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Entomopathogenic Nematodes (EPNs) for Management of Insect Pests in Montana

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Nematodes are microscopic un-segmented worms that inhabit environments ranging from fresh water to salt water, soil, digestive tracts, plants and even polar ice caps. Some of the better known nematodes are parasites of humans and our crops. However, there are also numerous species of beneficial nematodes that infect soil borne insects and are capable of significantly reducing pest insect populations. Nematodes that infect insects are commonly referred to as entomopathogenic nematodes (EPNs). EPNs help growers by killing insects and reducing their overall population (i.e. 'biological control'). EPNs naturally occur in most soils, but can also be purchased and introduced to supplement native populations. EPNs that infect insects don't infect humans, birds or mammals. Because of these characteristics, as well as their ease of mass production and exemption from EPA registration, a number of commercial enterprises produce these beneficial nematodes as biological "insecticides" for use in home and commercial agriculture.

Research initiated at the Montana State University Western Triangle Agricultural Research Center in Conrad, MT is looking into the use of EPNs for control of insect pests of wheat, barley and canola in Montana. Many of the pests affecting these crops have soil dwelling stages or are concealed within the plant for a significant period of time making them difficult or in some cases impossible to control with conventional pesticides. Dr. Gadi V.P. Reddy, Superintendent and Entomologist/Insect Ecologist, and Dr. Brian Thompson, Entomologist/Postdoctoral Research Scientist, have initiated a research program evaluating the effectiveness of EPNs for the control of emerging and existing insect pests on these crops as part of an existing integrated pest management (IPM) program. Results from this research are being disseminated through MSU Extension Agents to the local growers.

Nematodes have special attributes that enable them to act in areas where conventional pesticides may not. For example, nematodes applied to soil or plant material actively search for insect prey. Searching nematodes are even capable of penetrating living plant tissue in search of their insect hosts. Once EPNs find the insect, the nematodes burrow into the body of the insect through the

mouth, anus, spiracles, or sometimes by puncturing directly through the cuticle of the insect. The nematodes kill insect hosts by releasing a bacterial partner (symbiont) into the body of the insect. EPN infected insects die within ~48hrs of infection. The EPNs then feed and reproduce inside the dead insect. Once the insides of insect cadaver have been completely consumed the nematodes (infective juveniles) bust from the cadaver and begin searching for a new host. The infective juveniles do not feed, mate, or develop. Each insect host may produce up to 500,000 new infective juvenile nematodes ready infect the next host.

How do EPNs work for the wheat stem sawfly and other insect pests?

Many growers and the general public are wondering how EPNs will cause mortality to the wheat stem sawfly larvae, which live inside the stem of wheat plants and other grasses. Another such deliberating point is that how EPNs will perform on solid stem versus hollow stem wheat varieties.

Dr. David I. Shapiro-Ilan, Research Entomologist, USDA-ARS, Fruit and Tree Nut Research Unit, Byron, Georgia has researched the use of EPN for biological control of wood-boring insects in fruit trees where EPNs penetrate into insect galleries in wood to infect wood-boring insects. Similarly, larvae of the wheat stem sawfly feed internally on wheat plants. Research by Drs Reddy and Thompson aims to determine whether EPNs will search out and kill wheat stem sawfly in the plant. This research could yield an important new tool for growers in controlling the wheat stem sawfly. The rate of EPNs application considered to be a minimum standard for most pests is ~1.5 billion nematodes per acre (~250,000 per m^2).

