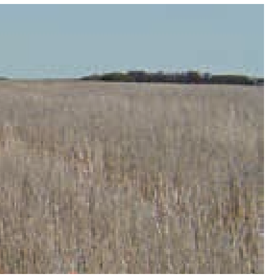
CANOLA digest

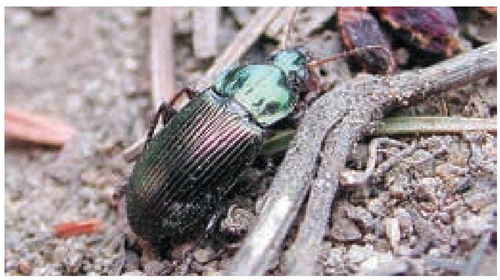
THE SOURCE FOR CANADA'S CANOLA GROWERS

SCIENCE 2013





SCIENCE SPECIAL: TOP SCIENCE FOR THE BOTTOM LINE

Research that yields

Well this is a first – the first ever special Science Edition of *Canola Digest*. Within these pages are the results of the very latest canola research, and information on how these results can be applied to your farm.

Over the past four years, the canola industry and the Government of Canada combined resources to invest more than $20 million in 31 canola research projects. Coordinated by the Canola Council of Canada, the research projects' ultimate goal was to produce new data that would continue to advance the economic and environmental sustainability of Canadian canola production.

Canola is the major revenue-generating crop for Western Canadian growers. The Canola Council of Canada aims to keep this momentum going. That takes research and it takes an enormous and sustained agronomy extension program to get the science off the bench into the field. This science edition of *Canola Digest* is just one part of our efforts over the next few years to deliver top science for your bottom line.

I'd like to thank our funding partner, the Government of Canada, for making this research possible. Not only did they provide financial support for the last four years of research, but they have also committed to future science funding which, over the next five years, will combine with industry funding to support $25 million in new canola research.

I'd also like to recognize the Alberta Canola Producers Commission, SaskCanola and the Manitoba Canola Growers Association, who put forward a significant portion of the funds to bring this magazine to you.

I hope you enjoy this special edition of *Canola Digest*, and that you find it a useful reference in the future.

Patti Miller
President, Canola Council of Canada

A working partnership

Through Growing Forward 2, our Government is making targeted investments in the agriculture research that industry has identified it needs to remain competitive.

Our initial investment in the Canola-Flax Agri-Science Cluster four years ago, led by the Canola Council of Canada, was a great success and provided benefit to growers and to the Canadian canola industry as a whole. It is clear that this partnership has paid off.

I want to commend the canola growers' organizations for seeing the value in sharing these results, and supporting the publication and distribution of this special science edition of *Canola Digest* magazine. I also commend the research staff, the university researchers and all other researchers who performed this important work.

It was the professionalism and results-driven initiative behind this first science cluster program that gave our Government the confidence to contribute $15 million to the next round of research. We announced this new investment under Growing Forward 2 earlier this year.

I look forward to reading about those results in another *Canola Digest* Science Edition in a few years' time.

Congratulations.

Gerry Ritz
Minister of Agriculture

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EDITORIAL OFFICE
Editor
Jay Whetter
Canola Council of Canada
400 – 167 Lombard Avenue
Winnipeg, MB R3B 0T6
(807) 468-4006
E-mail: whetterj@canolacouncil.org

Publisher
Debbie Belanger
Canola Council of Canada
400 – 167 Lombard Avenue
Winnipeg, MB R3B 0T6
(204) 982-2108 Fax: (204) 942-1841
E-mail: belangerd@canolacouncil.org

Production
Amanda Howard
(403) 410-7656
E-mail: amanda.howard@adfarmonline.com

ACPC OFFICE
Ward Toma
Alberta Canola Producers Commission
#170, 14315 – 118 Avenue
Edmonton, AB T5L 4S6
(780) 454-0844 Fax: (780) 465-5473
E-mail: ward.toma@canola.ab.ca

MCGA OFFICE
Bill Ross
Manitoba Canola Growers Association
400 – 167 Lombard Avenue
Winnipeg, MB R3B 0T6
(204) 982-2120 Fax: (204) 942-1841
E-mail: rossb@mcgacanola.org

SaskCanola OFFICE
Catherine Folkersen
SaskCanola
212 – 111 Research Drive
Saskatoon, SK S7N 3R2
(306) 975-0262 Fax: (306) 975-0136
E-mail: cfolkersen@saskcanola.com

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Openers and emergence

Management Practices for Optimum Canola Emergence

Principal investigator: Robert Blackshaw, Agriculture and Agri-Food Canada, Lethbridge, AB

Collaborators: Neil Harker, Eric Johnson, Bryon Irvine, Blaine Metzger (AgTech Centre), Ken Coles (Farming Smarter), Alvin Eyolfson (Battle River Research Group), Sherrilyn Phelps and Shannon Urbaniak (Saskatchewan Ministry of Agriculture).

Increasing seeding speed will reduce the precision of canola seed placement and thereby reduce the percentage of canola seeds that emerge — no matter which opener you use.

Bob Blackshaw with Agriculture and Agri-Food Canada (AAFC) led a two-year study to see how opener systems influenced canola seed emergence, and how speed influenced seed placement. The study compared six different openers in small plot replicated trials across different soil types in Western Canada at Lethbridge, AB, St. Albert, AB, Zealandia, SK, Indian Head, SK, and Brandon, MB in 2011 and 2012. Additionally, a field-scale study using farmers' seeding equipment examined the effect of various seeding speeds on canola emergence.

This opener study was a follow-up to a previously published AAFC study to determine the critical factors and agronomic practices influencing canola emergence and stand establishment. The multi-site, multi-year field study looked at the effects of cultivars, seeding depth and seeding speed on canola emergence using a ConservaPak drill equipped with 1 cm wide knife openers. The first study confirmed that deep seeding and higher seeding speeds have a negative impact on canola emergence.

The small-plot opener study used a seed drill from the AgTech Centre in Lethbridge.

Researchers measure the seeding depth to see how canola seed placement varies by seeding speed and opener type.

Various tool bars equipped with different opener types could be attached to the drill, thus avoiding possible confounding effects, such as drill weight, row spacing, seed metering system and packing system.

The six opener types evaluated were: (1) precision single shank single-shoot 0.5-inch narrow knife (low disturbance); (2) precision disc double-shoot (low disturbance); (3) precision single shank single-shoot three-inch spread tip (medium disturbance); (4) precision double shank (medium disturbance); (5) precision single shank double-shoot two-inch side band (medium to high disturbance); and (6) precision single shank double-shoot 4.5-inch paired row (high disturbance).

Canola was seeded into cereal stubble — wheat, barley or oats. Row spacing was 12 inches for all openers. Two seeding speeds were used with each opener type — four and six miles per hour (mph). Liberty Link hybrid canola was planted at 110 seeds per square metre in 2011 and 97 seeds per square metre in 2012. Canola emergence counts were made three weeks after planting.

Across all opener types, an increase in seeding speed from four to six mph in the small-plot study resulted in reduced canola emergence in 20 percent of comparisons in 2011 and 33 percent of comparisons in 2012. The results showed little difference

"Taking time to assess drill seed placement at various speeds definitely paid off for us. We were pleasantly surprised to learn that we could actually speed up by 0.5 mph and still achieve good seed depth and a strong plant count across all runs. We might not have learned this unless we had participated in this study. "

– Rob Florence, canola producer, North Battleford, Saskatchewan

Photo credit: Blaine Metzger

The small-plot study used a drill unit capable of attaching all six opener types, which avoided possible confounding effects such as drill weight, row spacing, seed metering system and packing system.

in performance between the six openers. All openers usually performed well.

This study also confirmed the results of previous studies indicating that canola emergence is highly variable and often in the range of 50 to 70 percent.

The field-scale study observed seeding tools and emergence results at farms in Alberta, Saskatchewan and Manitoba. In total, 21 farms participated in 2011 and 17 in 2012. They were selected to represent soil types and drill opener types similar to the small plot study. Producer cooperators seeded one strip at four mph and adjacent strips at higher speeds using their own seeding equipment. Researchers then determined canola emergence three weeks after seeding.

Field-scale farm trials also indicated a general trend of reduced canola plant stands with higher seeding speeds, except in Manitoba where seeding speed did not affect canola emergence at any of the three sites.

In several cases in Alberta, canola stand was reduced by greater than 20 percent at higher speeds, and reductions in canola yield and quality would be expected.

In Saskatchewan in 2012, canola emergence over all sites ranged from a low of 23 percent to a high of 68 percent, indicating how variable canola emergence can be at the farm level.

Excellent soil moisture during the study years may have been the great equalizer among treatments in terms of canola emergence in these studies. ●

Table 1. Canola emergence response (plants m^2) to various seed drill opener types at five sites in 2012.

Seed drill opener	Disturbance	Lethbridge	St. Albert	Zealandia	Indian Head	Brandon
Single shank single shoot 0.5" knife	Low	65	75	68	78	75
Disk double shoot	Low	58	65	58	69	72
Single shank single shoot 3" spread tip	Medium	50	61	66	69	76
Double shank	Medium	53	73	71	74	70
Single shank double shoot 2" side band	Medium to High	49	75	57	77	76
Single shank double shoot 4.5" paired row	High	45	66	60	74	71
Overall mean		51	67	65	73	73
Percent emergence		53	69	67	75	75

Photo credit: Blaine Metzger

Stands too thin

Impact of Management and Environment on Canola Establishment Based on Survey Data

Principal investigator: Julia Leeson, Agriculture and Agri-Food Canada, Saskatoon, SK
Collaborator: Christoph Neesor

Many canola fields across the Prairies do not have the plant stands needed to meet yield potential. That's according to surveys in Alberta in 2010 and Saskatchewan in 2012. For the majority of canola producers, improved crop establishment would help their yields.

This is one result from a survey of actual canola fields and interviews with the producers. Julia Leeson conducted the study to establish a baseline of producers' canola crop establishment practices. In 2010, 218 fields were surveyed in Alberta, and in 2012, 464 fields were surveyed in Saskatchewan. Manitoba data is from surveys conducted in 1,086 canola fields between 2000 and 2003.

In general, producers appear to be targeting stand densities at the lower end of the recommended range. In years with extreme weather conditions, this often results in lower than recommended stand densities.

Figure 1 shows that over 40 percent of canola fields surveyed in Alberta in 2010 and over 50 percent of fields surveyed in Saskatchewan in 2012 had overall average stand densities at or below the four to five plants per square foot threshold considered the minimum for canola to reach its yield potential.

This is the overall average. Figure 2 shows that most fields have patches where the stand is inadequate to meet the crop's yield potential, even if the overall average is above five plants per square foot. Over 70 percent of canola fields surveyed in Saskatchewan in 2012 had areas with fewer than four plants per square foot.

In Alberta in 2010, 71 percent of producers surveyed reported a seeding rate of five pounds per acre and 11 percent used a lower rate. In Saskatchewan in 2012, 52 percent of producers surveyed reported using a seeding rate of five pounds per acre, and 33 percent used a lower rate.

Weather can improve crop establishment, as survey results found. However, even under relatively good environmental conditions, Leeson concludes that approximately 40 percent of producers would benefit from better crop establishment.

The study also measured the relationship between canola plant stand establishment and weed density. As expected, weed densities were higher in poorly established crops. This potentially means higher herbicide costs and a further reduction in yield due to weed competition.

Figure 1. Average canola density in each survey year.

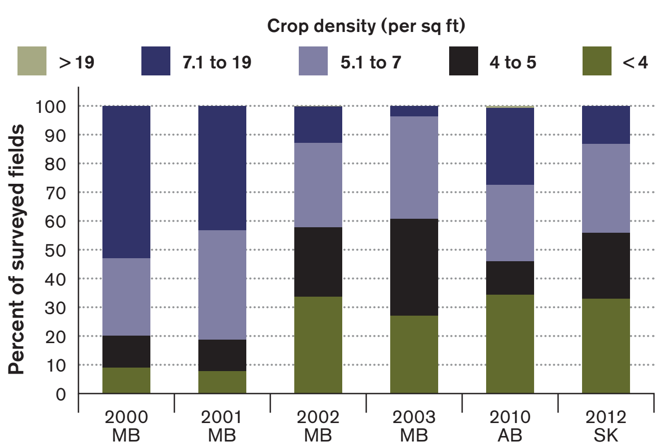
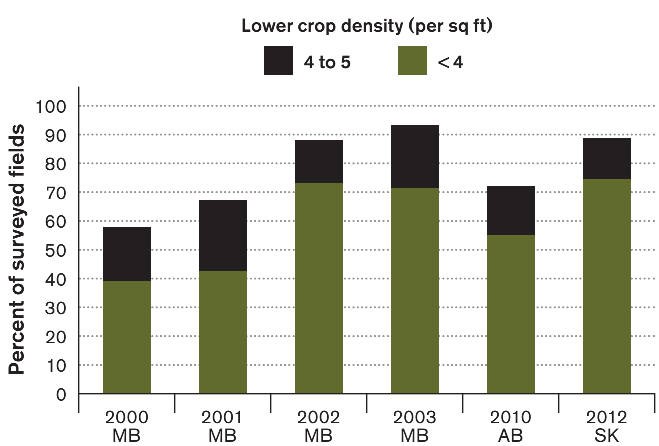


Figure 2. Percent of fields with patches of less than recommended canola plant density in each survey year.



Stubble height

Enhancing Canola Emergence with Innovative Stubble Management Practices and Use of Crop Establishment Aids

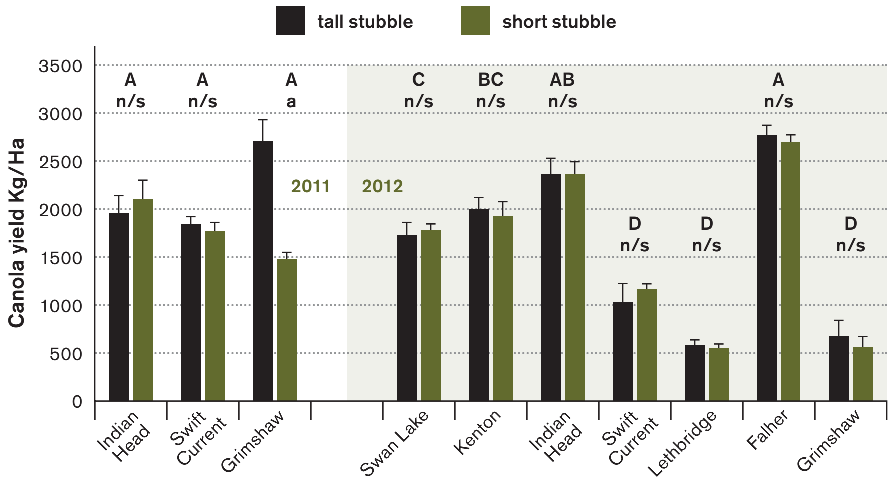
Principal investigator: Aaron Glenn, Agriculture and Agri-Food Canada, Brandon, MB
Collaborators: Mike Cardillo, Paul Bullock, Herb Cutforth, Guy Lafond and William May

Whether canola is seeded into tall or short wheat stubble, there is no impact on yield, according to this study.

The three-year study measured how crop residue height and the amount of straw on the soil surface influenced the establishment, disease level and yield of canola. Trials were conducted at four sites in 2011 – Swan Lake, MB, Indian Head, SK, Swift Current, SK and Grimshaw, AB. Sites were added at Lethbridge, AB, Falher, AB and Brandon, MB in 2012. Preceding spring wheat stubble was cut at 20 cm (short), 50 cm (tall), and/or harvested with a stripper header. Emergence counts, plant stand counts, final biomass weights and disease assessments were recorded.

The study showed no consistent significant effects of standing stubble height on canola emergence, disease pressure or yield at any of the sites. Significant differences were observed between sites and years, but this may be mainly attributed to variations in weather conditions. Of the 11 site-years in the study, the only significant stubble treatment effect observed was for Grimshaw in 2011, which had a significantly higher yield in the tall stubble compared to the short stubble treatment.

Figure 1. Canola yield in 2011 and 2012



During the 2011 and 2012 growing seasons, standing stubble was lodged over the winter and in spring at some sites. Seeding into tall stubble proved challenging at other sites. These two factors likely contributed to the lack of significant findings.

COMPANION CROP TRIALS

The same study also included a second trial at a couple of Manitoba sites to see if companion crops – crops seeded with the canola – could increase canola yield. At Brandon in 2010 and Morden in 2011 and 2012, hybrid canola was planted at 2 cm and 6 cm depths alone or with a companion crop of canary seed, foxtail millet, camelina or flax.

Companion crops were eliminated when the canola crop was at the two-leaf stage. In all site years, canola seeded with Golden German millet at the 2 cm depth had yields equal to planting without a companion crop. When canola was planted with Golden German millet at the 6 cm depth, yields were 12 percent and 15 percent higher in 2010 and 2012 respectively compared to canola planted at the 2 cm depth, but 15 percent lower in 2011. Due to the limited number of site-years included in the current study, it is difficult to make a recommendation, but the data suggests there is potential for further evaluation. ●

More plants, more yield

Improving Canola Establishment and Uniformity across Various Soil-Climatic Zones of Western Canada

Principal investigator: Yantai Gan, Agriculture and Agri-Food Canada, Swift Current, SK

Collaborators: Neil Harker, Byron Irvine, Eric Johnson, Randy Kutcher, Bill May, Guy Lafond, and Rob Gulden

Canola yield increases as plant population increases, according to this study. As plant population went from 20 plants per square meter up to 100 per square meter, yield also increased at all site years.

Uniform plant stand is also important, especially for low plant populations, this study found. (See Figure 1.) Overall, uniform planting produced 14 percent greater seed yield than non-uniform planting at low- to average-yielding sites when plant density was at or below 80 plants per square meter (roughly eight per square foot). At high yielding sites, uniform and non-uniform plantings resulted in similar seed yield — as long as plant density was greater than 60 plants per square meter.

Yantai Gan with Agriculture and Agri-Food Canada (AAFC) in Swift Current led a three-year study to determine the effect of various degrees of seeding uniformity and non-uniformity on canola plant establishment and seed yield in various soil-climatic zones. In 2010, experiments were conducted at five sites: Swift Current, SK, Melfort, SK, Carman, MB, Brandon, MB and Lacombe, AB. In 2011 and 2012, the sites were Swift Current, SK, Melfort, SK, Indian Head, SK, Carman, MB, Morden, MB and Lacombe, AB.

