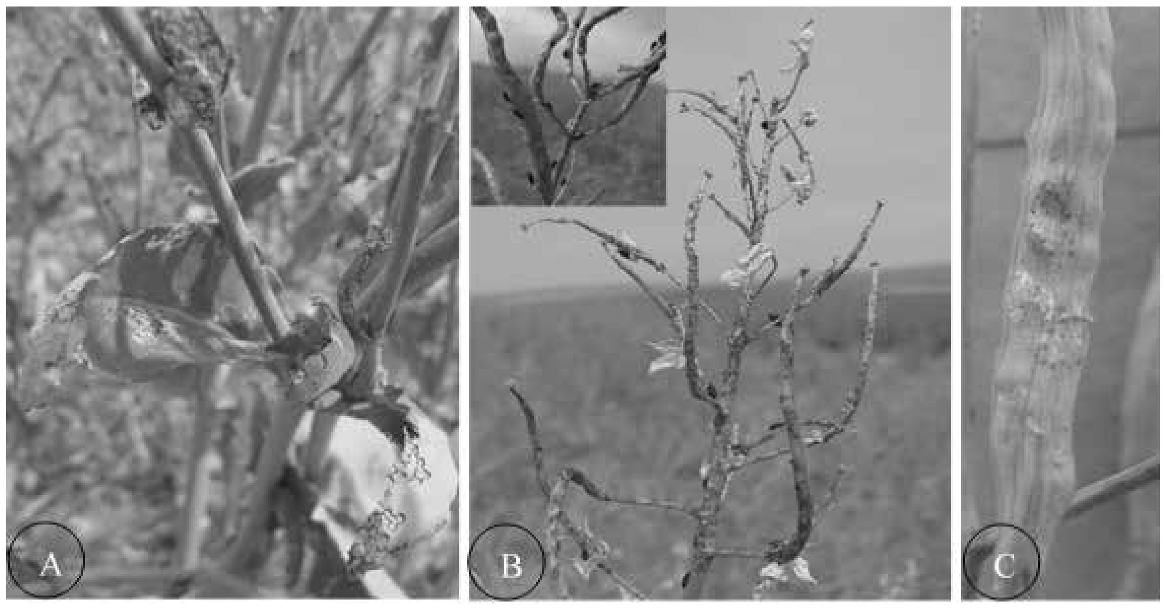

Figure 1. Flea beetle damage to leaves and pods of canola at WTARC site (A, B). Thrips population on pods of canola at Cut Bank in summer of 2018.

Efficacy of bio-pesticides for managing flea beetles on canola

By Anamika Sharma and Gadi V.P. Reddy, Montana State University, Western Triangle Agricultural Research Center, Conrad, Montana

Among oilseed crops, brassicas are the second largest group of crops grown globally after soybean. Canola crop belongs to genus *Brassica* from which the oil shall contain less than 2% erucic acid along with less than 30 micromoles of anyone or any mixture of 3-butenyl glucosinolate, 4-pentenyl glucosinolate, 2-hydroxy-3 butenyl glucosinolate, and 2-hydroxy- 4-pentenyl glucosinolate per gram of air-dry, oil-free solid. These traits of oil are considered healthy for humans.

In the USA, since 1985, serious efforts have been taken to grow canola on a large scale and it is grown in North Dakota, Oklahoma, Kansas, Texas, Minnesota, Montana, Idaho, and Oregon. Canola has gained attention, especially in last 10 years, among Montana farmers due to good market value and as an excellent rotational crop. In addition, due to proximity to Canada, it is easier for Montana farmers to transport their canola crop to Canada for further processing to yield oil.

However, Montana farmers also face direct entry of insect pests of canola which already exist in Canada. The major insect pests of canola in Golden Triangle Area are flea beetle (*Phyllotreta cruciferae*) and cabbage seedpod weevil (*Ceutorhynchus obstrictus*). Nevertheless, other parts of Montana also have established populations of other insect pests such as tarnished plant bug, (*Lygus* sp.) and diamondback moth (*Plutella xylostella*). To control these insect pests, topical insecticides and seed treatments are used. Being a major pest of canola, flea beetles have one generation per year but adults appear twice during the growing season. In the spring, overwintered adults emerge and feed on canola seedlings. In the fall, offspring of earlier generation feeds on canola leaves, stems and seed pods. During cool weather conditions, adults shelter and feed on the other adjacent cruciferous plants. During favorable conditions, they start feeding on the new canola crop, mate, and lay eggs in the soil during May and June. The larvae are white with a brown head and feed on the root hairs and taproots of seedlings. By early to mid-July flea beetle larvae pupate. The new generation of adult emergence begins after mid-July and continues until October and feed on the leaves, stems and pods of canola plants.

