely, yield of tomato, a warm season crop, increased with increasing number of hot days and decreased with increasing number of days with precipitation. Marketable yields of horticultural crops are sensitive to changes in weather because several quality factors are involved in determining market acceptability. Marketable yields of cabbage, rutabaga and tomato may provide a useful indicator of changing climate.

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Web-based "Expert knowledge system – a new decision making tool for crop producers"

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Achievement of best management practices requires crop producers to assemble a multitude of knowledge resources to support their decision-making including: (a) a high level of knowledge about every topic that influences the sustainability of a particular field; (b) long-term records of soil, landscape, moisture, fertility, crop, weed, disease and insect pest history; (c) records of the physical and chemical management in the cropping system used; and (d) ability to access and appropriately integrate relevant new agronomic discoveries and technologies. Producers vary in their success level in bringing the most recent and complete information to bear on their individual decisions, partly reflecting the diversity of media forms and places where information is available. This paper presents the schematic of a novel web-based knowledge system for producers that systematically and holistically links the needed knowledge sources to the informational requirements of specific production fields, for crop planning, diagnostics, and long-term management.

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Phytate-P Study in Barley and Other Cereals

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This study describes the range of phytate-P in barley, wheat, triticale, rye and oat. Phytate is a salt of phytic acid and it is the most abundant form of phosporus (P) in seeds where it is used as phosphorus reservoir during germination. Phytate is indigestible by humans and non-ruminant livestock. Excessive non-digested phytate from feed ends up in animal waste, and plays a role in eutrophication of waterways. In this study, samples of 423 barley, 114 wheat, 38 triticale, 24 oat, 8 rye genotypes, and 20 ground feed samples were analyzed for phytate-P and total P on a wet and dry basis. The phytate-P percent of total P, on a dry matter basis, ranged between 2.6 and 70.2 for barley, 39.3 and 84.1 for wheat, 44.6 and 84.8 for triticale, 43.5 and 64.3 for oats, 52.1 and 63.5 for rye and 13.9 and 46.4 for the ground feed samples. The widest variability of phytate-P was found in barley compared to other cereal species. This study showed there is variability in phytate-P content in the cereals analyzed.

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Use of Westerwolds Ryegrass and Festulolium as Companion Crops in the Establishment of Perennial Forage Crops

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Annual cereal crops are often seeded as companion crops with slow establishing perennial forages to provide an economic return in the year of establishment. Fast establishing forage species, such as the annual westerwolds ryegrass and the short-lived perennial festulolium, may also have potential as companion crops with perennial forages. Experiments were seeded in May, 2003 at Saskatoon and Melfort, SK, Canada. Perennial forages were alfalfa, crested wheatgrass and meadow bromegrass in pure stands or grass-alfalfa mixtures. Companion crops were westerwolds ryegrass or festulolium seeded at 0, 2 or 5 kg ha^{-1}. Two forage harvests were taken in 2003 at Saskatoon and one at Melfort, and stand densities of each species determined. At Saskatoon, the presence of the westerwolds ryegrass companion crop increased dry matter yields from 26-89% over the no companion crop stands; while festulolium increased yields from 0-24%. Drought and weed competition at Melfort resulted in low yields and no significant differences. Numbers of perennial grass and alfalfa plants were reduced in stands with companion crops; the effect on second year forage yields will be determined in 2004.

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Intercropping berseem clover with barley and oat cultivars for forage

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Cereal-berseem clover intercrops offer potential to partition forage yield between silage and fall grazing. Intercrop performance may differ among oat and barley cultivars. Berseem clover was intercropped with five oat and four barley cultivars at Edmonton in 2000 and 2001. Silage-stage DM yields averaged 9.9 Mg ha^{-1} with 18% berseem by dry weight. Berseem regrowth (Cut 2) averaged 2.8 Mg ha^{-1} DM with crude protein of 210 g kg^{-1}. Intercrops with oat cultivars had greater silage-stage yield, and equal or greater total forage yield, than intercrops with barley. Intercrops with barley cultivars had advantages of greater total protein yield and greater Cut 2 yield. Early-maturing and semi-dwarf cultivars caused less suppression of berseem, and had greater Cut 2 yields, than late-maturing and conventional-stature cultivars. To maximize fall forage and increase the legume component of silage harvest, early-maturing and short-stature cultivars of oats and barley are recommended for cereal-berseem clover intercrops.

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Soybean yield as affected by seeding date, row spacing, crop density and time of glyphosate application for weed control in transgenic narrow-row soybeans

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Research in other areas has also shown that weed control and crop yield in glyphosate tolerant soybeans (*Glycine max* L. Merr.) can be affected by crop management factors such as seeding date, row spacing, and crop density. We evaluated the interaction of these factors with time of glyphosate application over two years at Charlottetown, PEI in 2001 and 2003. The soybean cultivar 2601-RR having CHU rating of 2650 was planted using a no-till drill into barley stubble in a split plot design with 4 replications. Each plot was 12 rows wide including 2 guard rows on each side. The glyphosate treatments were applied at the unifoliate and 1st, 2nd, 3rd, or 4th trifoliate leaf stages of the soybean. Herbicides were applied in 200 L/ha spray solution at 214 kPa using a tractor mounted compressed air sprayer. Soybean responded differently between the two years to time of seeding with late seeding giving highest yield in 2001 and early seeding giving highest yields in 2003. There was no interaction between time of seeding and time of herbicide application. In both years and at both seeding times, soybean yield was progressively reduced as glyphosate application was delayed past the 2nd trifoliate stage. Application at the unifoliate or 1st trifoliate sometimes had yields lower that application at the 2nd trifoliate stage due to late emerging weeds. Soybean responded similarly in the two years to row spacing with wide spacing at 34 cm having lower yields than narrow spacing at 17 cm in both years. There was no interaction between row spacing and time of herbicide application. In both years and at both row spacings, soybean yield was progressively reduced as glyphosate application was delayed. Soybean responded similarly in the two years to planted density with lower density at 75% and 50% of full density having lower yields than full density in both years. There was an interaction between density and time of herbicide application. In both years and at all densities, soybean yield was progressively reduced as glyphosate application was delayed.

