Abstracts of Papers Presented at the NAPIA Meeting Newark, Delaware

Oral Presentations

Genetics and analysis of early maturity strategies in chickpea

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Greenhouse and field studies were conducted to determine the genetic control of earliness traits in chickpea and to examine the effect of double podding, early flowering and short internode length on maturity duration. Variance compo-nents, heritability and predicted gain from selection were determined for the key earliness traits including days to flowering, days to first pod maturity, percent pod maturity at four months after planting, and days to maturity. Both double podding and early flowering traits contributed to earliness of crop maturity, with the former trait having the more pronounced effect.

Field pea breeding at Agriculture and Agri-Food Canada

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The mandate of the field pea breeding program at Agriculture and Agri-Food Canada (AAFC) is to develop field pea varieties or improved germplasm lines for western Canada. The main characteristics of the recent field pea varieties are high seed yield, good lodging resistance, excellent seed quality, appropriate maturity, resistance to powdery mildew, and moderate resistance to Mycosphaerella blight and Fusarium wilt. The future breeding objectives will include improved nutritional value for animal feed and resistance or tolerance to Fusarium, Rhizoctonia and Aphanomyces root rot.

Preliminary assessment of allelic diversity in USDA pea core collection

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Discovery of allelic diversity in the USDA pea core collection using SNP and INDEL assays is underway. We have sequenced portions of pea genes on a diverse set of accessions and a preliminary assessment of allelic diversity for 13 genes will be discussed.

Options for minimizing ascochyta blight in chickpea

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Ascochyta blight, caused by *Ascochyta rabiei*, is the major constraint for chickpea (*Cicer arietinum* L.) production worldwide. The pathogen infects all aboveground parts of the plant during all stages of crop development. This paper discusses specific agronomic management practices and options for managing the disease in a commercial setting. The focus is to integrate all available agronomic options, along with selective use of resistant cultivars, to minimize the damage caused by the disease.

Pea production in the east

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Peas for canning or freezing have been planted in Delaware and on the Delmarva Peninsula since the 1880s. Currently, approximately 9,000 acres are contracted by farmers with four processing companies. Field representatives of two processors will share their observations and current issues in processing pea production.

Performance of kabuli chickpea with fern and unifoliate leaf traits in the northern great plains

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Selection of the best leaf type of kabuli chickpea for canopy development, light interception and utilization, biomass and yield production may increase yield in the short growing season of the Northern Great Plains. Six kabuli chickpea cultivars representing fern and unifoliate leaf types were grown at 45 and 85 plants m^{-2} in 2003 and 2004 at Saskatoon and Swift Current, Saskatchewan to determine the relationship between leaf type and crop growth, productivity and light interception parameters. In general, maximum aboveground biomass, maximum light interception, seasonal cumulative intercepted photosynthetically active radiation, harvest index and yield were higher for the fern leaf cultivars than for the unifoliate leaf ones, which indicated an opportunity for increasing chickpea yield by using the fern leaf in cultivars for the Northern Great Plains.

Consensus genetic map of pea based on STMS markers

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The goal of this research was to capitalize on the development of advanced molecular tools and establish a high density genetic map of pea that could serve as a framework from which other gene mapping projects could build. A consensus genetic map of pea comprised more than 200 microsatellite markers and a total of 466 markers including PCR-based, isozyme and morphological markers on seven linkage groups. Transferability of the co-dominant STMS markers to other populations provides significant advantage compared to other marker systems. Wide application of these markers is expected to allow direct alignment of information obtained in different laboratories worldwide.

Mapping fusarium wilt race 2 resistance (FNW) in pea

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Fusarium wilt race 2 is an increasingly important economic pathogen of peas in the U.S. Pacific Northwest. Genetic resistance is conferred by a single dominant gene, *Fnw*. Our objective was to identify sequence-tagged microsatellite (STMS) markers tightly linked to the Fusarium wilt race 2 resistance gene, *Fnw*, which could be used in marker assisted selection. Three closely linked markers, PSMPSAD171 (7.7 cM), PSMPSAD126 (19.0 cM) and K16_900 (14.9 cM) were identified and anchored to pea linkage group IV.

Pulse crop research: past, present and future

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Progress and changes in pulse crop research over the past 40 years are reviewed with the goal of highlighting the major events that have shaped current efforts. Foremost are the genes for morphological traits and disease resistance that have dramatically altered phenotypes of new varieties and imparted greater resistance to disease. Emerging biotechnological tools such as quantitative trait loci analysis, comparative genomics, micro arrays and reverse genetics are being looked to for genes needed for continued improvement of pulse crops.