The experiment compared uniform and non-uniform plant establishment for plant stands of 100, 80, 60, 40 and 20 plants per square meter. Plant stands were hand-thinned at the three-leaf stage to create uniform and non-uniform plant stands.

SEED VIGOUR AND STRAW MANAGEMENT

Study 3.1.4 included a second experiment to evaluate the effect of seed vigour and straw management options on plant establishment and crop yield in canola. It compared four residue management options: (1) 20-30 cm standing stubble, (2) 40 cm tall stubble with a spring mow to less than 5 cm, (3) shorter than 10 cm stubble with straw chopped, and (4) shorter than 10 cm stubble with straw removed.

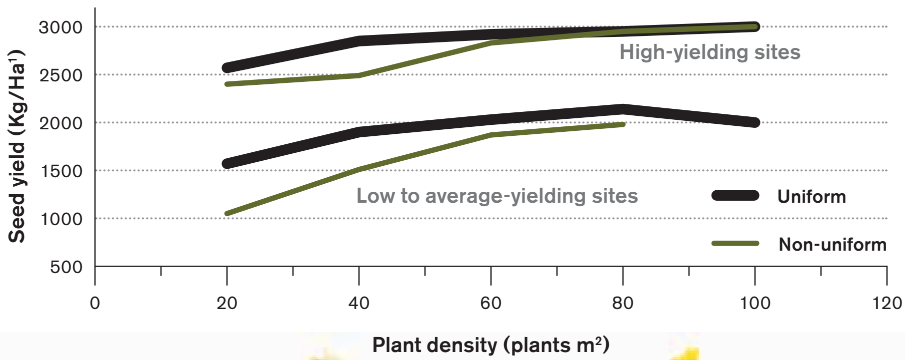
The effect of straw management options on canola establishment and seed yield was inconsistent across the different sites and years. However, some specific effects did show consistent results.

In particular, option (3) decreased soil temperature during seedling emergence, slowed the initiation of flowering, and delayed maturity of canola compared with other management methods, particularly in Swift Current and Carman.

As for weed management, taller stubble patterns reduced the number of broadleaf weeds, and option (4) had the lowest ability for inhibiting grassy weeds.

The second experiment also compared three seed vigour options: (1) 120 high-vigour seeds per square meter, (2) 120 low-vigour seeds per square meter, and (3) a blend of 80 high-vigour seeds and 40 low-vigour seeds per square meter. Generally, the results showed that high-vigour seed promoted the speed of seedling emergence, improved plant growth, and increased canola seed yield. However, seed vigour had an inconsistent effect on plant maturity. Nonetheless, use of high-vigour seed does not mean producers should reduce their seeding rate. ●

Figure 1. Uniform stands yield more, especially at lower plant densities.



High yields

Farm Gate Investigation of Best Management Practices in Canola Establishment and Production Systems

Principal investigator: Yantai Gan, Agriculture and Agri-Food Canada, Swift Current, SK
Collaborators: Chang Liu

The canola producers who are achieving the greatest canola yields are seeding shallow and directly into chemfallow (or crops with inherently short stubble). They are seeding at earlier dates and with narrower row spacing. They also avoid seeding canola into canola stubble.

Yantai Gan with Agriculture and Agri-Food Canada (AAFC) led a study to investigate the best management practices that more advanced and experienced canola producers from across the major canola production zones of Western Canada are using. A total of 68 canola farm fields were randomly selected and sampled across Alberta, Saskatchewan and Manitoba. The survey started in spring 2011 and collation of all needed data finished by October 2012. An AAFC research team made multiple trips to those individual farm fields to count seedling emergence, measure seeding depth and row spacing, sample relevant soil properties and collect various yield-related variables.

The study found a very large variation in terms of farming practices and approaches used in canola production across individual farm fields. Some of the cropping practices were adopted by the majority of the canola producers, whereas other practices were used only by a few individual farmers. This presented challenges for statistical analysis, and highlighted the need for more research into many of these areas.

Stubble type or preceding crop had a significant effect on canola yields for the 68 fields. Canola yields were highest on chemfallow. Cereal stubble was next, with barley, oats and wheat stubble producing similar canola yields. Legumes and corn followed. The three fields surveyed where canola was seeded into canola stubble produced the lowest yields among all fields surveyed, yielding only 54 percent of the average yield in fields where canola was seeded into cereal stubble.

No-till increased yield relative to fields where pre-seeding tillage was used, although the increase was marginal.

The survey showed no yield difference for canola that received pre-seed glyphosate versus canola that received no pre-seed herbicide treatment. About 40 percent of the producers grew their canola on cereal stubble, 17 percent on chemfallow, and the rest on other crop stubbles. Of the canola fields surveyed in the project, 30 percent of the fields used potassium (K) fertilizers in the canola production, and received an average of 25 percent seed yield increase compared with those canola fields without using potassium fertilizer.

Six of the 68 producers harvested their canola crops by straight combining. Their seed yield was significantly higher compared to canola harvested using the conventional swath-combine method (24 percent higher).

In his observations, Gan suggests that judging canola productivity based on seeding rates is not scientifically sound. Instead, the actual plant density — the number of plants that emerge — should be used in predicting canola crop yields. Producers should take note of typical survival in their regions, and adjust their seeding rate accordingly to achieve the target plant stand.

Results from the 68 fields also indicate that deeper seeding, wider row spacing, increased stubble height of previous crops, and delayed seeding after April 25 can all reduce canola seed yield. ●

Table 1. Mean canola yield response based on previous crop for 68 randomly selected fields.

Previous crop	No. of Samples	Seed yield (kg ha¹)	Std Err
Chem-fallow	12	2557	156
Barley	19	2283	171
Oat	6	2164	211
Wheat	21	2096	126
Others	3	1962	540
Grain legume	4	1725	268
Corn	3	1663	312
Canola	3	1177	312

Seed shallow

Factors Influencing Canola Emergence

Principal investigator: K. Neil Harker, Agriculture and Agri-Food Canada, Lacombe, AB

Collaborators: Robert Blackshaw, Eric Johnson, Guy Lafond, Bill May

Published: Harker, K. N., J. T. O'Donovan, R. E. Blackshaw, E. N. Johnson, G. P. Lafond, and W. E. May. 2012. "Seeding depth and seeding speed effects on no-till canola emergence, maturity, yield and seed quality," Can. J. Plant Sci. 92:795-802.

Canola growers who consistently seed at a shallow depth of one centimetre can reap significant benefits. These include improved emergence density, decreased days to emergence, increased canola ground cover, decreased days to flowering and maturity, and decreased green seed levels.

Neil Harker with Agriculture and Agri-Food Canada (AAFC) in Lacombe, AB led a three-year project to study factors affecting canola emergence and quality, including seed type, seeding speed and seeding depth. Canola seed is a substantial input cost and poor canola stand establishment is a continuing concern for canola growers. On average, only 50 percent of planted seeds emerge, even when seed has a germination analysis above 90 percent.

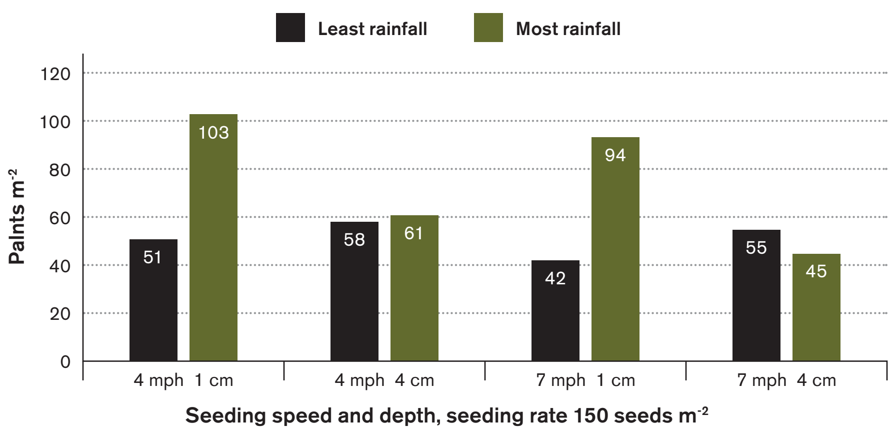
Direct-seeding experiments were conducted at four sites in Western Canada from 2008 to 2011: Lacombe, AB, Lethbridge, AB, Scott, SK, and Indian Head, SK. Data was collected for 10 of 12 possible site years. Flooding, hail and frost prevented data collection for two site years. Hybrid or open-pollinated glyphosate-resistant canola was seeded at speeds of four or seven miles per hour and at depths of one or four centimetres in replicated trials. Data collection included canola emergence density, flowering dates and durations, crop maturity, canola yield, oil and protein content, and percent green seed.

The researchers found that canola emergence density was greater for canola seeded at a depth of one centimetre compared to four centimetres. Soil moisture did influence results. Canola emergence averaged 35 percent for both seeding depths when precipitation levels were low. Differences between depths became significant with ample moisture. Emergence levels increased to an average of 66 percent when precipitation levels were high and when seeding depth was one centimetre.

Seeding at one centimetre versus four centimetres also decreased days to emergence, increased canola ground cover, decreased days to flowering and days to maturity, and tended to decrease green seed levels.

The higher stand densities that result from shallower seeding depth also create more competitive crop canopies, which can reduce the need for additional herbicide applications, reduce herbicide input costs and reduce selection pressure for herbicide resistance. Relatively high canola stand densities can also improve the ability of canola to successfully tolerate and accommodate biotic and abiotic stress.

Figure 1. The effect of seeding depth and seeding speed on hybrid canola (7145RR) emergence density (plants m^{-2}).



Means were estimated based on the PROC PLS analyses, which grouped sites according to environmental conditions; in this case the dominant factor was precipitation levels surrounding the time of seeding.

Neil Harker

The study also compared results for hybrid versus open-pollinated cultivars. There was no difference in emergence density between the two cultivars. However, the hybrid cultivar emerged one day earlier, grew faster, and covered the ground more quickly than the open-pollinated cultivar. These are important results from a crop-weed competition standpoint. Overall agronomic performance of hybrid canola, including seed yield and quality, was also usually superior to open-pollinated canola.

Seeding speed influenced canola variables to a much smaller degree than cultivar or seeding depth. ●

Table 1. The effect of seeding depth (1 vs. 4 cm) on canola variables (averaged across sites).

Variable	Unit	1 cm	4 cm	P value[z]
Days to emergence	d	16	18	<0.001
Canola emergence density	No. m^{-2}	67	56	0.002
Canola ground cover	%	43	36	0.002
Days to flowering	d	54	55	<0.001
Flowering duration	d	19	17	0.017
Days to maturity	d	112	113	<0.001
Seed protein	%	23.7	23.9	0.023
Green seed	%	2.0	2.3	0.086

[z]ANOVA P values. Seeding density was 150 seeds m^{-2}

Figure 2. Hybrid canola (71-45RR) seeded at 4 mph at depths of 1 cm (left) and 4 cm (right).

Photo credit: K. Neil Harker, Lacombe Research Centre, 2007.

Product and placement

Improving Nutrient Management in Canola and Canola-Based Cropping Systems

Principal investigator: Cynthia Grant, Agriculture and Agri-Food Canada, Brandon, MB
Funded collaborators: Sukhdev. S. Mahli, Brian Beres, Denis Pageau, Jean Lafond
Non-funded collaborators: Jeff Schoenau, Fran Walley, John Heard, Don Flaten, Tarlok S. Sahota, Brian Hellegards, Laryssa Grenkow

Canola stand density can be significantly reduced when seed-placed phosphate and sulphur fertilizers are used in combination, with sulphur being particularly damaging.

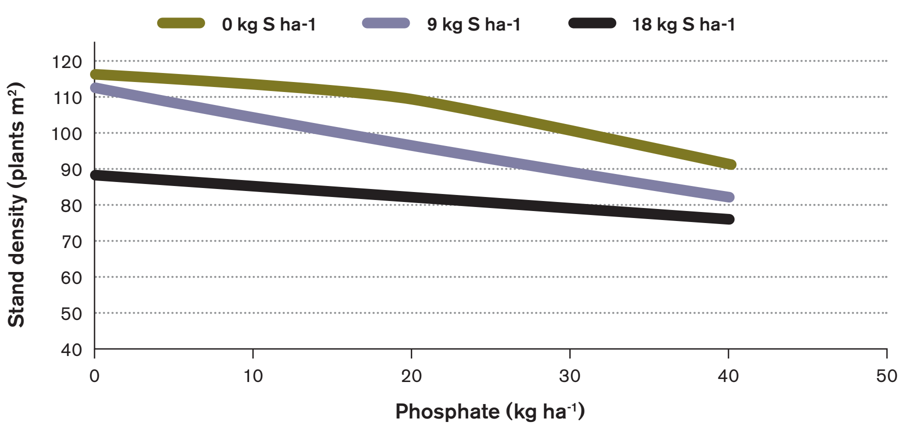
Cynthia Grant with Agriculture and Agri-Food Canada (AAFC) led this broad study, using field, growth chamber and laboratory trials in Alberta, Saskatchewan, Manitoba, Ontario and Quebec to evaluate improved practices for sulphur (S), phosphate (P) and nitrogen (N) management in canola.

The objectives were to determine:
(1) What are safe rates of P and S blends that can be seed-placed across a range of environments? (2) Do traditional and enhanced efficiency P and S fertilizers differ in their effect on seedling damage, nutrient use efficiency, crop yield, and canola quality when applied alone and in blends across a range of environments? (3) How does preceding crop (flax, wheat or canola) influence soil quality, microbial activity, canola yield, crop quality and rate of N and S fertilizers needed for optimum crop yield and quality? (4) How do various novel S fertilizer sources influence canola yield and quality for biodiesel production?

OBJECTIVES 1 AND 2 RESULTS

Study 1 looked at the first two objectives. Study 1a evaluated various combinations of seed-placed P and S fertilizer, using different forms and rates, to determine

Figure 1. Seed-placed sulphate and phosphate fertilizers can reduce canola stand density



Cynthia Grant

the effect on seedling damage, crop yield, and quality of hybrid canola.

About half the site years showed seedling toxicity with excess rates of monoammonium phosphate + ammonium sulphate (MAP + AS) or ammonium polyphosphate + ammonium thiosulphate (APP + ATS) in combination. Seed-placed P and S significantly reduced stand density at several of the sites, with the effect of S being particularly damaging.

Microessentials-15 (MES15) or the rapid release sulphur (RRS) product occasionally reduced seedling damage but did not generally increase final seed yield as compared to the traditional MAP+AS.

Seed yield increased with the application of P and S at two-thirds of the sites, with highest yield occurring when both nutrients were applied. Yield response to P and S varied considerably from site to site and was generally not strongly affected by the source of fertilizer. In contrast, where the yield response to S was strong, yield tended to be greater with the AS sources than with the other, possibly more slowly available forms.

Study 1b assessed seedling damage from combinations of seed-placed P and S fertilizer rates in a controlled environment. Treatments included 0, 10, 20, 30, 40 and 50 kg S/ha as ammonium sulfate (21-0-0-24) alone, and the same rates in combination with 15 and 30 kg P205/ha as monoammonium phosphate (12-51-0).

All napus cultivars could tolerate up to 30 kg S/ha, 66 kg P2O5/ha and 26 kg N/ha when applied together in the MES15 formulation.

Controlled environment studies using various Saskatchewan soil types showed no difference in biomass yield among the three S fertilizers on the Brown and Black soils. However, on Gray soils, which tend to be more S-deficient than the Brown or Black soils, biomass yield was highest for AS, followed by ATS and then NPS.

OBJECTIVE 3 RESULTS

Study 2 covered the third objective. Flax, canola and wheat were grown in the first year of a two-year cropping sequence. Researchers applied recommended rates of N, S and P for the location and crop, based on soil test values. The following year canola was grown after all three preceding crops, using a standard rate of 20 kg P2O5/ha as seed-placed MAP, with varying rates and sources of N and S fertilizer. The N source in year two was 75 percent ESN and 25 percent urea side-banded at seeding. The sulphur was side-banded as ammonium sulphate (21-0-0-24).

Canola yield tended to be the highest after wheat and the lowest after canola. Highest yields generally occurred when both N and S were applied at moderate to high levels.

Canola yields may be lower on canola stubble because the preceding canola crop removed more nutrients from the soil than the preceding wheat crop. Increasing fertilizer rates for canola on canola did seem to provide some help, although low canola yields following a canola crop were not solely due to enhanced N depletion. Increased disease pressure in canola following canola may also play a role.

On S-deficient sites, low S supply prevented the crop from responding efficiently to N applications. At one location, application of N in the absence of S led to no increase or a slight decrease in seed yield, indicating a severe S deficiency.

Including canola in the rotation did not seem to harm important soil parameters such as microbial biomass, glomalin production, or associated physical characteristics such as water stable aggregation.

OBJECTIVE 4 RESULTS

Study 3 covered the fourth objective. Replicated field trials were conducted at an S deficient site near Star City, SK. Treatments included rapid release micronized elemental S fertilizer and potassium sulphate fertilizer at different application timings and placements. Rates were 20 kg/ha for S and 150 kg/ha for N.

