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Sept. 14, 2019

**A potential tool to manage wireworms
in wheat and barley**

From Ramandeep Sandhi, Anamika Sharma and Gadi V. P. Reddy, Montana State University, Western Triangle Agricultural Research Center (WTARC), Conrad, MT

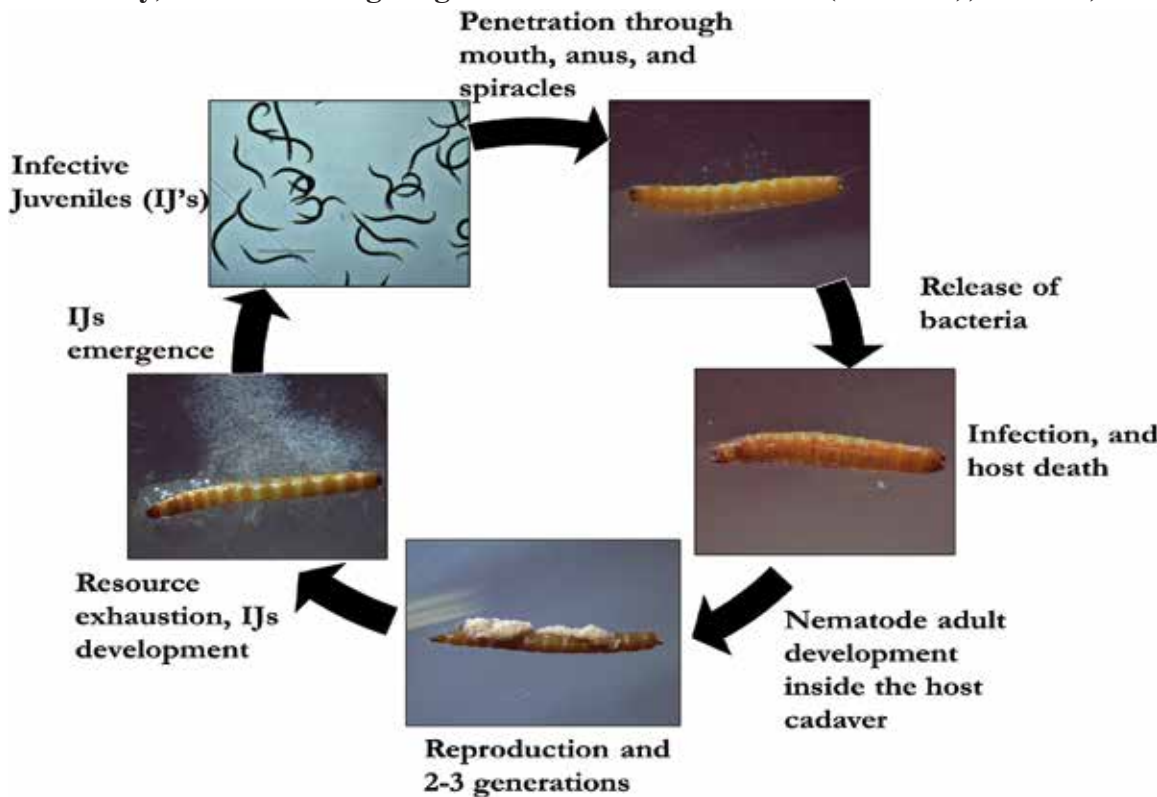


Figure 1. Entomopathogenic (predatory) nematode infection cycle

Wireworms, the larvae of click beetles, are becoming serious pests of wheat and barley in Montana. The farmers are facing significant crop losses due to wireworm damage. The wireworms live beneath the ground, move in the soil up and down when environmental conditions are favorable and feed on germinating seeds, roots and seedlings, ultimately killing the growing plants. This cryptic (hidden) behavior of wireworm makes it difficult to monitor and control the wireworm population. Based on our survey we have come across three species of wireworms; *Limonius californicus*, *Hypnoidus bicolor*, and *Aeolus mellillus* that damage wheat and barley fields in the Golden Triangle region of Montana. With the ban of insecticide Lindane in 2009, there has been continuous research efforts and requirement for an eco-friendly, long-lasting and dependable control techniques to manage wireworm population and to avoid yield losses.

At, WTARC, we have been researching to find an effective biological control option to manage wireworms since 2012. These biological control methods involve Entomopathogenic nematodes (EPNs), entomopathogenic fungi, and bio-based insecticides. EPNs are soil inhabiting biocontrol agents that can kill a variety of insects with negligible effect on non-target insects and provide an environmentally friendly option to manage insect pests. These EPNs mainly fall under two nematode genera; *Steinernema* and *Heterorhabditis*. EPNs work in association with the symbiotic bacteria present inside the EPN bodies. The infective juveniles (IJs), 3rd juvenile stage of EPNs, penetrate the insects through natural openings and release symbiotic bacteria inside the body which will release some toxins and enzymes inside the insect body and eventually insects will die in 2-3 days (Figure 1). These bacteria provide nutrition to nematodes and nematodes, in return, provide shelter to the bacteria. Because EPNs specifically target soil-living insects and are proved to be not harmful to other organisms, they are exempt from registration with the United States Environmental Protection Agency (USEPA) as a commercial insecticide. We are using wax moth (*Galleria mellonella*) larvae to rear different species of EPNs in the laboratory on a regular basis.