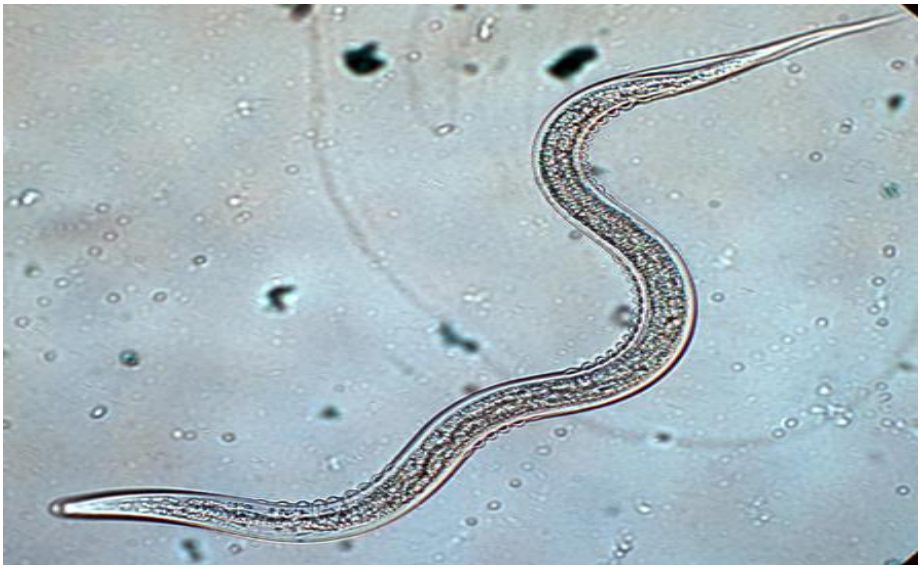
Early results with EPNs

Last year pilot projects showed encouraging results for control of wheat stem sawfly. These results, published in the *Journal of Agricultural Sciences*, 2014, 6: 1-9 showed EPNs significantly reduced damage caused by wheat stem sawfly. As a result yields were increased compared to plots that did not receive EPNs. In a similar study, work with EPNs showed promising results for control of the canola flea beetle (*Journal of Economic Entomology* 2014, 107: 661-666). Damage caused by *Phyllotreta cruciferae* (canola flea beetle) was reduced when EPNs were applied after sowing canola. A prophylactic strategy was attempted to control the early larval stages of flea beetles by application of EPNs at standard rates when early stages of the pest are present in the field. These experiments show promise for a broad spectrum of control strategies using nematodes in IPM.

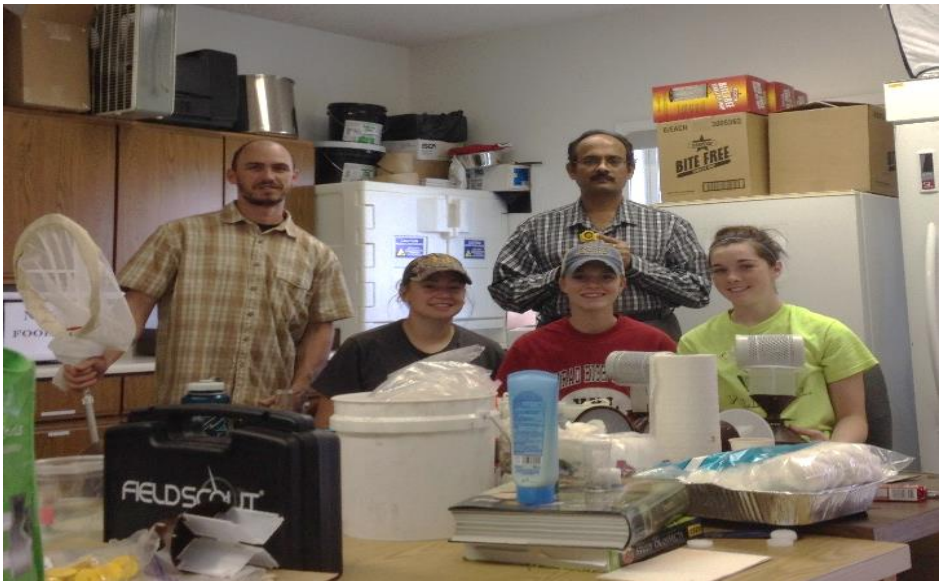
Nematodes into the future

Tests to improve the effectiveness of EPNs in Montana are underway. EPNs are living organisms that are sensitive to environmental stress. The primary concern and determinant of nematode survival and thus their effectiveness are desiccation (drying) and UV light. In this vein, research into protective coatings that promote nematode survival are scheduled for the summer of 2014. EPNs and other biological control agents, such as predatory insects, parasitic insects and pathogenic fungi, are attractive options for insect pest control. Biological control organisms are relatively easy to produce, non-toxic, target specific, and actively search out their target hosts. For these reasons biological controls are an attractive addition to IPM strategies in Montana and across the region. In addition to sawflies and flea beetles, EPNs may also be effective against orange wheat blossom midge and alfalfa weevil or virtually any soil-borne insect, though further research is badly needed on these insects. On the other hand, wireworms are a difficult pest to control with EPNs because the usual routes of entry used by EPNs may be inaccessible. The production of nematode technology by major chemical producers (e.g. BASF) and smaller specialized producers means EPNs are already available to virtually any grower interested in adopting this technology.

The present research on nematodes was funded by the Montana Wheat and Barley Committee. The EPNs for the current work are being supplied by BASF Specialty Products through Jennifer Bergh, Market Development Specialist for the Western region (jennifer.bergh@basf.com). For additional information, please contact Dr. Gadi V.P. Reddy or Dr. Brian Thompson at 406-278-7707.



Entomopathogenic nematode infective juvenile



A team from MSU-Western Triangle Agricultural Research Center working on entomopathogenic nematodes (Standing L to R: Dr. Brian Thompson and Dr. Gadi V.P. Reddy and sitting L to R: Kayla Troester, Taylor Judisch, Morgan Fowler)