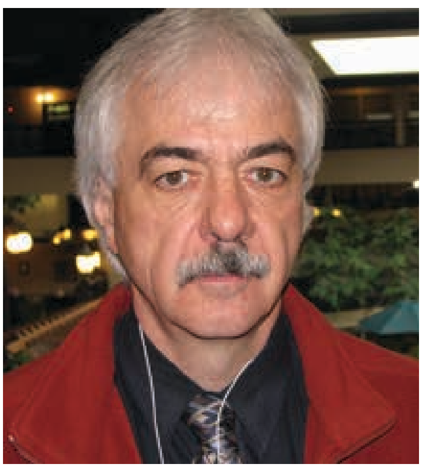
Canola seed yield increased considerably with all sulphate-S treatments compared to the zero-S control, although seed yield tended to be slightly lower in the sideband spring and autumn broadcast treatments than the other sulphate-S treatments. Compared to zero-S control, seed yield also increased significantly with all rapid release elemental S (RRES) treatments, but the increase was much greater with autumn applied RRES than with spring applied RRES. Autumn applied RRES produced only slightly lower and spring applied RRES produced much lower seed yield than the highest yielding spring applied sulphate-S broadcast pre-till or seedrow-placed S treatments. ●

GreenSeeker evaluation

Enhancing Nitrogen Management in Canola: Addressing Field Spatial and Temporal Variability with In-Crop Variable Rate Applications of Nitrogen Fertilizer

Principal investigator: Guy P. Lafond, Agriculture and Agri-Food Canada, Indian Head, SK
Collaborator: Byron Irvine

Guy Lafond finished two years of this three-year project before he passed away earlier this year. We include this report, though incomplete, to recognize his long-term dedication to agronomy research on the Prairies.



Guy Lafond

Producers are looking for ways to apply nitrogen fertilizer more efficiently based on variability within each field. Recent advances with optical sensors allow producers to uncover spatial (plant density) and temporal (plant staging) variability in real time, and then top dress nitrogen to address this variability.

Optical sensors measure the amount of light reflected off the crop, which is used to calculate Normalized Difference Vegetative Index (NDVI). A difference in NDVI implies differences in above-ground biomass or growth. Differences in plant growth also imply differences in nutrient uptake.

A commercial NDVI tool, GreenSeeker, is available to producers, and a canola yield potential algorithm specific to the Canadian Prairies has been developed and field tested (to a limited extent). Validation is needed on a plot- and field-scale over a wider geographical area to better understand its potential and limitations.

The objectives of the project were to answer the following questions: (1) Does using an optical sensor improve the ability to arrive at a more optimum rate of nitrogen (N) in canola as compared to the current methods of N rate determinations? (2) How does repeated use of optical sensors on the same area affect grain yield and N use in canola over time? (3) When scaling to a farm level, what lessons can be learned from producers using the technology? (4) Do the economic benefits warrant the extra cost for the technology and the extra application costs? (5) What are the agronomic and economic benefits of other variable-rate technologies?

Lafond led the study at three locations: Indian Head, SK, Brandon, MB, and Edmonton, AB. The site at Edmonton was lost in 2011, so only five site-years of data are available at this point. Early results support the hypothesis that nitrogen can be applied more efficiently when used in conjunction with an optical sensor and that savings in nitrogen are possible without sacrificing yield. However, Lafond had planned for a four-year study, using canola and wheat in rotation, to measure the cumulative effects of the various approaches to nitrogen management. ●

More nitrogen

Nitrogen dynamics

Principal investigator: Robert Blackshaw, Agriculture and Agri-Food Canada, Lethbridge, AB

Collaborators: Xiying Hao, Neil Harker, John O'Donovan, Eric Johnson, and Cecil Vera

Published: Blackshaw, R. E., X. Hao, R. N. Brandt, G.W. Clayton, K. N. Harker, J. T. O'Donovan, E. N. Johnson. and C. L. Vera. 2011. "Canola Response to ESN and Urea in a Four-Year No-Till Cropping System." Agronomy Journal. 103:92-99.

Li, C., X. Hao, R. E. Blackshaw, J. T. O'Donovan, K. N. Harker, and G. W. Clayton. 2012. "Nitrous oxide emissions in response to ESN and urea, herbicide management, and canola cultivar in a no-till cropping system." Soil and Tillage Research 118:97-106.

Both hybrid and open-pollinated canola responded positively to higher nitrogen fertilizer rates in about 50 percent of the cases. The study also looked at the relationship between nitrogen and weeds, finding that weed tissue nitrogen concentration was often lower with ESN than with urea, indicating that crop-weed competition for soil N might be reduced if ESN were utilized.

Robert Blackshaw with Agriculture and Agri-Food Canada (AAFC) led a multi-year study to determine the merits of polymer-coated urea (specifically Environmentally Smart Nitrogen (ESN) from Agrium) compared with standard urea on weed management and yield of hybrid and open-pollinated (OP) canola. Information from the study will be used to develop improved fertilization strategies for canola production on the semiarid Prairies.

The study started at three Alberta sites in 2005 – Lethbridge, Lacombe and Beaverlodge. Two Saskatchewan sites were added in 2006 – Scott and Melfort. Trials included two varieties of glufosinate-resistant canola (hybrid 5020 and OP LBD2393 LL) and two varieties of barley (hulled AC Lacombe and semi-dwarf hulled Vivar).

Fertilizer treatments consisted of urea or polymer-coated urea (ESN) at rates of 100 percent or 150 percent of recommended levels to reach target yields. In-crop herbicides were applied at 50 percent or 100 percent of recommended rates. Canola was grown in rotation with barley in a no-till system and both crops of the rotation were grown each year. Canola was seeded at 150 seeds/m^2 on nine-inch rows.

Data collected included: crop and weed emergence dates, crop and weed density, crop and weed nitrogen concentration at four and eight weeks after emergence, weed biomass shortly before harvest, crop maturity date, crop yield, and crop quality parameters such as oil and protein concentration.

NITROGEN RESULTS

Hybrid and open-pollinated canola responded positively to the 150 percent fertilizer rate versus the recommended 100 percent rate in about half of the cases. Overall yields were higher for hybrids most of the time.

ESN provided a canola yield increase over urea in 25 percent of the cases. Otherwise yields were the same for both treatments.

Canola seed oil concentration was unaffected by ESN versus urea.

Nitrous oxide emissions were measured at the three Alberta sites. Overall, nitrous oxide emissions averaged 20 percent less with ESN than with urea, indicating

continued on page 16

Robert Blackshaw

Table 1. Mean yield increase of hybrid compared with OP canola when significant ($P<0.05$) differences occurred (15 of 20 site-years).

	kg/ha	bu/ac
Lethbridge	260	5
Lacombe	670	12
Beaverlodge	430	7
Melfort	290	5
Scott	340	6
Mean	400	7

MORE NITROGEN
continued from page 15

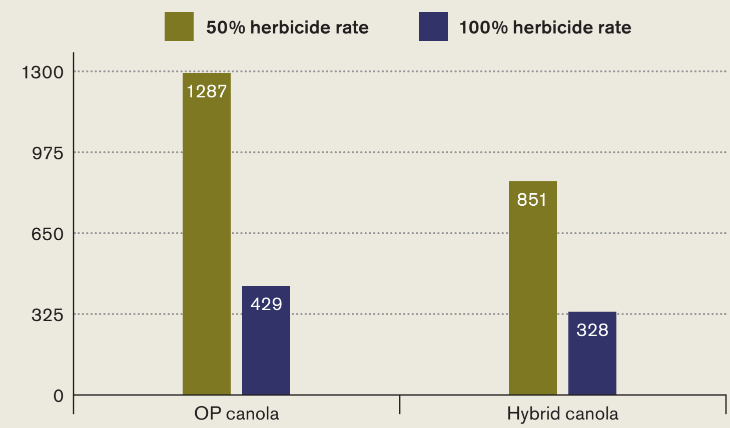
the merits of ESN use, especially in wet environments. However, cumulative nitrous oxide emissions over the three growing seasons were low (0.15 to 2.97 kg N/year) for all treatments and sites. This study confirms that nitrous oxide emissions are not a major concern on the Canadian Prairies. This attribute can be used as a marketing advantage when selling Prairie crops domestically and in the export market.

WEED MANAGEMENT RESULTS

Study results confirmed that hybrid canola cultivars are more competitive with weeds than open-pollinated (OP) canola. Weed tissue nitrogen concentration and weed biomass were often lower with hybrid canola.

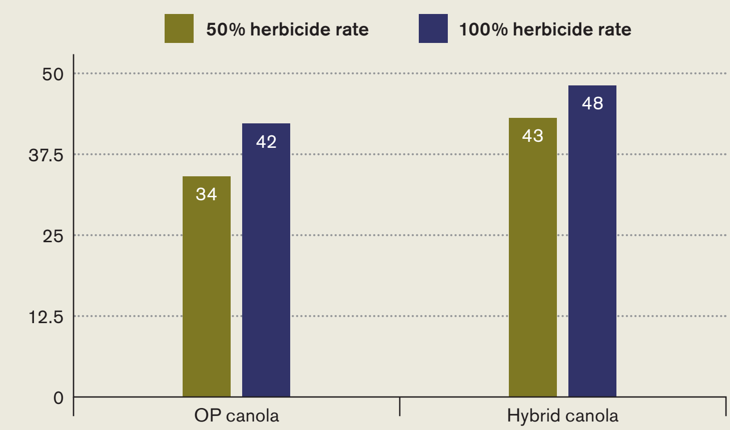
Weed tissue N concentration was often lower with ESN than with urea, indicating that crop-weed competition for soil nitrogen might be reduced if ESN were utilized. ●

Figure 1. Weed biomass (kg/ha) based on herbicide rate



Source: Bob Blackshaw, Agriculture and Agri-Food Canada, 2010.
Notes: Figures based on a mean of 18 site years. Here are the numbers with standard error of the mean in brackets: 1,287 (239); 429 (61); 851 (132); 328 (36).

Figure 2. Canola yield (bu./ac.) based on herbicide rate



Source: Bob Blackshaw, Agriculture and Agri-Food Canada, 2010.
Notes: Figures based on a mean of 18 site years. Here are the numbers with standard error of the mean in brackets: Yields for OP canola: 34 (1.6) and 42 (1.8). Yields for hybrid canola: 43 (2.0); 48 (1.8).

The enhanced efficiency phosphorus fertilizers evaluated in this study provided little economic benefit compared to traditional monoammonium phosphate (MAP) or ammonium polyphosphate (APP) fertilizers. The polymer coated controlled-release MAP (CRP) product may reduce the risk of seedling toxicity if it is necessary to exceed safe levels of seed-placed phosphorus (P) fertilizer to optimize crop yield.

Cynthia Grant with Agriculture and Agri-Food Canada (AAFC) led field studies from 2008 to 2010 to evaluate the effect of various enhanced efficiency P fertilizers on seedling toxicity, yield and quality of canola.

Field studies were conducted at two locations in Western Manitoba, one on a fine sandy loam (FSL) soil and the other on a clay loam (CL). Soil analysis was conducted to select sites low in P to increase the likelihood of seeing a P response. At each location, nitrogen (N) and sulphur (S) were applied before seeding to ensure an adequate nutrient supply for optimum yield, based on soil test results. Pre-plant banding was used to avoid any risk of seedling damage from the N. Plots were seeded using a Seed-Hawk type plot seeder equipped with narrow hoe openers. Seeding rate for the canola was 5 kg/ha.

Polymer coated P

Impact of Traditional and Enhanced Efficiency Phosphorus Fertilizers on Canola Emergence, Yield, Maturity and Quality

Principal investigator: Cynthia Grant, Agriculture and Agri-Food Canada, Brandon, MB
Collaborators: Jo-Anne Relf-Eckstein, Rong Zhou

The trial compared seven treatments: (1) control with no P application; (2) standard MAP; (3) CRP formulated for broad-acre agriculture; (4) Avail-treated MAP, with treatment to sequester antagonistic ions and reduce soil P reactions; (5) ammonium polyphosphate, a liquid product; (6) Avail-treated APP; and (7) Polyon, a polymer coated MAP product formulated for horticulture.

Each source was applied at four application rates (10, 20, 40 and 80 kg P2O5/ha) with a single control, for a total of 25 treatments per site. Each treatment was replicated four times per site.

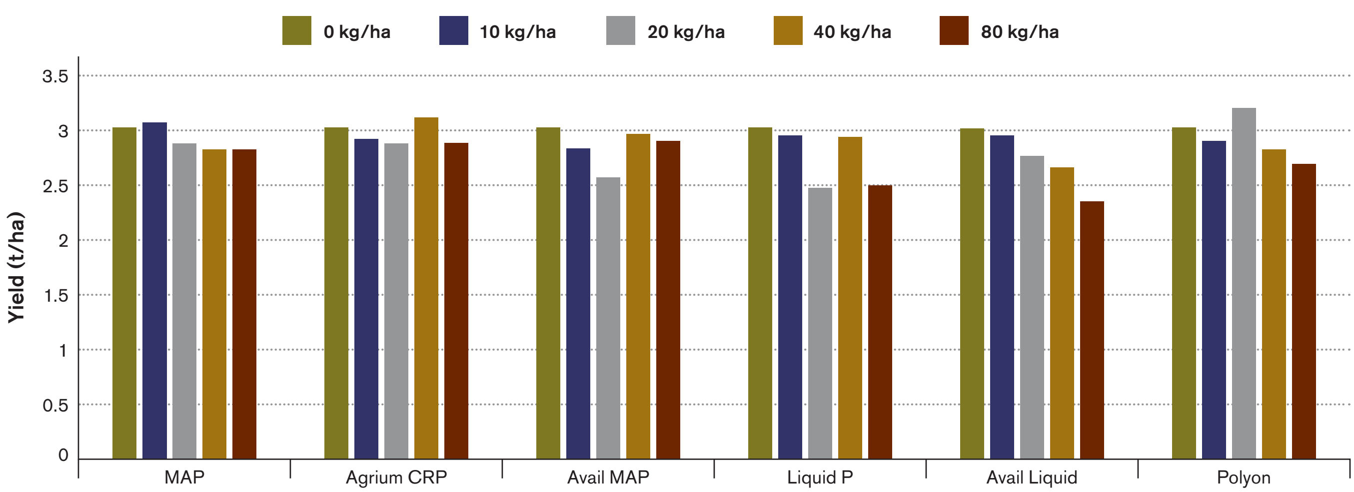
Canola yield generally increased with moderate rates of P application, but there was little difference among P sources in their effects on canola seed yield. Where seedling damage occurred, use of polymer coated MAP reduced the risk.

Seedling damage occurred with high rates of applied P unless soil conditions were very wet, with damage being particularly evident with liquid P. Damage occurred with P rates of 40 and 80 kg P2O5/ha. Yields tended to increase to between 20 and 40 kg P2O5/ha and then decline, reflecting the seedling damage at higher application rates.

The study found that canola could compensate for seedling damage if stands were not reduced below critical levels. Where stand density was low, seed yields declined and maturity was delayed due to seedling toxicity.

An additional part of this study compared yellow- and black-seeded canola cultivars, following the methodology described for the previous study. The yellow-seeded canola displayed extremely poor emergence and vigour. Yields were low in relation to the black-seeded cultivars, and assessing P responsiveness was difficult due to the poor crop performance. ●

Figure 1. Seed yield as affected by source and rate of phosphorous fertilizer at two locations in 2010.



Source: Grant, AAFC 2012

Sclerotinia petal test

Facilitating the Delivery of Practical Sclerotinia Stem Rot Risk Forecasts Based on Improved Assessment of Canola Petal Infestation

Principal investigator: T. K. Turkington, Agriculture and Agri-Food Canada, Lacombe, AB

Collaborators: Randy Kutcher, Bruce Gossen, Debra McLaren, Khalid Rashid, Stephen Strelkov, Derwyn Hammond, Faye Dokken-Bouchard, Vikram Bisht, Jim Broatch, AARD, Emile deMilliano

A new quantitative polymerase chain reaction (qPCR) test can quickly detect and quantify *S. sclerotiorum* DNA with a high level of sensitivity and specificity. This DNA test of canola petals could provide canola producers with an assessment of sclerotinia spore load without the three- to five-day waiting period required for the current petal test.

If proven to work, a qPCR risk assessment tool can assist canola producers in making informed spray decisions and reduce non-economic fungicide application.

Kelly Turkington with Agriculture and Agri-Food Canada (AAFC) led the three-year study to develop a rapid, qPCR-based method for detection of *Sclerotinia sclerotiorum* DNA in canola flowers. This can be related to actual disease levels across the Prairie canola growing region.

The study will determine the relationship between the quantity of *S. sclerotiorum* DNA on flower petals (estimated with qPCR) and final stem rot levels in commercial fields. The strength of the statistical relationship will determine whether qPCR estimates of petal infestation levels are a good indication of final disease incidence. Researchers also want to determine if this method can be deployed in private seed testing labs with qPCR capabilities for commercial use.

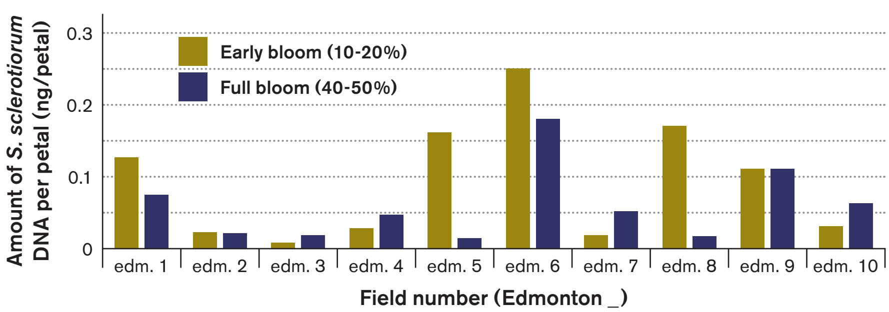
Early and late bloom samples were collected from fields in Saskatchewan, Manitoba and Alberta in 2010, 2011 and 2012, and from central Alberta in 2013. They are currently being assessed using qPCR. Final disease incidence and severity were recorded in the same fields and will be used to determine the relationship between qPCR results and stem rot disease incidence/severity. In approximately a third of the fields, the average percentage petal infestation with *S. sclerotiorum* was also assessed using an agar plate procedure. Typically 200 petals were plated per field and presence of *S. sclerotiorum* was assessed after three to five days. The agar plate test results will be used to statistically determine the correlation between qPCR results and the traditional method for estimating petal infestation levels.

Petal testing and final disease results will be compared with environmental data and results from weather-based forecasts to determine the potential for use in practical integrated stem rot forecasts.

The study shows that the developed qPCR assay is able to detect and quantify *S. sclerotiorum* DNA from field collected canola petals with a high level of sensitivity and specificity. An internal control has been included to control for false negatives.

