

INSECTICIDES ARE NOT THE ONLY OPTION: NATURAL ENEMIES CAN CAUSE HIGH MORTALITY ON LARGE APHID POPULATION OUTBREAKS IN SMALL GRAINS

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The bird cherry-oat aphid, *Rhopalosiphum padi* (Figure 1), is one of the common aphids found in Kentucky on small grains, such as winter wheat and barley. *R. padi* is of economic importance due to the direct damage caused to grains by the transmission of barley yellow dwarf virus (BYDV). Infection by BYDV in early growth stages of the host plant are the most damaging since it can stunt growth of the crop and produce heads of reduced size. Bird cherry-oat aphid populations are generally managed by natural predators, such as parasitic wasps, lady beetle larvae, lacewing larvae, and hoverflies.

In early April 2017, a large population of the bird cherry-oat aphid was detected in a barley field in Logan County located in Western Kentucky. The numbers of aphids per row foot were above the economic threshold (our aphid tallies in this field were greater than 100 aphids per row foot), despite the field being treated twice with a synthetic pyrethroid in the fall of 2016 and twice between February and March of 2017. Aphid-infested barley plants were taken to the lab for further evaluation on pesticide resistance. Upon examining the samples in the laboratory, fungal spores (Figure 5a) were spotted on the blades of barley with moribund (dying) aphids.



Figure 1. Adult bird cherry-oat aphid
(Photo: Y. Gonzalez, UK)



Figure 2. Petri Dish set up for a LD50 test.
It contained two 4-cm. barley blades and 10 adult aphids

METHODS

LD50 Laboratory Test

Four different concentrations (1.977, 19.777, 197.777, and 1977.777 ppm) of Baythroid® and a water control were used, and replicated three times. We used a 100 x 15 mm petri dish containing two 4-centimeter blades of barley and 10 adult aphids, collected from the infested Logan County field (Fig. 1). The effect of the pesticide was monitored every 24 h. The reproduction of the adult aphids was also documented.

Logan County Field Test

Six insecticides plus a control (Table 1) were lined up side by side measuring 200 ft long and 4 ft wide each with a gap of 5 ft in-between each treatment. From each treated strip there was 4 one foot samples randomly collected. These strips were monitored 1d, 3d, 7d and then weekly for live aphid populations during 3 week period.

Table 1. Insecticides used for the field test.

Treatments	Rates	Application date
Warrior® (lambdacyhalothrin)	1.28	4/14/2017
Beleaf® (flonicamid)	2.8	4/12/2017
Endigo®(λ-cyphalothrin+thiametoxam)	4.5	4/12/2017
Hero® (Z-cypermethrin+bifenthrin)	5.5	4/12/2017
Stallion™ (Z-cypermethrin+chlorpyrifos)	11.75	4/12/2017
Warrior® + Exponent® (piperonyl butoxide)	1.28 + 8.0	4/14/2017
Water control	-	-

RESULTS AND DISCUSSION

LD50 Laboratory Test

There was significant mortality in all treatments within the first 24 h and only $43.0 \pm 0.66\%$ (mean \pm SEM) survival in the water control (Fig. 3). The number of nymphs decreases as the concentration rate increased, with the control having the higher number of nymphs (Fig. 4). At 48 h, there was 100 percent mortality across all treatments. Upon a closer look, fungal spores were observed developing on the aphids in all the treatments. It appeared that all replicates were affected by an unidentified entomopathogenic fungus (Figure 5).

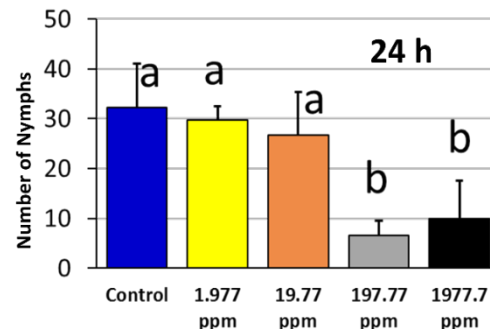


Figure 3. Percent survival of *R. padi* at 24 h. High mortality was seen throughout all treatments including water control.

