SCOUTING FOR APHIDS IN WINTER WHEAT FIELDS WITH OR WITHOUT INSECTICIDE SEED TREATMENT IN MARCH AND APRIL IS CRITICAL TO REDUCE BYDV

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INTRODUCTION

Most of the small grain fields in Kentucky are located in the western region. Small grains (i.e. wheat, barley, rye) are planted in this region from October to the end of November after soybean and corn were harvested. Barley yellow dwarf virus (BYDV) is one of the most important pest problems in wheat. If infections occur in earlier stages of plant development yields might be reduced drastically. Barley yellow dwarf viruses are caused by luteoviruses transmitted by several aphid species. At least 25 aphid species are potential vectors of these viruses (Bauske et al. 1997). Most of these species are present in Kentucky however, *Rhopalosiphum padi* (bird cherry oat aphid) (Figure 1) is the most abundant and common species, followed by *Sitobion avenae* (English wheat aphid). Furthermore, the most effective vector of BYDV is *R. padi* (Smith 1963).

The objectives of this publication are to present findings on the detection of BYDV in commercial wheat fields from December 2016 to May 2019, to report data collected on aphid abundances in research plots in 2019; and to discuss these results.

Figure 1. Adult and Immature Stages of the Bird Cherry Oat Aphid

PROCEDURES

Commercial fields. Random wheat tissue samples were taken from commercial fields located in several counties in western Kentucky (Figure 2). Samples were collected from at least six sites in each field; three samples from border rows and three samples from rows distant >100 m from border edges. Leaf tissue were placed in a labeled re-sealable zipper plastic bag and placed in a cooler and transported to the laboratory. Leaf samples were stored at -20^{o} C until shipped to AGDIA Inc. (Elkhart, IN) for virus test.

In December 2016, and 2017, 15 and 14 commercial fields were sampled, respectively; in March 2019, 11 fields were sampled (this latter sampled replaced the samples conducted in December in 2017 and 2018), and in May 2017, 2018 and 2019; 11, 13, and 12 commercial fields were sampled, respectively.

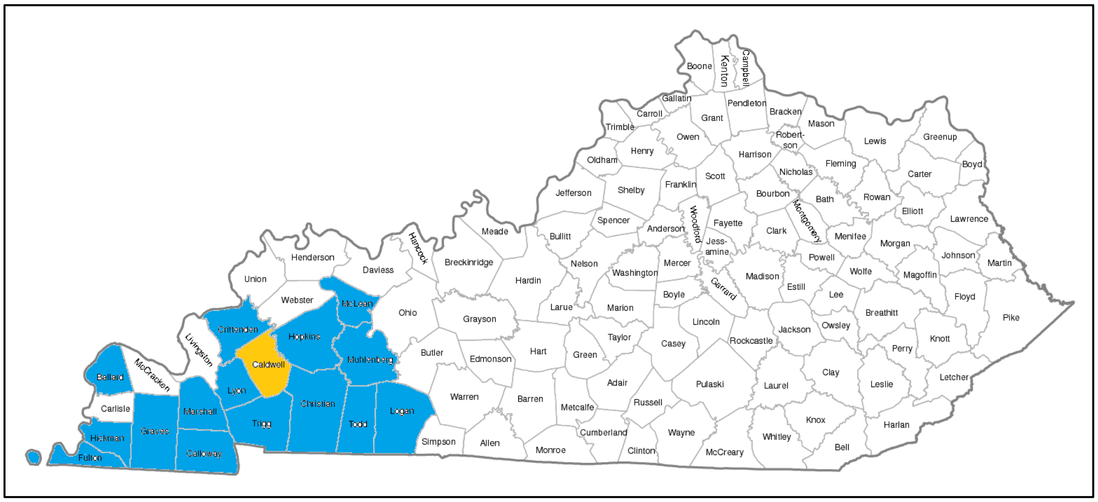

Figure 2. Western Kentucky Counties (Blue) where Tissue Samples were Collected from Commercial Wheat Fields in 2016, 2017, 2018, and 2019. Samples Collected from Experimental Wheat Plots were Taken from Research Plots of the University of Kentucky's Research and Education Center, Caldwell Co. (Yellow).