Field petals collected are currently being analyzed to determine the relationship between qPCR results and final disease incidence, which will determine the potential for this assay to serve as a risk assessment tool. ●

Figure 1. Quantitave PCR estimations of petal infestation for canola fields around Edmonton, AB in 2013



This graph shows the S. sclerotiorum *DNA content on petal samples, as measured by qPCR, from various fields around Edmonton in 2013. These quantitative tests tell us that the amount of inoculum is not the same in every field, thus the disease risk is not the same in every field. Factors such as canopy density and weather conditions can have an important impact.*

Source: B. Ziesman, graduate student

Sclerotinia predictor

Controlled environment studies will be required to determine specifically how temperature and moisture affect several key stages in the lifecycle of the sclerotinia stem rot.

Weather-based Assessment of Sclerotinia Stem Rot Risk

Principle investigator: Paul Bullock, University of Manitoba, Winnipeg, MB

Weather conditions play a critical role in the timing of sclerotinia ascospore release. But the specific weather conditions that trigger this ascospore release are still unknown.

Paul Bullock with the University of Manitoba led a two-year study to assess the risk of sclerotinia stem rot disease on canola based on standard weather conditions and the canopy microclimate. He ran plot studies at two sites, Winnipeg, MB and Carman, MB, during the 2011 and 2012 growing seasons. At each site, he compared high, medium and low density canopy treatments using high, medium and low seeding and nitrogen fertilizer rates.

Standard weather data was monitored during the growing season including air temperature, relative humidity, wind speed, solar radiation and precipitation.

Bullock observed that ascospore levels jumped up at exactly the same time in both Carman and Winnipeg across the entire range of canopy density treatments at both locations. A broadly-based environmental factor is controlling the production of ascospores, but data from this study did not isolate the factors that lead to release of ascospores.

Nor did the study data show a correlation between average daily temperature or relative humidity values and daily ascospore levels. The study showed very similar canopy air temperatures in the high, medium and low density plots, but the low density plots displayed significantly lower relative humidity. However, that variation in canopy relative humidity alone was not sufficient to create differences in ascospore levels.

Increasing average wind speeds showed an increase in ascospore concentrations in most cases, but this effect was slight.

Field history is a factor in overall disease incidence, but does not affect timing of ascospore release.

Moisture is likely the key factor, but this study could not isolate this factor. Ascospore production was not increased where a misting system was used to maintain leaf wetness in comparison to non-misted canola. This may have been a result of the wet growing conditions when the misting system was in use.

We still have a lot to learn about the complexities of sclerotinia stem rot infection. Sclerotia must overwinter, and then form apothecia, which have their own temperature and moisture requirements for growth and development. Mature apothecia may have a different set of environmental requirements for when they burst and release the ascospores. If ascospores do land on the canola petals, specific canopy conditions are required for the petals to stick to the stems in order for the disease to develop. Both rainfall and wind may be involved in this step.

In order to understand the range of microclimatic and weather conditions required for infection to occur, controlled environment studies (instead of field studies) will be required to determine how temperature and moisture affect several key stages in the lifecycle of the disease. These can then be tested in the field. ●

Blackleg monitoring

Defining Populations of the *L. maculans* Pathogen in Test Sites Used for Canola Blackleg Resistance Trials

Principle investigators: Hossein Borhan and Derek Lydiate, Agriculture and Agri-Food Canada, Saskatoon, SK

Blackleg resistance seems to be losing its effectiveness for some varieties in some regions. That could be because the races of *L. maculans* (the pathogen that causes blackleg) present in a region or specific field are changing. One possible way to manage this is to rotate among canola varieties with different genetic resistance to specific *L. maculans* races.

In order to refine this recommendation, we need a way to monitor which races are present in an area, and which resistance in canola is most effective in that area.

As a step in this direction, Hossein Borhan and Derek Lydiate with Agriculture and Agri-Food Canada (AAFC) produced a set of single blackleg-resistance gene *B. napus* lines in a common susceptible background for the accurate pathotyping of *L. maculans* isolates as well as the in-field monitoring of *L. maculans* populations in Western Canada. These lines are for blackleg research and monitoring purposes only, and will not be for commercial production.

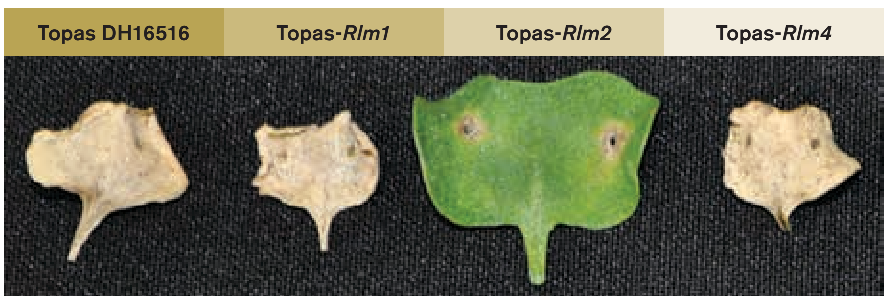
The seven lines are Topas-*Rlm1*, Topas-*Rlm2*, Topas-*Rlm3*, Topas-*Rlm4*, Topas-*LepR1*, Topas-*LepR2* and Topas-*LepR3*, named for the single blackleg resistance gene they each carry.

All seven lines and the susceptible parent line Topas DH16516 were included in all eight WCC Blackleg Co-op Trials for 2013.

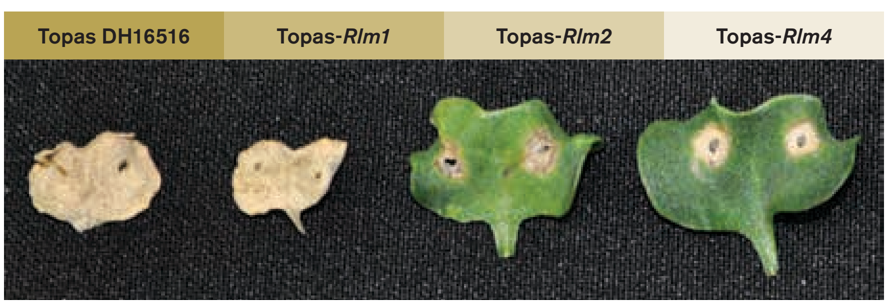
The final BC5S3 lines are expected to be 99.8 percent homozygous and contain less than two percent of the donor parents' alleles, thereby eliminating interference from other *R*-genes that may be present in other background material.

Having the individual *R*-genes isolated in a common background greatly reduces ambiguity in assessing phenotypic responses and will prove to be extremely valuable to the blackleg research community, both in Canada and worldwide. It will also provide valuable insight into the effects of different genomic backgrounds on the expression of *R*-gene phenotypes. ●

Figure 1. Resistance reactions of Topas Introgression Lines inoculated with different isolates (races) of *L. maculans*. These reactions allow researchers to determine which avirulence genes each *L. maculans* isolate possesses.



***L. maculans* isolate A (possessing avirulence genes avrLm1, AVRLm2, avrLm4)**



***L. maculans* isolate B (possessing avirulence genes avrLm1, AVRLm2, AVRLm4)**

Striped versus crucifer

Mitigation of Risk to Canola from Spring Flea Beetle Injury

Principal investigator: Julie Soroka, Agriculture and Agri-Food Canada, Saskatoon, SK

Collaborators: Bob Elliot, Lloyd Dosdall, John Gavloski, Owen Olfert, Chrystel Olivier, Jennifer Otani

Crucifer and striped flea beetles react differently to their environment. This is especially noticeable in their response to neonicotinoid seed treatment, with striped flea beetles less susceptible to control by the insecticides tested. This highlights how important it is for producers to monitor emerging canola seedlings for evidence of flea beetle damage.

This project investigated the differences in biology of two flea beetle species, *P. striolata* (striped) and *P. cruciferae* (crucifer), in order to better target management methods. The objectives were to quantify the risk of injury by flea beetles to Prairie canola production by: (1) determining the factors that affect distribution, spring emergence, flight, and feeding levels of the two species;, and (2) investigating reasons for seed treatment failures as well as alternatives to seed treatments for flea beetle control.

The study involved investigating flea beetles at four locations: Carman, MB, Saskatoon, SK, Edmonton, AB and Beaverlodge, AB.

OBJECTIVE 1 CONCLUSIONS

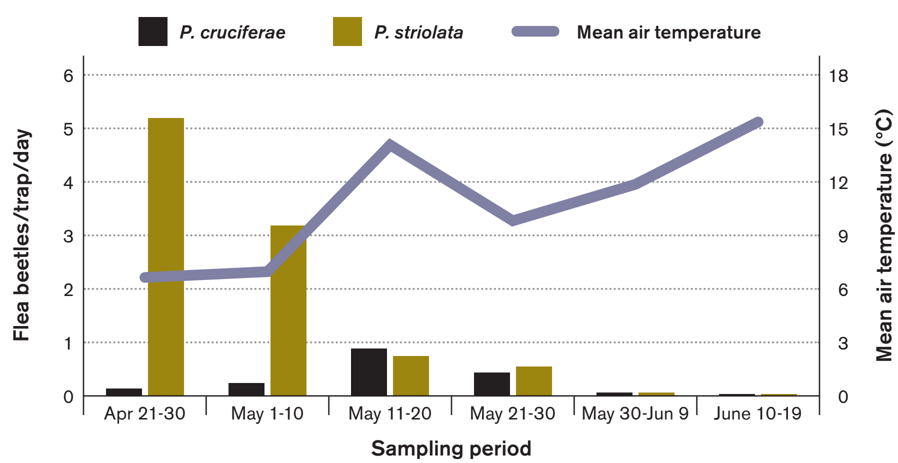
- Both striped and crucifer flea beetles are more likely to fly from field to field when temperatures exceed 15°C. Crucifer flea beetle flight height decreased with increases in mean relative humidity.
- Emergence timing was inconsistent in the studies. Striped flea beetles are active at temperatures lower than crucifer species, and typically emerge first in the spring. Crucifer flea beetles become active when temperatures are closer to 15°C, and are much more likely to emerge over an extended period in the spring.
- Crucifer flea beetle damage to cotyledons nearly doubled with each 5°C increase in temperature from 5°C to 25°C. With two crucifer beetles per seedling, feeding damage at 15°C was below the economic threshold (25 percent damage) after seven days. At 20°C, two flea beetles can exceed the damage threshold after five to six days. At 25°C, two can exceed the threshold after three to four days. Canola should be inspected daily when temperatures reach 20 to 25°C.
- Striped flea damage also increased as the temperature increased. The economic threshold with two striped flea beetles per seedling was reached after seven days at 20°C and after four to five days at 25°C.
- Juncea canola is more susceptible to striped flea beetle damage at higher temperatures than are OP and hybrid canola.

OBJECTIVE 2 CONCLUSIONS

Researchers used growth chamber experiments and field trials to determine the effects of temperature and soil moisture on the toxicity of neonicotinoid seed treatments to striped and crucifer flea beetles.

They found that neonicotinoid seed treatments provided substantially better control and protection against crucifer flea beetles than striped flea beetles. Therefore, seed treatment failures are more likely to occur when striped flea beetles are the most abundant species. Seed treatment failures are also more likely to occur when above-average rainfall causes saturated soil conditions during germination and seedling emergence, and when high temperatures occur during germination and seedling emergence (20 to 30°C). ●

Figure 1. Mean number of flea beetles captured in mustard oil traps at Saskatoon, averaged over 2010-2011, and daily mean air temperatures for each sampling interval.



Limit loss

Evaluation of Harvest Losses and Their Causes in Canola Across Western Canada

Principle investigator: Rob H. Gulden, University of Manitoba, Winnipeg, MB
Collaborators: Neil Harker, Linda Hall, Steve Shirtliffe, Chris Willenborg

Increased combine ground speed contributes significantly to harvest losses in canola, according to this study.

The study also found that higher yields — a sign of good management that starts at the time of planting — were associated with lower harvest losses.

On-farm harvest losses in canola are a complex phenomenon influenced by environment and management-specific factors. Several harvest-specific management variables suggest that, in some cases, harvest losses can be reduced by altering harvest practices.

Rob Gulden with the University of Manitoba surveyed harvest losses of canola on farms across Western Canada over three years, from 2010 to 2012. The survey was designed to determine whether harvest losses are similar across production areas of Western Canada, what factors strongly contribute to harvest losses, and if harvest losses in canola have changed over the past decade.

A total of 310 fields were surveyed in Alberta, Saskatchewan and Manitoba over the three years. Yield losses were determined using a vacuum cleaner method shortly after the crop was harvested.

For each field, producers were asked to prepare a survey questionnaire that addressed general agronomic information and specific harvest-related facts. This information was used to explain the harvest loss data.

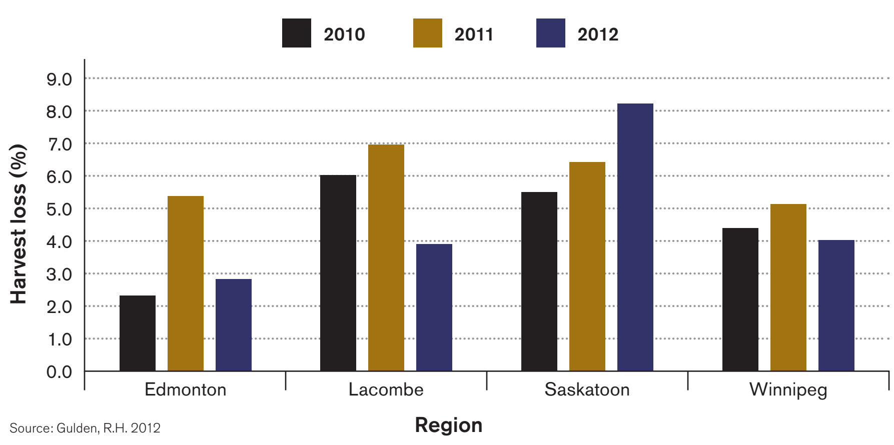
In general, canola harvest losses from 2010 to 2012 were similar, as a percentage, to losses reported 10 years ago (Gulden et al. 2003) when canola losses were about 5.9 percent. However, generally higher yields of modern cultivars have resulted in greater absolute total harvest losses. This represents lost revenue for producers, and adds more seed to the volunteer canola seedbank. Six percent of 40 bu./ac. is 2.5 bu./ac. That's 125 lb./ac., which is 25 times the typical seeding rate.

Some producers had very low losses while others had very high losses. Of the fields surveyed around Saskatoon, for example, the lowest loss was 3.8 percent and the highest was 11.2 percent. Of the producers surveyed around Lacombe, the lowest loss was 2.3 percent and the highest was 9.4 percent. These results suggest that management decisions at the producer level contribute to harvest losses in canola, and that some producers can consistently achieve lower harvest losses than others. Some reduction in proportional total harvest losses in canola is possible through improved management.

CONCLUSIONS

The survey included five Saskatchewan farms that both swathed and straight combined canola. No differences in harvest losses were observed in a side-by-side

Figure 1. Total canola harvest losses expressed as a percentage of yield among regions and years.



Source: Gulden, R.H. 2012

Rob H. Gulden

comparison between swath-harvested and direct-harvested canola on these farms. This is an encouraging result, however the number of producers who direct-harvested canola was low and a more thorough investigation is warranted if direct-harvesting becomes a more popular harvesting method.

While higher combine ground speed increased harvest losses, there was no evident difference between combine brands. Combine manufacturer and combine type (rotary or conventional) did not influence the total proportion of canola harvest losses.

Application of a fungicide at flowering did result in a reduction of proportional harvest losses of 1.4 percent, but absolute losses were not affected. This may suggest the fungicide played a role in increasing yield, or that fungicide applications were targeted only at fields with higher yield potential.

Choice of variety may play a role in canola harvest losses. Results from this survey suggest that this is not a dominant role and that other factors may be equally or more important in contributing to total harvest losses in canola.

No differences in proportional or absolute total harvest losses were attributable to the time of day of swathing. Similarly, time of day of combining, on its own, could not be identified as a significant factor contributing to total harvest losses.

Proportional harvest losses decreased with increasing canola yield. Management factors that contribute to high canola yield and earlier swathing dates, such as adequate canola plant density, resulted in proportionally lower harvest losses. ●

"Participating in the harvest loss survey made us more aware of how harvest timing affects canola losses. We left a few fields standing for straight combining this year because this survey showed us how swathing over-ripe canola can lead to increased losses. The survey also showed the importance of sclerotinia management. Our harvest losses were highest on fields with higher sclerotinia infection."

– Lee Oatway, canola producer, Rosser, Manitoba

To measure harvest losses, all soil and crop debris, including dropped seeds, are vacuumed. Seed is then separated from the sample, and weighed.

Measuring loss

Developing Methods to Estimate Pod Drop and Seed Shatter in Canola

Principle investigator: Rob H. Gulden, University of Manitoba, Winnipeg, MB

Canola has high potential for seed shatter, and seed losses at harvest can be substantial. Researchers are trying to find and test methods to improve genetics and machinery to reduce losses. However, they need more efficient tools to measure those losses. At this time, no proven time-efficient tools are available to estimate pod drop and pod shatter accurately and consistently. This project was designed to improve research tools.

The vacuum method (see the photo with the previous article) is the current standard for measuring pre- and post-harvest loss, but it takes a lot of time and tedious work to achieve accurate results. It literally means vacuuming up all fallen material on the soil surface, including pods and loose soil.

Digital force gauge tool in action in the field.

This study evaluated different methods — catch tray, pod retention resistance, visual rating using digital photography, and the standard vacuum method — to address the following questions:

- How do the visual rating and tray-based methods compare for determining pod-drop and seed-shatter?
- Can digital images be used to estimate pod-drop and seed-shatter?
- Can pod retention resistance be quantified quickly and reliably and is this measurement related to pod-drop in canola?
- Are there fundamental differences in pod-drop and seed-shatter between open-pollinated and hybrid canola varieties?

Field trials were conducted in 2011 and 2012 at Carman, MB and Kelburn Farm south of Winnipeg, MB to compare the methods. Field studies compared eight different canola varieties — four hybrid and four OP — at two different seeding densities.

The visual rating and catch tray methods improved time efficiency. However, the visual rating method only provided a good measure of seed-shatter, it did not measure pod drop. The catch tray method provided good estimates of both pod drop and seed shatter. Data generated from this method was comparable to the vacuum method.

