For *Traders Dispatch,* July 2014

Pathogenic Fungi Kill Wireworms Where They Feed

Gadi V.P. Reddy and Brian Thompson
Montana State University
Western Triangle Ag Research Center
9546 Old Shelby Rd
P. O. Box 656
Conrad, MT 59425, USA

The management of insect pests on our agricultural crops relies heavily on the use of chemical insecticides. However, due to the environmental and economic concerns arising from heavy and repeated use of insecticides (i.e. insecticide resistance and non-target effects on pollinators and natural enemies) the desirability of more environmentally sustainable practices in pest management are increasing. Under these circumstances, the development of sustainable biorational insecticides (biopesticides) like soil dwelling fungi pathogenic to insects have attracted considerable attention.

Many pest insects have a soil dwelling stage in their life-cycle. For some it is a short stint, while for others the majority of the life-cycle is spent below the surface. Soil dwelling insects present a particular problem for growers as their 'concealed' habit protects them from exposure to topical insecticides. The family of beetles known as 'Click' beetles are one such species that spends the majority of its life below ground. Unfortunately, some herbivorous members of this diverse family of beetles are emerging as a major pests of wheat and barley.

Immature Click beetles are better known as wireworms for their "wire-like" cylindrical hardened bodies. The armored appearance of wireworms belies the battleground of interactions between predators, pathogens and prey in the soil. Fungal pathogens are promising control agents for wireworms. Spores of these pathogenic fungi persist in the soil. Upon touching the cuticle of a passing insect the spores stick and are carried along with the insect. Spores stuck to insect cuticle proceed to grow and enter the body of the insect by dissolving a hole in the cuticle. Once inside the fungus kills the insect and consumes it from inside. Once consumed the fungus fills the cadaver of the insect with spores that will eventually burst forth from the insect ready to repeat the process all over again.

Wireworms are active in the soil column and move up to a meter or more through the soil in search of the seeds and roots on which they feed. Under high populations wireworm damage can significantly affect crop yield. Wireworm damage is often confined to certain areas of a field, and stand losses can vary from zero to 60 or 70 percent. Historically, wireworms have been severe pests with few or no effective management techniques. Effective control was not achieved until inexpensive and broad-spectrum insecticides became available in the 1950s. Lindane was used as a seed treatment against wireworms in many crops for more than 30 years. The resurgence of wireworms in recent decades can be attributed in large part to the cancellation of the registrations of many conventional insecticides that were formerly used for wireworm control, and the ineffectiveness of their second-generation replacements. Biopesticides, such as fungal pathogens might be an attractive alternative for wireworms.

Producers, industry, agriculturalists, and scientists all recognize wireworms as an increasing threat to the sustainable production of many field crops, of which at least 40 have been noted in the

literature. Now, producers must contend with a serious pest without effective management tools or the fundamental knowledge to develop new tools. In recent years, wireworm damage has become an increasing problem for growers, so the demand for meaningful risk assessment and useful methods to restrict damage is increasing. However, due to the below ground habitat of the wireworms, pest control is difficult and leads to unsatisfactory results. Although many wireworms are pests of wheat, a recent survey indicates that *Limonius californicus* and *Hypnoidus bicolor* are the dominant wireworm species found in Montana, particularly in the Golden Triangle area.

Montana State University Western Triangle Agricultural Research Center started research on the use of biopesticides for the control of wireworms, wheat stem sawfly and canola flea beetles in 2012. In this work, three entomopathogenic fungi were tested for their efficacy against wireworms in spring wheat.

The three fungal species used (*Metarhizium brunneum* F52, *Beauveria bassiana* GHA, and *Metarhizium robertsii* DWR 346) were evaluated as seed-coat, in-furrow granular, and soil band- over -row drench applications in addition to imidacloprid (Gaucho® 600) seed treatment (as a chemical check), the approach currently being used by growers. Wireworm damage in these treatments was evaluated as standing plant counts, wireworm population surveys, and yield. The three fungi applied as formulated granules or soil drenches and the imidacloprid seed treatment all resulted in significantly higher plant stand counts and yields at both locations than the fungus-coated seed treatments or the untreated control. Significant differences were detected among the application methods but not among the species of fungi within each application method. All three fungi, when applied as granules in furrow or as soil drenches, were more effective than when used as seed-coating treatments for wireworm control, and provided an efficacy comparable or superior to imidacloprid. The fungi used in this study provided significant plant protection under moderate wireworm pressure and increased crop yield, supporting their value in the management of this pest. These results were published in *Journal Invertebrate Pathology*, 2014, 120: 43–49. We have recently taken up field trials to evaluate the efficacy of the combination of two fungal formulations so that we can reduce the application rate to cut the costs and improve upon this technology.

Biopesticides fall into three categories, microbial, plant incorporated protectants and biochemical pesticides. Microbial biopesticides act through bacteria, fungi, viruses or protozoans to kill or deter insect pests. The microbial 'active ingredient' may have specific or broad spectrum action and may act on either insects or plants. The bacterium, *Bacillus thuringiensis* (Bt) is a good example of a widely used biopesticides that has both broad and specific action depending on the strain used. The use of insect pathogenic fungi and bacteris to control wireworms and other crop pests is an emerging technology and one that may help where available chemical pesticides have not been effective. However, cost, shelf-life, and consistency are persistent problems that need to be dealt with in the development of this technology. Numerous studies have been carried out to explore the potential for increasing their compatibility, e.g. lowering costs, improving field performance and stability, etc. Despite the high desirability of utilizing environmentally safe biopesticides, the commercial development and broad-scale use of these microbial biocontrol agents are still largely limited.

Generally, biological control of wireworms using entomopathogenic fungi is a promising option, especially in the absence of effective chemical agents and given the potential for incorporating their use into an integrated pest management program. For additional information, please contact Dr. Gadi V.P. Reddy (reddy@montana.edu) or Dr. Brian Thompson (brian.thompson@montana.edu) at 406-278-7707.

Wireworms affected by entomopathogenic fungi