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Effect of topdressing nitrogen on the yield and protein content of wheat

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From 1995 to 1998 we employed three designs (22 trials) to examined the effectiveness of topdressing N at Feekes 4 to 5, 7 to 8, 10.1 and 11.1, two designs (22 trials) to assess the effectiveness of a variety of products (urea, ammonium nitrate, ammonium sulphate, urea/ammonium nitrate, Pro N and N Sure; the former three both in granular and liquid forms) and one design (11 trials) to derive the most appropriate N rate for topdressing. In general, splitting application of the N requirement resulted in significant increases in grain protein content (up to 1.5%) albeit at a significant yield loss (up to 25%). The later the application of topdressing the greater the increase in protein and the corresponding yield loss. In general similar increases in grain protein content through topdressing were obtained by applying the total amount of N at or prior to seeding. The products tested did not perform consistently in all trials.

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An immature wheat spike culture system to evaluate the effects of abiotic stresses on grain development

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Simple, reproducible and efficient methods are needed to monitor the impact of factors such as salinity, pH and heavy metals in plants. The objective of this research was to develop an *in vitro* method to study the effects of abiotic factors on wheat grain development. Immature spikes were cultured in liquid medium consisting of sucrose and glutamine. Effects of salinity, pH, and cadmium levels were compared to germination assays; the latter being less reliable than the spike culture. High pH increased number of grains/spike, decreased protein content, but did not affect average grain weight. Sodium chloride (5 g/L) reduced number of grains by 30% and protein content by 50%. Cadmium chloride (0.05 g/L) reduced grain starch concentration by 60%. 0.001% of the supplemented cadmium accumulated in the grain. This study has demonstrated the utility of immature spike culture to study grain development.

Effect of Preceding Crop and P Fertilization on Flax Yield and Cd Content

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In field studies conducted for three years at two locations in western Manitoba, flax grown after canola had lower seed yield, lower mycorrhizal association and higher Cd concentration than flax grown after wheat. Reduced tillage decreased early season P concentration in flax grown after non-mycorrhizal canola, but not after mycorrhizal wheat. Side-banded P fertilizer and P applied to the preceding canola or wheat crop had little effect on flax seed yield. Phosphorus fertilization of flax may be beneficial on soils where P supply is extremely depleted, but with moderate deficiencies, the benefit is likely to be low. If flax is being grown for the health food market, excess levels of Cd may be a concern. Sequencing flax after cereals rather than canola may help reduce Cd to meet quality goals for human consumption.

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Effect of Jazz (Trifloxystrobin and Metalaxyl), Crown (Carbathiin and Thiabendazole), Allegiance FL (Metalaxyl), and Vitaflo 280 (Carbathiin and Thiram) fungicidal seed treatments on Nitrogen Fixation of Chickpea, Lentil, and Pea

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Limited information is available on the effect of Jazz, Crown, Allegiance FL, and Vitaflo 280 fungicidal seed treatments on dinitrogen (N_2) fixation of chickpea (*Cicer arietinum* L.), lentil (*Lens culinaris* Medikus), and pea (*Pisum sativum* L.). To determine if Jazz, Crown, Allegiance FL, and Vitaflo 280 have a negative effect on the ability of the Rhizobium to nodulate and fix N_2 from the atmosphere on chickpea, lentil, and pea, experiments were established at two locations in Saskatchewan in 2003. Treatments were: i) Rhizobium applied to untreated control, ii) Rhizobium applied sequentially to fungicide and, iii) non-inoculated Rhizobium untreated control. Two Rhizobium strains were used. Percent nitrogen derived from the atmosphere was determined by the ^{15}N natural abundance method using flax as a reference crop. Jazz, Crown, Allegiance FL, and Vitaflo 280 had no negative effects on the ability of the Rhizobium to fix N_2 from the atmosphere.

Management of Alternative Grains

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Small plot replicated field trials were conducted on four crop types in Truro, NS from 2000-2003 to evaluate the potential of these crops as alternative feed grains. Two hulless barleys, AC Alberte and Condor, and Pronghorn, spring triticale were compared to Chapais six-row-hulled barley and Belvedere spring wheat for their yield and protein response to nitrogen fertility, plant growth regulator (PGR) and fungicide applications. Pronghorn spring triticale significantly out yielded all other crops in total grain yield and protein yield in 2001 and 2002. In 2000, delayed maturity and lodging under wet conditions reduced triticale yields. In 2003, Pronghorn yielded second to Chapais barley for both grain and protein. Chapais yielded an average of 5.9, Pronghorn 5.6, Condor 4.0, Belvedere 4.6 and AC Alberte 4.5 tonnes / ha over the four years. Protein yields averaged 750kg/ha for Pronghorn compared to 717 kg/ha for Chapais and 598 kg/ha for Belvedere which was the lowest. Generally no grain yield benefit was found in comparing a single 50 kg/ha nitrogen application at seeding and a split application of 100 kg/ha nitrogen. Grain yield did significantly increase with a split application of 150 kg/ha nitrogen. Protein yields increased significantly from the 50 kg/ha N application to the split 100 kg/ha N application and again from the 100 kg/ha N split to the 150 kg/ha N split. Protein yields averaged 587 kg/ha under low inputs (50 kg/ha N), 650 kg/ha under medium inputs (100 kg/ha N split) and 743kg/ha with high inputs (150 kg/ha N spilt + PGR + Fungicides). The incidence of Septoria leaf infections in the spring wheat and triticale and net and spot blotch in barleys were significantly reduced with the application of fungicides. . Application of the plant growth regulator, Ethephon, at a rate of 0.420 kg a.i. ha^{-1} did significantly reduce plant heights and lodging but lodging was not severe in any of the crops under any management for all years.