Pod retention resistance was measured using a new force gauge method. The gauge measures the force required to tear the petiole of the pod from the rachis, the weakest point of attachment. This provided quantitative data on pod-drop potential for each variety. Refinement and validation across a more broad range of germplasm and different environments are required.

Digital image analysis used cameras to identify dropped canola pods and seeds. Identification of canola pods against a soil background was possible in the greenhouse experiment, but identifying them on a clean soil background was more challenging due to their size and colour. Analysis of images collected in the field was even more challenging. Current software does not have the capacity for shape and size recognition, and it was not possible to adapt the software for rapid pod or seed recognition from field images. Therefore, this method cannot provide rapid and efficient data generation at this time.

Trays used to determine pod-drop and seed-shatter in canola before harvest. In 2012, catch trays were modified by adding a top section to reduce possible predation and/or the effect of adverse weather conditions.

VARIETY DIFFERENCES

Generally, seed shatter and pod-drop losses were similar for hybrid versus OP varieties. There are differences among the varieties that were tested.

Pod-retention resistance was remarkably consistent for individual varieties over years and locations. The study found that pod retention is not affected by moisture content. ●

High-oil storage

Digvir S. Jayas

Storage and Handling Characteristics of New Varieties of High Oil Content Canola

Principal investigator: Digvir S. Jayas, University of Manitoba, Winnipeg, MB

Collaborators: Noel D.G. White

Research Assistants: Fuji Jian, Chelladurai Vellaichamy, Ke (Ray) Sun

Safe storage periods are similar for canola with low oil (less than 42.5 percent) and high oil content (about 45 percent). High oil content canola can be safely stored for at least 20 weeks, which was the total duration of this study, if temperature is below 25°C and moisture content is 10 percent or lower. Warmer canola has a shorter safe storage period: Canola at 10 percent moisture and 30°C can be safely stored for only six weeks.

Digvir Jayas at the University of Manitoba led the study to see if canola with higher oil content required different storage guidelines than canola with lower oil content. It included three different experiments: (1) small-scale storage; (2) large-scale storage; and (3) a physical properties study.

The small scale study compared high oil canola (NX4-105RR, 45H49, and 5440) and a standard canola variety (5525 CL) stored in 20L pails at eight, 10, 12, and 14 percent moisture content. Plastic pails were kept inside environmental chambers for up to five months. Samples were removed from the containers every two weeks and tested for germination, visible mould, and free fatty acid values (FAV). Free fatty acids increase as grain ages and deteriorates. FAV is an important index in evaluating the quality of grain.

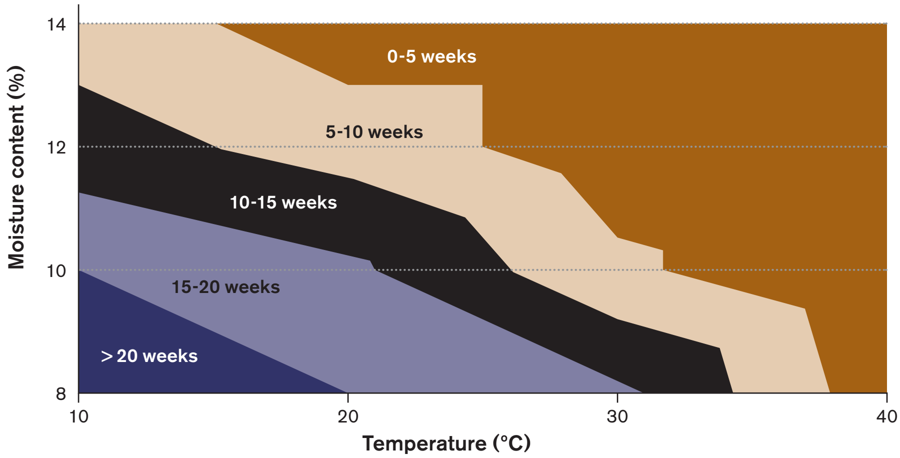
After 20 weeks, canola with eight, 10 and 12 percent moisture stored at 10°C and 20°C did not have significant quality changes, no matter the oil content. Canola with 14 percent moisture had a considerable germination drop after just 10 weeks at 20°C. At 30°C and 40°C, germination of both high oil and standard canola varieties dropped significantly in a short time. Mould was evident in some high oil content varieties with higher moisture content stored at higher temperatures.

For the large-bin study, Nex4 105 canola moisture was loaded into three flat bottom bins inside an environmentally-controlled room. At the beginning of the study, canola was aerated with humid air to bring the seed moisture content to 10 percent. A computer system controlled room temperature and humidity to simulate Western Canadian storage conditions from September to December 2010.

Germination for canola in the top layer of all three bins dropped more than 20 percent after 16 weeks. By six weeks, visible mould appeared at the top layers of the three bins, and after 10 weeks, one bin had visible mould at all layers. Mould causes canola to heat and spoil. It can multiply fast in either tough or damp seeds at warm temperature.

The physical properties study concluded that buildings strong enough for low oil canola could also support high oil canola. ●

Figure 1. Safe storage guidelines of high oil content canola.



Source: D.S. Jayas, University of Manitoba

Short-term bags

Feasibility of Bag Storage System for Canola Under Prairie Conditions

Principal investigator: Digvir S. Jayas, University of Manitoba, Winnipeg, MB

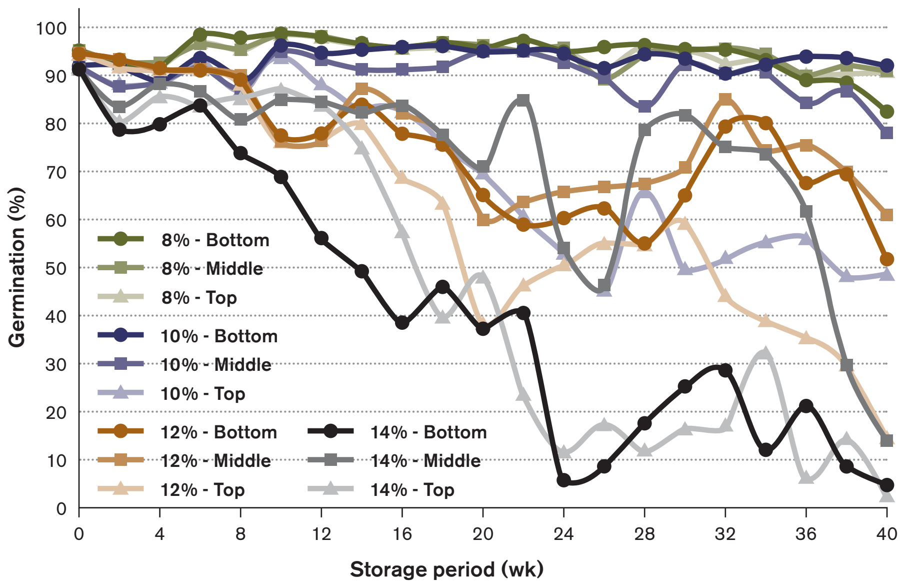
Collaborators: Noel D.G. White

Research Assistants: Chelladurai Vellaichamy, Fuji Jian

Published: "Feasibility of Storing Canola in Harvest Bags (Silo Bags) under Western Canadian Prairie Conditions: Preliminary Results". In the Proceedings of the CSBE/SCGAB 2011 Annual Conference, Winnipeg, MB, 10-13 July 2011.

"Harvest Bags for Grain Storage: An Overview and Review of Current Research". In the Proceedings of the 3rd International Conference on Food Technology, IICPT, Thanjavur, TN, India. 4-5 January 2013.

Figure 1. Germination of canola seeds at different layers of silobags (2010-11 and 2011-12)



Storing dry canola for a short duration is the best way to use harvest bags under Prairie conditions. Dry canola seeds can be stored for up to eight months and 12 percent moisture content canola can be stored for up to five months without any significant change in quality or grade using harvest bags during autumn and winter. Canola above 12 percent moisture should be stored for only three to four weeks in the harvest bags to avoid quality and quantity losses.

Digvir Jayas with the University of Manitoba led the study. For the first year, canola of eight, 10, and 14 percent moisture was loaded into the bags in October 2010 and unloaded approximately 10 months later. Samples were collected every two weeks. Seeds with eight and 10 percent moisture had not changed significantly in quality over the 10 months. Canola with 14 percent moisture had germination drop to below 50 percent and fatty acid value (FAV) double after 16 weeks.

For the 10 percent moisture seeds, germination for canola at the top of the bags dropped below 50 percent after 24 weeks. This is because of temperature and moisture migration inside the silo bags.

In September 2011, the second year, three 70-foot-long bags were loaded with 12 percent moisture canola. The bags were unloaded sequentially at five, seven and 11 months. Germination remained above 70 percent for up to five months of storage, and then declined to around 50 percent. Commercial grading at the elevators indicated no loss of grade after five months. But canola seeds lost one grade after seven months. After 11 months, which included the hot summer months, the canola was graded as "feed".

In October 2012, the third year, canola seeds with 12 percent moisture were loaded into three 70-foot bags. Two silo bags were damaged in a vandalism incident in November, leaving only one bag. Seed samples, CO_2 and temperature profiles of seeds were collected at four different locations along the length of the bag. Seed samples were collected every two weeks using a standard torpedo probe to check moisture content and quality. Temperature was measured every 30 minutes, and CO_2 samples were collected every two weeks.

Third year results showed higher moisture content at the top of the bag. Daily temperature fluctuations, temperature gradient, and convection inside the grain bag might have caused moisture migration or condensation at the top. CO_2 remained constant for most of the storage period, indicating air tightness of the bag. Increased CO_2 and reduced O_2 concentration after 28 weeks indicated some biological activity inside the bag in the summer storage period. ●

Wild oat options

Integrated Crop Management Systems for Wild Oat Control

Principal investigator: Neil Harker, Agriculture and Agri-Food Canada, Lacombe, AB

Collaborators: John O'Donovan, Kelly Turkington, Vern Baron, Robert Blackshaw, Eric Johnson, Denis Pageau, Linda Hall, Chris Willenborg, Steve Shirtliffe, Rob Gulden, John Kobler, Newton Lupwayi and Elwin Smith

Rotations that include fall-seeded crops, silage crops and perennials seem to provide effective wild oat control without the need for herbicides. These principles can be used in an integrated weed management program.

Neil Harker with Agriculture and Agri-Food Canada (AAFC) leads a five-year study at eight sites across Canada: Lacombe, AB, Lethbridge, AB, Edmonton, AB, Scott, SK, Saskatoon, SK, Winnipeg, MB, New Liskeard, ON and Normandin, QC. Experiments and data collection will continue through the 2014 growing season.

The objective is to determine if diverse rotation treatments combined with other cultural practices can reduce wild oat populations. The study will also see if diverse crop rotations influence the wild oat seed bank, soil microbes, and crop quality.

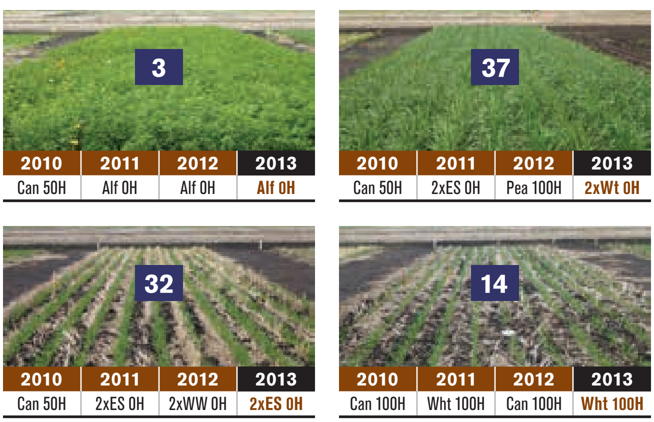
Natural wild oat populations were supplemented with seeded wild oats at each site to ensure adequate, uniform wild oat populations. Broadleaf weeds were treated with full herbicide rates.

Many of the crops were seeded at two times the normal seeding rate.

This no-till study shows that a rotation that includes fall-seeded crops such as winter wheat, perennial crops such as alfalfa, and annual crops with alternative harvest dates, such as silage barley, can provide significant wild oat management and reduce the need for herbicide applications. This can reduce the risk of building up a population of herbicide-resistant wild oats, and provide effective control options in fields where herbicide resistant wild oats already exist. ●

Figure 1. Selected individual plot photos at Lacombe in the Spring of 2013 (May 31).

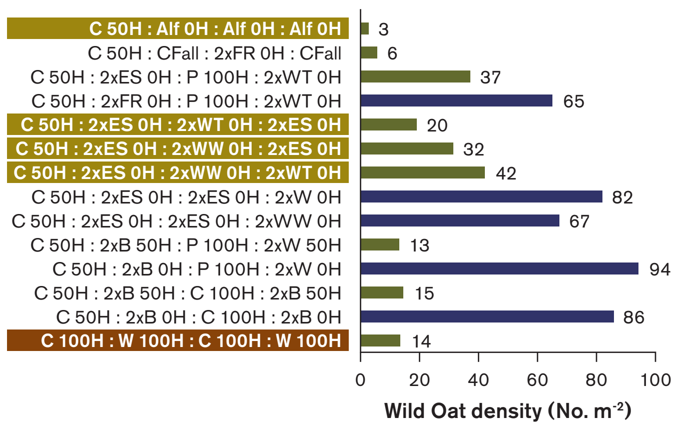
Can, Alf, ES, WT, WW, and Wht = Canola, Alfalfa, Early-Cut Barley Silage, Winter Triticale, Winter Wheat, and Wheat, respectively.



Note the canopy cover for perennial and winter annual (top) versus barley or spring wheat (bottom) crops at the time when wild oat is emerging. The former effectively preclude adequate light and other resource acquisition by emerging wild oat seedlings. Seeding rate is either recommended or double (2x). Herbicide rates are 0, 50 or 100% (H). The large numbers indicate spring wild oat emergence density averaged across four replications for the specific treatment.

Figure 2. Wild oat emergence density at Lacombe in the Spring of 2013 (June 7).

C, Alf, CFall, FR, ES, P, WT, WW, and Wht = Canola, Alfalfa, Chem Fallow, Fall Rye, Early-Cut Barley Silage, Pea, Winter Triticale, Winter Wheat, and Wheat, respectively.



Seeding rate is either recommended or double (2x). Herbicide rates are 0, 50 or 100% (H). Blue bars are significantly greater than the bottom treatment ($P < 0.05$). Treatments with the yellow box are those that received no wild oat herbicides for the last 3 years and yet have similar wild oat density as the 100% herbicide regime in the canola-wheat rotation (red box).

Attack on diamondback moth

Improved Integrated Crop Management with Beneficial Insects

Principal investigator: Lloyd Dosdall, University of Alberta, Edmonton, AB

Co-principal investigator: Owen Olfert, Agriculture and Agri-Food Canada, Saskatoon, SK, Julie Soroka, AAFC, Saskatoon, SK, Neil Harker, AAFC, Lacombe, AB

Collaborators: Mohammed Bahar, Diana Bekkaoui, Jim Broatch, Cathy Coutu, Dwayne Hegedus, Sadia Munir, Patty Reid

***Diadegma insulare**, shown here along with one diamonback moth larvae, are known to sometimes completely terminate diamondback moth outbreaks in Western Canada.*

Producers are encouraged to carefully monitor pest and natural enemy populations to make sure insecticide applications are necessary. That's because, as this study shows, parasitism of diamondback moth larvae and pupae can be relatively high early in the season.

Lloyd Dosdall, entomologist with the University of Alberta, focused this 2010, 2011 and 2012 study on the parasitoids that help keep diamondback moth populations regulated. Parasitoids of diamondback moth are poorly studied in canola, even though the parasitoid *Diadegma insulare* is known to sometimes completely terminate diamondback moth outbreaks in Western Canada. Two other parasitoid species – *Microplitis plutellae* and *Diadromus subtilicornis* – also attack diamondback moth and sometimes inflict high levels of parasitism. The aim of this project was to develop forecasting strategies to predict abundance levels and distributions for these three parasitoids.

Surveys in Alberta and Saskatchewan determined the parasitoid fauna of diamondback moth in canola, and assessed the levels of parasitism in different sites and ecoregions. Laboratory colonies of diamondback moth and its dominant parasitoid, *D. insulare*, were established and analysed at the University of Alberta and Agriculture and Agri-Food Canada (AAFC) Research Centre in Saskatoon. Further research at the University of Alberta studied the effect of plant stress on diamondback moth and parasitoid development and fitness.

Field surveys provided some important finds. The first was the discovery of an unknown species of braconid, believed to be *Cotesia vestalis*. This species appears responsible for a very substantial level of the total parasitism of diamondback moth. Another species, *Mesochorus bilineatus*, was identified as a primary parasitoid of diamondback moth. *Conura sp.* was also responsible for a low level of parasitism in central Alberta in 2011.

Parasitoids attack diamondback moth at two life stages: *D. insulare*, *M. plutellae* and *Cotesia sp.* attack larvae, and *D. subtilicornis* attack pupae. As well, two ichneumonid species *Itoplectes quadricingulata* (Provencher) and *I. conquisitor* (Say) – typically pupal parasitoids of leafrollers and other Lepidoptera – emerged from diamondback moth pupae collected in Saskatchewan, a new host record for these parasitoids.

The most efficient approach to monitoring canola for diamondback moth and its parasitoid fauna is to take sweep net samples in production fields. Because populations of moths and parasitoids are not uniformly distributed, several locations within each field should be sampled. No thresholds have been established.

Lab analysis found that diamondback moths were attracted to the sulphur content in canola leaf tissue. For this reason, canola producers should apply recommended levels of sulphur based on soil sample recommendations, and avoid applications that exceed recommended levels, as diamondback moth are attracted to sulphur in plant leaf tissue.

Moisture stress is another factor. When water stress occurs, control of diamondback moth by natural enemies may not be as efficient compared to conditions with sufficient soil moisture levels.