Use of phosphorous acid to manage root rots in fresh peas caused by oomycete pathogens

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Aphanomyces and Pythium root rots, caused by the Oomycetes *Aphanomyces euteiches* and *Pythium* spp., are considered to be some of the greatest threats to fresh pea production across the United States. Foliar applications of phosphorous acid to many crops have helped to manage other oomycete-type pathogens through the stimulation of natural defense mechanisms in the plant. New research demonstrates the potential use of phosphorous acid to manage oomycete root rots in fresh peas.

Development of the red lentil crop in Saskatchewan

Vandenberg, A., Tullu, A., Banniza, S., Bett, K., Tar'an, B., Lulsdorf, M., Vail, S., Kumar, P., Bruce, J., Fiala, J., Davey, B. and Warkentin, T.D.
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Expansion of the red lentil crop in Saskatchewan is in full stride. The growth is the result of improved grower and exporter confidence based on improvements in agronomy, focused market development and rapid access to better varieties. Future improvements will result from research on improvements in milling efficiency.

Improving field pea quality for food and feed markets

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Several research initiatives are in progress with the goal of improving the value of field pea for food and feed markets. Near infrared spectroscopy calibrations have been developed to rapidly predict the relative concentrations of crude protein, starch and fiber fractions. Development of low phytate field pea could improve the value of the crop for feed and reduce phosphorus pollution. Understanding the genetic control of seed shape, dimpling and color stability should allow selection for improved quality for food markets.

Gene discovery in *Pisum sativum* ssp. *abyssinicum*

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The Abyssinicum pea [*Pisum sativum* ssp. *abyssinicum* (A. Braun) Govorov] is a taxon that continues to be grown as a crop in what is now Eritrea and Ethiopia. The extremely narrow and divergent genetic base of *P. s.* ssp. *abyssinicum* relative to both domesticated pea (*P. s.* ssp. *sativum*) and the wild progenitor (*P. s.* ssp. *elatius*) suggests that the Abyssinicum pea has been isolated from the two other taxa for some time and has gone through a relatively recent genetic bottleneck. An analysis of the genetic basis of traits segregating in progeny derived from (*Pisum sativum* ssp. *sativum* x *P. s.* ssp. *abyssinicum*) revealed the presence of new loci or novel effects of known loci. Plant height, leaf size and shape, flowering time and root/shoot ratio all displayed polygenic inheritance in the populations studied. Two major genes were found to influence plant height, and these appeared to be the same as two identified as affecting height in *P. s.* ssp. *elatius* x *P. s.* ssp. *sativum* populations. One of these genes (gibberellin 3-oxidase) also appeared to influence leaf size and total root area, although the presence of a tightly linked locus affecting leaf size and/or root area remains an alternative explanation. The difference in total root area between the Abyssinicum pea and cultivated pea was also influenced by a locus on linkage group II. The genotype for flowering genes in Abyssinicum pea was determined to be *Lf, Sn, hr, E,* with a fifth locus possibly responsible for the relatively early flowering node for the genotype. The most distinctive trait of the Abyssinicum pea, that of strongly dentate leaflets, was confirmed to be controlled by a single dominant gene, *Ser*, on linkage group III. *Ser* was tightly linked to the breakpoint of the translocation that contributes to the reduc-tion of fertility in *P. s.* ssp. *sativum* x *P. s.* ssp. *abyssinicum* crosses. Segregation distortion strongly favoring *P. s.* ssp. *sativum* alleles was observed for this region of linkage group III and for several other regions of the genome, indicating that it might be difficult to introgress certain *P. s.* ssp. *abyssinicum* alleles into commercial germplasm.

Development of a transformation system for *Ascochyta rabiei* using *Agrobacterium*-mediated transformation

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Ascochyta rabiei causes Ascochyta blight, an important disease of chickpea. In order to identify genetic factors conditioning pathogenicity of the pathogen, a genetic transformation system is being developed for the pathogen *A. rabiei*. Conditions for efficient transformation of *A. rabiei* using *Agrobacterium*-mediated transformation have been determined. This transformation system will allow us to carry out random mutagenesis, targeted mutation and complementation tests to advance our understanding of the pathogenic mechanisms of *A. rabiei*.

Posters

Effect of pulse grains on performance of newly weaned steer calves

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This study evaluated pulse grains in feedlot receiving diets. Over the 42-day period, calves fed diets with chickpeas, field peas or lentils as the protein source gained 9.2% faster (4.08 vs. 3.68 lbs/day) and tended to consume more dry matter (16.3 vs. 15.0 lbs/day) than those fed the control diet with canola meal as the protein source. The calves fed pulse-based diets continued to show increased gains (0.59 lbs/day) for at least 7 weeks after the termination of the receiving trial Field peas, chickpeas and lentils appear to be highly palatable and support excellent feedlot performance.

