Proposal Category: Research

Title: Determining the Impact of Early and Late Summer Broad Mite Infestations and Evaluating New Products for Potential Registration.

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Final Report

Abstract

Late-summer broad mite infestations are becoming commonplace in floricane fruiting blackberry cultivars across the Southeast. It is not currently understood how damage to first-year canes could affect floricane production in the following year. Additionally, all miticides known to effectively control broad mite have a preharvest interval (PHI) of 7 days, meaning that control of infestations is often complicated. This study aims to better understand damage by both early and late-summer infestations of broad mites in floricane fruiting cultivars by comparing treated and untreated blackberries, and to generate data on miticides with low preharvest intervals that could be used to manage broad mite. A yield impact trial was initiated in 2021 and was assessed through 2023, while two miticide alternative trials were initiated in 2022. Four replications of the following treatments were established on 5 plant plots for the yield impact trial: treated plots with well-timed miticide applications when broad mites were observed at thresholds, and untreated plots where no broad mite control was utilized. Singificantly more broad mites were observed in treated plots in 2021 when compared to untreated plots, but very little broad mite was observe d in 2022. Although significant injury was also observed in 2021, not yield impact was observed in 2022 or 2023. Two miticide trials were established: trial 1 assessed 5 miticides compared to an untreated check. Trial 2 compared Portal with two known standards, Magister and Agri-Mek, as well as the UTC. Results from both trials indicate that Portal is an excellent miticide to utilize during blackberry harvest, and both Agri-Mek and Magister offer excellent control and residual activity.

Introduction

Broad mite, *Polyphagotarsonemus latus* (Banks), was first reported as a pest of blackberry in the United States in 2007 and was further realized as a serious threat to commercial blackberry production in 2014

(Vincent et al. 2010; Johnson and Garcia 2015). In 2019, serious late-summer broad mite infestations were observed in Arkansas and other states across the Southeast (NC, SC, and VA). Many of these infestations were far more serious than previously observed on floricane fruiting blackberries across much of Arkansas. Some plants exhibited heightened forms of the typical broad mite symptomology; extreme leaf distortion and curling, stacking of nodes on all canes of a plant, and even tip die-back (growth at cane tips becomes necrotic). Infestations of broad mite were not yet observed this late in the season, and the overall population dynamics and effect on crop are still not well understood for floricane fruiting cultivars.

Currently Agri-Mek (abamectin) and Magister (Fenazaquin) are the only registered and effective products for use in Southeast commercial blackberries for broad mite (Lefors and Johnson 2017). The combination of these products allows three total applications across a growing season with all applications warranting a 7-day pre harvest interval (PHI). Considering the potential for both early and late season infestations, and that infestations were observed in 2019, 2020, and 2021 during primocane fruit harvest, an increased variety of control options with lower PHI's is needed.

We proposed to assess the impact of yield by both early and late-summer broad mite infestations in AR and NC, and screen additional unregistered miticides in AR and NC to support expanded labels in Southeastern commercial blackberry production.

Objectives

1. To determine the impact on yield of both early-summer and late-summer broad mite (*Polyphagotarsonemus latus*) infestations on floricane fruiting blackberry cultivars.

2. To generate data on currently unregistered pesticides against broad mites to support expanded labels in the Southeastern US.

Materials and Methods

Yield Impact Trial

A field trial was initially established at the University of Arkansas Fruit Research Station in Clarksville, Arkansas in 2020. This trial was abandoned going into 2021 due to a lack of damage observed in untreated plots after initial miticide applications. Additionally, collaboration with NC state was planned but not carried out as Hannah Burrack took a new position at Michigan State. A new blackberry planting was established for 2021 in Arkansas that was isolated from other blackberry research trials and potential drift. A yield impact trial was established across two rows of first year "Ouachita" blackberries that consisted of 5 plant plots with 5 ft. bare ground buffers between each plot (Figure 1). Treatments were replicated four times and consisted of the following two treatments: **treated** plots with well-timed miticide applications when broad mites were first observed near threshold (1-5 broad mites per leaflet), and **untreated** plots where no broad mite control was used. The trial was organized as a randomized complete block design with 2 blocks being present on each of two rows of blackberries. Within each block 4 untreated and 2 treated plots were established (16 untreated and 8 treated plots total). Many plots were left untreated to minimize the impact of the miticide treatment on the total present population and to maximize the potential damage to untreated plots.