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Yield Increases With Frost Seeded Spring Wheat

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Yield of spring cereals is generally favored by early planting dates. In Ontario, cereal planting normally occurs once soil moisture levels have decreased to a level where tillage and/or planting equipments can be operated. Frost seeding is a technique whereby planting is conducted when the soil surface is sufficiently frozen so as to support planting equipment, while not preventing penetration by planter seed furrow openers. In 2003, replicated trials were conducted at three sites to compare frost seeding of four spring wheat [milling and feed] varieties to a 'normal' seeding date. At approximately eight additional grower sites frost seeding was evaluated in strip trials. Plant stands, heading dates, protein, straw quality and yield were evaluated. Results indicate that spring wheat yields can be significantly increased by frost seeding.

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Effect of time and method of establishment on seed yield of irrigated perennial ryegrass

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Perennial ryegrass (*Lolium perenne* L.) seed production is an opportunity to diversify agriculture in Alberta, but limiting factors for the species are its lack of drought tolerance and winter hardiness. Irrigated trials were established at Bow Island and Brooks in southern Alberta to determine profitable cropping options for seed production. Perennial ryegrass seed yields were highest at Bow Island when spring established with a barley companion crop harvested either for silage or grain with yields averaging 2220 and 2127 kg ha^{-1} respectively. The barley companion crop treatment harvested as silage at Brooks resulted in the highest average perennial ryegrass seed yield at 1590 kg ha^{-1}. All treatments resulted in higher economic returns over two years when compared to perennial ryegrass only straight-seeded. Establishing perennial ryegrass with spring-seeded companion crops or seeding in mid-summer following grain or silage harvest would be economically acceptable for subsequent perennial ryegrass seed production.

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Improving field crop production efficiency using information technology (IT) that interactively connects the farmer, the production field and the best knowledge on the web

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To assist crop producers in achieving Best Management Practices (BMP), an expert knowledge management program has been developed that includes information and decision tools for over 130 crops and the cropping systems of Western Canada. It evaluates agronomic practices in individual fields and flags 'Production Issues' the producer should address. This web-based program uses an on-line 'Field History', specially designed for access by an 'Expert Virtual Field Scout', that automatically flags the potential risk level for over 100 potential 'Production Issues', in comparison to BMP benchmarks. All flags are automatically web-linked to the best web sites collected in a 'Knowledge Index', about the factors and decision tools that are needed to address each separate 'Production Issue'. A collection of over 4,000 reviewed web-sites forms the complete 'Knowledge Index'. Over 100 different 'Production Issues' have been programmed, covering all aspects of the crop production and field management cycles.

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Fate of corn transgenes and Bt protein in silage and processed grain

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The safety of genetically-modified plants is still questioned due to the possibility of horizontal gene transfer, even though the probability of such an event is extremely low. The persistence in the environment of proteins encoded by transgenes is also a concern. The fate of the encoded Bt [cry1A(b)] protein and transgene fragments present in two Bt11 [*CaMV35S* (195 bp), *cry1A(b)* (311 bp), *bar* (377 bp)] and one Bt176 [*CaMV35S* (195 bp), *cry1A(b)* (105 & 195 bp), *bar* (242 bp), *bla* (805 bp)] corn hybrids was monitored in silages and processed grains. The two Bt11 (N44-P4, N27-M3) and the Bt176 (N09-K9) hybrids with their isolines were field-grown in four replications. Seven 1.4-kg capacity mini-silos were made per plot and then opened after 1, 2, 4, 8, 16, 32, or 64 days. For each hybrid, two 500-kg plastic bag silos were made and then opened after 30 or 198 days. In mini-silos, the transgene fragments could no longer be amplified after 32 days of fermentation. In 500-kg plastic bag silos, the transgene fragments were still detectable in the three Bt hybrid silages after periods of 30 and 198 days of fermentation. At ensiling, the Bt protein concentration was 2.69, 4.11, and 0.83 μg g^{-1} DM for the three Bt hybrids, respectively. The Bt protein concentration measured after 64 days of fermentation in mini-silos represented 4.2, 2.0, and 0.6 % of the concentration observed at ensiling, whereas, after 198 days of fermentation in the 500-kg silos, it represented 16.0, 8.6, and 8.8 % of the concentration observed at ensiling for the three Bt hybrids, respectively. Differences between types of silos were most likely related to differences in fermentation characteristics as pH was on average 0.14 unit lower in silages from mini than large silos. After stringent processing treatments, transgene fragments, except the *bla* gene fragment, could be amplified from corn grains. The Bt protein concentration initially low in unprocessed corn grain (61, 239, and 21 ng g^{-1} DM for the three Bt hybrids, respectively) decreased by 35, 74, and 67 %, respectively, after micronization, by 92, 98, and 89 % after extrusion, and by 100 % after flaking. Even though some Bt transgene fragments are still detectable in silage from large scale silos and in processed grains, the Bt protein is present in very low concentration in these feeds and is unlikely to have secondary impacts on the environment.

