Can we immunize the plants for defense against wheat stem sawfly attack?

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Wheat stem sawfly (Cephus cinctus) is the most economically important insect pests affecting Montana wheat production. In order for wheat producers to maximize production efficiency and profitability, insects, weeds and diseases should be well managed. In the area of insect pests, few of them exclusively attack wheat. However, wheat stem sawfly has a history of more than one hundred years for causing damage and yield losses to Montana wheat production.

Wheat stem sawfly originally attacked native grasses of Northern Great Plains. In the late 1890s, wheat producers in Montana, North Dakota, Manitoba and Saskatoon first began to notice wheat stem sawfly damage in their spring wheat production. By the 1920s, wheat stem sawfly apparently became most detrimental insect pest of spring wheat in the Northern Great Plains. However, over the last few decades wheat stem sawfly has adapted to winter wheat, and winter wheat now sustains extensive damage in the Northern Great Plains. Currently, in the United States, wheat stem sawfly is only a major issue in Montana and North Dakota. In recent years, wheat stem sawfly problems in winter wheat production has also spread to other states including western South Dakota, eastern Wyoming, western Nebraska and northeastern Colorado. At current wheat prices, economic grain yield losses caused by wheat stem sawfly damage is estimated to be $ 250 million per year alone in Montana.

Wheat stem sawfly has a unique life cycle with cryptic (hidden) feeding habitat. The adult is truly a small wasp. It is about three quarter inches long with shiny black body, yellow legs and three yellow bands around the abdomen. The adults are most active when temperature is 70-90 0F, with sunny sky and little wind. They are weak fliers and usually search host plants near their emergence sites. However, recent reports indicate that adults can migrate up to several miles in search of host. In Montana, adults begin to emerge from late May to early June and emergence may continue until early July. Female adults deposit eggs inside developing wheat stems. Multiple eggs can be laid within a stem, but only a single larva survives up to maturity. Eggs hatch about five to seven days after being laid. Throughout the summer, the larvae eat the inside of the wheat plant, disrupting sugar and water movement, weakening the plant and reducing yield levels. As wheat plants mature in summer, the larvae cut the wheat stems at the base to prepare for a period of dormancy called diapause. The diapausing larvae spend whole time inside wheat stubble during the fall and winter. In the spring, adults emerge from the stem, and the life cycle continues.

Because of wheat stem sawfly larvae hidden feeding habitat, it is often challenging to manage the damage with a single control measure. Therefore, several integrated pest management strategies including pest monitoring, host plant resistance, cultural control and biological control have been investigated and developed in Montana and North Dakota. Wheat stem sawfly infestations can be easily monitored during spring and summer at crop growing conditions or after crop harvest in field during fall. During spring and summer periods, infestations can be checked by sweep netting for the adults and splitting the stems for presence of sawfly egg, larva or frass. In the fall, wheat stem sawfly infestation can be surveyed by looking for plugs in infested wheat stubble. The presence of plugs in wheat stubble indicate the presence of diapausing (inactive stage) larvae inside stems. Based on Canadian research, it is recommended to plant solid stemmed winter wheat varieties if there was a 10-15% infestation in the previous year. Host plant resistance is one of best integrated pest management strategies for wheat stem sawfly management. Solid stemmed wheat varieties are often known to tolerate wheat stem sawfly damage. In Montana, for instance, "Warhorse" is known as a wheat stem sawfly tolerant solid stemmed winter wheat variety. However, producers should also aware that solid stemmed varieties may produce lower yields compared to hollow stemmed varieties which are usually susceptible to sawfly damage.

Cultural control such as planting trap crops (e.g., barley, oat or rye) along the wheat field margin may be helpful in minimizing damage and reducing adult numbers in the subsequent year. Crop rotation with broadleaf crops (e.g., pulses, corn and canola) would also be worthwhile to consider when wheat stem sawfly populations are high, since they do not lay eggs in these crops. When infestation level exceeds 15%, producers should consider for swathing the wheat crop once kernel moisture drops below 40% to save infested stems before they fall on the ground. Two parasitic wasps, Bracon cephi and B. lissogaster are important biological control of wheat stem sawfly in Montana. These two wasp species can parasitize up to 98% of larvae, but are most effective when populations are low. Currently, there is no effective or producer user friendly synthetic chemicals that can be used to manage wheat stem sawfly. An organophosphate insecticide (Thimet 20-G®) has recently been registered in Montana for use to manage wheat stem sawfly. This chemical is restricted and poses many health and environmental risks. Because of this, producers are often reluctant to use it. In this context, the use of plant defense elicitors to "immunize" plants could provide additional management strategies against wheat stem sawfly.