Broad mite density was monitored at least weekly by pulling 5 leaflets per plot and quantifying the number of mites. These leaflets were pulled from leaves near the ends of canes, where broad mites are known to feed. Plots were monitored before treatments were initiated until they were no longer observed in the Fall. Additionally, the amount of broad mite damage was also estimated by calculating a broad mite

damage rating which quantified the average number of canes exhibiting broad mite damage symptomology in new growth. In 2021, 10 canes were observed in each plot and visual injury was determined as the percent of canes exhibiting "fresh" broad mite damage in the newest growth, with a potential score of 0-10. In 2022 we augmented our visual injury ratings to also give an indication of severity by assessing injury (1-5) on 10 canes in each plot. Using this 1-5 BMR scale, a rating of 1 indicated the absence of damage, a rating of 2 indicated reduced leaf size and upturned terminals, a rating of 3 indicated the beginning of leaf cupping and bronzed or upturned terminals, a rating of 4 indicated severe leaf cupping and beginning of leaf necrosis, and a rating of five indicated leaf necrosis and shoot dieback (Figure 2). This same rating scale was used for the miticide alternative trial in 2022.

This trial was initiated once broad mite populations were observed to be established on August 16, 2021. Agri-Mek at 3.5 fl oz/acre + 1% non-ionic surfactant was applied at an output of 40 GPA using a single nozzle hand boom after initial leaflet count observations on 8/16 in 2021 and 7/20 and 9/29 in 2022. It is important to note that all surrounding blackberry plantings at the Clarksville Fruit Station were sprayed with the same rate of Agri-Mek at similar timings to suppress infestations present in breeding and production trials, which may have effected immigration of broad mite into our trial. Yield was assessed for each plot in 2022 and 2023 by measuring marketable weight, percent cull, and average berry weight over the course of several harvest dates in each year. These yield metrics were converted to yield per plant where appropriate and were analyzed using proc GLIMMIX in SAS v 9.4, and a Tukey's HSD post hoc analysis was used to separate means at α=0.05.

Miticide Alternative Trial

The efficacy of multiple miticides were assessed with two separate spray trials compared to known standards in commercial blackberries in Arkansas. These trials were performed in a grower field where broad mite injury was easy to find and preliminary sampling indicated broad mite numbers to be well above threshold (1-5 per leaflet). Trials used a randomized complete block design with 4 replications of each treatment in 5 plant plots with 3 plant buffers between each plot. Cane damage ratings were taken at each sampling date, with 10 random canes within the 5-plant plot examined and rated from 1-5 as shown in figure 2. Leaf samples consisted of 10 leaflets, from 10 unique leaves, pulled from the first node with fully unfurled leaves (generally the 3rd node from the terminal) and were taken back to the lab where the number of adults, immatures, and eggs were counted per leaflet. Trial 1 assessed 5 miticides compared to an untreated check (UTC), and a second application was made 21 days after the first (21 DAA) (Table 1). Trial 2 compared Portal with two known standards, Magister and Agri-Mek, as well as the UTC. Trials were assessed 0, 3, 5, 7, 10, 14, and 21 days after application where possible. Treatments containing Portal and Agri-Mek in Trial 1 were resprayed after 21 days due to plots breaking control, and those plots were reassessed for 14 days after the second application (DA2A). Trial 1 and 2 were accidentally over sprayed by the producer on 14 DA2A in trial 1 and 14 DAA for trial 2. Trials were terminated after the overspray, as samples from the following week were devoid of broad mite. Average broad mites per leaflet (adults + immatures) and damage ratings were analyzed using proc GLIMMIX in SAS v 9.4, and a Tukey's HSD post hoc analysis was used to separate means at α=0.05.

Table 1. Miticides used in two different miticide efficacy trials where all products were compared to an untreated check (UTC) at a grower field in Arkansas.

	Trial 1		
Active Ingredient	**Product**	**Rate**	**PHI**
acetamiprid	Assail 70WP	2.3 oz/acre	1
hexythiazox	Savey	25.4 fl oz/acre	1
fenpyroximate	Portal	32 fl oz/acre	1
GS-omega/kappa-Hxtx-Hv1a	Spear Lep	32 fl oz/acre	1
abamectin	Agri-Mek	3.5 fl oz/acre	7
	Trial 2		
Active Ingredient	**Product**	**Rate**	**PHI**
fenpyroximate	Portal	32 fl oz/acre	1
fenazaquin	Magister	36 fl oz/acre	7
abamectin	Agri-Mek	3.5 fl oz/acre	7

