Effects of Insecticide Seed Treatment on Aphids and Natural Enemies

Introduction

Aphids are a major pest in wheat globally. The English grain aphid and bird cherry oat aphid are the most common aphid species that infest wheat in Kentucky. English grain aphids (*Sitobion avenae*) are green with black legs and cornicles, while bird cherry oat aphids (*Rhopalosiphum padi*) are dark green or brown, with a reddish spot near the rear end (Flanders et al. 2006). The main concern of aphids that infest wheat in Kentucky is their ability to transmit diseases such as barley yellow dwarf virus (BYDV). Both species spread the virus by feeding on infected plants and then transferring the virus to healthy ones, an aphid will carry the virus throughout the rest of its life cycle. The severity of the impact of barley yellow dwarf virus largely depends on the timing of infection. However, BYDV can reduce growth of tillers, curling of leaves, discoloration, stunted growth, and in some cases death of the entire plant. As one could imagine these ill-effects can greatly reduce yields in winter wheat crop.

There are several ways to manage aphids such as using insecticide seed treatment, foliar insecticide application, and conservation of natural enemies. One of the most effective ways of preventing or weakening aphid populations is using insecticide seed treatments. Insecticide seed treatment can kill aphids for up to a month after planting (Owens et al. 2018). By doing this it may prevent or greatly reduce the transmission of BYDV and may affect aphid populations and/or populations of natural enemies in the spring. Insecticide seed treatment may reduce aphid populations initially, making early sprays unnecessary. However, winter wheat plants grown from insecticide treated seeds may require foliar sprays in the spring, as levels of the systemic insecticide is reduced during that time. During the spring scouting for aphids is still extremely important. Scouting and other IPM tools (i.e. insect thresholds, conservation of natural enemies, use of reduce risk insecticides) allows farmer to monitor insect populations, avoid unnecessary sprays, and reduce expenses of farmers.

The objective of this study was to determine if differences exist in aphid and natural enemy populations during the spring between wheat plants that were established with and without insecticide seed treatments.

Materials and Methods

Insect populations: On 3 December 2018 a Pembroke 2016 variety of wheat was planted into two 50 by 300-ft (width and length) areas at the University of Kentucky's Research and Education Center at Princeton KY. One area consisted of seed that was treated with the insecticide Poncho (clothianidin). The seed used to establish the other area was untreated. In each area two sampling methods were used weekly from 12 April 2018 to 5 June 2018. To determined aphid populations, each week the number of aphids was measured in a one-foot section of a single row at six random locations in each area. To determine natural enemy populations, ten sweeps were completed at ten random locations in each area once per week. The natural enemies tallied in this study were lady beetles, syrphid flies, and parasitoids. If any aphids or caterpillars were present in the sweep net samplings, they were also recorded. Insect population means of insecticide treated seeds and untreated seed were compared using the t-test.

Yields: Harvest was conducted in each of the two plots in seven blocks per treatment. Each harvested block consisted of an area of 5-row wide by 10-ft. long. The blocks were randomly selected throughout each area. Harvested wheat plants were thrashed, their moisture level measured, and weighted. The percent moisture and weight were then used to calculate average yield for each area.

Results and Discussion

The mean numbers of aphids exceeded the economic threshold in both treatment (>10 aphids/1-ft row) on 24 April 2019 (Figure 1). However, significant difference among the treatments (p>0.05) were not found. At this time a foliar insecticide application would have been recommended; though, aphid populations were reduced drastically in the following dates and they did not surpass the economic threshold levels in any of the two treatments. Owens et al. (2018) reported that seed treatment is only directly effective for up to a month after planting in the field; whereas Villanueva (unpublished reports) shown that in small pots the insecticide seed treatment can be effective up to 40 days after emergence. Therefore, something else must have caused the drop of aphid populations.

