EFFICACY OF NEONICOTINOID SEED TREATMENTS ON THRIPS IN COTTON

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Abstract

Seed treatments are common and effective pest control methods in many crop systems. Cotton seed treatments are often used for control of early season pests. A market shift in seed treatments to neonicotinoid formulations followed the phasing out of aldicarb (Temik®). Imidacloprid and thiamethoxam (Cruiser®) are two commonly used insecticide cotton seed treatments, but concern lies with the possibility of varying degrees of efficacy of these seed treatments on the different thrips species. The common thrips species that infest cotton seedlings are tobacco thrips (*Frankliniella fusca*), flower thrips (*Frankliniella tritici*), western flower thrips (*Frankliniella occidentalis*), and onion thrips (*Thrips tabaci*), and each of these exhibit different degrees of susceptibility to various insecticide formulations. It is necessary for us to evaluate the thrips species composition in Texas cotton, as well as the impact of thiamethoxam and imidacloprid seed treatments on those species. The evaluated locations throughout Texas included: Chillicothe, College Station, Halfway, Kress, Lamesa, and Wall. These are representative sample areas of the High Plains, Rolling Plains, and Central Texas areas. Thrips populations were low in Chillicothe, Lamesa and Wall, but there were fewer thrips in treated seeds for most sampling dates in College Station, Halfway and Kress. Imidacloprid treated seed resulted in greater yield than the control in College Station, which was the only harvested location with thrips populations exceeding treatment threshold (one visible thrips per true leaf) levels. Greenhouse evaluations of thiamethoxam and imidacloprid seed treatments for western flower thrips provided information on maximum potential efficacy of these products in a more controlled environment.

Introduction

Thrips are an important early season insect pest on cotton throughout the U.S. cotton belt. In Texas, the thrips complex generally ranks first in terms of cotton lint yield loss due to insect pests (Williams 2013). Until 2011, thrips were commonly managed by using in-furrow applications of aldicarb (Temik®) and growers achieved satisfactory control. However, the removal of Temik® from the market due to concern over its possible environmental impact has forced cotton producers to resort to other available insecticide seed treatments. These seed treatment insecticides primarily belong to one insecticide group, the neonicotinoids. Currently, there are two neonicotinoid insecticides available for use as cotton seed treatments. Although both insecticides (imidacloprid and thiamethoxam) belong to the same group, their physical and chemical properties vary, which may result in differences in efficacy of these two products on the target insect pest (thrips). Therefore, region-specific evaluation of different seed treatment products is necessary to determine their effectiveness in managing thrips populations in respective regions. Also, a product may not be equally effective on all the prevalent thrips species impacting cotton across Texas' production regions. For example, a thrips population may be composed of individuals from different species. The common thrips species that infest cotton seedlings are tobacco thrips (*Frankliniella fusca*), flower thrips (*Frankliniella tritici*), western flower thrips (*Frankliniella occidentalis*), and onion thrips (*Thrips tabaci*). Each of these thrips species could have variable levels of tolerance or susceptibility to each of the available insecticides. Western flower thrips populations, for example, have been found to be resistant to both organophosphates and pyrethroids in Australia (Herron *et al*. 1996). Similarly, resistance to pyrethroids within western flower thrips populations has been documented from Missouri and California (Zhao *et al*. 1995, Immaraju *et. al*. 1995). Historically, western flower thrips have shown to develop resistance to insecticides, as evident from the previous examples and a number of other reports from around the world. Therefore, it is possible that western flower thrips in cotton could develop resistance to the neonicotinoid seed treatments over time. While western flower thrips are a potential candidate for developing resistance to neonicotinoid seed treatments, there are already reports of resistance development to thiamethoxam in tobacco thrips populations as documented by several researchers from the mid-south of the U.S. (Stewart 2013).