Results and Discussion

Yield Impact Trial

Significantly more broad mites were observed in untreated plots compared to treated plots in 2021 but not in 2022 (Table 2). In 2021 blackberry plots averaged 5.7 and 1.3 broad mites for untreated and treated plots respectively, while only averaging 1.2 and 0.8 broad mites per leaflet in 2022 for untreated and treated plots respectively. Leaflet samples in 2021 from directly before the miticide application indicated that plots were averaging over threshold (1-5 broad mites per leaflet) at the time of the first application on 8/16/2021, which is a typical situation for most growers (Figure 3). Directly after the miticide application in 2021, treated plots dropped below threshold levels within 7 days. Treated plots continued to stay around 1 broad mite per leaflet in 2021 except for a 2-week period where numbers spiked to upper threshold levels, and then quickly collapsed again. In 2022 two miticide applications were made as populations reached 1 broad mite per leaflet on 7/20/2022 and rebounded again by 9/29/2022. Very few differences were observed in broad mite density in treated and untreated plots after both miticide applications in 2022 (Figure 3). Broad mite numbers exceed 1 mite per leaflet until mid-late September in 2022, a full month later than 2022. Ultimately, untreated plots in 2021 averaged above the upper threshold limit of 5 broad mites per leaflet, while only averaging just at the lower threshold limit of 1 in 2021 (Table 2).

Significantly higher injury was observed in untreated plots compared to treated plots in both 2021 and 2022 (Table 2). While a striking difference in visual injury was observed in 2021, where untreated plots averaged 2.7 damaged canes compared to 1.4 damaged canes in treated plots, all plots in 2022 averaged below a visual injury threshold of 2, where untreated and treated plots averaged a rating of 1.5 and 1.4 respectively. Broad mite visual injury ratings followed a similar trend to the number of broad mite adults observed in 2021 (Figure 3). Untreated plots consistently exhibited more damage than treated plots and damage began to increase as broad mite numbers increased. In 2022, visual injury in late July followed the observed spike in broad mite populations, but little differences were observed until broad mite populations spiked again, later in October (Figure 4).

Yield from each plot was assessed and no significant differences were observed between sprayed and unsprayed plots in both 2022 and 2023 (Table 3). Marketable weight, average berry weight, and percent of culled berries were not found to be different in sprayed and unsprayed plots. Ultimately these data

indicate that broad mite populations near the current threshold are unlikely to affect yield in the following year. It's likely that broad mite damage occurred on these plants too late to affect portions of cane that were not pruned, and the average damage observed was not serious enough to impact the entire plant. However, we do consistently see broad mite injury on floricane fruiting cultivars in excess of what was quantified by our trial. For instance, data shared in this report in the miticide alternative trial showcased broad mite densities on floricane fruiting cultivars 8 times higher than the threshold and damage ratings of a 4 (1-5) scale (Figure 5 and 6). Broad mite is capable of exploding well beyond what we observed on an experiment station where surround blackberries are highly managed, so growers should still consider a threshold of 5 broad mites per leaflet when managing floricane fruiting varieties. When populations exceed this number they commonly rapidly increase in density and excessive injury including tip dieback can be observed, although this was not captured in our yield impact trial.

Miticide Alternative Trial

Results from Trial 1 indicated that Portal was able to suppress broad mite populations as good as Agri-Mek over a 7-day period compared to the UTC (Figure 5). Broad mite populations rebounded much more quickly in plots containing Portal around 10 days after the first application and were well above threshold 14 DAA (Days after application) (Figure 5). Acetamiprid, Hexythiazox, and Spear-Lep did not offer acceptable suppression and were not found to be significantly lower than the UTC on most sampling dates. When considering damage ratings, Portal and Agri-Mek were similar 14 DAA, but at 21 DAA excessive damage was observed in Portal (Figure 6). After the second application (sprayed on 21 DAA), broad mite numbers and damage ratings in Portal plots crashed once again, but did not look as good as Agri-Mek. This likely indicates that Portal could be a short-term solution for broad mite and potentially should be sprayed on tighter intervals if issues persist and if allowed by the label (14-day restriction).

Results from Trial 2 indicated that all 3 miticides (Portal, Magister, and Agri-Mek) were able to knock back excessive broad mite populations (Figure 7). Magister and Portal exhibited less residual control compared to Agri-Mek, with populations bouncing back to 3-4x threshold by 13 DAA. Samples could not be assessed for 21 DAA as this trial was accidentally over-sprayed by the grower. Damage ratings in this trial indicated an excessive 3.5 rating at 0 DAA when initial applications were made, and all three miticides were able to reduce ratings under 3 by only 7 DAA (Figure 8). These results indicate that Agri-Mek was most effective with the best residual control, and both Portal and Magister would likely warrant a second application within 14 DAA if broad mite persisted.