A probable cause for the aphid population reductions might be the presence of natural enemies observed in Figures 2 and 3. In both treatments sweep net sampling shown the presence of natural enemies. Ladybugs, syrphid flies, and hymenopteran parasitoids were observed actively searching, preying or parasitizing aphids. Syrphids were significantly (p<0.05) more abundant in the untreated seed plots compared with the insecticide treated plots on 26 April, 17, and 23 May (Figure 2). As well, parasitoids of aphids and caterpillars followed similar trend and significantly greater numbers (p<0.05) were found in the untreated plots on 26 April and 1 May (Figures 3). Whereas ladybugs where significantly more abundant (p<0.05) in the insecticide treated plots than untreated plots on 3 and 23 May. Using sweep net sampling aphids were also captured but there were not significant differences observed (Figure 2). In addition, caterpillars were also captured using sweep nets on 1 May and these tallies shown that they were significantly higher (p<0.05) in the untreated plots compared with the insecticide treated seed plots (Figure 3).

Reduced numbers of hymenopteran parasitoids and syrphid flies were found in the in the insecticide treated plots (Figures 2 and 3). This may be the effect of residual traces of clothianidin in the insecticide seed treatment. Clothianidin may have still present in the plants at low levels. These residual traces may not affect aphids however, parasitoids and syrphids might have been affected. However, the high number of ladybugs on the insecticide treated plots shown that these predacious insects may be less susceptible to the clothianidin residues. Neonicotinoids such as clothianidin can persist and accumulate in soils, however as they are systemic, they can be found in nectar and pollen of treated crops or adjacent plants. Trace levels in floral resources such as nectar and pollen utilized by adult parasitoids and syrphid flies may be high enough to affect these beneficial organisms (Goulson, 2013).

The mean yields in the insecticide treated plots showed significantly higher bushels/acre than untreated plots (Figure 4); p = 0.02, t = 1.78, 12 df. The use of the insecticide seed treatment is highly recommended in southern states around the Gulf and up to TN; although in this study the

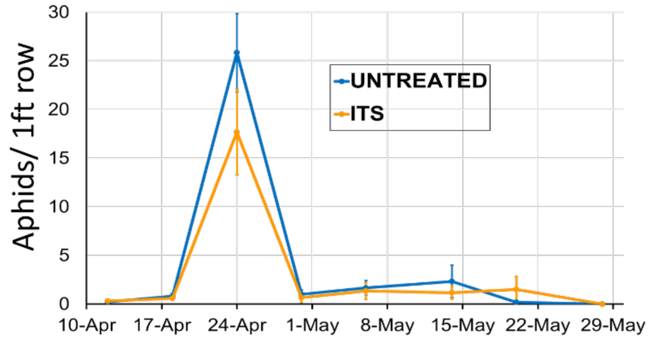

Figure 1. Mean numbers (±SEM) of aphids in untreated and insecticide treated seed (ITS) plots. Aphid populations in plots differed but they were not significant different (*p*>0.05).

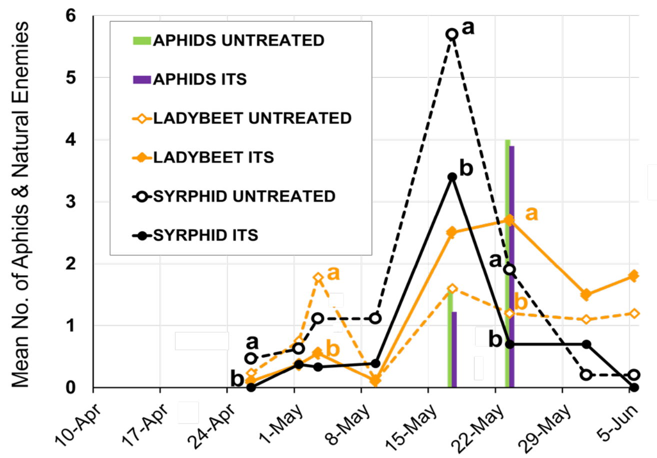

Figure 2. Mean numbers of natural enemies in insecticide treated and untreated seed plots. Column bars represents aphids found using sweep nets. Significant differences between treatments for ladybeetles, and syrphids are indicated by different letters at the same date (*p*<0.05).