Field studies in the UK-REC at Princeton in the 2018-2019 season. Two large fields, 25 m wide by 95 m long were planted with the cv. Pembroke-2016 with (clothianidin, Poncho®) and without insecticide seed treatment on 1 December 2018. Aphid tallies were conducted in 1-foot row length (30.4 cm) of wheat (at the bottom and along the entire plant foliage) searching visually for aphids and using 10X magnifier lenses during the fall 2018, and since the beginning of March until the end of May in 2019 in at least six sites in each plot. Also, natural enemies (syrphid flies and larvae, and parasitoids were tallied using 10 pendular sweep net movements from 26 April to 4 June. These plots were not sprayed with insecticides. At maturity, yields were evaluated recording the yields of seven (10-ft two rows) sites across the length of the fields; these data were converted to Bu/A. Means were compared using a *t*-test. All aphid densities and wheat weights were analyzed using Statistica® 13.3 (TIBCO® Software Inc.) In addition, three tissue samples from each plot were tested for virus in March and May 2019.

RESULTS

Virus detection in commercial fields. ELISA analysis of wheat samples conducted in December in 2016, 2017, 2018 and March 2019 provide only negative results for the presence of BYDV. However, samples taken in May 2017, 2018 and 2019 resulted in the positive presence of BYDV; 72.7%, 46.2%, and 41.7%, respectively (Figure 3).

Field studies in the UK's REC at Princeton in the 2018-2019 season. The numbers of aphids in the fall 2018 and in March 2019 were from absent to insignificant. Populations started to increase in April (Figure 4) and, aphid populations peaked on 24 April in the untreated and treated plots with 25.8±4.0 and 17.7±4.4 (Mean±SEM), respectively. After this date, aphid numbers dropped rapidly, and on 30 April aphid counts were below 1 aphid/1-ft row. Aphid population did not increase above economic threshold levels (>10 aphids/1-ft row) after this period. Natural enemies (Figure 5) were tallied on 26 April (after the peak aphid population). Parasitoids were significantly higher in the untreated wheat ($p<0.05$) only on that date. Thereafter, parasitoid populations tended to be higher in non-insecticide seed treatment, although the populations were statistically similar to aphid numbers recorded in insecticide-treated seed plot. Syrphids also were high during the peak aphid population, although significant differences were not found on any date. From all six tissue samples (three from each field -with or without insecticide seed treatment) sent for an ELISA analysis, only one resulted positive for BYDV. This sample was originated in the insecticide treated seed field. Mean yields from fields without and with insecticide seed treatments were 39.6±3.6 and 49.9±2.8 Bu/A, respectively. These means were significant different ($p< 0.05$, $t\text{-}test_{6df}=2.44$).

DISCUSSION

During the last three years, aphid tallies were conducted in replicated small plots in the University of Kentucky's Research and Education Center at Princeton, KY; and in commercial wheat fields. Tallies in the fall in 2016, 2017, and 2018 resulted in undetectable to low numbers of aphids. Aphid numbers did not increase until mid-March. This low population explains the absence of BYDV in commercial fields of western Kentucky during the period this study took place (Figure 3). In addition, from December to mi-March, the low temperatures (<45^{o} F) do not allow aphids to continue their feeding or reproduce unless environmental conditions are suitable (Brabec et al. 2014). Furthermore, foundress aphids (Figure 6) such *R. padi* and *S. avenae* that drop and inhabit wheat fields in November or December rarely increase populations however, when spring arrives, they start to lay nymphs that will rapidly colonize wheat fields.