Our results indicate that Portal is an excellent option for broad mite management during harvest. Agri-Mek continues to provide excellent control with great residual, but a 7-day preharvest interval hampers its usefulness. Portal is a good option for growers that are either looking to finish out floricane harvest or need to protect developing fruit while harvesting primocane fruiting varieties. Results from both trials indicate that Portal will knock back damaging broad mite populations and limit the amount of plant injury that is observed, while offering a 1-day preharvest interval. We would likely expect higher efficacy in real-world applications, as less reservoirs for reinfestation would exist compared to our small plot trials. However, any grower that uses Portal should continue to scout for injury and mites. A second application of Portal should only be considered 14 days (label restriction) after the first if harvest is ongoing, and either Agri-Mek or Magister should be prioritized for a second application to help reduce the likelihood of resistance.

Table 2. Average broad mite population density and visual damage ratings (1-10 scale in 2021, 1-5 scale in 2022) on blackberry plants located in Johnson County, AR in 2022 and 2023.

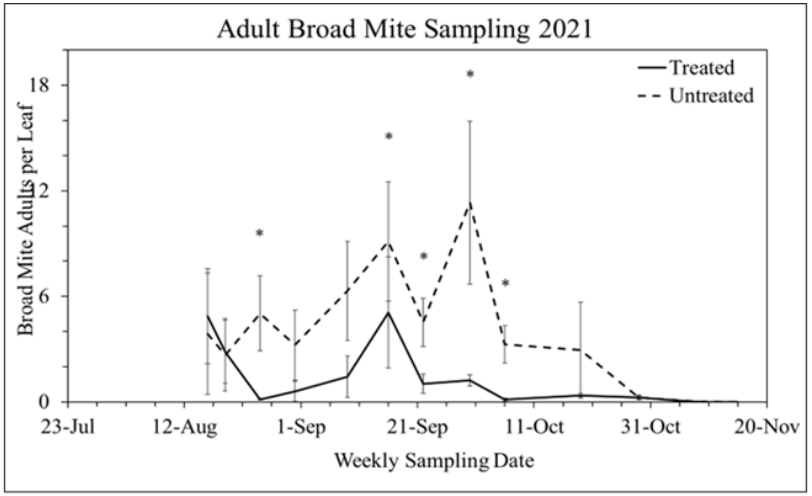
Year	Treatment	n	Adults	Adults and Immatures	Adults and Eggs	Egg	Visual Damage
2021	Treated	40	.	1.3	3.8	2.5	1.4
	Untreated	58	.	5.7	22.0	16.3	2.7
		P-Value		< **0.001**	< **0.001**	< **0.001**	**0.002**
2022	[1]Treated	34	0.6	0.8	1.2	0.7	1.4
	Untreated	84	0.7	1.2	2.1	1.3	1.5
		P-Value	0.677	0.839	0.484	0.191	**0.002**

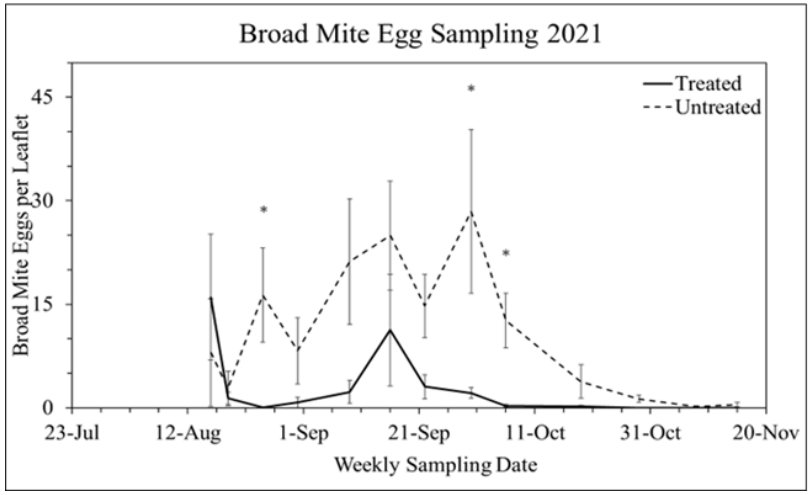
Table 3. Average marketable yield, marketable berry weight, and percent cull yield from broad mite treated and untreated plots of blackberry plants grown in Johnson County, Arkansas in 2022 and 2023.

Plot Type	n	Marketable Yield (kg)	Berry Weight (g)	% Cull
Treated	16	9.23	6.86	38.3%
Untreated	33	10.21	6.79	36.1%
P-value		0.152	0.804	0.255

Figure 1. Ouachita blackberries where the yield impact trial was established. This picture shows the plot layout of 5 plants per plot with a 5 ft buffer between plants.

Figure 2. 1-5 Rating scale for broad mite damage. A rating of 1 has no shortened internodes or leaf cupping. A 2 rating indicates leaf bronzing, reduced internode length and the beginning of leaf cupping or upturned leaves. A rating of "3" exhibits excessive leaf cupping and a rating of 4 indicates that leaves are beginning to become necrotic. A rating of 5 indicates tip-dieback and excessive necrosis of new leaves. Photos by Ryan Keiffer and Aaron Cato.