Management of ascochyta blight in chickpea

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Ascochyta blight (AB) is the major constraint to chickpea production in western Canada. Use of partially resistant cultivars can reduce fungicide applications in chickpea production. Plant tissues are governed by specific genes which react to pathogens at each tissue level. Experiments were conducted at four sites in Saskatchewan to study the response of chickpea varieties to AB on leaves, stems and pods. A total of 12 desi and 12 kabuli varieties were tested under high- and low-fungicide spraying regimes. Kabuli varieties differed more than desi verieties in disease severity. Varieties within a class responded to fungicides similarly at all three tissue levels with a few exceptions. The measurement of AB severity at different tissue levels could be used to develop disease management strategies.

Can lentils improve soccer performance?

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The ultimate goal of increasing pulse consumption is a complex and long-term task that will require multidisciplinary interaction among scientists, food companies, health and nutrition professionals and marketing consultants. The entire effort may take many years. This project is a first step.

Color classification of green lentils

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We used a DuPont™ Acurum™ to rapidly classify 100 seeds each of 36 green lentil genotypes grown at 8 locations in Saskatchewan. This method has excellent potential for use in the lentil industry and in plant breeding to provide accurate and rapid assessment of seed samples. We are using it in a genetic study of the inheritance of the ability to retain green seed coat color in lentil.

Weed control in direct-seeded field pea

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Weed control and crop response to selected pre- and post-applied herbicides were evaluated in direct-seeded field pea. Pre-applied treatments generally provided good to excellent control of green and yellow foxtail, common lambsquarters, protrate and redroot pigweed, and wild buckwheat, except carfentrazone and thifensulfuron + tribenuron. Pea seed yield ranged from 68.9 to 70.7 bu/A with pre sulfentrazone at 0.188 lb/A followed by Post bentazon at 0.5 lb/A compared to the untreated check at 49.2 bu/A.

Introgression of resistance to *Colletotrichum truncatum* race *CT0* in *Lens culinaris* from wild *Lens* species

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Anthracnose, caused by *Colletotrichum truncatum* (Schwein.) Andrus & W.D., is a major disease on lentils grown in the prairies. Resistance to race *Ct0* of *C. truncatum* has not been reported in *L. culinaris* but has been found in *L. ervoides, L. nigricans* and *L. lamottei*. An advanced interspecific hybrid population of *L. culinaris* and *L. ervoides* has been evaluated FOR RESISTANCE TO RACE *Ct0* and ongoing studies will continue to examine several genetic and practical aspects of characterizing resistance genes. By increasing our understanding of the genetics of resistance to *C. truncatum* in *L. culinaris*, effective deployment of resistance genes can occur in the lentil breeding program at the Crop Development Centre.

Selection of seed size and its impacts in kabuli chickpea

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Using small seeds in kabuli chickpea can reduce production costs because a lower volume of seeds is needed per unit area. This study determined the effects of seed size and selective use of small seeds, year after year, on the field performance of kabuli chickpea in Saskatchewan. Separated large (9.1-11.0 mm diameter) and small (8.1-9.0 mm) seeds of certified 'CDC Xena' were compared with the original, unseparated seeds during the 4-year study period. Small seeds separated from small-seeded previous crops and large seeds separated from large-seeded previous crops were also compared with unseparated seeds in various generations of selection. The feasibility of using small seeds for cultivation and large seeds for marketing are discussed.

Response of lentil to rhizobium in a semiarid environment

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Use of rhizobial inoculants may increase nodulation and seed yield of annual legumes. This study determined the effect of formulations (seed-applied powder vs. soil-applied granular inoculants) and placement of granular inoculants in soils (applied in the seed-row vs. side-banded) on plant establishment, nodulation, and seed yield of green lentil (*Lens culinaris* Medik.) in a semiarid environment of western Canada. The effect of soil type/texture on inoculant performance was also determined by growing the crop on a silt loam and a heavy clay soil during a three-year period.

Survey and control of dry pea root rot pathogens in North Dakota

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Field surveys in 2004 and 2005 were conducted to determine the presence of various root rot pathogens of dry pea in North Dakota. Plant and soil samples were taken from 47 fields in 2004 and 45 fields in 2005 during the surveys. Many *Fusarium* spp. were recovered from roots and *Aphanomyces euteiches*-like isolates were recovered from soil. Identification of *Fusarium* spp. and confirmation of *A. euteiches*-like cultures is currently underway. Seed treatment trials were also conducted to evaluate azoxystrobin, fludioxonil, hymexazol, mefenoxam, and biocontrol products for their effectiveness in improving stand and reducing disease.