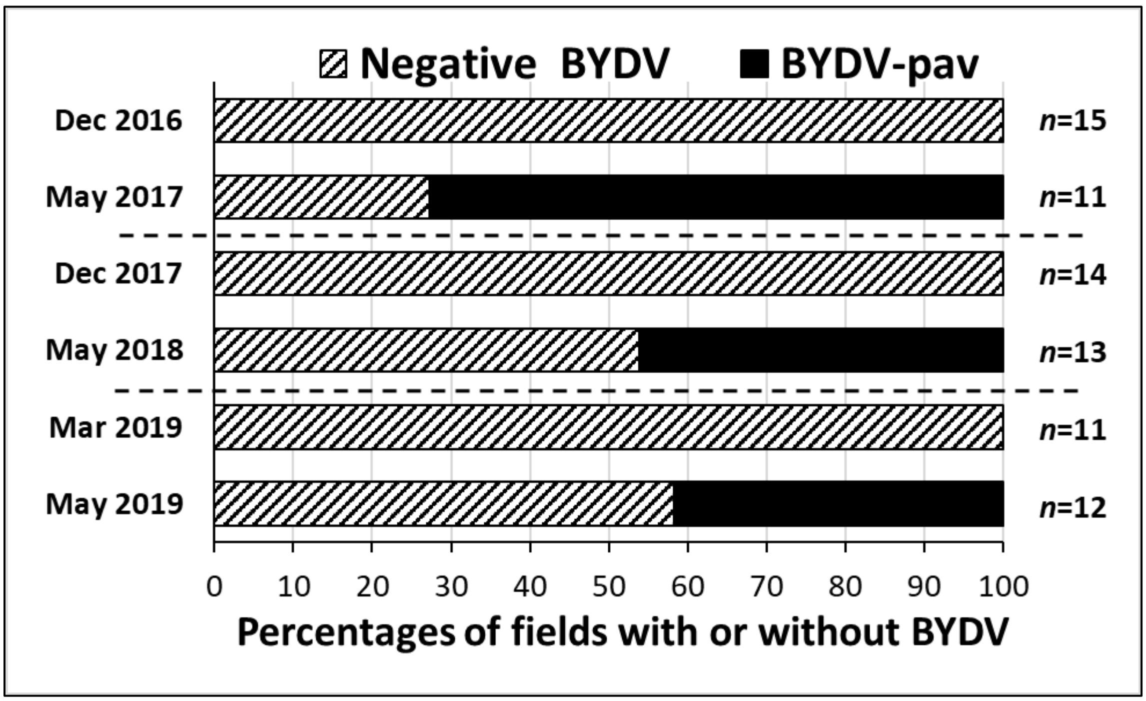

Figure 3. Percentages of Commercial Wheat Fields with or without Barley Yellow Dwarf Virus (BYDV) from 2016 to 2019 in Several Counties of Western Kentucky. '*n*' Indicates the Total Number of Samples Tested Each Date.

The presence of positive BYDV samples in May for 2017, 2018, and 2019 shows the synchrony of the biological cycle of aphids in winter wheat. Aphid species begin their feeding activity in March in wheat or moving from grasses adjacent to wheat fields, and start to transmit pathogens such as BYDV. This pattern is visualized in the study conducted in 2019. Aphids start to increase in early April and peaked by the end of the month. Aphid populations were above the economic threshold (>10 aphids/1-ft row) on 24 April in the insecticide treated seed and untreated plots (Figure 4). However, the surge of this aphid population was brief, and it collapsed in less than one week. Aphids were reduced to fewer than 1 aphids/1-ft row in both plots (Figure 4). Natural enemies such as parasitoids, syrphids, or even airborne entomopathogens may have contributed to aphid population reductions (Figure 5).

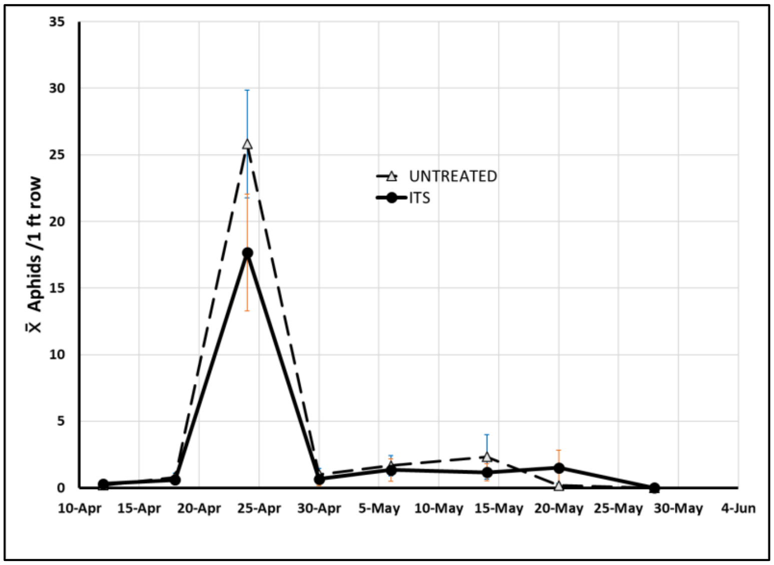

Figure 4. Mean Aphid Numbers (±SEM) in Plants Grown from Untreated and Insecticide Treated Wheat Seeds (Its) in 2019.