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Dietary cation-anion difference (DCAD) of five grass species

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The dietary cation-anion difference [$DCAD_S = (Na^+ + K^+) - (Cl^- + S^{2-})$, or $DCAD_L = (Na^+ + K^+ + 0.15\ Ca^{2+} + 0.15\ Mg^{2+}) - (Cl^- + 0.6\ S^{2-} + 0.5\ P^{3-})$] is used in balancing rations for dry cows. Low DCAD diets induce a mild, compensated metabolic acidosis that stimulates bone resorption, improves Ca homeostasis, and prevents milk fever. Dry cow rations contain a high proportion of forage and, therefore, forages fed to dry cows 2 to 3 weeks prepartum should have a low or even negative DCAD value. We evaluated the DCAD values of five cool-season grass species grown in eastern Canada: meadow bromegrass (*Bromus riparius* Rehmann), orchardgrass (*Dactylis glomerata* L.), smooth bromegrass (*Bromus inermis* Leyss.), tall fescue (*Festuca arundinacea* Schreb.), and timothy (*Phleum pratense* L.). For each species, two to four cultivars were grown in four replications at three locations in Quebec [Normandin (48° 50' N), Saint-Augustin (46° 44' N), and Sainte-Anne-de-Bellevue (45° 24' N)]. Two harvests were taken in 2002 and analyzed for mineral concentrations. For both spring growth and summer regrowth, the $DCAD_L$ value of orchardgrass was the highest (708 and 708 mEq kg^{-1} DM, respectively) and that of timothy the lowest (373 and 362 mEq kg^{-1} DM, respectively); $DCAD_S$ and $DCAD_L$ values of meadow bromegrass, smooth bromegrass, and tall fescue were intermediate. Species also differed in spring growth DM yield and in concentrations of K, Mg, and P in both spring growth and summer regrowth. DCAD values of grass species were strongly influenced by K concentrations, which ranged from 25.2 for timothy to 42.7 g kg^{-1} DM for orchardgrass in spring growth. Within the same species, cultivars did not differ in DCAD values. We conclude that timothy is the best suited cool-season grass for the production of forages for dry cows.

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Organically managed barley cultivars

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The objectives of this study were to determine (1) if specific cultivars perform differently when managed organically than conventionally and (2) if better weed control can be achieved with delayed seeding. Ten recommended barley cultivars were grown organically at two seeding dates at the Harrington Research Farm, PEI in 2002 and 2003. Each year plots received 20 tons ha^{-1} of manure. Weeds were controlled by fingerweeding at pre-emergence and at the 3-leaf stage. Delayed seeding reduced grain yield by 0.67 t ha^{-1} and 0.37 t ha^{-1}, in 2002 and 2003, respectively. There was no trend to indicate that some cultivars are more suited to organic management than conventional management. Therefore, results from conventional trials may be used to select cultivars for organic production. There was no consistent trend to indicate that delayed seeding was more effective in controlling weeds than early seeding.

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Evaluation of weed control methods in organic barley and spring wheat

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One of the main concerns in an organic cereal production system is weed control. Four barley and four spring wheat cultivars were grown in 18.5 m x 3.7 m plots at the Harrington Research Farm in 2002 and 2003. Each year plots received 20 t ha^{-1} of manure. Weed control treatments were: 1. Fingerweeding once at GS 8 (2002) and GS 11 (2003), 2. Fingerweeding twice at GS 8, 12 (2002), GS 11, 14 (2003), 3. Herbicide application of Refine-Extra + MCPA at GS 21 (2002, 2003) and 4. Unweeded. Fingerweeding twice increased grain yield for each crop in one of the two years in some experiments and reduced most weeds, such as corn spurry and lamb's quarters, comparable to herbicide application. However, fingerweeding once did not improve grain yield or reduce weeds significantly compared to the unweeded control. Effective weed control can be achieved mechanically in an organic cereal production system.

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Interseeding winter cereals into potatoes

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Emphasis on potato production in the Maritimes has resulted in fields that are left bare for the winter months and are subject to erosion by wind and water. Growers are being encouraged to allow overwintering crops, such as winter cereals, to produce cash crops the following year. Research is needed to determine suitable cultivars, seeding methods and the latest seeding date of seeding winter cereals into potatoes. A fall rye and two winter wheat cultivar were seeded at 3 seeding dates from mid-September to mid-October (1) broadcast before potato harvest or (2) direct seeded following harvest of the potato cultivar Russet Burbank. Grain yield decreased with later fall seeding date but was not affected by seeding method. Survival and soil cover of fall rye was not affected by seeding date but decreased for winter wheat. Fall rye provides a better ground cover than winter wheat but the grain is of lower value.

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Impact of Changing Annual Environmental Conditions on Native Forage Species

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Spring seeding is thought to provide the most successful forage plantings. A study was initiated in 2001 to examine the optimal seeding time for native species mixes: simple (6 cool season grasses with 1 legume) and complex (11 warm and cool season grasses, 1 legume and 2 shrubs). Seeding occurred in 2 consecutive and contrasting years; 2002 was mesic, 2003 was xeric. In 2002 early spring seeding resulted in greater canopy cover for western wheatgrass, slender wheatgrass and winterfat but green needle grass, awned wheatgrass responded best to fall seeding. In 2003, only western wheatgrass and green needle grass continued to show an effect related to their seeding date for second year of growth. Fall seeding was the only date of seeding with any success for slender wheatgrass, western wheatgrass, northern wheatgrass, awned wheatgrass, needle and thread grass and green needle grass. Winterfat emerged from the early spring seeding only. Climate changes may result in a shift to a drier climate than we presently have. If this does occur a shift to fall seeding may be required if the conditions of 2003 are closer to the future norm.

