Ideas and observations from Canola Discovery Forum 2016
By Curtis Rempel

Canola Discovery Forum is a key event for the Canola Council of Canada's crop production & innovation team. One of the team's major roles is knowledge and technology transfer (KTT), which at one time was called "agriculture extension". We synthesize best management practices for canola production from a variety of sources but our gold standard is well-designed trials that have been subjected to appropriate replication, statistical analysis and interpretation. However, like physicians, agronomists and farmers have to make significant decisions with incomplete information.

Canola Discovery Forum brings forward these areas where decisions are made based on incomplete information. It provides opportunities (a) for growers, agronomists and industry scientists/specialists to provide academic researchers with gaps and opportunities, (b) for public scientists to share research results with growers, agronomists and industry specialists, (c) for researcher to researcher (and peer to peer) engagement to foster and facilitate research networks in Canada and (d) to develop and validate KTT platforms and tools.

The goal is to increase canola yields, profitability and sustainability, and reduce production risk. This is germane to the industry strategy of "52 bushels per acre by 2025" to supply forecast demand for canola in domestic and export markets.

The following highlights some of the ideas and observations from Canola Discovery Forum 2016.

Genetics

Agriculture and Agri-Food Canada (AAFC) and universities have developed robust platforms for identifying genetic variability within *Brassica napus* (canola) and selecting for genetic "pieces" (individual genes or multiple genes) that can be exploited for improving canola. Traits important for canola production include resistance to insect pests, drought tolerance, improved nitrogen use efficiency and reduced secondary seed dormancy. Scientists are addressing these using a variety of "modern breeding" or genomic and phenotying approaches.

Researchers at University of Guelph (Ian Tetlow, Michael Emes et al.) have developed a novel means of increasing vegetative biomass and oilseed production in *Arabidopsis thaliana*, which is a model plant for *B. napus*. They introduced genes from corn that change the balance of starch or energy synthesis and accumulation in leaves and pods, and this significantly increased biomass and more than tripled seed yield. Researchers are now looking for

funding to move from the model crop to canola and test the performance under field conditions.

The Canola Variety Performance trial workshop affirmed that canola growers value independent evaluation of variety performance across Western Canada. Data analysis showed that small-plot trials are a good predictor for variety performance in field trials and field-scale trials are a good predictor for variety performance in small-plot trials. Producers are keen to have independent trial data but feel that collaborative participation with life science/seed companies is the best model as industry has experience in conducting excellent variety evaluation trials.

Stand establishment

Due to differences in equipment, farm size and biological factors (soil moisture, residue) we are moving into an era where no seeding rate recommendation works for all. Murray Hartman, oilseed specialist with Alberta Agriculture & Forestry, presented an updated meta-analysis of canola plant stand versus yield. The long-standing recommendation of seven to 10 plants per square foot might not be economically viable any longer. A move to five to seven or six to eight may be more appropriate and should satisfy agronomic concerns in most field scenarios. Growers may be ahead of science in this instance.

Growers need to set target densities based upon individual fields and equipment limitations and their individual appetite for risk. Future research projects will need to assess things like weed control, seed-placed fertilizer rates, fungicides, insect thresholds and harvest management decisions at lower plant densities. The caution: When seed rate and resultant plant populations drop below a critical point (four plants per square foot), the yield declines very rapidly and significantly.

Fertility

Optimal nitrogen recommendations for canola have been difficult to establish. Consequently, some growers over-fertilize to “protect” yield while others under-fertilize to minimize risk. Nitrogen application recommendation is in theory a simple equation, but is extremely complex in practice due to many interactions in the field: nitrogen source x rate x canola variety x environment x soil properties x microbes x residue x equipment.

Nitrogen applications for canola in western Canada are “risky” as growers tend to apply the entire amount at or before planting. Applying some during the growing season may prevent loss and increase yield, but our short growing season and resulting time constraints and other factors make this logistically and biologically difficult. More research is needed but time constraints are difficult to overcome.

Observations:

1. One of the largest returns in precision agriculture may be removing from production those areas that have consistently negative return on investment for inputs.
2. Some of the nitrogen efficiency products optimized for corn need data for canola as the growing season is shorter than corn and critical period is different from corn.
3. Nitrous oxide emissions, especially in spring, need to be addressed for sustainability and profitability.
4. A slight increase in nitrogen use efficiency (NUE) may pay huge dividends for yield and sustainability.
5. Canola varieties differ in nitrogen (and phosphorus) uptake and NUE.

Nitrogen fertilizer products will become increasingly “smart”, responding to plant root signals and uptake sites. This fertilizer will not be cheap, so fundamental research on nitrogen requirements and NUE will be important.

Integrated Pest Management: Beneficial insects

Several presentations highlighted the value of pollinators and other beneficial insects for canola production and the value of maintaining habitat for these insects.

