Researchers conducted several field studies in four ecoregions across the Canadian prairies to develop integrated approaches for flea beetle control for modern high-yielding canola varieties. The preliminary analysis of the results supports the 25% defoliation threshold as a valid management tool to control flea beetle populations. Detailed analysis of the economic threshold data is in progress. Significant associations between landscape structure and flea beetle abundance were found, and predator species attacking flea beetles were identified in the laboratory. Researchers found significant associations between flea beetle abundance, plant density and damage to canola plants, and between flea beetle abundance and weather parameters. This information can be used by growers to improve flea beetle monitoring and management, and diminish canola yield losses.

Flea beetles are chronic pests on canola and result in yield losses estimated at $300 million CAN each year. Two species are responsible for most of the damage: the exotics *Phyllotreta cruciferae* (crucifer) and *P. striolata* (striped). Currently, the most widespread technique to control flea beetles in North America is the use of preventive insecticide treatments in canola seeds followed by foliar sprays if damage is still prevalent.

Researchers from University of Manitoba and several collaborators from across western Canada conducted several field studies in four ecoregions across the Canadian prairies to develop integrated approaches for flea beetle control for modern high-yielding canola varieties. There were several objectives of the project:

1. **To determine economic threshold for flea beetles**

   For this project, a total of 41 field trials in four regions were conducted over three field seasons starting in 2015. Five treatments were compared, including an unsprayed control, Neonicotinoid treated seed treatment with no foliar insecticide spray, or foliar insecticide spray at three different thresholds: 15-20%, 25% and 45% defoliation.

   Canola defoliation by flea beetles was assessed weekly until plants reached the 2.2 phenological stage. The abundance of flea beetle species and generalist natural enemies’ abundance were assessed weekly using double sided yellow sticky card traps until the 2.2
stage in treated plots (treatments 2-5), and the whole season for unsprayed control plots. Canola emergence/survivorship counts were also assessed. When the average defoliation of a sprayed treatment reached its threshold, the plots were sprayed with Matador (lambda-cyhalothrin) at 34 ml/ac, within 24 h of the assessment. Repeated insecticide applications were performed when thresholds were reached on more than one occasion per treatment.

Flea beetle populations were highly variable across experiments and resulted in various levels of damage. Treated seed had numerically higher yield than the control. Initial analyses suggest that the seed treatment is the most frequently associated with yield increases, followed by the 15-20% and 25% defoliation treatments. As well, in two of the three statistically significant trials, yield of the seed and 25% defoliation treatments did not differ. Late trials experienced less flea beetle damage and no significant yield effect. This preliminary analysis supports the use of a nominal economic threshold of 25% defoliation.

2. **Determine the specific effective natural enemies impacting flea beetle populations using molecular gut-content analysis.**

Molecular gut content analysis is the most efficient and accurate method for determining what predator species eat flea beetles and how often. One method involves amplifying the pest DNA from the guts of predators. Although multiple primers were tested, several were not species specific or resulted in excessive non-target banding. Two primers were developed to amplify flea beetle DNA in the gut contents of predators for two species of flea beetles, *Phyllotreta cruciferae* and *P. striolata*.

Laboratory experiments testing predation on crucifer flea beetles include two common Phalangiidae species (harvestmen), three Lycosidae spiders, several ground beetle predators (Coleoptera: Carabidae), including *Pterosticus melanarius* and several *Amara* spp. species. Experiments testing predation on striped flea beetles include *P. melanarius* and *A. torrida* as predators.

Overall, study results showed that common ground beetles can consume flea beetles under laboratory conditions and may be able to do the same in the field during early stages of canola. The carabid beetle *P. melanarius* consumed several flea beetles of both species. Similar results were found for predation of *A. torrida* on striped flea beetle, while other predators showed sporadic consumption. A more detailed analysis of the findings is being completed.

3. **Identify landscape features promoting effective natural enemies and decreasing infestation levels of flea beetles**

Several commercial canola fields in four regions, Manitoba, Alberta-Peace River Area, Alberta-Lethbridge, and Saskatchewan were sampled over the three years of the project for determining flea beetle, and natural enemy abundance, species composition, and to determine landscape effects. The fields selected were represented in a gradient of landscape complexity. Sampling started in mid-May when canola was in its most susceptible stage (cotyledon to the two-leaf stage) and continued throughout the season,
to capture the population peaks and seasonal phenology of different flea beetle species in each field. Sticky card traps were used to assess flea beetle and natural enemy abundance; plant stands and weekly crop phenology were also assessed.

Overall, initial analysis indicates that the proportion of canola in the landscape is related to flea beetle abundance. Crucifer flea beetle abundance decreased with an increase in the proportion of canola and other crops (i.e. minor crops combined) in the landscape at various scales. A similar pattern was found for striped flea beetles responding negatively to increases of proportion of canola and cereals in the landscape.

The abundance of the two most common flea beetle species varied throughout the season in each region sampled. Both crucifer and striped flea beetles were abundant in Manitoba. In southern Alberta, crucifer flea beetle was the most abundant species. The striped flea beetles were abundant in the Peace River area of Alberta and in Saskatchewan. Low numbers of hop flea beetles were also found. Change in relative abundance of flea beetles is evident with striped flea beetles dominating in many areas, in comparison with historical records in the regions sampled. The data for species composition and the abundance of natural enemies of flea beetles in sticky cards is still being analyzed.

4. Develop models to predict flea beetle emergence and major seasonal activity based on abiotic environmental conditions
To develop predictive models, 72 locations were included over three years, with a total of 563 observations from May until August, including a wide spectrum of weather data (relative humidity, temperature thresholds, etc.). For easier analysis, the flea beetle
populations were divided into four groupings; spring and summer striped flea beetle and spring and summer crucifer beetle.

The analysis showed that a warmer April and May, a cooler and wetter June and accelerated plant growth is positively correlated with an increase in striped beetle populations. Also, a warmer May is positively correlated with an increase in the population of spring crucifer beetles. May had the most impact temperature wise, as warmer temperatures signal larger beetle pressure whereas cooler temperatures signal lower beetle pressure. Researchers also found that low crucifer beetle pressure in spring means a low probability of crucifer population in the summer.

Researchers also concluded that modeling using only weather data is difficult because in some instances where locations were less than 20 km apart and had the same weather, different flea beetle patterns were found. This could be because other outside factors such as; the number of overwintering sites for the flea beetle, previous year’s prevalence of flea beetle, tillage practices, field data (seeding date, spaying data) among many other factors were not taken into account.

Overall, preliminary results of this project suggest that defoliation thresholds could be used as a valid management tool to control flea beetle populations. Detailed analysis of the economic threshold data is in progress. Significant associations between landscape structure and flea beetle abundance were found, and predator species attacking flea beetles were identified in the laboratory. Researchers found significant associations between flea beetle abundance, plant density and damage to canola plants, and between flea beetle abundance and weather parameters. This information can be used by growers to improve flea beetle monitoring and management, and diminish canola yield losses.