Canola plant density was not linked to distributions of either diamondback moth or its parasitoids. ●

Quick recovery

Input Study and Recovery

Principal investigator: Neil Harker, Agriculture and Agri-Food Canada, Lacombe, AB

Collaborators: John O'Donovan, Kelly Turkington, Robert Blackshaw, Newton Lupwayi, Eric Johnson, Randy Kutcher, Yantai Gan, and Byron Irvine

Published: Harker, Neil K., John T. O'Donovan, T. Kelly Turkington, Robert E. Blackshaw, Eric N. Johnson, Stewart Brandt, H. Randy Kutcher, and George W. Clayton. (2013). "Weed Interference Impacts and Yield Recovery after Four Years of Variable Crop Inputs in No-Till Barley and Canola." Weed Technology 27:281-290.

doi: http://dx.doi.org/10.1614/WT-D-12-00115.1

Four years of annual crop production with no herbicide use can drive canola productivity toward zero. However, the good news for producers buying abused land is that canola productivity can recover in one year with adequate weed control.

Neil Harker with Agriculture and Agri-Food Canada (AAFC) led a four-year initial input study at five locations in Alberta and Saskatchewan, followed by a two-year recovery study, to determine how quickly canola and barley yields can recover from heavy weed interference.

In the initial input study (2005-08), main plots were split between canola and barley. Subplots were given various input treatments, including standard and low input packages and selected combinations – including a treatment with no herbicide and full fertilizer over a four-year period. All input strategies were imposed on each plot for a period of four years to evaluate cumulative effects in a canola-barley or barley-canola rotation.

After four years without herbicides, weed biomass levels exceeded 2,000 kg/ha in barley and 4,000 kg/ha in canola plots (see Figure 1). Barley was more competitive than canola, with generally lower weed biomass levels in all situations where herbicide was reduced or excluded. Weed biomass levels tended to be highest in plots that received fertilizer in the absence of herbicides, possibly due to better utilization of nutrients by the weeds compared to the crops.

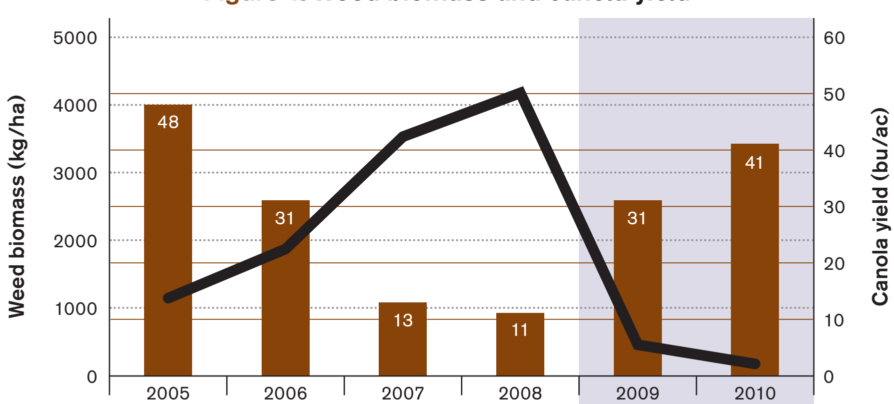
After four years of the initial input study, all plots received standard inputs for two years (2009-10) in the recovery study.

After standard optimal inputs were restored, barley and canola plots at most sites recovered to optimal yield levels after one year (see Figure 1). The yield recovery occurred despite high weed biomass levels in 2008 and high wild oat seedbank levels (> 6,000 wild oat seeds/m^2), which persisted at the end of the study (2010).

The study shows that herbicide application can optimize yields in weedy fields despite relatively high weed seedbank levels. Therefore, it is probably more important to optimize yield by managing weeds early in the growing season than to repeat herbicide applications later in the season that may reduce weed seedbank levels and recruitment in the following year. Repeat herbicide applications will definitely increase selection pressure for weed resistance to herbicides.

Overall, the negative effects of high soil weed seedbanks can be mitigated if growers use appropriate seed and fertilizer rates to achieve healthy crop canopies, and use judicious herbicide applications to adequately manage weeds. ●

Figure 1. Weed biomass and canola yield



Cumulative weed biomass (line) and canola yield (bars) effects in plots that repeatedly received all inputs but herbicides from 2005 to 2008 (means of five sites). Shading shows weed biomass and yield after standard inputs were restored for one (2009) and two years (2010). Canola was grown in a canola-barley rotation.

Legume benefits

Legume Crops to Improve Soil Fertility for Enhanced Canola Production

Principal investigator: John O'Donovan, Agriculture and Agri-Food Canada, Lacombe, AB

Co-principals: Robert Blackshaw, AAFC, Lethbridge, AB, and Cynthia Grant, AAFC, Brandon, MB

Collaborators: Michael Edney, Eric Johnson, Yantai Gan, Neil Harker, Guy Lafond, Newton Lupwayi, William May, Elwin Smith and Kelly Turkington

Growing legume crops in rotation with canola and barley can provide a viable alternative to inorganic nitrogen. Legumes can provide a nitrogen benefit to the following crop, but a consistent, measurable benefit does not extend to crops grown two and three years afterward.

John O'Donovan with Agriculture and Agri-Food Canada (AAFC) led this study to see whether legume crops (fababean, pea and lentil, specifically) in the rotation can provide a practical alternative to inorganic nitrogen (N) fertilizer. Legumes, with their ability to fix nitrogen, have the potential to reduce the requirement for inorganic N in subsequent crops. The objectives of this study were to investigate the effects of growing canola on various legume crop residues compared to growing canola on wheat or canola residues, and to find out if growing a legume crop to supplement the nitrogen requirements of canola is economical and could reduce the amount of inorganic nitrogen required to optimize yield.

Experiments were established in 2009 at seven locations: Beaverlodge, AB, Lacombe, AB, Lethbridge, AB, Scott, SK, Indian Head, SK, Swift Current, SK, and Brandon, MB. In the first year, main plots were seeded to all stubble options, including peas, lentils, fababeans, wheat and canola harvested for seed, and fababeans as green manure. In 2009, legumes received no fertilizer nitrogen (N) while canola and wheat were fertilized according to the soil test recommendation.

The original stubble crops, including the legumes, were planted in 2009 only, and the effects on barley and canola yield were measured for the following three years. In 2010, hybrid canola was seeded into all stubbles, and N was applied at 0, 30, 60, 90 and 120 kg/ha. Each specific N rate was maintained on the same plots again in 2011 and 2012. All crops were direct seeded using zero tillage seeders with knife openers. In 2011, malting barley was seeded into the canola stubble. In 2012, the trial rotated back to canola.

CANOLA 2010 RESULTS

Significant increases in canola yield occurred on pea and lentil residue at Beaverlodge, Indian Head, Swift Current and Brandon, but the increases were generally not as high as when canola was grown on fababean green manure.

John O'Donovan

Canola yield increases, averaged over all N rates, ranged from 158 to 320 kg/ha with pea residue and 173 to 606 kg/ha with lentil residue as compared to canola grown in wheat residue.

Growing canola on canola residue resulted in significant canola yield reductions at Beaverlodge, Lethbridge and Brandon.

At most locations, the percentage of canola oil decreased and protein concentration increased as the applied N rate increased.

BARLEY 2011 RESULTS

Barley produced higher yield on legume stubble than on wheat stubble at most locations. Fababean green manure residue tended to be the most consistent and effective in enhancing barley yield, but beneficial effects of pea and lentil residue also carried over to 2011. Pea residue increased yield at Beaverlodge, Lethbridge and Brandon, while lentil residue increased yield at Beaverlodge, Lacombe, Indian Head and Brandon.

In most cases, there was a general increase in yield with increasing N rate. However, the significant interaction between residue and N rate at Beaverlodge and Lacombe suggests that the N rate required to optimize yield varied with crop residue at these locations.

Optimum barley yields tended to occur with N rates of 60 kg/ha at Scott and Lethbridge, 90 kg/ ha at Indian Head and Swift Current, and 120 kg/ha at Brandon.

CANOLA 2012 RESULTS

The effects of the crop residues established in 2009 had highly variable, unexplainable, and somewhat unexpected effects on canola yield in 2012.

Improved canola yield due to the fababean green manure residue was evident only at Lacombe and Lethbridge, while improved yield due to pea and lentil residue occurred only at Lethbridge.

Unexpectedly, there were several instances of canola yield decreases where legume crops were grown in 2009 compared to where wheat residues were grown. This occurred with pea residue at Beaverlodge, Lacombe, Indian Head and Brandon, with lentil residue at Brandon, and with fababean green manure residue at Swift Current and Brandon. At Brandon, all residues (with the exception of fababean grown for seed) resulted in reduced canola yield relative to wheat residue. These results are difficult to explain. There was no evidence of increased disease incidence with the legume residues.

OTHER OBSERVATIONS

Both N and non-N effects are expected from crop rotations. These include disease effects, effects on microbial community, residue volumes, physical effects of fibrous versus taproots, and different rooting depths.

In the 2010 canola crop, there were no differences in soil microbial biomass, diversity or enzyme activity between treatments at Lethbridge. At Beaverlodge, microbial biomass was highest where canola was grown after field pea, and lowest where canola followed lentil. At Lacombe, there were no differences between treatments.

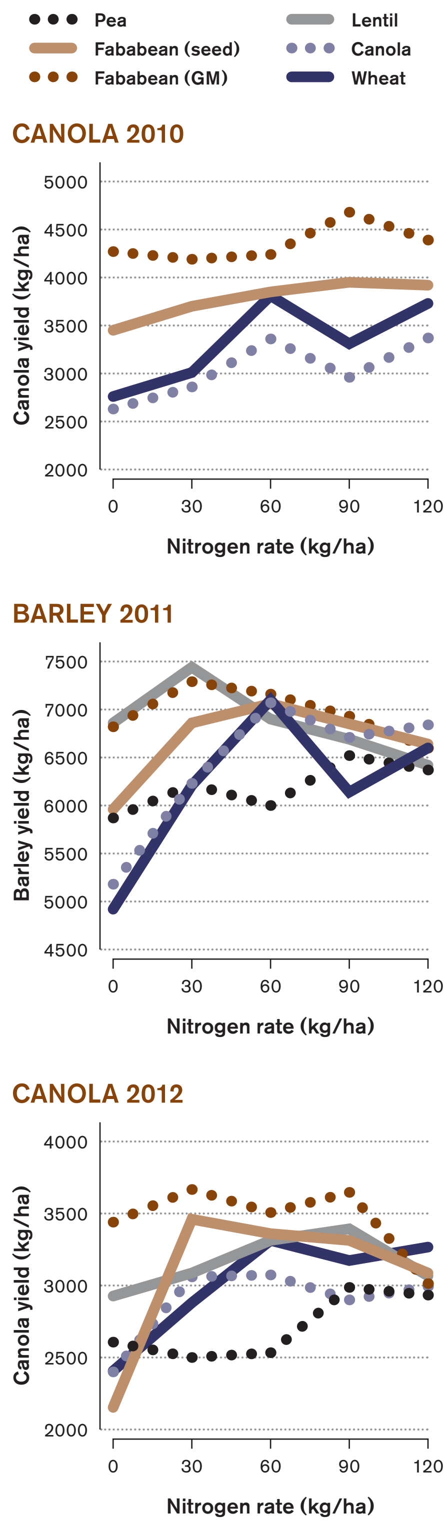
Crop residues had few significant effects on gravimetric soil moisture.

In the fall of 2009, total soil nitrate-N in the upper 60 cm was highest after fababean green manure in half of the sites, but it was not consistently higher after legume crops than after canola or wheat. However, when averaged across locations, fall nitrate levels were highest after fababean green manure and lowest after wheat. Effects of preceding crop on nitrate-N persisted through the following season of canola production to the fall of 2010. By 2011, after the production of a second crop, barley, significant effects of the crop grown in the first year of the study only occurred at Beaverlodge, where the fababean green manure still had higher soil nitrate levels than the other crops. ●

Significant increases in canola yield occurred on pea (shown here) and lentil residue at Beaverlodge, Indian Head, Swift Current and Brandon.

Figures 1-3. Canola (2010, 2012) and barley (2011) yield at Lacombe

as affected by nitrogen rate and various crop residues established in 2009.



Source: O'Donovan, AAFC 2013

A ground attack

Determining Arthropod Biodiversity in Canola Cropping Systems as a Key to Enhancing Sustainability of Production

Principal investigator: Lloyd Dosdall, University of Alberta, Edmonton, AB
Research Team: Jim Broatch, Hector Carcamo, J. Spence

We have reasonable knowledge of the insect pests found in canola, but substantial gaps exist in our understanding of other potentially beneficial insects, predators, parasitoids and soil macroinvertebrates at work in our fields.

This study provides a starting point, developing a new database of insect biodiversity in canola fields in Alberta. Interestingly, but perhaps not surprisingly, weeds in a field increased insect biodiversity. For this reason, sequential herbicide applications to control late-emerging weeds should be avoided so that small weedy backgrounds in canola are maintained. The negative effect of these weeds on crop yield may be minimal, and the study indicates that small weedy backgrounds have the potential to enhance arthropod biodiversity, especially of predatory ground beetles.

The study objectives were to determine: (1) species of arthropods previously known to exist in canola agro-ecosystems; (2) species of arthropods found in various regional insect collections but not previously documented in canola; (3) gaps in our knowledge of the taxonomy and biology of arthropods in canola; and (4) how arthropod species respond to variations in vegetation diversity. Arthropods include insects, spiders and mites.

The study found that in canola, significant gaps exist in knowledge and understanding of the fauna of insect predators and parasitoids, crop pollinators, and arthropods that are important in soil decomposition and nutrient recycling.

Dominant predators in canola cropping systems include ground beetles, rove beetles, and spiders. The study found that high mortality occurred to a lepidopteran pest insect (diamondback moth larvae) from predators in the crop, principally ground beetles and spiders. Daddy-long-legs (related to spiders) were found to climb onto canola foliage to attack diamondback moth larvae. Several ground predators also fed on diamondback moth larvae when they fell to the ground after heavy showers.

Ground beetle populations are particularly influenced by plant diversity. A positive association occurred between weed density and ground beetle density: greater numbers of beetle species and individuals occurred when weeds were abundant in the crop than when weed density was low.

The potential economic benefit of ground beetles, rove beetles and spiders to canola could be determined with further study. ●

"The vast majority of insects in our canola fields are beneficials, and when we spray, the beneficials seem to be the last to bounce back. So we do everything we can to not spray. For lygus for example, we always wait until numbers are at least double the thresholds before considering a spray. I'm willing to lose a few bushels per acre from an outbreak in order to help maintain the beneficial population, which I believe will reduce my insect management costs in the long term."

– Josh Fankhauser, canola producer, Claresholm, Alberta

P. lucublandus *is a common ground beetle in cultivated fields in the Prairies. Ground beetles are known to eat diamondback moth larvae.*

C. sericeus*, another ground beetle, is not as common as* ***P. lucublandus****, but colourful.*

Carabus serratus *beetles are found in canola.*

Carabus meander *is relatively common in some sites in Western Canada.*

Here is what a beetle larva looks like. This is a second instar of ***Carabus nemoralis****.*

Wolf spider devours a green grass bug, which is in the same family as lygus bug.

Spiders will eat lygus bugs, as shown here in a composite flower.

Banchus parasitic wasps lay eggs in bertha armyworm larvae, and larvae from these eggs will kill the bertha armyworm.

This lacewing larva feeds on an aphid.

Input ROI

Economic Profitability and Sustainability of Canola Production Systems in Western Canada

Principle investigator: Elwin Smith, Agriculture and Agri-Food Canada, Lethbridge, AB

Collaborators: Robert Blackshaw, Stu Brandt, Neil Harker, Eric Johnson, John O'Donovan

Published: "Smith EG, Brandt S, Kutcher HR, Malhi SS, Johnston AM. 2013. Economic evaluation of canola and pea interval in rotations. Canadian Journal of Plant Science 93(5): 933-940."

Weed control is essential to canola profitability. Without weed control, all other major inputs will not pay off. Higher seeding rates of canola, higher fertilizer rates or better genetics cannot overcome the weed competition.

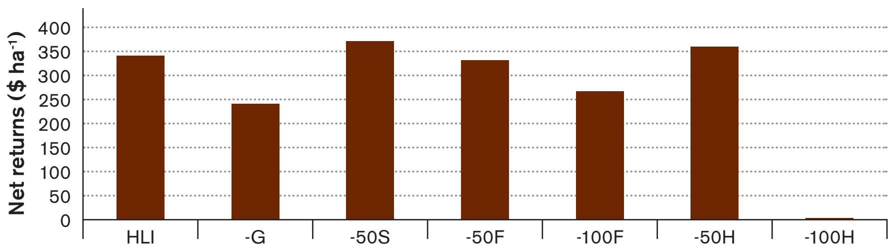
This study was a two-part economic analysis of data from recently completed field studies, the Canola Grower Survey of canola growers (study 7.9), and secondary sources for prices, input costs and other financial data. This project did not have any field experiments.

INPUT STUDY

The first part, the input study, evaluated different rates of input use – specifically, seed type, seeding rate, fertilizer, and herbicide – used in canola production. Differing rates for inputs were examined in isolation (i.e. changes in single inputs) as well as in combination (i.e. examining multiple inputs simultaneously). Key findings were:

- In a barley-canola rotation, the primary input that influenced yield was weed control. Without weed control, the addition of genetics, a higher seeding rate and nitrogen fertilizer had no impact on net return.
- The most expensive input to eliminate was herbicides, but in this study, using a 50 percent herbicide rate had a similar net return to using the full herbicide rate. The herbicide savings when reducing rates were about equal to the loss in yield from any additional weed competition.

Figure 1. No weed control, no profit.



Net returns for canola starting from the highest input level and subtracting inputs.
HLI*=highest level of inputs*
G*=reduced genetics (conventional non-hybrid cultivar for canola)*
50S*=reduced seeding rate by 50 percent*
F*=nitrogen fertilizer reduced by 50 percent and 100 percent from recommended rate*
H*=herbicide reduced by 50 percent and 100 percent from recommended rate*

- Reducing the seeding rate and 50 percent of the nitrogen application did not reduce the net return. Lowering the genetics, especially going away from hybrid canola, reduced the net return.
- Nitrogen fertilizer increased net return in a weed-free environment, but a high rate of nitrogen was not necessarily profitable.
- A higher than recommended seeding rate to increase plant density reduced net return.

ROTATION STUDY

The second part, the rotation study, examined the economic costs and benefits of shortening the interval between canola in crop rotations. This was only relevant for areas free of clubroot.