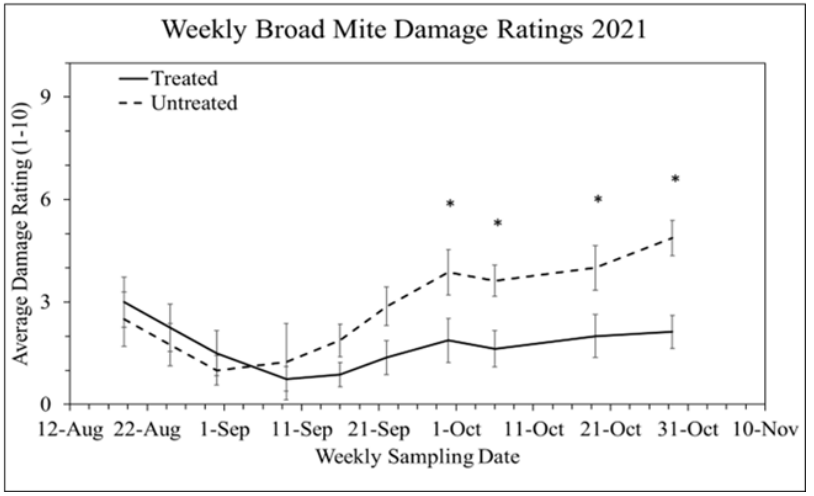
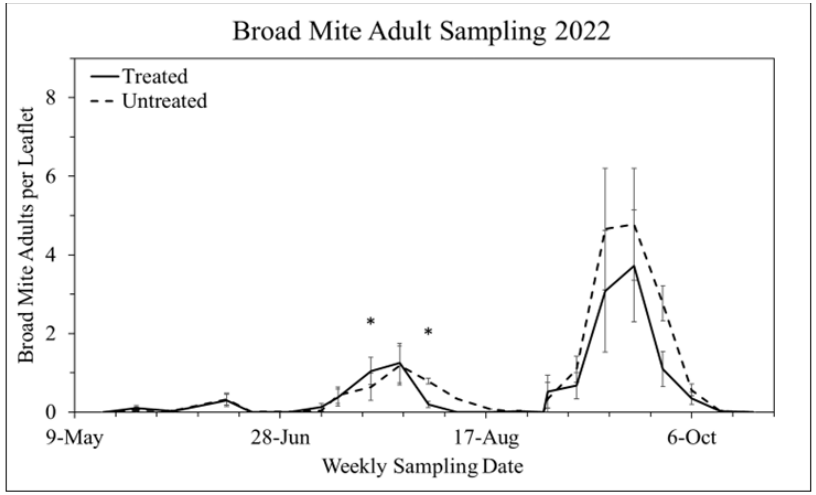
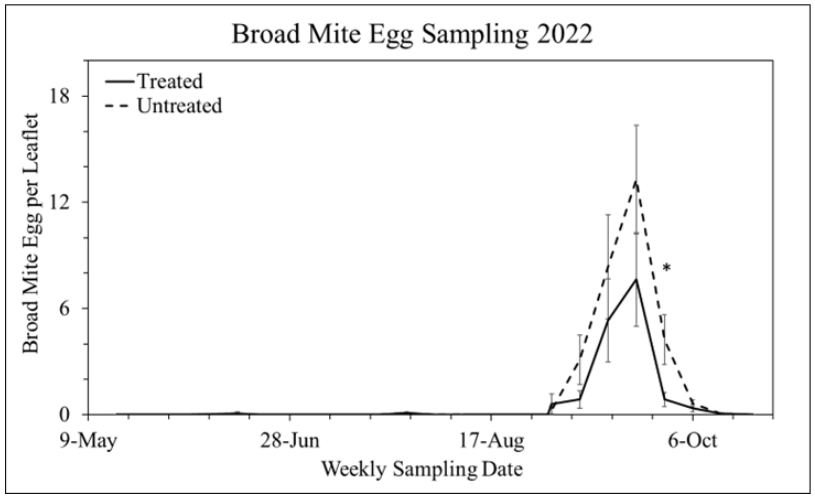


Figure 3. Weekly broad mite adult and egg counts in treated and untreated blackberry plots along with broad mite damage rating using a 1-10 scale in Johnson County, Arkansas in 2021. Significant differences between treated and untreated plots for a specific week are indicated by '*' using $\alpha = 0.05$.