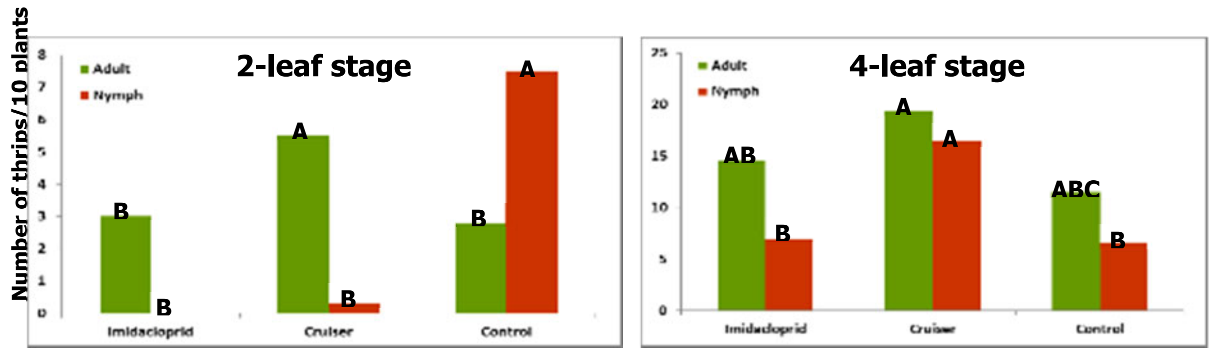

Fig. 1. Number of thrips recorded on cotton seedlings resulting from two different neonicotinoid insecticide treated seed plantings along with an untreated control; all three treatments evaluated at two plant growth stages.

The thiamethoxam (Cruiser®) resistance in tobacco thrips is a great concern for U.S. cotton growers; not only in the mid-south, but also in Texas. There are also some suggestions that thrips populations in south Texas, which is dominated by tobacco thrips, is less susceptible to Cruiser® (thiamethoxam) as compared to imidacloprid (Fig. 1). The above graphs represent the results from a trial conducted in Matagorda Co., TX by Dr. Roy Parker and observed that the thiamethoxam (Cruiser®) treated cotton plots had more thrips compared to the seedlings resulting from seed treated with imidacloprid (Gaucho Grande®). It is imperative for us to evaluate this product (thiamethoxam) more closely in different Texas cotton production regions in order to detect any possible resistance development in our thrips populations. The two objectives of this study will effectively address the possibility of varying degrees of the neonicotinoid seed treatment efficacy on different species. Specifically, surveying the thrips species present in Texas fields will provide information on the current and changing species composition of thrips in Texas cotton, while comparing the seed treatments in different locations will give us direct information on the current level of efficacy of the seed treatment insecticides, especially thiamethoxam. The final goal of this project is to generate information regarding thrips populations in Texas cotton production regions so that our regional growers and consultants have useful information on what thrips species are most likely to occur in their fields and what available effective products be used to control those specific thrips species.

Materials and Methods

Greenhouse Trials

To evaluate the efficacy of thiamethoxam and imidacloprid in a controlled environment, we conducted a greenhouse study. Two weeks prior to planting the cotton seeds, we planted solid trays of wheat in order to build the western flower thrips populations within the greenhouse. Metro-mix® was used as the potting medium for both wheat and cotton. Prior experiments in the greenhouse had highest success with planting one tray of wheat for every 2 trays of cotton, so we planted 48 trays of wheat to ensure adequate thrips populations. We planted 288 FM 1944 GLB cotton seeds (one seed per experimental cup), 96 of each treatment (thiamethoxam, imidacloprid, and control). The seedlings were completely randomized within trays containing 18 seedlings total, 6 of each treatment. Samples of 4 trays were taken at 7 days after emergence (DAE), 14 DAE, 21 DAE and 28 DAE. The samples were taken by cutting the base of the seedlings, and placing 6 seedlings of each treatment in a quart-sized mason jar containing 70% ethanol. Thrips were counted from these samples using the thrips washing method (Burris *et al.* 1989).

Field Trials

The field trials consisted of three treatments (thiamethoxam, imidacloprid, and control), with 4 replications. Plot size was 4 rows wide by 50 feet long, with 5 feet alleys separating the plots. Each trial consisted of 12 plots, randomized within the replication (block). The sites for the field trials were all located in Texas, the locations as follows: Kress (Swisher county), Halfway (Hale county), Lamesa (Dawson county), Wall (Tom Green county), Chillicothe (Hardeman county), and College Station (Burleson county). All trials were conducted with sufficient irrigation. The cotton variety used was the same as we used in the greenhouse, FM 1944 GLB. This cotton variety was chosen as it is suited to the regions we chose for trial sites, as well as having some tolerance to root-knot nematodes. No nematicide was applied to the seeds in order to avoid any possible interaction with the insecticides we are testing. Planting dates were adjusted in each location according to the location's recommendation, and sampling took place at the cotyledon, 1-2 true-leaf and 3-4 true- leaf stages of the plants. Ideally, sampling was to take place at 7-day intervals, but inclement weather and other management logistics forced us to deviate from the 7-day intervals in some cases. During sampling, 10 random seedlings from each plot were placed in a quart-sized mason jar and taken to the lab to be processed using the thrips washing method (Burris *et al.* 1989). We recorded the number of thrips larvae, adults and the total number of thrips from each plot, and placed the adults in 70% ethanol for species identification later.