Observations:

1. Canola is a fantastic crop for ecosystem insect biodiversity. We need to optimize this for yield and integrated pest management.
2. Diverse landscapes are more resilient. Increasing biodiversity is better able to deal with insect and disease challenges.
3. Use low yielding areas as habitat repositories.
4. Shelterbelts are more welcoming to beneficial insects than to pests.
5. Pollination deficits can be filled by native bees. These decrease exponentially based on the distance from native habitat.
6. Which species give us the biggest “bang for the buck”? And how do we as growers and industry monetize this?

Integrated Pest Management: Blackleg

Provincial disease surveys show an increase in blackleg incidence in the past decade while efficacy of blackleg resistance in commercial canola varieties has decreased. Farmers have conveyed a message to CCC agronomists: “I believe I have too much blackleg in my field for an R-rated canola variety.” Research shows that this is due to widespread use of a one resistance gene (*Rlm3*) in the majority of canola varieties for sale in the market.

Knowing that resistance gene *Rlm3* (and *Rlm1*) have been or are being overcome on the Prairies means that in addition to crop rotation, growers should also be using different blackleg resistance genes in rotation. In Australia and Europe, rotation of blackleg resistance genes has shown to be effective in managing the disease. R-gene rotation is both simple and complex due to *Leptosphaeria maculans* race population dynamics. In its simplest form, if you grow a variety with resistance gene *Rlm3* for several years, rotating to a variety with another resistance gene can help reduce blackleg and resulting yield loss. In Australia, research has shown that growing a variety on its stubble in a field results in significant disease while growing a variety on the stubble of a variety containing a different blackleg resistance gene results in minimal to no disease.

Blackleg loss models developed by University of Alberta researcher Stephen Strelkov are slightly different from Australian and EU models. Australia reported no yield losses from blackleg until 50% of the stem cross-section is blackened (a “2” on the blackleg rating scale). In Canada, losses begin between “1” and “2” on the rating scale, Strelkov says, and losses are very significant when greater than 75 percent of the stem cross-section has disease symptoms.

Many Canadian canola varieties contain what is called adult-plant or quantitative resistance to blackleg. This type of resistance has proven very beneficial to Canadian growers. Breeders and pathologists are continuing to characterize and select for quantitative resistance to blackleg.

Integrated Pest Management: Sclerotinia stem rot

The challenge for managing sclerotinia disease is good predictive models for timing fungicide applications. Predictive models for sclerotinia are feasible and will be a very useful tool for growers. Soil physical properties and soil environmental conditions have a significant impact on sclerotia germination and apothecia development and should be included in a predictive model.

Observations:

1. Sclerotia that are produced from a sunflower crop appear to be very aggressive on canola.
2. Sclerotia viability is affected by soil microbes. Soils with higher organic matter tend to have more microbial activity and this can play a role in reducing Sclerotia survival in soil.
3. Sclerotia deeper than four centimetres in the soil don’t contribute to disease as the apothecia cannot grow more than four cm.
4. Even with good predictive models, growers will benefit from fungicide application systems that deliver product into the lower portion of the canopy for maximum efficacy.
5. Growers cannot skimp on water volume when applying fungicides for sclerotinia control.

Root microbiome

Microbes and exudates in the soil surrounding the root and on the root itself have the ability to reduce disease, affect nutrient uptake and use efficiency, reduce environmental stress and increase yield directly by altering hormonal activity within the plant itself. We know that the root microbiome is enormous, with thousands of species of bacteria, fungi, actinomycetes and other organisms and billions of spores and cells present. When all of these are taken together, this mass of individual species and cells has a “genome” (genetic DNA) that, similar to a bee hive, can and should be analyzed together as the microbiome genome.

The discovery forum presentation stressed that with all of our current molecular tools and techniques, we now have the capacity to make sense of this massive biological community. Futhermore, we need to consider that the crop genome affects the root microbiome genome and gene expression, and the root microbiome genome impacts the crop genome. They need to be studied together as well as separately. Understanding this can result in rotation sequences and addition or manipulation of microbial species that can increase nutrient uptake and prevent fertilizer loss, reduce root and stubble borne diseases and protect against drought or standing water.

The human body is similar. Only one tenth of the DNA in your body may be you. The rest is bacteria! The vast majority of these bacteria keep you healthy and happy, and if you did not have these, you would be sick. Several species of bacterial (example *E. coli*) should never be present and make you severely ill if they are. You can think of the soil around the root zone as the Earth’s stomach. It harbours many biological organisms, the vast majority good and are necessary for agriculture, and but some are bad. Sorting this out takes many types of researchers (soil scientists, microbiologists, physiologists, molecular biologists, geneticists, biostatisticians and mathematicians and perhaps most importantly agronomists) working together. Solutions to advance productivity and sustainability are much more involved than simply adding a “biological” product with the seed and hoping it increases yield.

This article provides a quick overview of Canola Discovery Forum 2016. It does not cover every topic addressed. For the detailed Canola Discovery Forum Proceedings, please email Ellen McNabb at mcnabbe@canolacouncil.org.

– Curtis Rempel, MBA PhD, is Vice President, Crop Production & Innovation, with the Canola Council of Canada.