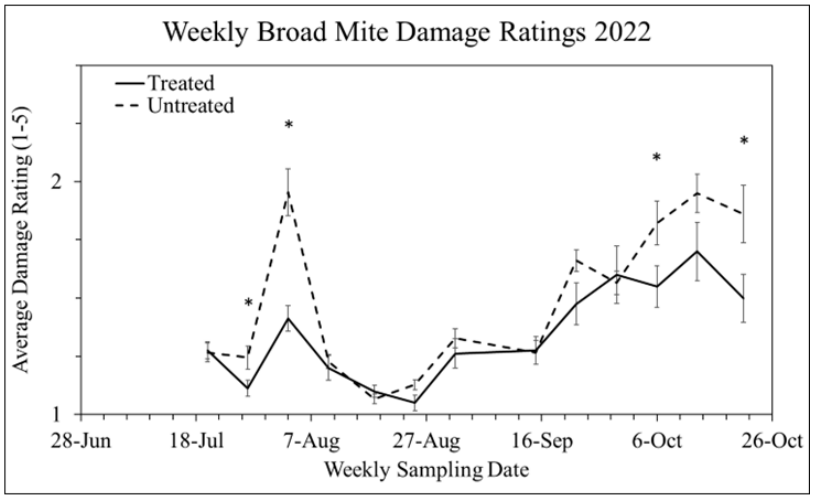


Figure 4. Weekly broad mite adult, and egg counts in treated and untreated blackberry plots along with broad mite damage rating using a 1-10 scale in Johnson County, Arkansas in 2022. Significant differences between treated and untreated plots for a specific week are indicated by '*' using $\alpha = 0.05$.

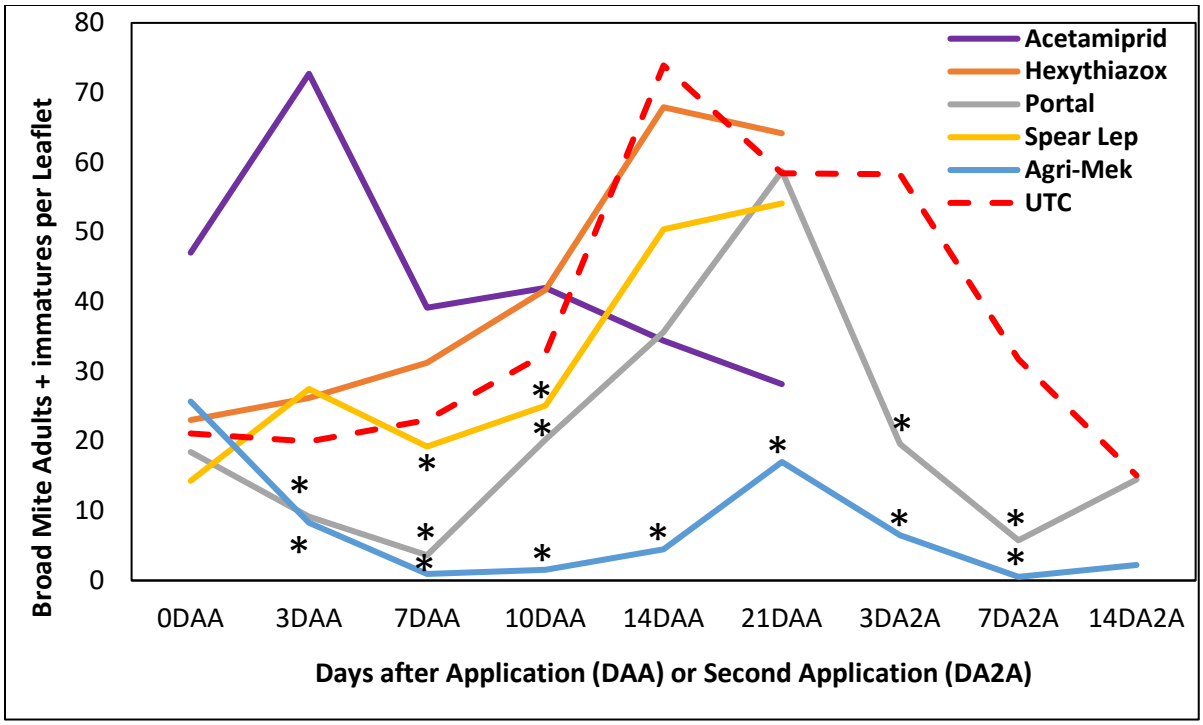


Figure 5. Broad mites observed per leaflet in Trial 1 across 5 miticide treatments in blackberry compared to an untreated check (UTC) observed 0-21 days after the first miticide application (DAA) and 3-7 days after the second miticide application (DA2A) on a grower field in White County, AR. *indicates significant difference from Untreated Check at α=0.05.