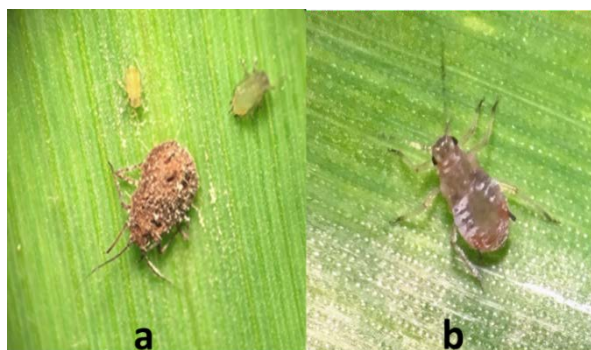


Figure 5. (a) Adult, and (b) nymph *R. padi* affected by an unknown entomopathogenic fungus during LD50 test.

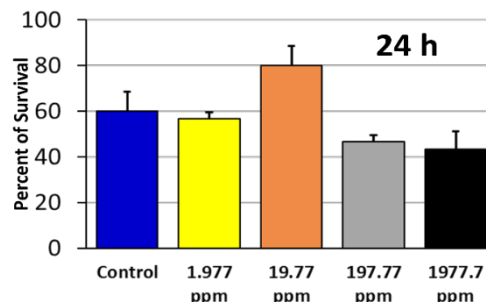


Figure 4. Nymphs laid by *R. padi* at 24 h. Number of nymphs decreased as the concentration rates increased.

Logan County Field Test

Throughout all treatments aphid populations decreased, including the aphids in the untreated control (Fig. 6). This latter observation indicated that some other factor might be causing this population reduction. In this field, high numbers of parasitoids and mummified aphids were observed. This resulted in collection of 4 bundle samples of the barley that were taken to the laboratory to check for parasitoid population and species identification.

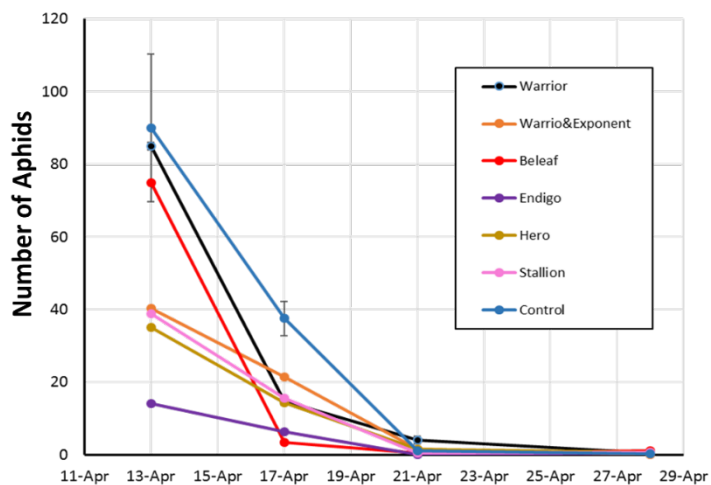


Figure 6. Population of *R. padi* decreased in all insecticide treatments, and the water control plots.

Factors Affecting Rapid Aphid Population Reduction

Parasitic Wasp

A 35cm x 20cm x 10cm shoe box (Sterilite, Townsend, MA) was used to hold the collected bundles of barley (3 replicates by ea. treatment) (Figure 7). They were put in a 25° F incubator for 7d. The populations recorded in the shoe boxes showed the control, Warrior®, and Warrior® + Exponent® did not vary from one another. Belief™, Endigo®, Hero® and Stallion™ had lower number of parasitoids and only Stallion™ had significantly ($p<0.05$) lower number of parasitoids compared to the untreated control (Figure 8). The parasitoid was identified to be *Lysiphlebus spp.*



Figure 7. Shoe box used to determine levels of *R. padi* parasitism in insecticide field treatments in Logan Co.