Ascochyta management in chickpea and determination of U.S. pathotypes and sensitivity to fungicides

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Ascochyta rabiei isolates collected in the Northern Great Plains and Pacific Northwest from 2002 to 2005 and prior to QoI fungicide registration are being identified by pathotype. To date, all 2002-2005 isolates are pathotype II. These isolates will be tested to determine if shifts in sensitivity to azoxystrobin, boscalid, and pyraclostrobin have occurred. Field trials at three sites in North Dakota are evaluating continuous or rotating fungicide control programs for efficacy and pathogen resistance to QoI fungicides.

Phenolic and antioxidative activities in lupin (*Lupinus angustifolius* L.)

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Eight lupin cultivars grown at four locations in southern Alberta in 2004 were evaluated for variability in phenolic constituents and antioxidant activity. Cultivar was the main source of variation for content of phenolic compounds and antioxidant activities. Phenolic compounds in cultivars varied minimally from 11.9 to 14.7 mg catechin equivalent and 4.15 to 4.95 mg rutin equivalent g^{-1} lupin for total phenolic and flavonoid contents, respectively. Antioxidant activity of lupin cultivars measured by a photochemiluminescence assay was not related to phenolic contents of seeds.

Breeding for higher levels of resistance to ascochyta blight in chickpea

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The objectives of the research were to find better sources of resistance to ascochyta blight from cultivated and wild species accessions of chickpea and to examine the genetics of resistance in the varieties adapted to Canadian environments such as Amit, CDC Frontier, FLIP 97-133C and ICC12512-1. At least two genes, one dominant each in Amit, CDC Frontier, and ICC12512-1 and one recessive in FLIP 97-133C were identified. Screening of the wild species accessions identified the highest level of resistance in *C. judaicu*m followed by *C. bijugum*.

Potential of wild species as sources of resistance to ascochyta blight in lentil (*Lens culinaris* Medikus)

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Ascochyta blight caused by *Ascochyta lentis* is a major disease in lentil grown in the prairies. New pathotypes of *A. lentis* capable of overcoming resistance in some varieties calls for a more aggressive plan that continuously seeks new sources of resistance in both cultivated and wild species. We discuss the performance of wild species of lentil for resistance to *A lentis* under field and greenhouse investigations.

Genetic transformation of *Sclerotinia sclerotiorum* through *Agrobacterium tumefaciens*-mediated transformation

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In order to study genetic factors of pathogenicity, insertional mutants of *Sclerotinia sclerotiorum* were generated using *Agrobacterium tumefacience*-mediated transformation with both mycelial fragments and ascospores. Transformants were tested for number of insertions by Southern hybridization and for stability of hygromycin B resistance and are being screened for altered pathogenicity on lentil plants and for production of oxalic acid. The tagged mutations will allow identification of mutated genes.

Effect of seed moisture, dehulling time and abrasive wheel speed on dehulling characteristics of red lentil (*Lens culinaris*)

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Red lentils (*Lens culinaris*) are mainly processed into a dehulled and split form before human consumption, and dehulling efficiency is one of the most important quality characteristics. A grain testing mill (TM05C, Satake Engineering Co., Hiroshima, Japan) was used in this study. The effect of abrasive wheel speed, dehulling time and seed moisture content on dehulling characteristics was investigated. Information gathered from this study will be useful for lentil breeders, processors and marketers.

Faba bean breeding in Saskatchewan

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After a hiatus of a decade, faba bean breeding is back, and we hope, better than ever! Specific breeding objectives include early maturity, specific quality traits and compatibility with current agronomic systems.

Plant architecture and water use efficiency in chickpea

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Crop cultivars with high water use efficiency (WUE) i.e. yield per unit water use will be at an advantage on the Prairies where low and variable rainfall is frequently the main limiting factor on crop yield. Improving WUE through early canopy closure by reducing soil evaporation and thus increasing the fraction used by crop transpiration was investigated using six chickpea genotypes with varying plant architecture i.e. growth habit (narrow, branched and prostrate) and leaf type (fern and unifoliate) at two plant densities of 45 and 75 plants m^{-2} over different soil type locations in Saskatchewan. Results indicate that the branched and prostrate growth habits as well as the fern leaf traits are generally superior in WUE to the narrow and unifolate traits.