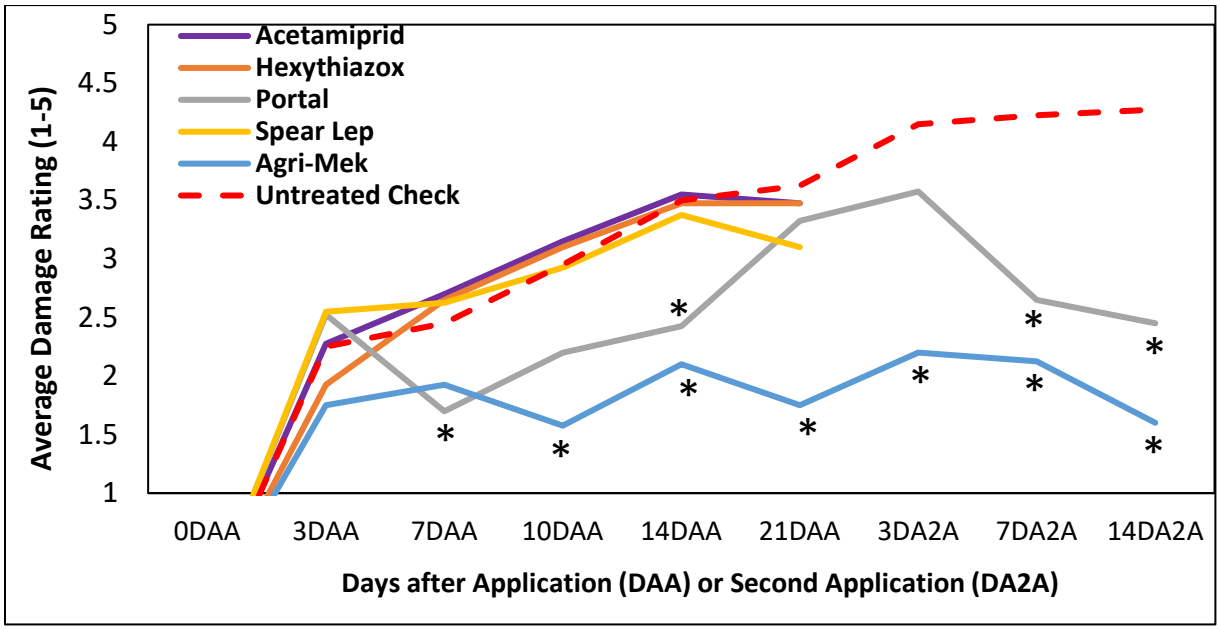


Figure 6. Broad mite damage ratings (1-5) in Trial 1 across 5 miticide treatments compared to an untreated check observed 0-21 days after the first miticide application (DAA) and 3-7 days after the second miticide application (DA2A) on a grower field in White County, AR. *indicates significant difference from Untreated Check at α=0.05.