Earlier, we wrote an article in the Traders Dispatch (January 2018) about using EPNs strains that are commercially available to

test if they can potentially kill wireworms. In 2018, 10 different strains of *Steinernematids* and *Heterorhabditis* genera were received from Dr. David Shapiro (USDA-ARS) and tested against wireworms with different doses (2.5, 5.0, 10.0, and 20 × 10⁹ IJs/ha). Some promising EPN strains like *Steinernema carpocapsae* and *S. riobrave* were found to cause 50-60% wireworm (*Limonius californicus*) mortality in 2-3 weeks in laboratory and green house experiments in 2018. We are testing these EPN strains in the field during the summer 2019 to assure virulence in the field.

Apart from this, in summer 2018, we surveyed different areas in Golden Triangle Region of Montana (Pendroy, Shelby, Ledger, Conrad, Brady, Sunburst, Choteau, Knees, etc.) to find and extract the native EPNs from soils of Montana. Overall, we collected 150 soil samples from 30 field sites in different areas as mentioned above. The soil samples were left for seven days with wax moth larvae to see if they are getting infected with naturally present EPNs in the soil. Out of these 150 samples, 19 samples were found positive with naturally occurring native EPNs. However, we were able to culture only four samples out of these 19 positive samples. It might be due to the presence of some other bacteriophage nematodes or less adaptation of EPNs to the laboratory conditions. These EPN species are from Valier, Choteau, and Kalispell areas. On the basis of morphological characteristics of these EPNs and infectivity symptoms in insects, three of four species were identified as *Steinernematids* (members belong to genus *Steinernema*) and one species belong to *Heterorhabditis* genus. To identify these nematodes to species level, we are using molecular techniques i.e. DNA extraction and gene sequencing. These studies are being conducted at Brigham Young University, Provo, Utah.

We tested the efficacy of these four Montana native EPN species against wireworms (*Limonius californicus*) in the laboratory with different doses i.e. 700 IJs, 1400 IJs, 2800 IJs, and 5600 IJs/wireworm larva. Out of four species, three species belonging to *Steinernema* genus caused 40-50% mortality within three weeks. However, our results indicated *Heterorhabditis* species was not able to kill the wireworm larvae as effectively as *Steinernematids*. This confirmed the results of the experiments conducted

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MSU to purchase pigs from 4-H'ers for use in dining halls

From MSU News Service

Buyers for Montana State University's (MSU) Culinary Services have begun fanning out across the state to purchase pigs at 4-H auctions that will end up on the plates of college students.

Last year, MSU purchased 42 pigs from 4-H'ers at eight county fairs held across the state from Plentywood to Hamilton, which accounted for 5,000 pounds of pork used in the university's two dining halls. This year, MSU expects to purchase about 60 pigs at 12 fairs across Montana.

"We're committed to buying as much Montana food as we can, and there is nothing more Montanan than livestock raised by a 4-H kid," said Rich Huffman, MSU Culinary Services director.

This year, MSU buyers plan to visit the following fairs on the following dates:

- Gallatin County Fair, Bozeman, July 19
- Lewis and Clark County Fair, Helena, July 27
- Carbon County Fair, Red Lodge, July 27
- Sheridan County Fair, Plentywood, July 27
- Butte-Silver Bow County Fair, Butte, August 1
- Richland County Fair, Sidney, August 2
- Western Montana Fair, Missoula, August 10
- Madison County Fair, Twin Bridges, August 10
- Northwest Montana Fair, Kalispell, August 17
- Ravalli County Fair, Hamilton, August 31
- Beaverhead County Fair, Dillon, August 31
- Sanders County Fair, Plains, September 1

"We so enjoy meeting the 4-H youth; their enthusiasm and professionalism stands out," Huffman said. "They often approach us before the auction with a firm handshake and introduction, tell us all about raising their pig, how much they feed it each day, how much it weighs and how well it was judged. And, to a person, they always thank us afterwards, and often send us a nice thank you note and picture of their hog. These individuals are our future, and we know we're in good hands!"

Each year, MSU Culinary Services purchases approximately \$2 million in local food, Huffman said, which amounts to about 25% of its total food purchases. That includes purchases of more than 60 MSU lambs and more than 25 steers from the MSU College of Agriculture's Steer-A-Year student program.

Culinary Services provides more than 12,000 meals in its dining facilities each day during the academic year. More information is available at montana.edu/culinaryservices/.

A potential tool to manage wireworms

CONTINUED FROM PAGE A10

with already available EPNs where *Steinernematids* were more infective than *Heterorhabditis* species. In 2019, these three effective native EPNs from Montana are being tested against wireworms in greenhouse studies to explore the possibility of using the native EPNs for management of wireworms.

In addition, these experiments are being conducted in different soil types present in the Golden Triangle Region. These soil types include sandy loam soil, clay loam, clay, loam, and others. The variation in efficacy of these native and available EPNs against wireworms in different soil types are being investigated at WTARC. Since these soil types are prevalent in different parts of Montana, it will be practical to see if specific EPN species can suppress wireworm population in specific soil type.

We believe, the Montana native EPNs would be more efficient than non-native commercially available EPNs for wireworm management. There are many reasons for this assumption. These strains are adaptive to Montana's extremely cold and hot weather as compared to non-indigenous EPN species. Also, these Montana native EPNs can persist in the soil for a longer period of time as compared to available EPNs, which can make them more suitable for commercial application in Montana. There will be no need for repetitive application of native EPNs in fields. Overall, these EPNs can play a significant role in wireworm management in Montana especially Golden Triangle Region in the suppression of wireworms, helping the farmers to reduce crop yield losses. These EPN species can be integrated with other biological tactics particularly in high wireworm infested areas to manage the populations, making them safer to the environment as well as other non-target organisms.