Results and Discussion

In the greenhouse, we found no significant difference between treatments at any time intervals, but over the first 3 weeks the thrips populations increased. At the 3rd true leaf stage, we had about 42 thrips per seedling. Soil selection likely impacted our results, and this trial is to be repeated using field soil rather than a potting soil mix in 2015 (Fig. 2).

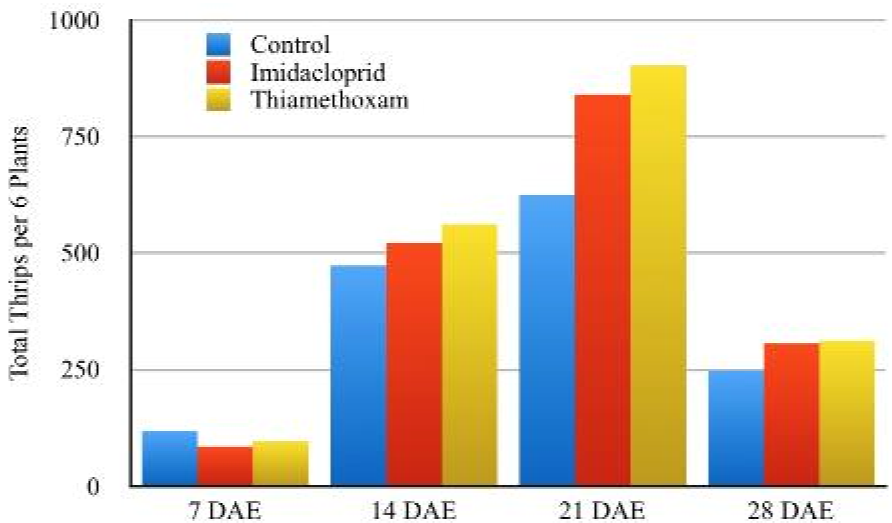

Fig. 2. Total number of thrips per 6 plants in the greenhouse at 7 DAE, 14 DAE, 21 DAE and 28 DAE. There are 3 separate treatments, a control, imidacloprid, and thiamethoxam. There was no significant difference between treatments at any sampling date.

At the farthest north location, the Kress site, our untreated control plots had over 20 thrips per plant at the 1st true leaf stage, while the treated plants had about 20 total thrips on all 10 seedlings. The 2nd sampling date followed cool and wet weather, and we saw no difference in thrips numbers between treatments. This field site was replanted to sorghum shortly following the 2nd sampling date due to a poor stand after adverse weather (Fig. 3).

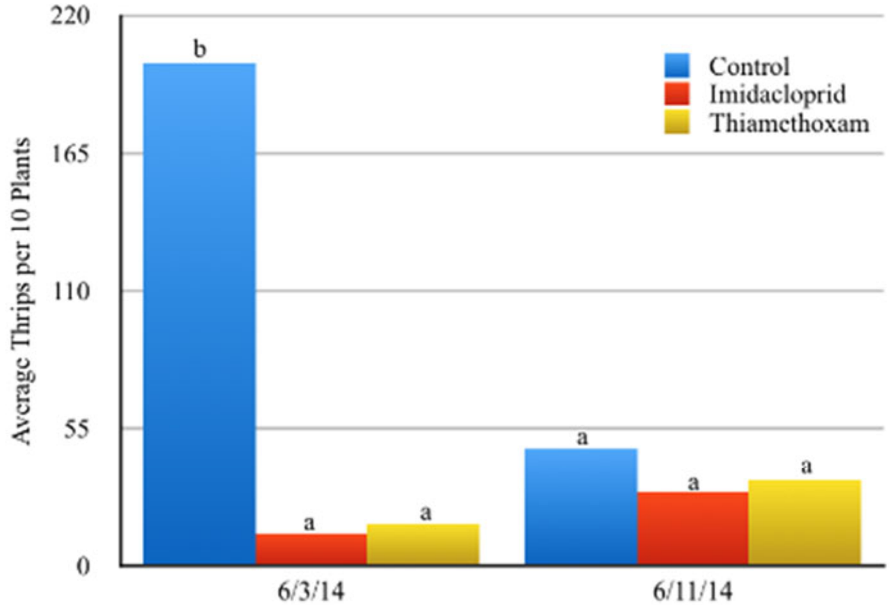

Fig. 3. Total number of thrips per 10 plants at 2 separate sampling dates at the Kress site. There are 3 treatments, a control, imidacloprid, and thiamethoxam at each sampling date. The trial was planted on 5/13/14. Letters note significant difference between treatments within sampling dates.