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Evaluation of Barley and Wheat Cultivars for Resistance to Ergot (*Claviceps purpurea*)

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The ergot fungus *Claviceps purpurea* (Fr.) Tul. can infect a wide range of grasses and cereals. In 2003, the susceptibility to ergot of 35 barley (*Hordeum vulgare*) cultivars (24 six-row and 11 two-row cultivars) and 11 wheat (*Triticum aestivum*) cultivars was evaluated at St-Edmond (Quebec, Canada) where the disease is endemic. The study was conducted under natural conditions of infection. The ergot content of the grain harvested was determined from a 200g sample by separating and weighing the ergot sclerotia. Four two-row barley cultivars (AC Metcalfe, CDC Kendall, Chief and Xena) and 13 six-row barley cultivars had an ergot content below 0.1 %. The cultivars AC Alma (six-row) and Island (two-row) were the most susceptible with an ergot content of 1.44 % and 1.36 % respectively. Wheat cultivar SS Fundy was the most susceptible with an ergot content of 0.19 %. Results show that there is genetic variability for ergot resistance in barley and wheat. This resistance may be useful to control ergot problems under natural conditions of infection.

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Controlling Volunteer Canola in Barley: Effect of Herbicide Application Timing

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Canola (*Brassica napus*) is generally included in a 4-year crop rotation and plants emerging from remnant seeds in the subsequent years are a common problem. From 2001 to 2003, three herbicides (2,4-DB, MCPA amine, and thifensulfuron methyl/tribenuron methyl) applied at four cereal growth stages (3-4 leaf, tillering, stem elongation, heading) were evaluated to determine their efficiency to control volunteer canola in barley (*Hordeum vulgare*). In control treatment, canola volunteer populations were 24, 11 and 39 plants m^{-2} in 2001, 2002 and 2003 respectively. Applications of thifensulfuron methyl/tribenuron methyl was less effective to control canola compared to 2,4-DB and MCPA. Time of herbicide applications had a significant effect on canola population at cereal harvest. Best control of volunteer canola population was obtained when herbicides were applied at 3-4 leaf stage. Delayed herbicide applications result in poor control of canola populations. This trial indicates that herbicides were more effective when applied at 3-4 leaf stage.

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Effect of Day Length and Night Temperature on Crop Growth and Flowering in Four New Pulse Crop Species

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Preliminary field evaluations on crop phenology of new pulse crop species namely, mung bean (*Vigna radiata*, cv. AC Harosprout), pigeon pea (*Cajanus cajan*, line P 8304 B), moth bean (*Vigna aconitifolia*, unnamed cultivar) and black gram (*Vigna mungo*, unnamed cultivar) conducted at the Crop Diversification Centre South, Brooks in 2003, have indicated that all these plant species had a slow crop growth and late flowering, consequently subjected to frost damage in mid September, prior to crop maturity. Longer day length and cooler night conditions were considered to be the major contributory factors for slow crop growth and development. A growth cabinet study was conducted to examine the impact of day length and night temperature on crop growth, flowering of these crop species by growing under four different conditions (16 h day length at 24^{o}C and 8 h night at 12^{o}C; 16 h day length at 24^{o}C and 8 h night at 6^{o}C; 12 h day length at 24^{o}C and 12 h night at 12^{o}C; 12 h day length at 24^{o}C and 12 h night at 6^{o}C). Results indicated that irrespective of night temperature, long day length conditions accelerated seedling emergence in all crop species. Conversely, regardless of day length, warmer night conditions induced flowering in both pigeon pea and mung bean, whereas for black gram and moth bean, warmer night temperatures were crucial for flower induction, particularly when grown under short day conditions. Longer day length combined with warmer nights enhanced the crop growth in all crop species. These results suggest that cooler night temperatures are the main impediment for production of these tropical-origin crop species on the Canadian Prairies.

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Ensilability of temperate grasses cultivated in Eastern Canada

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The heap silo method necessitates ensiling grasses at high humidity level (70%). In such conditions, acidification potential (AP) (water soluble carbohydrates (WSC)/ buffering capacity (BC)) of grasses might be a limiting factor. The objective of this trial was to determine the AP of timothy (Bounty and Champ), orchard grass (Kay) and bromegrass (Baylor). All plots were harvested at early heading. WSC was determined by colorimetric method and BC by titration. For the first growth, AP varied from 1.6 to 2.2. Such AP would necessitate a minimal dry matter of 270 to 320 g kg FM^{-1} to ensure good conservation. For the second growth cycle, AP varied from 0.9 to 1.5 needing a dry matter level over 330 g kg FM^{-1}. These results suggest that the AP of grasses might not be sufficient to ensure a good conservation each time with the heap silo method.

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Intergeneric Hybridization Between *Sinapis alba* (Yellow Mustard) and *Brassica napus* (Canola) for Germplasm Production and Utilization

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Sinapis alba (yellow mustard; SalSal, 2n = 24) is largely grown as a condiment crop in western Canada. It is resistant or tolerant to many major insect pests of Brassica crops in the North America. It is an important potential source of resistance or tolerance to diseases (e.g. blackleg and *Alternaria*), pests (e.g. flea beetle, diamond back moth and cabbage seedpod weevil), and climatic stresses (drought and heat stress) for rapeseed (Canola, *Brassica napus*; AACC, 2n = 38). Canola reciprocally is an important potential source of high seed yield and oil content for developing oilseed *S. alba*. The objective of this research is to transfer traits *S. alba* and *B. napus* through intergeneric hybridization. Intergeneric reciprocal crosses were made by hand pollination followed by ovule culture and embryo rescue, to obtain F1hybrids. A total of 1707 *B. napus* x *S. alba* crosses were made yielding only 6 F1 hybrid plants (0.35%). However, reciprocal crosses (total 1606) of *S. alba* x *B. napus* when *Sinapis alba* was used as female yielded 69 F1 hybrids plants (4.3%). F1 hybrids were male sterile and their hybrid status was confirmed using flow cytometry and morphological analyses. This research presents an opportunity to develop improved, more disease, insect and stress tolerant canola which would require fewer chemical applications and will have potential to grow under semi-arid prairie environment. Furthermore, introgression of traits from rapeseed to *S. alba* will be useful to develop oilseed *S. alba.*