As integrated pest management (IPM) strategy to control flea beetle, cultural controls (planting dates, increased seeding rates) and insecticide treatments are recommended. However, applying conventional insecticide has its major repercussion on environment and biodiversity. Canola also serves as an important crop for bees since bees consume canola as an early and a rich source of nectar. Moreover, bees are also good for canola crop since they increase canola yield by enhancing seed germination, seed ripening, uniform flowering, and early pod setting. This scenario creates a mutual relationship between canola crop and bees which is both economically and ecologically beneficial for the environment and farmers. The use of conventional insecticides can jeopardize the relationship between canola crop and bees. Due to heavy exposure to insecticides, bees populations decline. Keeping this in mind at the Western Triangle Agricultural Research Center (WTARC), Conrad, we have been trying to explore various bio-pesticides to control insect pest populations on canola. Unlike conventional pesticides, which are generally synthetic compounds and can be harmful for the environment, bio-pesticides are derived from the natural material such as minerals, bacteria, fungus, plants, and animals. Hence, bio-pesticides are used for target-specific pest control which has minimal impact on non-target beneficial organisms and are safe for the environment. Also, bio-pesticides are used in resistance management programs since insect pests do not develop resistance to bio-pesticides.

In the summer of 2018 we established an experiment to explore the impact of three bio-pesticides on crucifer flea beetles: Mycotrol ESO® (*Beauveria bassiana* GHA, an insect-killing fungus), Aza-Direct® (azadirachtin, a compound derived from Neem plant, which has insect-killing properties), and Entrust WP® (spinosad 80%, compounds with insect-killing properties derived from the bacterial species) in comparison to two conventional insecticides, Gaucho® (imidacloprid, as seed treatment), and Mustang Maxx® (Zeta-cypermethrin, as topical spray). Field trials were conducted at two non-irrigated fields, one in Conrad at the WTARC and another in Cut Bank. We sprayed only once throughout the season.

In general, in 2018, there was a severe attack of grasshoppers to several crops especially to canola crops. Hail damage also occurred to the canola crops due to the short growing season. Among insect pests, flea beetles were a major concern and moderate to the low infestation of cabbage seedpod weevil, diamondback moth was noticed in some counties such as Toole and Hill counties. Out of two selected sites to examine the bio-pesticides in 2018, at Conrad, Roundup

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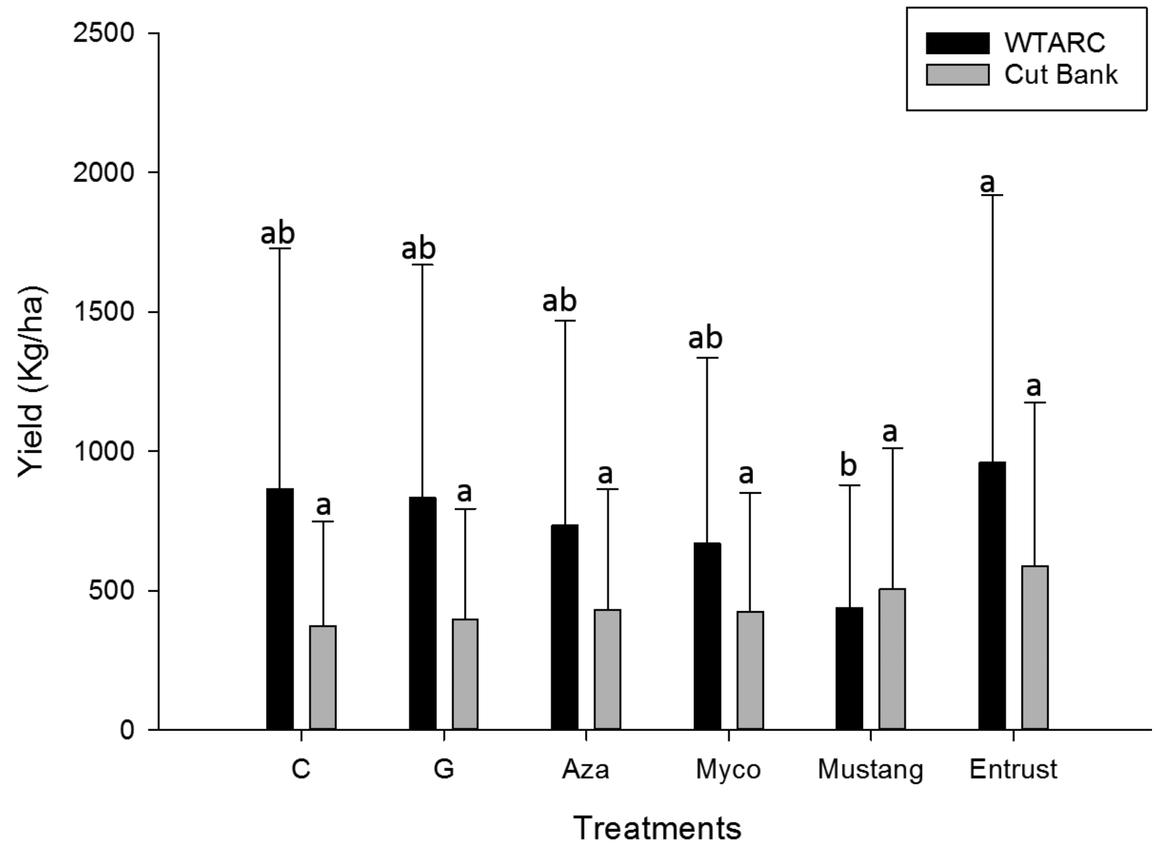