When seeding canola cultivars that are susceptible to blackleg, a longer duration between canola (four-year rotation) was more profitable. When growing hybrid canola with blackleg resistance, there was an economic incentive to shorten the rotation and include field pea in a three-year rotation of pea-canola-wheat. When growing canola hybrids with blackleg resistance, two-year canola rotations were as profitable as four-year rotations, especially when canola price was high compared to wheat.

Continuous canola had the lowest return of the five rotations.

There are concerns about disease pressure, even with the blackleg resistance hybrids, when shortened canola rotations are used for many years, so there is a need to have flexible rotations and have some time periods when canola is not planted too frequently. ●

GHG improvement

Environmental Footprint of Canola and Canola-Based Products

Principle investigator: Vern Baron, Agriculture and Agri-Food Canada, Lacombe, AB

Co-Lead: Reynald Lemke

Published: Shrestha, B. M., McConkey, B. G., Smith, W. N., Desjardins, R. L., Campbell, C. A., Grant, B. B. and Miller, P. R. 2013. "Effects of crop rotation, crop type and tillage on soil organic carbon in a semiarid climate." Can. J. Soil Sci. 93: 137_146. (Part 2)

Achieving a high yield per acre is the best way to reduce the environmental and carbon footprints of canola.

Vern Baron with Agriculture and Agri-Food Canada (AAFC) led a three part study to assess the environmental footprint of canola production in Canada. Part 1 was a life cycle assessment of Western Canadian canola crop production to see how the environmental footprint changed from 1990 to 2010. This assessment would also determine if implementation of beneficial management practices for canola production affected its environmental footprint. Part 2 looked at existing long-term rotations on the Brown Soil Zone to determine how canola production systems affect emissions of nitrous oxide, the soil nitrogen (N) balance, and the land carbon balance compared with other crops. Part 3 was a field-scale study to compare canola and barley on a greenhouse gas balance and energy intensity basis.

Part 1 was carried out in the Alberta Black Soil Zone. Average yield increased by 1.6 times from 1990 to 2010, which reduced the environmental impact per kg of seed produced. In that time, the introduction of herbicide resistant canola varieties reduced the amount of herbicide used, and the movement from conventional to minimum tillage enhanced carbon sequestration and reduced the fossil fuel requirement. These factors helped improve the carbon footprint of canola:

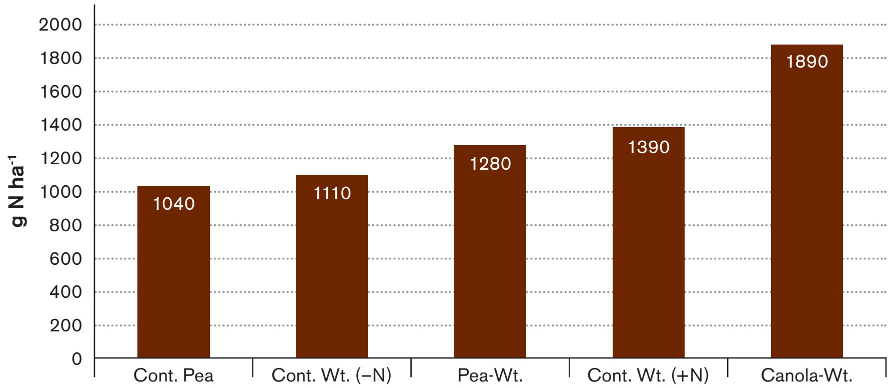
- CO_2 equivalent (eq) produced per tonne of canola dropped from 787 kg in 1990 down to 488 kg in 2010 in the Gray Soil Zone.
- CO_2 eq produced per tonne of canola dropped from 689 kg in 1990 down to 365 kg in 2010 in the Black Soil Zone.
- CO_2 eq produced per tonne of canola dropped from 501 kg in 1990 down to 399 kg in 2010 in the Brown Soil Zone.

These large reductions do not include the effect of reduced cropping intensity due to the decline in summerfallow acres. After completing this calculation, the canola footprint will decline further.

Part 2 data came from crop rotation studies in Saskatchewan. Analysis of data from Scott, SK found that crops such as wheat following canola emitted significantly more nitrous oxide (N_2O) than wheat following peas, and continuous wheat or continuous peas (see Figure 1). Generally, annual emissions were low, but when wheat was grown on canola residue the accumulated emission over three years was substantially larger than the other treatments.

Part 3 was based on field scale studies at Lacombe, AB. It found that early-planted canola appeared to sequester more ecosystem carbon than late-planted canola and barley. Because more fertilizer N is used in canola production and more residue is returned from canola to the soil than from barley, canola production may result in larger amounts of N_2O emitted than barley.

Figure 1. Three-year cumulative N_2O loss by rotation, Scott, SK



Juncea versus napus

Evaluation of Adaptability and Ecological Performance of *Brassica juncea* Canola in Diverse Growing Environments

Principal Investigator: Yantai Gan, Agriculture and Agri-Food Canada, Swift Current, SK
Collaborators: Robert Blackshaw, Eric Johnson, Cecil Vera, Bill May, Guy Lafond

The two *B. napus* cultivars in this five-site trial were quicker to mature and yielded more than the *B. juncea* cultivars. Therefore, *B. napus* may be better than *B. juncea* for short growing season areas.

Yantai Gan with Agriculture and Agri-Food Canada (AAFC) led the three-year study to determine the yield capacity of *Brassica juncea* canola in comparison with *B. napus* canola in various sites. The study also examined the suitability and feasibility of straight-combining *B. juncea* canola and *B. napus* canola by quantifying seed and pod losses during plant maturity.

Field trials were conducted over 11 site-years in Western Canada at Melfort, SK, Indian Head, SK, Scott, SK, Swift Current, SK and Lethbridge, AB (Table 1). Seven *Brassica* varieties were compared at each location, including: *B. juncea* hybrid (201045J10), three *B. juncea* varieties (8571, 8570 and a genetic line), a Roundup Ready *B. napus* canola (46P50), a Liberty Link *B. napus* canola (5440), and *B. juncea* condiment mustard (Cutlass). All plots were straight combined and seed yields measured.

Oriental mustard required the shortest growing period to reach maturity. The two *B. napus* cultivars took longer to reach maturity than oriental mustard, but they were quicker to mature than the *B. juncea* cultivars.

B. juncea had the lowest amount of shattered seed among the oilseed species, with no significant differences in seed shattering among all four *B. juncea* cultivars. However, this was not enough to overcome the higher yield potential of *B. napus* canola when straight combining. Overall, hybrid *B. napus* canola was still the best yielding crop at most sites and in most years, even in the drier areas of the average- and low-yielding sites.

These are the sites with a p-value (presented in the very right column) smaller than 0.05, which means the differences in seed yield among the seven varieties were significant statistically. Yield values followed by different letters within a row mean significant difference between the varieties in seed yield. ●

Table 1. Seed yield (kg/ha) of different types of canola evaluated at different site-years

Site-years	Hybrid juncea	Juncea 1	Juncea 2	Juncea 3	LL napus	RR napus	Oriental mustard	P value
Indian Head 2011	1479c	1530bc	1479c	/	2039a	1770abc	1812ab	0.002
Indian Head 2012	746c	1054abc	/	881bc	1328a	822bc	1254ab	0.025
Lethbridge 2011	3159ab	3344a	/	/	3397a	2846b	3429a	0.007
Melfort 2010	1329bc	1345bc	1172c	/	1802ab	1953a	1583abc	0.029
Melfort 2011	1615b	1568b	1515b	/	2855a	2562a	2721a	<0.0001
Melfort 2012	1647ab	1306b	/	1549ab	2059a	2043a	1973a	0.028
Scott 2010	1820c	2097bc	1752c	/	2888a	2532ab	1820c	0.0001
Scott 2011	2232b	2424ab	1177c	/	2618a	2372ab	2379ab	<0.0001
Swift Current 2010	952c	1199b	1031bc	/	1824a	1842a	1190b	<0.0001
Swift Current 2011	1300e	1743c	1307e	/	2195a	1937b	1537d	<0.0001
Swift Current 2012	1201ab	1105bc	/	1313a	1320a	1022c	1303a	0.0001

Rotation and weeds

Exploring the Ecological Impact of Canola-Inclusive Cropping Systems in Western Canada

Principal Investigators:
Christian Willenborg and Master's Student Ted Chastko

Collaborator: Julia Leeson

Long-term climate and annual weather are the key factors determining weed populations in a region, but herbicide practices play a major role in shaping the weed community in each field.

Christian Willenborg of the University of Saskatchewan led a three-year study in collaboration with Julia Leeson of Agriculture and Agri-Food Canada (AAFC) in Saskatoon. The study looked at weed abundance, species distribution, community diversity and function in canola-inclusive rotations across Western Canada and their relationships with management practices, canola frequency in the crop rotation, and diversity of the crop rotation. The project combined field data from an AAFC rotation study in Alberta in 2011 and 2012, a survey of 464 Saskatchewan fields in 2012 (see Table 1), and mining of long-term weed survey data from across the Prairies.

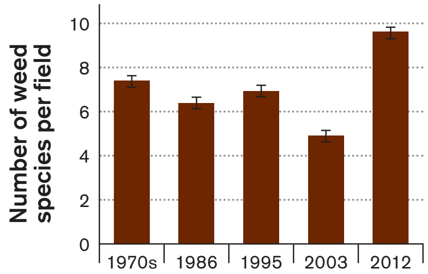
Weed species diversity and overall weed numbers tended to be lower in rotations with a high frequency of canola. Relatively few weed species (other than volunteer canola) were associated with continuous canola. However, the risk of developing herbicide resistant weeds under continuous canola production is high and extreme caution must be used when incorporating a risky practice such as this into a cropping system.

Field survey results showed that the canola herbicide system did not have a significant impact on species diversity.

The strong influence that weather has on weed diversity was demonstrated in two Saskatchewan field surveys: Under the dry conditions of 2003, weed species richness was lower than ever previously recorded. Under the wet conditions in 2012, weed species richness was higher than ever previously recorded.

However, the timing of herbicide application and rotational diversity also significantly influenced weed diversity from field to field. The study concluded that a spring burnoff application is essential in tight canola rotations. It is also essential that producers use more than one mode of action for resistance management. Rotational diversity should not be discounted due to the many critical agronomic benefits it brings over the long term.

Figure 1. **Number of weed species per field in each survey year.**



A weed management plan that includes herbicide rotation, different herbicide timing and crop rotation will also lead to better resistance planning and a slower evolution of resistance in the field. Greater rotational diversity does not always lead to fewer weeds in terms of population numbers, but it does generally reduce the likelihood of resistance issues. This should be an important concern for growers in tight rotations where the risk of developing glyphosate and/or glufosinate resistance is real. ●

Table 1. **Top ten abundant species in 2012 Saskatchewan canola (464 fields).**

Rank	Species	Frequency	Uniformity		Density		Relative	
			All	Occurrence	All	Occurrence	Maximum	Abundance
1	Green foxtail	49.3	19.9	40.4	8.4	17.0	365.6	34.2
2	Wild buckwheat	74.8	26.5	35.5	2.5	3.4	42.2	25.5
3	Wild oats	49.7	17.9	36.0	3.7	7.5	140.4	21.9
4	Wheat	40.3	13.1	32.5	2.3	5.6	220.0	15.4
5	Spiny annual sow-thistle	41.1	12.4	30.1	2.3	5.5	167.0	15.2
6	Cleavers	36.2	13.4	36.9	2.1	5.9	127.2	14.8
7	Shepherd's-purse	42.7	12.3	28.7	1.8	4.3	59.0	14.3
8	Barnyard grass	20.3	6.3	30.9	2.6	12.8	286.2	11.1
9	Lamb's-quarters	41.8	8.8	21.0	1.1	2.7	69.0	10.9
10	Narrow-leaved hawk's-beard	28.9	7.7	26.6	1.3	4.7	90.6	9.6

Long-term plan

Consistent and Environmentally Sound Canola Production

Principle investigator: Robert Blackshaw, Agriculture and Agri-Food Canada, Lethbridge, AB

Collaborators: Neil Harker, Hector Carcamo, Newton Lupwayi, Xiying Hao, Elwin Smith, John O'Donovan, Kelly Turkington, Eric Johnson, and Kevin Falk

Published: "Blackshaw, R.E., X. Hao, R. N. Brandt, G. W. Clayton, K. N. Harker, J. T. O'Donovan, E. N. Johnson, and C. L. Vera. 2011. *Canola response to ESN and urea in a four-year no-till cropping system*. Agronomy Journal 103:92-99."

"Li, C., X. Hao, R. E. Blackshaw, J. T. O'Donovan, K. N. Harker, and G. W. Clayton. 2012. *Nitrous oxide emissions in response to ESN and urea, herbicide management, and canola cultivar in a no-till cropping system*. Soil and Tillage Research 118:97-106."

This project continued or completed previously initiated research studies with the goal of generating recommendations on best management practices for economic and environmentally sustainable canola production.

Robert Blackshaw with Agriculture and Agri-Food Canada (AAFC) led the multi-study project. The specific studies were: a canola rotation study led by Neil Harker with AAFC in Lacombe, AB; a nitrogen study (see report 3.2.3 in this issue) led by Robert Blackshaw; an input study led by Eric Johnson with AAFC in Scott, SK; and an Ethiopian mustard breeding program led by Kevin Falk with AAFC in Saskatoon, SK.

Harker's rotation study included continuous canola, canola every second year, or canola every third year grown in various combinations with cereal and pulse crops. It will continue for another three years at five sites in Western Canada. Results so far indicate that canola yields trend lower when canola is grown every year compared with being grown in two-year rotations (canola-wheat) or three-year rotations (peas-barley-canola or lentils-wheat-canola). Continuous canola production is not a sustainable practice.

Blackshaw's nitrogen study compared polymer-coated urea (ESN) to standard urea as they relate to weed management and yield of hybrid and open-pollinated (OP) canola. It found that both hybrid and open-pollinated canola respond positively to higher than currently recommended nitrogen (N) fertilizer rates in about 50 percent of the cases. When compared to urea, ESN reduced N_2O emissions by 20 percent and increased canola yield in 25 percent of the cases.

Eric Johnson

Johnson's input study determined the agronomic and economic benefits of hybrid and open-pollinated cultivars, various seeding rates, various fertilizer rates, and various herbicide rates conducted at six sites (24 site-years) in Western Canada. It found that competitive cropping systems (hybrid cultivars, adequate seed rates) can lessen dependence on herbicides for weed management. Weed biomass could be maintained at low levels if herbicides were applied at a 50 percent rate, as long as a competitive hybrid canola cultivar was grown and the 100 percent seeding rate was utilized. However, total removal of herbicides resulted in large increases in weed biomass and this became worse over the four-year study.

Johnson's overall results indicate that crop inputs could be reduced for one or two years without large negative effects on canola yield, but that crop productivity markedly declined with reduced crop inputs in subsequent years. The ranking of canola yield response to the various inputs was herbicide > fertilizer = cultivar > seed rate.

Falk's breeding program looked at the feasibility of canola-quality Ethiopian mustard (*Brassica carinata*). Ethiopian mustard shows good potential to be a new oilseed crop on the Canadian Prairies, but advanced breeding is required. ●

Sustainable rotation

Canola Biodiesel Sustainability

Principal Investigator: Neil Harker, Agriculture and Agri-Food Canada, Lacombe, AB

Collaborators: John O'Donovan, Kelly Turkington, Robert Blackshaw, Newton Lupwayi, Eric Johnson, Yantai Gan, Gary Peng, Byron Irvine, Ramona Mohr

Published: "Dosdall, L. M., K. N. Harker, J. T. O'Donovan, R. E. Blackshaw, H. R. Kutcher, Y. Gan, and E. N. Johnson. 2012. Crop sequence effects on root maggot (Diptera: Anthomyiidae: *Delia* spp.) infestations in canola. J. Econ. Entomol. 105:1261-1267."

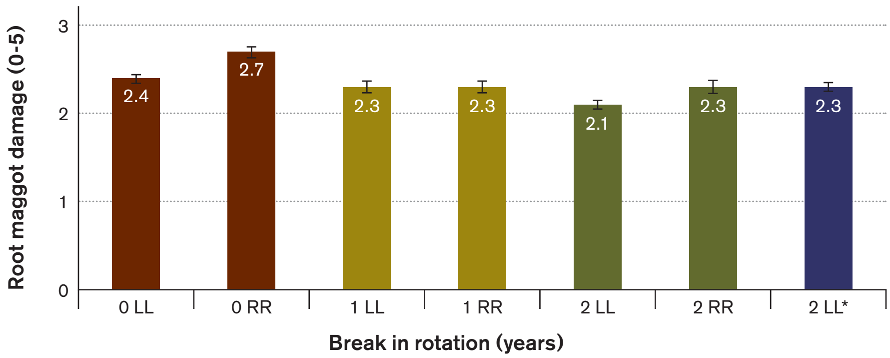
The goal of this study is to see how often producers can put canola in their rotation to meet food and fuel demand for canola oil before yield results start to drop.

Neil Harker with Agriculture and Agri-Food Canada (AAFC) led two six-year studies at five sites — Lacombe, AB, Lethbridge, AB, Scott, SK, Melfort, SK and Swift Current, SK — to determine the agronomic and economic implications of growing canola in "tight" rotations, and to determine crop sequence effects on canola yield. Both studies wrapped up with the 2013 growing season.

The first study, initiated in 2008, compared results for continuous canola, various two-crop and three-crop rotations, and one six-year rotation, all of which included canola. For each rotation the study collected data on crop emergence, crop density, weed density, diseases and insect pests every year, and weed biomass and microbial diversity (years three and six only).

The second study included various risk mitigation treatments, including growing different canola cultivars in alternating years and growing mixtures of canola cultivars within a given year. Data collection included insect infestation levels, disease assessments, crop maturity date, grain yield, grain oil content, grain protein content, and fatty acid profile (years three and six only).

Figure 1. Influence of number of non-canola years in rotation on root maggot damage on RR or LL canola roots.