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Variability in water use efficiency and gas exchange of diverse barley varieties in response to drought

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Barley is an important cereal crop grown in the prairie region of Canada. This region experiences occasional water deficit, which is an important constraint for plant productivity and yield stability. This poster describes results of ongoing research aimed at characterizing the water use efficiency (WUE) of diverse barley varieties recommended for the prairie region with a view of developing drought tolerant varieties. Five varieties were subjected to induced drought in a greenhouse at the jointing stage, which was then released at mid-heading. Leaf gas exchange and water potential were measured 10 days after inducing drought and leaf laminas were collected for ^{13}C determination. Water use was monitored and plants were harvested pre-drought, end of drought and at maturity at which time WUE was calculated as dry weight/water use. Preliminary analysis of results shows variability in drought responses and WUE among varieties, which can be exploited in developing high performing varieties.

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Can leaf chlorophyll measures at differing growth stages be used as an indicator of winter wheat and spring barley nitrogen requirements in eastern Canada?

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Plant need-based N management approaches may increase the efficiency of N fertilizer application in wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.). Field trials were conducted near St. John's, Newfoundland between 1997 and 2000 to describe the relationship between winter wheat and spring barley grain yield, protein content, protein yield and SPAD measurements, as affected by differential stage of crop growth, seeding rate and topdress N fertilizer. Grain yield, protein content, and protein yield of winter wheat and spring barley exhibited linear responses to increasing N topdress application rate. SPAD-502 values were moderately to highly positively correlated with grain yield, protein content, and protein yield as a result of increasing topdress N fertilization, and moderately negatively correlated as a result of increasing seeding rate. It may be difficult to make an N-application rate recommendation based on SPAD measurements, as a critical SPAD value may vary among years, locations, cultivars, and soil characters.

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Temperature trends from 1950 in southwestern Saskatchewan

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Previously, we had analyzed long-term weather data (from 1950 to 1997) to study the annual as well as seasonal change in air temperature within an approximately 15000 km^2 area in the semiarid prairie near Swift Current, SK. We reexamined the air temperature data to see if annual and seasonal trends in temperature from 1950 to 1997 continued through 2003. The annual and seasonal temperature trends determined from weather data collected from 1950 to 1997 continued at similar rates with the addition of data from 1998 to 2003. Generally, over a large area within southwestern Saskatchewan, annual temperatures have continued to increase; seasonally, JFMA continued to experience the largest warming trend whereas SOND has not warmed since 1950.

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Frost dates and seasonal temperature trends on the Canadian Prairie

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The climate of the Prairies has warmed over the past century, especially during late winter and early spring. Some regions of the Prairies have warmed faster than others. We examined weather records gathered at several long-term weather recording sites across the agricultural regions of the Canadian Prairies for evidence of trends in last spring frosts, first fall frosts, and frost-free durations. The general trend was towards earlier last spring frost dates and towards longer frost free seasons in the agricultural regions of the Canadian Prairies. The relationships of frost dates and frost free durations with year and the rates of change were regionally dependent. Generally, the regional changes in frost dates and frost free durations have followed closely the regional warming patterns on the prairies. The largest changes have occurred in the central and northern agricultural regions of Alberta whereas the least change occurred over much of southern Alberta and in southern Manitoba.

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In-season plant tissue nitrogen as an indicator of grain yield in oat

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Oat (*Avena sativa*) has become an increasingly important crop in Manitoba in recent years. However, limited research has been conducted to identify nutrient management practices to optimize oat yield and quality. In order to identify the plant N concentration at which optimum grain yield is attained, data were collected from a three-year field study established to assess the effect of fertilizer management on oat yield and quality. Three methods for determining plant N status at crop heading were compared: N concentration in a whole plant sample, N concentration in the flag leaf, and chlorophyll meter readings. The relationship between plant N status, as determined by these three methods, and grain yield, was determined.

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Expression of quantitative trait loci for durum endosperm pigment content across environments

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Two durum wheat populations segregating for endosperm pigment content were grown over multiple environments. In the first cross, the moderate pigment content parent, 'Kyle'*2/'Biodur'sel., was crossed with the high pigment parent, 'Kofa', to generate doubled haploid progeny. In the second cross, the low pigment parent, IC13102, was crossed with the moderate pigment parent, 'Kyle', to generate a recombinant inbred line population. Both populations expressed transgressive segregation for pigment content. Polymorphic markers were applied to each population followed by single marker analysis with SAS and simple and composite interval mapping analysis with MQTL. Even though the IC13102/'Kyle' population had a higher marker density, only two quantitative trait loci (QTL) were identified compared to seven identified in the 'Kyle'*2/'Biodur'sel.//'Kofa' population. Chromosome locations differed for pigment QTLs between the two populations. Across seven environments, each QTL locus occurred in more than one environment in the 'Kyle'*2/'Biodur'sel.//'Kofa' population.

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Component analysis of triticale for food or feed

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A set of three commonly grown Canadian spring triticale (X *Triticosecale* Wittmack) varieties, AC Certa, AC Ultima and Pronghorn and one novel triticale, T163 were compared to two Canada Prairie Spring (CPS) wheat (*Triticum aestivum)* varieties, AC Crystal and AC Vista and a common Soft White Spring (SWS) wheat, AC Reed for levels of moisture, protein, lipid, ash, starch, pentosans, total dietary fibre, soluble dietary fibre and insoluble dietary fibre. With the exception of pentosans, fibre content, and protein, very few significant differences were detected between triticale and the two wheat classes evaluated.