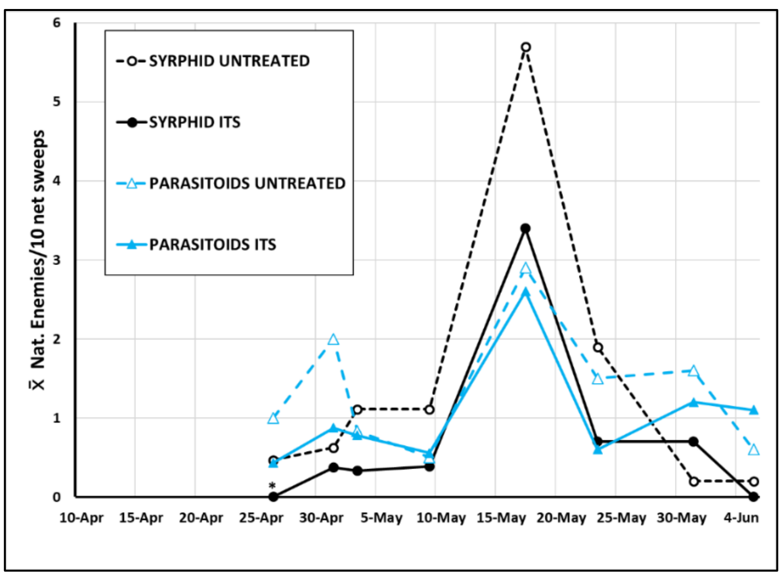

Figure 5. Mean Numbers of Syrphids and Parasitoids in Wheat Plants Grown from Untreated and Insecticide Treated Seeds (Its) in 2019.

The studies reported above shown that the transmission of BYDV most likely occurs during the last weeks of winter or beginning of spring in western Kentucky. Although BYDV infections during earlier stages of wheat development can potentially happen and affect yields drastically, this did not occur during the last three years in KY. Our studies shown that aphid populations become active in western Kentucky by the end of March, thus scouting for aphids should be conducted aggressively during this period (i.e. check fields regularly at least once a week). If aphids are above the economic threshold (>10 aphids.1-ft row), then sprays might be conducted, and aphids may be effectively controlled. Nowadays, with the advent of warmer temperatures and short winters scouting in March and April must be a priority. In spite of these results, wheat farmers and consultants conduct prophylactic (preventive) sprays by mid-March and April. The sprays are conducted for several reasons (i.e. time constraints, reducing trips to fields, risk aversion, or contract restrictions with seed provider). Wheat farmers or consultants need to conduct these insecticide applications based on pest population presence. For instance, in 2019 when the threshold was exceeded, preparations were made to conduct an application of pyrethroids. However, the aphid population declined, and the insecticide spray was cancelled (Figure 4). Aphid population declined. Most likely this population drop occurred due to the presence of natural enemies such as parasitoids, syrphids (Figure 5) or ladybugs, and even entomopathogens.

Figure 6. Winged Adult Foundress Aphid on an Emerging Wheat Seedling. Corn, Bird Cherry Oat, or English Cereal Aphids can Overwinter in Wheat Fields and be Sheltered from Weather Inclemencies Under Organic Matter, Stubble, or Deep in Soil Crevices.

The insecticide seed treatment in our study increased significantly the yield by almost 10 Bu/A compared with the untreated plot. However, the effect on controlling aphid populations was not significantly different. There is still controversy in the use of this technology for many field crop systems. Entomologist from the southern states are in favor of planting insecticide-treated seeds as they confront high insect pest pressures (North et al. 2014). However, researchers from northern states found that a minimal or negligible the contribution of insecticide seed treatments in soybeans to control insect pests or improve yields (Mourtzinis et al. 2019). In winter wheat, the use of this technology is even more contentious because the insect populations are low in winter, as explained above. Also, the effectiveness of the insecticide seed treatment declines when insect pests start to appear in the spring. Insecticide seed treatments may last up to 30 day. In previous studies, conducted in the UKY's REC, we obtained inconsistent effects of insecticide seed treatments. However, Perkins et al. (2018) in Tennessee, observed a positive contribution of the insecticide seed treatment on wheat. In Kentucky, this technology is used by >77% of wheat farmers (Villanueva unpublished) in spite of its recent introduction (fewer than 10 year). A definitive conclusion on the positive contribution of insecticide seed treatment needs further evaluations in winter wheat.

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