*0 is continuous canola, 1 is a one-year break between canola, and 2 is a two year break. The seventh column with the * is the six-year rotation with canola twice in the rotation. RR is Roundup Ready. LL is Liberty Link. Root maggot damage is on a 0-5 scale, with 0 being no evident damage. Contrasts: O vs. 1Y break: P=0.342, O vs. 2Y break: P<0.001*

These rotation studies will continue beyond 2013, but some preliminary trends have been observed:

- Canola yields in 2012 (year 5) indicate that Liberty Link canola or Roundup Ready canola grown continuously always had lower yields than when grown in a three-year rotation with field peas and barley. There were yield benefits of simply rotating canola with wheat, but this was not significant at all sites.
- Blackleg incidence was lower and root maggot damage was lower when there was a two-year break between canola crops (Figure 1). (The published study is based on the root maggot results.)
- Yield differences observed at a number of the sites likely reflected levels of blackleg found in the trial. There was a relatively high incidence in 2012, which suggests that blackleg resistance is breaking down in some canola cultivars.
- There appears to be little or no disease management or yield benefits to growing different canola cultivars in alternating years and growing mixtures of canola cultivars within a given year.
- Overall, early indications are that production risks are higher in continuous canola, or canola in a two-year rotation depending on the variety/location.

These results are likely to be confirmed in the last year of this study. ●

Pest management

Detection, Surveillance and Management of Weed, Insect and Disease Pests that Threaten the Economic Viability of Crop Production and the Environmental Health of Prairie Agro-Ecosystems

Principle investigators: Owen Olfert and Bob Elliott, Agriculture and Agri-Food Canada, Saskatoon, SK

Collaborators: Hector Carcamo, Julia Leeson, Debra McLaren, Jennifer Otani, Gary Peng, Julie Soroka, Kelly Turkington

Published: Over the three years, 61 scientific papers, review articles and proceedings were derived from the study.

This study detected, monitored and managed various weed, disease and insect pests to find new ways to reduce their threat to the economic production of canola and the environmental health of Prairie agro-ecosystems. The study enhanced the potential for producers to successfully use integrated management of cyclical native pests and an increasing number of invasive species.

The ultimate aim is to develop novel assessment technologies and crop management tools for control of insects, weeds and diseases in canola. The study had four objectives: (1) develop and implement field surveillance technologies and laboratory assays; (2) develop novel forecast and risk assessment technologies; (3) determine ecological, biological, climatological and crop management relationships that influence pest status; and (4) develop new alternative integrated control and mitigation tactics.

This thermal gradient plate is like 176 mini growth chambers. Researchers use it to quantify the process of seed germination, plant shoot emergence, insect growth and development, and plant and insect pathogen infections. From these data, they can quantify the ecological, biological, and climatological relationships that influence pest status.

OBJECTIVE 1 RESULTS

- Relative abundance of lygus bugs in weeds in the spring weeds has no relationship to lygus counts in canola later in the season.
- Sweep netting in canola at the pod stage likely severely underestimates the number of lygus nymphs.
- Weed surveys showed that weed species richness was higher than ever previously recorded. Species increasing since the 1970s include wild buckwheat, spiny annual sow-thistle, cleavers, barnyard grass, biennial wormwood, foxtail barley, round-leaved mallow and kochia. Species decreasing include lamb's-quarters, stinkweed, annual smartweed species, field horsetail, wild mustard, Russian thistle, flixweed, bluebur and cow cockle.
- Insect survey protocols were developed and standardized.

OBJECTIVE 2 RESULTS

- Spatial analysis systems (Arc-GIS, SPANS) were used to summarize the distribution and density of insect pests (bertha armyworm, cabbage seedpod weevil, grasshoppers, pea leaf weevil, and wheat midge) into risk forecasts.
- A new field plot trial was initiated with Pest Management Centre support to investigate the impact of high densities of lygus feeding introduced at the bolting stage of canola development.
- Emergence of crucifer and striped flea beetles from early- and late-seeded canola varied yearly depending on the species, planting date and temperature. Striped flea beetles emerged two to three weeks earlier than crucifer flea beetles. Both species emerged one to five days sooner in early-seeded canola than in late-seeded canola. Both species also emerged earlier in years with above-average temperatures than in years with below-average temperatures.
- A DYMEX model to simulate the development of sclerotinia stem rot has been developed and is coupled with a model for canola growth. A CLIMEX model for potential distribution and severity of

sclerotinia stem rot has been developed. Models are still in the research realm.

- Given the size of clubroot resting spores, their dispersal with soil particles within a field or between adjacent fields can likely occur. It is unclear whether significant long distance transport of clubroot resting spores occurs via wind erosion, but there may be the potential for movement over tens to hundreds of kilometres. Conservation tillage and the avoidance of excessive soil disturbance will be keys to limit potential wind-mediated erosion.

OBJECTIVE 3 RESULTS

- Over three test years, flea beetle damage to canola was lower in early-seeded plots (14.6 percent) than in late-seeded plots (21.4 percent). Early seeding also improved canola yields by 12 percent.
- A study conducted at AAFC Saskatoon found that since 2009, populations of crucifer flea beetles have declined whereas populations of striped and hop flea beetles have increased. The shift in species was greater in early-seeded plots than in late-seeded plots.
- A three-year field investigation was conducted to see whether wheat stubble heights and soil preparation practices could deter feeding by flea beetles and root maggots in canola. Infestations of both pests were low for the duration of the three-year study, but trends suggest decreased feeding with increased stubble height.
- Bioclimate models were developed, using weather data and pest biology, to predict ecological and economic impact of invasive insect pests (lygus bugs, grasshoppers, cabbage seedpod weevil, diamondback moth, and cereal leaf beetle) in field crops in Western Canada. The results offer insights related to pest status and crop risk associated with changes in agronomic practices, new crops and a changing climate.

OBJECTIVE 4 RESULTS

- Field trials in 2010-2012 suggest that more effective seed treatments are needed for flea beetle control when cool, moist conditions prevail after seeding.
- Neonicotinoid seed treatments provide limited agronomic benefits when flea beetle damage is low and rainfall is above-average throughout most of the growing season.
- General Circulation Models were applied to bioclimatic models for a number of significant crop pest species, including grasshoppers, cereal leaf beetle, kochia and fusarium headblight, using weather data and pest biology to estimate the risk of these invasive insect pests in cereal and oilseed crops under a changing climate. Results indicated that all four crop pests would have increased range and relative abundance in more northern regions of North America, compared to predicted range and distribution under current climate conditions.
- New lines of crucifers were evaluated for resistance/susceptibility to flea beetle feeding. Hairy canola was as unpalatable to striped flea beetles as to crucifer flea beetles. ●

Figure 1. Blackleg in Manitoba 2003-2011

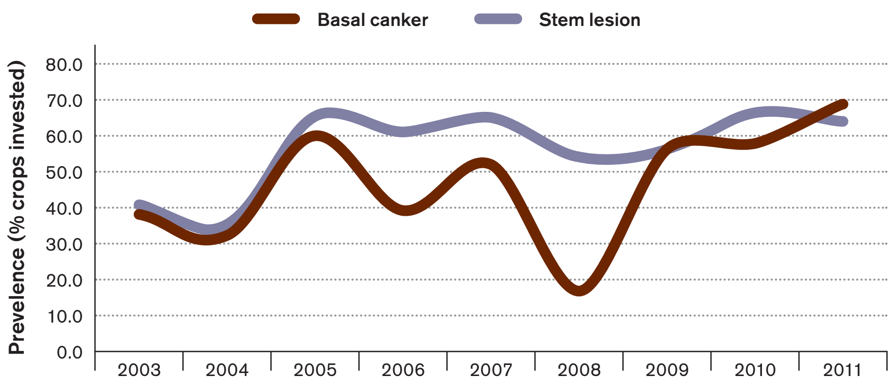
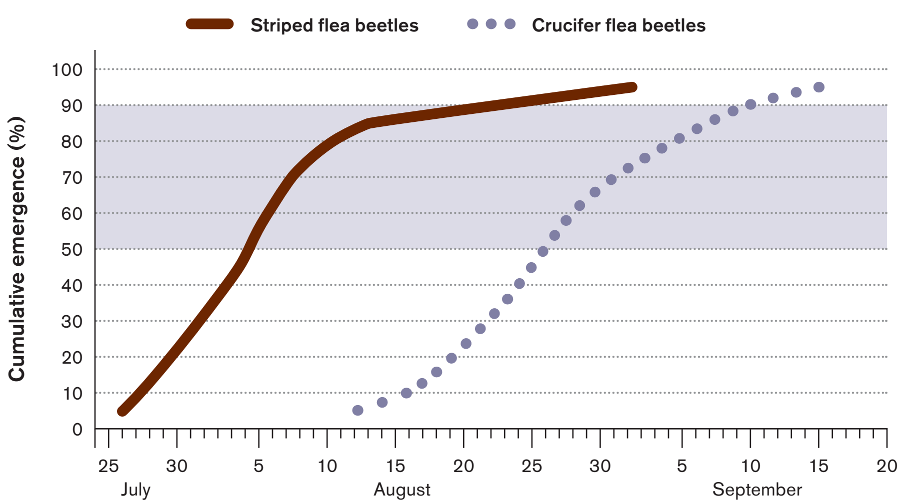


Figure 2. Cumulative emergence of striped flea beetles (solid line; n = 4 years) and crucifer flea beetles (broken line; n = 8 years) from early-seeded plots at Saskatoon in 2004-2011



As shown in the illustration, the summer (fall) population of striped flea beetles emerges earlier than the summer population of crucifer flea beetles. Therefore, producers should inspect fields in late July and early August to determine the abundance of striped flea beetles and inspect the fields again in late August and early September to assess the abundance of crucifer flea beetles. This can indicate flea beetle pressure the following spring.

Yield factors

Canola Growers Survey

Principle investigators: Elwin Smith, Agriculture and Agri-Food Canada, Lethbridge, AB
Collaborators: Richard Carew, Danny LeRoy, Scott Jeffrey

Surveys of Prairie canola producers during the winter of 2011-12 uncovered key factors that provide a positive contribution to canola yield. These were: nitrogen, irrigation, calibrating the seeder, swathing when seed colour changed, soil testing for fertilizer requirements, good to excellent moisture, and good to excellent temperatures during flowering. Factors that commonly reduced canola yield were: seeding late, adverse growing conditions and salinity.

During the winter of 2011-12, Agriculture and Agri-Food Canada (AAFC) and the Canola Council of Canada (CCC) sponsored a survey of canola producers to determine the management practices and inputs they commonly use. An independent survey company contacted producers, collected the required survey data from the set of questions, and provided a summary tabulation of the results.

Data collected were used to determine significant factors that explain differences in yield and profit. The survey also helped to identify production or technical barriers that need to be overcome.

The barrier identification will provide direction for future research that will have the greatest benefit to producers and the industry. Identification of the practices used by the top growers that obtain top yields, versus those with much lower yield, will help to focus extension and information needs for producers.

SURVEY RESULTS

- Nearly two-thirds of canola was no-till seeded in the Dark Brown and Brown Soil Zones of Saskatchewan. No-till was used by about half of the producers in the Black Soil Zone of Alberta and Saskatchewan. No-till was least common in the Gray Soil Zones. Conventional tillage was more prevalent in Manitoba than in either Alberta or Saskatchewan. However, reduced/minimum tillage was more common in Manitoba than conventional tillage.
- Nitrogen fertilizer was the main productive input used in canola production. The ratio of canola yield to nitrogen was about 2.25 to 2.4 lb./bu. for all regions, except Manitoba. Manitoba growers were expecting higher yields, and applied more than 100 lb./ac. of actual nitrogen. But Manitoba yields were lower than expected in the survey year, which increased the nitrogen to yield ratio.
- The source of nitrogen varied by region. Anhydrous ammonia was the most common source in Manitoba and the Gray Soil Zone of Saskatchewan, but urea was the most common elsewhere. Phosphate and sulphur application rates were similar across all regions.
- Past yield and experience were cited as the main decision factors used to determine fertilizer application rates. Soil test was the second most common factor. A significant percentage of producers used general fertilizer guidelines. For some, the main decision factor was cost.
- Almost all producers who swathed canola decided when to swath based on seed colour (73.4 percent). About one quarter of producers used either pod colour or field colour to decide when to swath.
- The majority of canola was seeded with a shank-type opener (as opposed to a disc opener). Drills (disc, press or hoe) were most common in Manitoba and Alberta.
- Most canola fields were sprayed in-crop for weeds more than once. The average number of spray passes ranged from 1.24 in the Dark Brown and Brown Soil Zones of Saskatchewan to 1.65 in the Gray Soil Zone of Saskatchewan.
- Almost all producers indicated they either used herbicides with multiple modes of action or rotated herbicides (91.3 percent combined) to prevent herbicide resistant weeds from evolving on their farm.
- Most soils were reported to have no soil problems. Salinity was the most common soil problem that growers identified.
- Canola yield varied by region and greatly within regions. In 2011, average yield tended to be lower in Manitoba, but this was a spring of very wet conditions in Manitoba and other areas of the Prairies. Manitoba yields were typically lower than the yield producers expected. Yield in the Dark Brown and Brown Soil Zones

was good relative to the expected yield for these growing regions.

- Almost 70 percent of the canola fields in this region in 2011 had a canola rotation length of two years or less. For the 2011 canola crop, 10.9 percent of producers in the Gray Soil Zone of Manitoba indicated they also grew canola on the same field in 2010. For the same region, 58.2 percent of growers grew canola on the field in 2009.

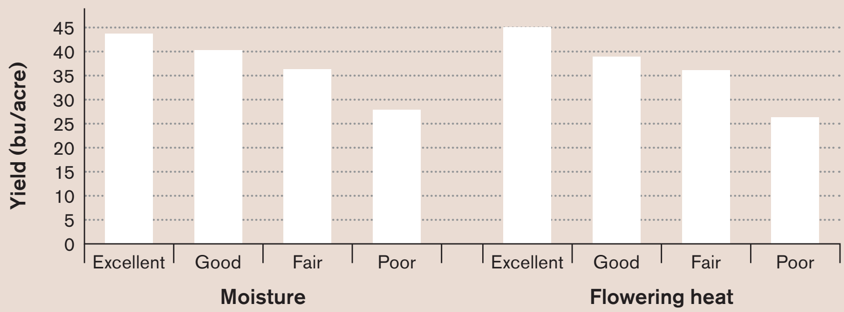
EFFICIENT FARMING

Scott Jeffrey with the University of Alberta is doing an efficiency analysis of the survey results. Technical efficiency is the degree to which the maximum level of output can be obtained from a given combination of inputs. His work will estimate the degree to which producers are able to get the most from whatever level of input use they choose. This is not the same thing as choosing input levels to maximize production.

The presumption is that some producers are "better" than others at getting the most out of their chosen level of input use. Jeffrey's specific objective is to assess whether the adoption of environmental stewardship practices (e.g. reduced or zero tillage systems, application of precision farming techniques and various nutrient management practices) has any effect on canola producers' efficiency in the Canadian Prairie region.

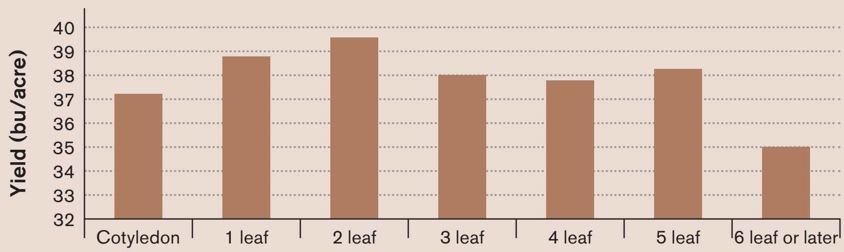
Preliminary results suggest that the impacts appear to be either neutral or positive. In particular, evidence of adoption of nutrient management planning, precision farming techniques and (to a lesser extent) soil testing is positively related to technical efficiency. However, producers were not asked about the use of environmental stewardship practices that are not directly related to canola production decisions (e.g. land use changes such as restoration of wetlands or implementation of buffer strips) and the effects of these practices on efficiency may well be different. Work is ongoing to refine and extend these results. ●

Figure 1. Growing conditions



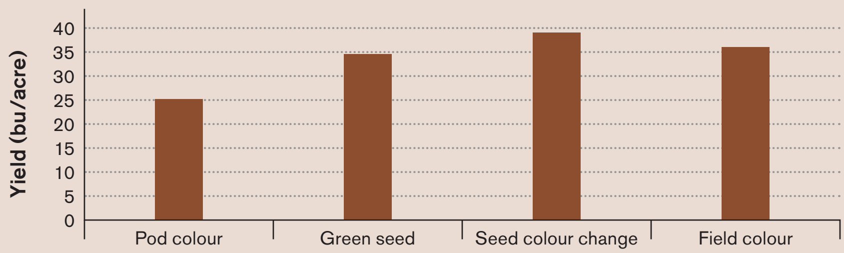
Moisture through the season and heat at flowering have a major influence on yield. A producer has no control over the weather, but this does highlight the importance of earlier seeding to avoid flowering during the heat of July.

Figure 2. First herbicide application



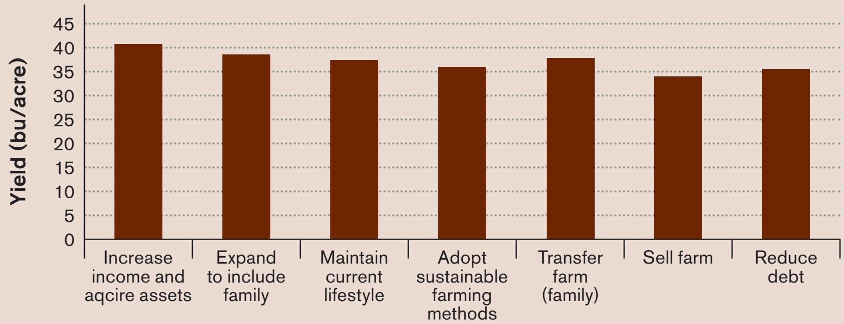
This survey found that growers spraying at the 1-leaf or 2-leaf stages had higher yields than growers going earlier or later with their first in-crop herbicide application.

Figure 3. Time of swathing



Yields were highest when growers based the time of swathing decision on seed colour change.

Figure 4. Farming goal



Producers who want to grow the business and acquire assets or who want to pass along the farm to family tend to have the highest yields.

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