At the Halfway site, we observed differences between the two seed treatments and the control at the first 2 sampling dates. The control plants for the first 2 sampling dates had about 1.3 thrips per plant, but by the third sampling date, the thrips populations had decreased, and were no longer significantly different (Fig. 4).

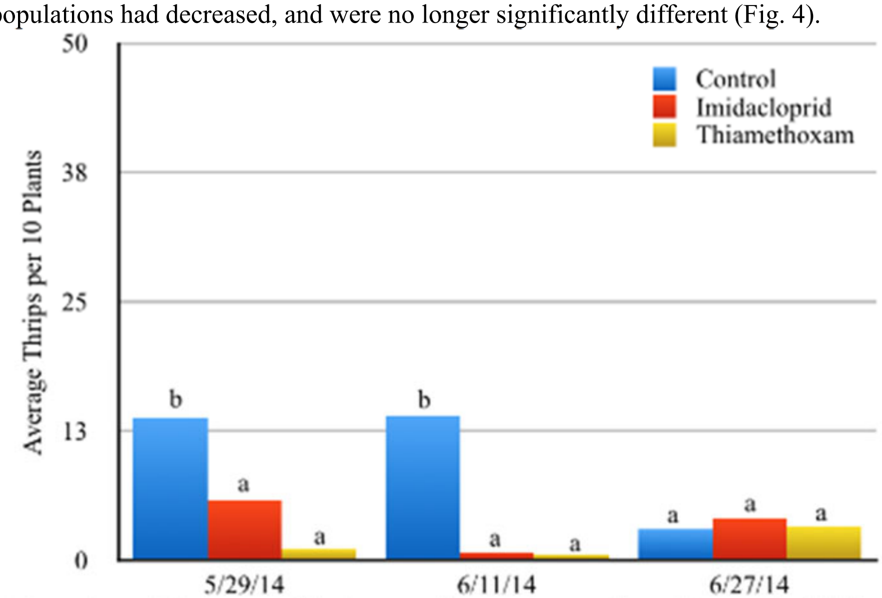

Fig. 4. Total number of thrips per 10 plants at 3 separate sampling dates at the Halfway site. There are 3 treatments, a control, imidacloprid, and thiamethoxam at each sampling date. The trial was planted on 4/6/14. Letters note significant difference between treatments within sampling dates.

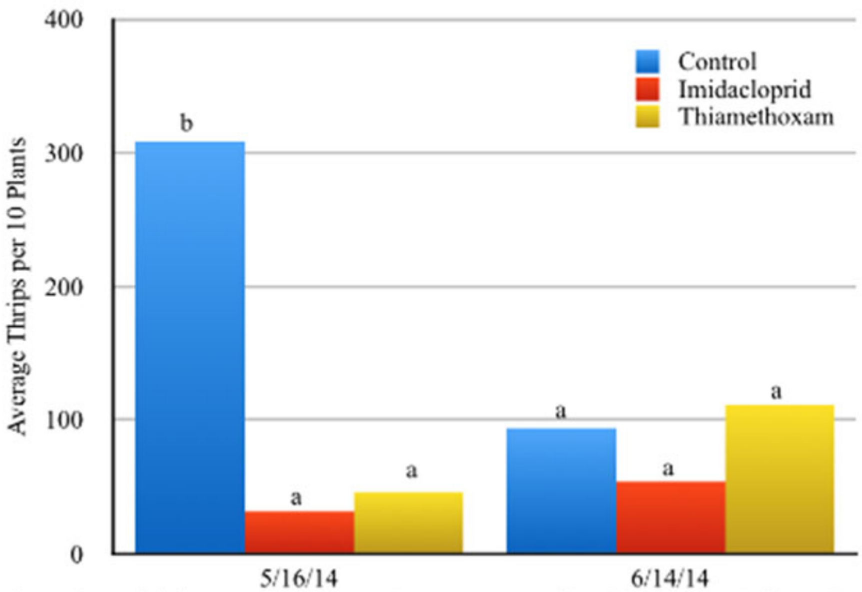

Fig. 5. Total number of thrips per 10 plants at 2 separate sampling dates at the College Station site. There are 3 treatments, a control, imidacloprid, and thiamethoxam at each sampling date. The trial was planted on 4/25/14. Letters note significant difference between treatments within sampling dates.