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Potential distribution and severity of fusarium head blight and cereal leaf beetle in the prairie ecozone of Canada using bioclimatic modelling

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The simulation software, CLIMEX^{TM}, was used to develop bioclimatic models to predict potential distribution and severity of fusarium head blight, *Fusarium graminearum* Schwabe (*F.g.*), and cereal leaf beetle (CLB), *Oulema melanopus* L. (Coleoptera: Chrysomelidae) in western Canada under current and changing climatic conditions. The models were also extended to examine the effect of irrigation due to the importance of moisture to these two pest species. *Fusarium graminearum*, a fungal disease that causes yield and quality losses to wheat and barley crops, is well-established in the eastern areas of the prairie ecozone. Its appearance in grain samples from central and western areas has raised concerns about the broader risk to cereal production. Cereal leaf beetle, an invasive pest insect of small grain cereal crops, has recently become established in north western USA. Causing yield losses of up to 75% in cereals, CLB is a new potential threat to the prairie ecozone where up to 10 million hectares of wheat, barley and oats are grown annually. Climate change scenarios were created for all possible combinations of temperature (LTN,+1,+2,+3,+4,+5,+6,+7) and precipitation (LTN, -60%, -40%, -20%, -10%, 0%, +10%, +20%, +40%, +60%). Climate data, based on grid data included with CLIMEX^{TM} was used as an input into the model. Based on current conditions, the models predicted that *F.g.* and CLB would readily survive in the cereal-growing areas of western Canada and present a significant risk to cereal production. The model demonstrated that *F.g.* was more sensitive to soil moisture than temperature. Irrigation may compensate for dryer atmospheric conditions in some regions resulting in disease levels similar to those occurring in the eastern prairies. Temperature increases of at least 2-4^{o}C with a minimum 20% increase in seasonal rainfall resulted in the greatest projected increase in the potential range and severity of *F.g.* in the prairie cereal growing ecozone. The model predicted that increased temperatures would result in extension of the CLB range into northern Quebec, Labrador and as far north as Great Slave Lake.

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Seeding management of direct-seeded hulled and hulless barley: I. Crop establishment

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Is plant establishment of hulless barley is less than hulled barley in the northern Great Plains? The objective of this study was to evaluate seeding depth and seeding rate to manipulate the establishment of direct-seeded hulless and hulled barley (*Hordeum vulgare* L.). A field experiment was conducted at Lacombe, Beaverlodge, and Fort Vermilion, AB, and Melfort, SK, from 1997 to 2000 to evaluate the effect of two seeding depths (3.8 cm and 6.4 cm) and four seeding rates (100, 200, 300, and 400 seeds m^{-2}) on plant establishment, yield components, and other production characteristics of hulless and hulled barley. Higher seeding rates resulted in increased plant density, spikes per m^2, earlier days to anthesis and days to maturity and less tillers per plant and kernels per spike. Barley matured 3 d earlier with the 3.8 cm vs. 6.4 cm seeding depth. Hulless barley emergence was 52 and 42% of kernels seeded at a rate of 100 and 400 kernels m^2, respectively. Hulled barley emergence was 76 and 59% of kernels seeded at a rate of 100 and 400 kernels m^2, respectively. Plant establishment of hulless barley, in particular, would benefit from increased seeding rate and shallower seeding.

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Assessing Seeding Rate, N Rate and N Placement on Barley Yield Loss from Wild Oat

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Producers frequently question whether seedling damage from nitrogen rate and placement can be counteracted by increasing seeding rates. Seedling damage can have a major impact on crop yield, competitive ability with weeds and crop yield loss. Our objective was to determine optimal combinations of seeding rate, N rate and N placement that would improve barley canopy and prevent yield loss. Experiments were conducted at two Alberta locations (Lacombe and Beaverlodge) and one Manitoba location in 2001 to 2003. Five nitrogen rates and two N placements (seed row and pre-plant band) were seeded at three rates (200, 300 and 400 seeds m). Experiments were a factorial arrangement of treatments (5 x 2 x 3) in a RCBD with 4 replications. Increased yield loss with increasing N rate indicates that wild oat can utilize applied N as well or better than barley. However, banding optimal rates of N feeds the crop, not the weed, and almost eliminates yield loss due to wild oat. Increased seeding rate can reduce the yield loss due to wild oat by 50% when N was seed-placed. These practices would enhance crop competitiveness with weeds, reduce reliance on repeated herbicide applications, and provide opportunities for integrated crop management (ICM).

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Seeding Rate, N Rate and N Placement Effects on Barley Plant Establishment

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Barley is sensitive to damage from seed-placed nitrogen (N) so it is generally recommended that the amount of N fertilizer placed with the seed be limited to maintain crop health and avoid reductions in plant stand. Our objective was to determine optimal combinations of seeding rate, N rate, and N placement that would improve barley plant establishment and early season canopy development. Experiments were conducted at two Alberta locations (Lacombe and Beaverlodge) and one Manitoba (Brandon) location from 2001 to 2003. Five nitrogen rates (0, 30, 60, 90 and 120 kg N ha^{-1}) and two N placements (seed row and pre-plant band) were seeded at three rates (200, 300 and 400 seeds m^{-2}). Experiments were a factorial arrangement of treatments (5 x 2 x 3) in a randomized complete block design (RCBD) with 4 replications. Our results indicate to seed barley at 300 to 400 seeds m^{-2} in the Black soil zone to improve plant stand, promote earlier ground cover and help the community of plants defend themselves against pests such as weeds. Avoid, if possible, to place N rates above 30 kg ha^{-1} in the seed row to limit seedling damage. Higher seeding rates can only partially compensate for seedling damage due to placement of N in the seed row.