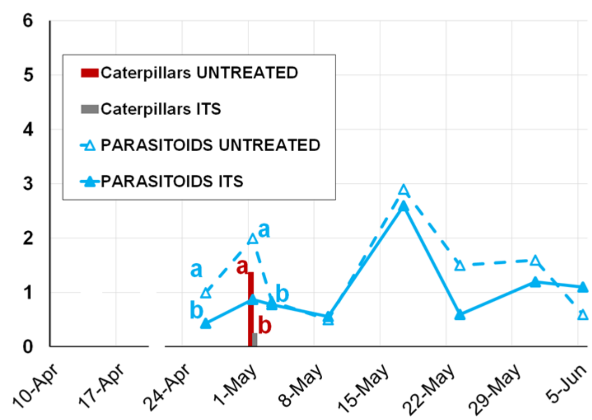

Figure 3. Mean numbers of parasitoids and caterpillars (column bars) in insecticide treated and untreated seed plots. Significant differences between treatments for ladybeetles, and syrphids are indicated by different letters at the same date (*p*<0.05).

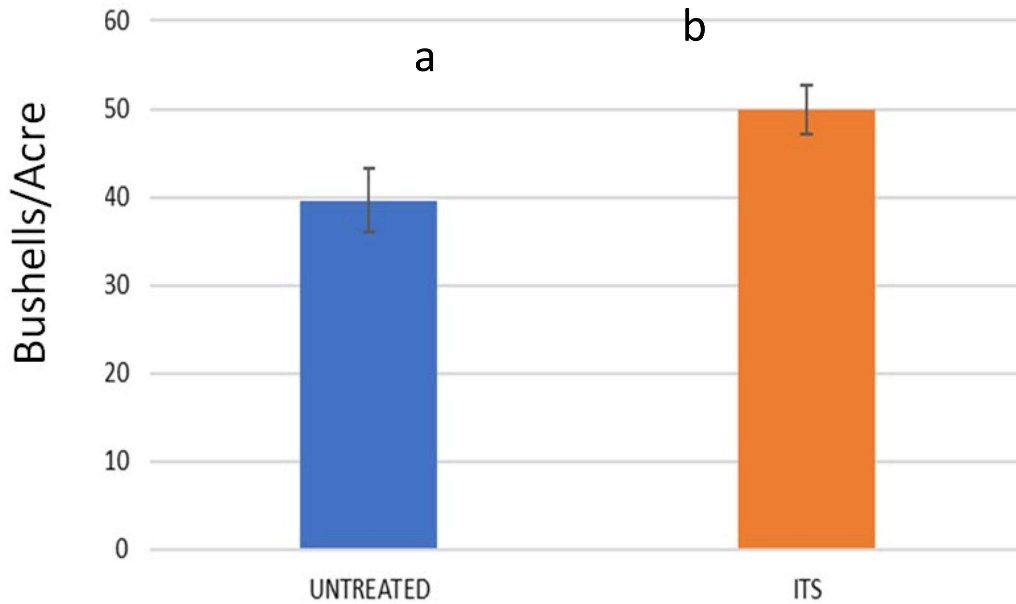

Figure 4. Mean yields (±SEM) in untreated insecticide treated plots (*p*<0.05). Significant differences are indicated by different letters (*p*<0.05)

effect of insecticide seed treatments was positive increasing yields, there is still some dispute about its use in northern states of the USA. Royer et al (2005) found that using imidacloprid as seed treatments often provided positive yield protection however, it did not consistently provide a positive economic return in Oklahoma. Whereas Perkins et al. (2018) analyzing 33 experiments from 2006 to 2017observed a positive contribution of the insecticide seed treatment on wheat reduced aphid populations, BYDV transmissions, and increased yields significantly in west Tennessee.

Conclusion

In this study there was only one date when aphids where above the economic threshold, but aphids were rapidly reduced by natural enemies. In plants grown from insecticide treated seed (ITS) the effects of the seed treatment should have dissipated in the spring however, this study showed that ITS might have some effects on not target natural enemy populations in the spring. Hymenopteran parasitoids, and syrphid flies might be affected indirectly. However, ladybugs did not show this tendency; there were more ladybugs in ITS plots compared with untreated plots. The ITS may have contributed to the yields as they were significantly higher than the untreated seeds. The ITS technology should be part of integrated pest management practices, however, is a tool that still needs further evaluations.

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