Figure 2. Mean yield (kg/ha) of canola at two sites, WTARC () and Cut Bank () in 2018. [n = 4]. Different letters above the bars indicate significant differences (α= 0.05). y-axis shows mean yield (mean yield+ SE) and x-axis indicate six treatments.

Efficacy of bio-pesticides for managing flea beetles on canola

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Ready canola was seeded and at Cut Bank, Cibus canola was seeded. At both the sites in 2018, no cabbage seedpod weevil was observed but both sites were infested with flea beetles. At WTARC site, flea beetle infestation was extremely heavy at two cotyledon stage as well as at pod stage (Figure 1 A, B), whereas at Cut Bank after application of insecticides, flea beetles population was much less. However, at Cut Bank site, an evident population of thrips was found (Figure 1 C). In addition, Cut Bank plots were damaged by hail, and yields were reduced. Nevertheless, at both the sites, a significant decrease in pod and leaf injury was recorded in the Entrust treated plots. Both Aza-Direct and Mustang did not efficiently protect canola crop from flea beetles in a single spray treatment. Gaucho and Mycotrol both performed better than Aza-Direct and Mustang (Figure 2). In 2018 study, Entrust seems to work best in terms of reducing the flea beetle population and also in increasing the yield. In spite of heavy infestation of flea beetle, a single spray of Entrust gave prolonged protection against flea beetle at WTARC. Entrust kills insect both by contact killing and through ingestion by the insect. Entrust can work efficiently along with seed treatment to avoid damage by flea beetles to canola crop in Montana. This year we did not have economic populations of cabbage seedpod weevil and lygus bugs. We believe that growers, in the future, that experience economic levels of these pest will benefit from the application of bio-pesticides, such as Entrust to enable management of insect pests on canola.

Researcher makes important finding in plant reproduction

By Katie Pratt, University of Kentucky College of Agriculture

A University of Kentucky (UK) researcher was part of an international group of scientists who traced the origins of sperm production in land plants to one protein. This could have important implications for plant breeding and weed management.

"Because this gene is conserved in all land plants, the generation of complete male sterile plants might be beneficial for plant breeding," said Tomokazu Kawashima, assistant professor in the UK College of Agriculture, Food and Environment. "In addition, it may be used for weed management by introducing sterile pollens to compete against viable pollens."

Kawashima led the project prior to joining the UK faculty when he was a senior research fellow in the Frederic Berger lab at the Gregor Mendel Institute of Molecular Plant Biology in Austria. Kawashima, institute scientists and researchers at Kyoto University in Japan found that the protein called DUO1 is responsible for the evolution of sperm in all land plants. Their findings were published recently in the academic journal Nature Communications.

"We knew from previous work that a protein called DUO1 controls the development of non-moving sperm in the model plant Arabidopsis," said Kawashima, a faculty member in the UK Department of Plant and Soil Sciences. "We found similar DUO1 proteins in liverworts and mosses, which are representative of the first land plants and have active sperm. When we disrupted the DUO1 gene in liverworts, they were no longer able to form sperm, confirming that DUO1 has controlled sperm development since land plants evolved."

The researchers found that a small change in the DUO1 protein that occurred at least 700 million years ago allowed it to bind to a new DNA sequence and regulate new genes. These genes were responsible for sperm development. While the protein continues to control sperm production, the gene networks have evolved to produce the different sperm types found in plants today. By analyzing other land plant ancestors, researchers were able to find the protein in stoneworts—algae that formed from an ancient ancestor common to all land plants at least 700 million years ago—confirming the DUO1 timeframe.

The entire journal article is available online at https://www.nature.com/articles/s41467-018-07728-3.