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Improvement in seed set in perennial cereal rye through selection

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ACE-1 Perennial Cereal Rye (PC rye) (*Secale cereale*) was developed by the Agriculture and Agri-Food Canada Research Centre, Lethbridge, Alberta for silage and green feed. ACE-1 is easy to establish, competes well with weeds, grows early in spring, produces more biomass than barley and fall rye but produces less seed than high yielding fall rye cultivars and is susceptible to ergot infection if moist conditions prevail during seed formation. These may be due to its inter-specific origin and consequent seed head sterility. A random sample of nodded seed heads were collected for four generations from open pollinated populations and compared with the straight seed heads for seed head length, seed set, 100 seed weight and yield per head. Nodded heads produced more seed and higher seed yield than straight seed heads in all generations indicating that selection for nodded seed heads can be used for reducing seed head sterility and possibly ergot susceptibility in this crop.

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First North American Forage Fenugreek Cultivar "Tristar"

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Tristar fenugreek (*Trigonella foenum*-graceum) tested as L3314 is an annual, self pollinated, legume crop. This accession (PGRC # CN 19118) was originally collected from Shiraz area in Iran in 1940. The line was selected for its ability to produce high biomass yield. Tristar produced more forage (t DM ha^{-1}) than Amber (common seed) on both irrigation and dryland, 6.0 vs 5.4 and 5.8 vs 5.7 respectively and more seed than Amber (t ha^{-1}) on irrigation and dryland, 1.2 vs 1.0 and 1.0 vs 0.9 respectively. Tristar fenugreek maintains high forage quality throughout the growing season. It is a dryland crop but responds well to irrigation. Tristar is easy to establish and can be harvested by using traditional hay or seed harvesting equipment. Agricore United and New Field Seeds have the multiplication and distribution rights for the cultivar. Seed for commercial production is expected to be available in 2005 fall.

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Native giant wild rye grass for improving wild life habitat in western Canada

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Rapid growth in spring (provide quick cover) and quick establishment are essential for wild life habitat improvement. Reliable supply of high quality grass seed with proven ability to grow well without close attention will help use of native grasses even in areas not suitable for agronomic species. Native giant wild rye (*Elymus cinerius* L.) populations have the potential to protect wild life and provide shelter belt within a short time (compared to trees) while providing quality forage during winters when forage is at a premium. Native giant wild rye collections at Lethbridge Research Centre have produced up to 27 t DM ha^{-1}. Development and commercialization of some of these adapted native grass populations for western Canada with high levels of genetic resistance to biotic and abiotic stresses will minimize the risk of growing these populations while eliminating any environmental concerns public may have with regard to use of introduced species for such a purpose.

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Using Growing Degree Days to Estimate Maturity in Small Grain Cereals

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Physiological maturity in small grain cereals is defined as the cessation of nutrient movement to the grain. It usually occurs when the grain is at a moisture content of 35%. Using temperature data from nearby weather stations, growing degree days ($GDD=3[(T_{min}+T_{max})/2]$ were calculated during the maturation phase of barley, wheat and triticale. Grain samples were collected from several cultivars of each grain from about 50% down to 10% grain moisture. During the linear phase of dry-down, moisture content was determined on the basis of GDD. For barley, an overall relationship was found such that estimation of GDD from sowing to physiological maturity can be made from moisture content measurements at harvest: $GDD_{physmat}=GDD_{harvest}- (35-Moisture_{harvest})/0.05933$. Introducing total growing season precipitation data into the equation made a slight improvement in the fit of the data, such that the average relationship became $GDD_{physmat}=GDD_{harvest}-[(35-Moisture_{harvest})-0.04293(Precipitation_{Total})]/0.07124$. A program based on SAS has been developed to determine days to maturity based on temperature, precipitation, moisture content of the grain at harvest, and the dry-down equations.

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Relationship of malting to feed traits in two-row barleys

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Both malt and feed barley markets prefer high test weight grain, but for the malt industry other traits must also be met such as low protein, high malt extract, high α-amylase, high diastatic power (DP) and low β-glucans. This study was conducted to determine the relationship of traits desirable in malting barley to those for feed. Quality analyses using NIRS were conducted on twenty barley lines and cultivars from our advanced two-row yield trials grown under eight environmental regimes in 2003. Digestible energy content and protein digestibility were found to be positively correlated with protein, DP, malt β-glucan and negatively correlated with malt extract and α-amylase. Starch content and total fiber were negatively correlated with protein and DP. Starch was positively correlated to malt extract and α-amylase and negatively correlated to malt β-glucan. When we select for good malting quality, we may be selecting away from high digestible energy content. However on a line by line basis, many lines had traits that would be desirable for both feed and malt markets. There are also lines that have very high digestible energy contents that would make them superior feeds.

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Molecular Marker Development for Scald Resistance in 'Seebe' Barley

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Scald (*Rhynchosporium secalis*) of barley is prevalent in central Alberta, Canada and causes considerable yield and quality losses. Scald has the ability of rapidly changing in pathotype composition and frequency. This makes it difficult to develop durable scald resistance in barley. Previous studies have shown that the cultivar 'Seebe' carries durable genetic resistance, however, barley breeders have found this trait difficult to transfer into new barley lines. Therefore, we are trying to develop molecular markers for scald resistance from Seebe. Recombinant inbred lines were created from the genetic cross of 'Harrington' (scald susceptible) and Seebe (scald resistant). Progeny of about 175 individual F_2 seedlings were advanced by single-seed descent to the F_8 generation. Disease resistance to a major scald race was phenotyped at the seedling stage in a green house. By utilizing bulked segregant analysis, resistant and susceptible pooled populations were compared by AFLP analysis. A total of 255 AFLP primer combinations were used to analyze the genetic population and several *Eco*RI-*Mse*I and *Pst*I-*Mse*I fragments were found linked to scald disease resistance. These AFLP fragments identified are currently being verified, sequenced and transformed into a site-specific marker. As well AFLP and SSRs markers are being used to map the putative scald resistance genomic location.

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