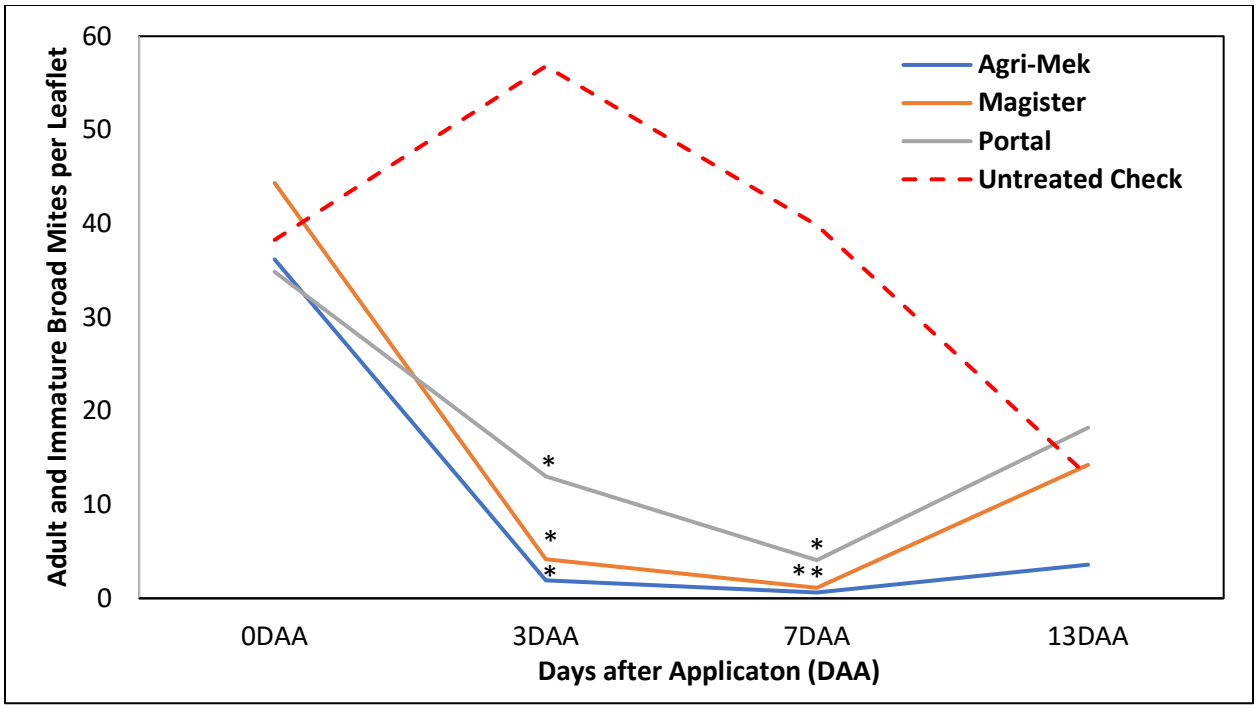


Figure 7. Broad mite adult and immatures observed per leaflet in Trial 2 across 3 miticide treatments in Blackberry compared to an untreated check observed 0-13 days after application (DAA) on a grower field in White County. *indicates significant difference from Untreated Check.

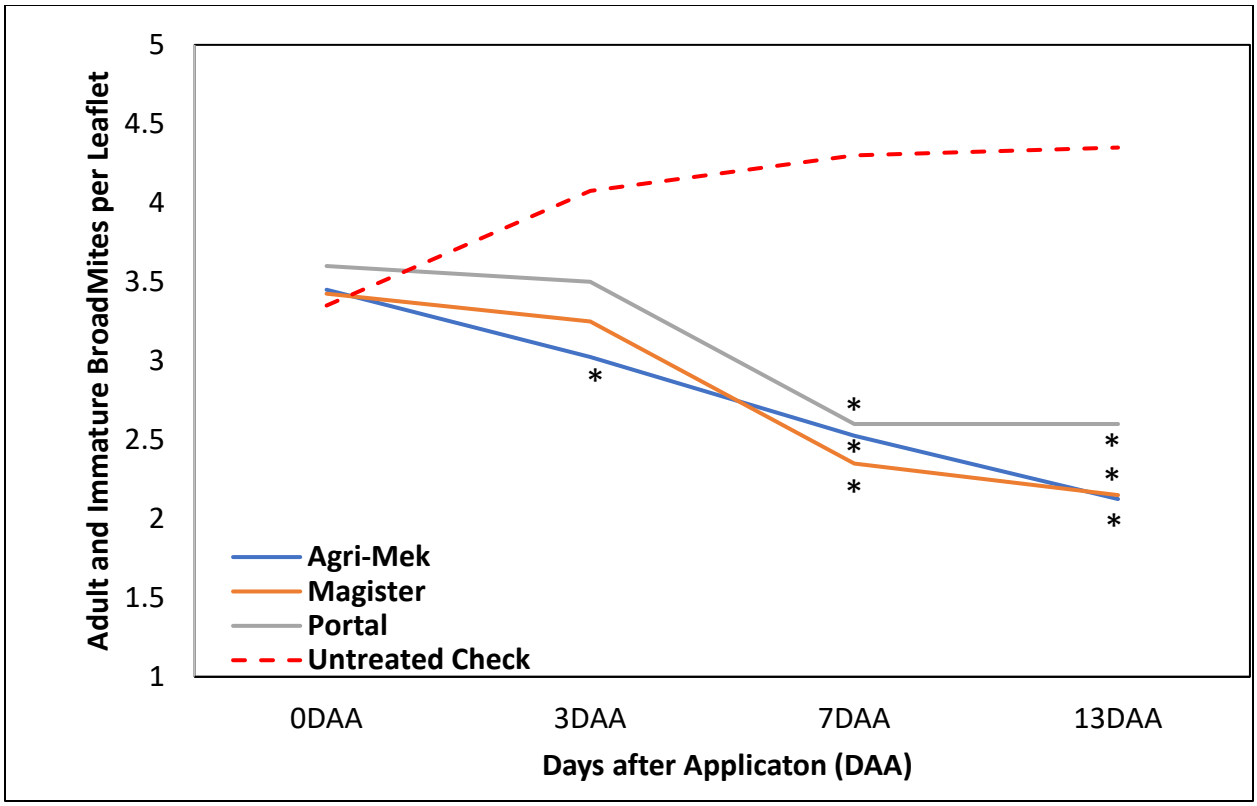


Figure 8. Broad mite damage ratings (1-5) in blackberry across 3 miticide treatments compared to an untreated check observed 0-13 days after application (DAA). *indicates significant difference from Untreated Check.

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