Entomopathogenic Fungus

An unknown entomopathogenic fungus hindered both the laboratory and field test, thus causing inconclusive results (Figure 5). The high occurrence of this fungus could be due to the high humidity seen in early April of 2017 (Figure 9). Although the fungus was effective, the possibility of another epizootic event is unlikely due to unpredictable weather patterns.

CONCLUSION

The development of resistance to pyrethroids has been occurring, in this study we were not able to detect resistance to this pyrethroids. This aphid outbreak may be caused by the several application of insecticides in the fall and spring, and including the warm winter temperatures that reached >70° F during several days in February and March 2017. However, the fortuitous occurrence of an entomopathogenic fungus

reduced effectively the aphid populations in less than 2 weeks. The presence of this entomopathogenic fungus could be due to the warmer temperatures and high humidity resulting from rains occurring across Western Kentucky in April 2017. Insect-killing fungus thrive in humid environments, which allow fungal spores to spread throughout soil and ultimately aphid populations. In addition, the parasitoid, *Lysiphlebus spp*, thrived in this field most likely as a result of the abundance of aphids.

The treatments with Warrior® and Warrior® + Exponent® did not apparently disrupt parasitoid population in this study as compared with the untreated water control (Figure 8), or their negative effect was not notorious due to the high numbers of parasitoids. However, one important finding here is the negative effect of multiactive insecticides (Endigo™, Hero, and Stallion) in the parasitoids. Parasitoid numbers were lower -although not significantly- in Endigo™, Hero™ and Beleaf™ (the latter is not a multiactive insecticide) compared with the control. The number of parasitoids recovered from the barley plants treated with Stallion™ were significantly ($p < 0.05$) lower than the control. Multi-active insecticides should be used with caution to avoid the reduction of natural enemies such as parasitoids as shown with Stallion™ and to reduce unnecessary cost in the control of phytophagous pests.

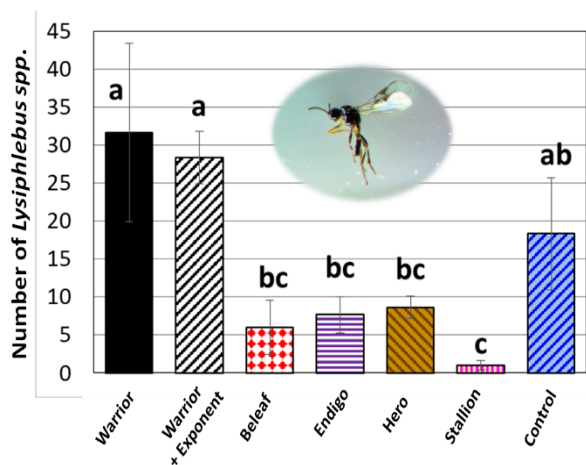


Figure 8. Numbers of the parasitoid, *Lysiphlebus spp.* did not significantly vary between the untreated control, Warrior®, and Warrior® + Exponent®. However, Beleaf®, Endigo®, Hero® and Stallion™ had lower number of parasitoids recovered. Stallion™ had significantly lower numbers than the untreated control

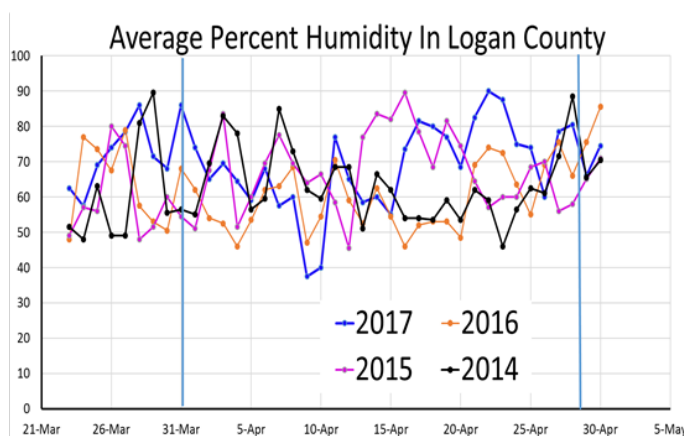


Figure 9. Average percent humidity recorded from late March to April 2014-2017. Entomopathogenic fungus was recorded early April of 2017