Plant defense elicitors are small molecules that activate induced defensive responses in plants, and thus make plants more resistant to pests. Defense elicitors have been used to develop new reduced risk pesticides and plant activators; for instance, defense elicitors are used as active ingredients in Actigard (Syngenta Crop Protection) and Messenger (Eden Bioscience Corp). The elicitors, that have been extensively studied, can provide resistance to plants by either of one of the defensive pathways in the plants: salicylic acid mediated resistance or jasmonic acid mediated resistance.

Salicylic acid, critical plant hormone that induces resistance in plants to fungal, bacterial, and viral pathogens. The plant elicitor benzo-(1,2,3)-thiadiazole-7-carbothioic acid S-methyl ester (BTH), commercialized with product name- BION® (in Europe) and Actigard® (in the United States), is a functional analog of salicylic acid. This product was primarily developed for disease control in a variety of agricultural crops, conferring resistance to a broad range of fungal, bacterial and viral pathogens. However, Actigard foliar applications have also been shown to confer plant resistance to insect herbivores such as aphids, whiteflies, and leaf miners.

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cis-jasmone is a well-known component of plant volatiles, and it is released naturally from insect-damaged plants. It is structurally related to Jasmonic acid and known to activate plant defense. Foliar application of cis-jasmone to plant surfaces have shown to induce resistance against many insect pests such as beet armyworm, western flower thrips, and grain aphids. However, the effects of salicylic acid and jasmonic acid mediated resistance on wheat stem sawfly performance on winter wheat have not yet been determined in Montana.

In 2017, we tested two commercially available synthetic defense plant elicitors (Actigard® and cis-jasmone) and a botanical insecticide (Azadirachtin®) for their ability to repel wheat stem sawfly adult settling behavior, and thus can provide protection for wheat from pest oviposition, under laboratory conditions. In addition, field experiments were performed to determine whether these chemicals impact the wheat stem sawfly fitness (larval mortality and larval body weight), winter wheat plant fitness (infestation, stem lodging, yield, and quality), adult population of wheat stem sawfly and Bracon spp., and larval parasitism levels. Field experiments were conducted in replicated field trials in three locations (Conrad, Knees and Choteau) of North Central Montana. At all field trial locations, chemicals were applied at the wheat stage with 4-6 nodes. Azadirachtin® was included in study because it has been known to have a variety of effects on insect pest species including insect behavior and insect physiology. Our previous study indicated that Azadirachtin® can reduce the wheat stem sawfly infestation damage percentage level.

Our lab results indicated that there were no significant differences in adult settling behavior (e.g., landing, resting and walking) on plants exposed separately to each chemical and control. In contrast, when adults were exposed simultaneously to treated and untreated plants, there was a significant reduction in the percentage of adults settling on Actigard® and Azadirachtin® treated plants compared to plants sprayed with water in the same cage. However, in field situations, regardless of application timing and field location, none of the chemicals significantly reduced adult population or stems damage.

Especially, two times applications of Actigard® (i.e. chemical spray at sawfly egg and larval stages) significantly increased diapausing larval mortality percentages and lowered stem lodging levels compared to untreated controls at Knees and Choteau locations, while no effects at Conrad location. Larval body weight was significantly lower in plots treated with Actigard® at Knees and Conrad, but no effects at Choteau. On the other hand, Actigard applied twice did not improve wheat yield and quality. The other two chemicals cis-jasmone and Azadirachtin® had no impact on wheat stem sawfly management under field conditions. The data from these experiments are compiled and incorporated in the 2017-WTARC Annual Report, (see page#110-123), http://agresearch.montana.edu/wtarc/reports-pdf/WTARC2017Report.pdf

In summary, additional field studies are planning to determine whether Actigard® application techniques (e.g., timing, rate, insect stage and crop stage) can reduce sawfly damage and improve wheat yield and quality. Overall, management of wheat stem sawfly using synthetic plant defense elicitors could be a potential option for managing this pest, especially in the absence of effective synthetic insecticides, and could be easily incorporated into an integrated pest management program.

Age to castrate horses

Controversy exists as to what is the best age of castrate (geld) a male. Some believe that the younger the age of castration, the taller the horse will grow, with less chance of the horse acquiring aggressive behaviors. Others want a horse to remain intact longer so that it will develop more body substance and a shapely, cresty neck. Having a distinctive crest (the topline of the neck) is desirable in some breeds.

Many breeders feel that only a superior horse should be a stallion for breeding purposes; all others should be gelded, with the belief that most good stallions make great geldings.

Some cultures have breeds that are seldom castrated. The majority of male Pure Spanish Horses are left intact. Machismo is thought to be one factor in this philosophy.