In College Station, we observed a difference between control and the 2 seed treatments at the first sampling date. Thrips populations had declined by the 2nd sampling date, following cool weather and heavy rainfall (Fig. 5). The Wall, Lamesa, and Chillicothe sites showed no difference between any of the treatments, but we also did not observe many thrips at any of these sites. (Figs. 6-8).

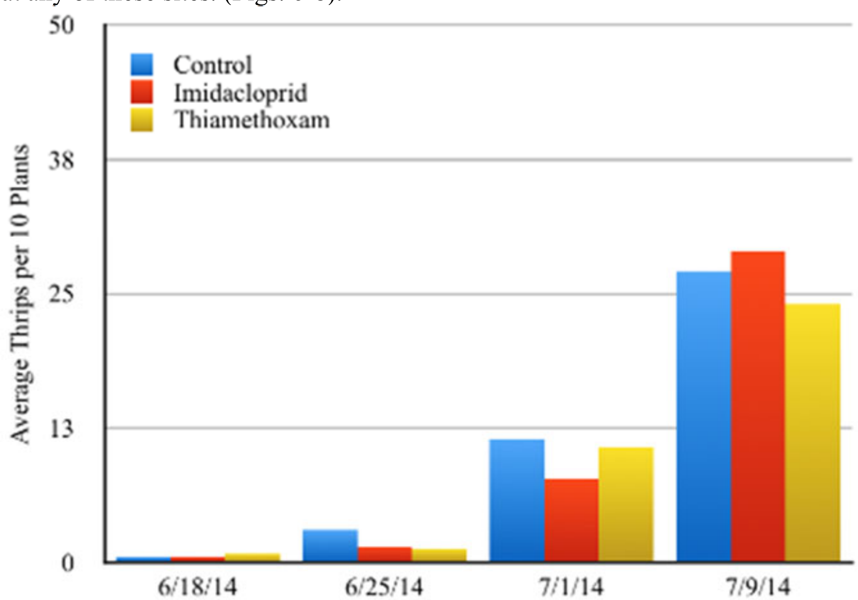

Fig. 6. Total number of thrips per 10 plants at 2 separate sampling dates at the Wall site. There are 3 treatments, a control, imidacloprid, and thiamethoxam at each sampling date. Lack of letters shows that there was no significant difference between treatments within sampling dates.

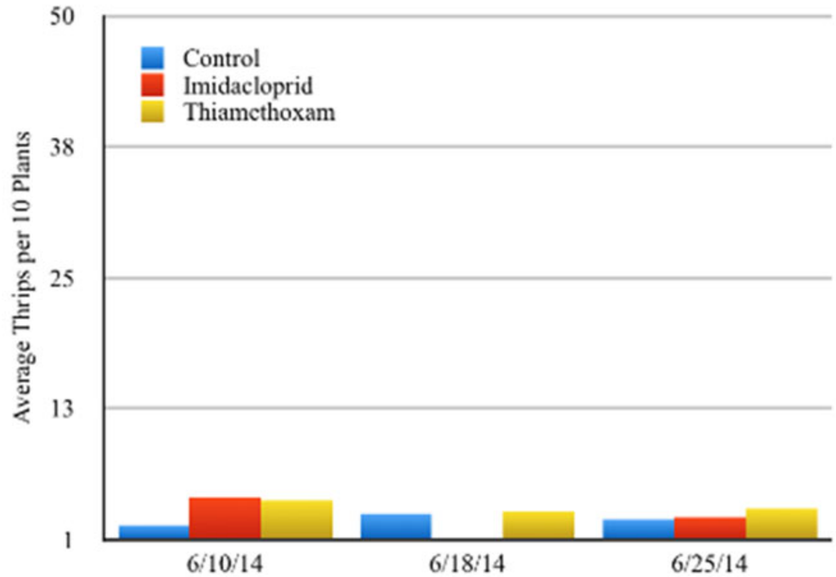

Fig. 7. Total number of thrips per 10 plants at 2 separate sampling dates at the Lamesa site. There are 3 treatments, a control, imidacloprid, and thiamethoxam at each sampling date. Lack of letters shows that there was no significant difference between treatments within sampling dates.

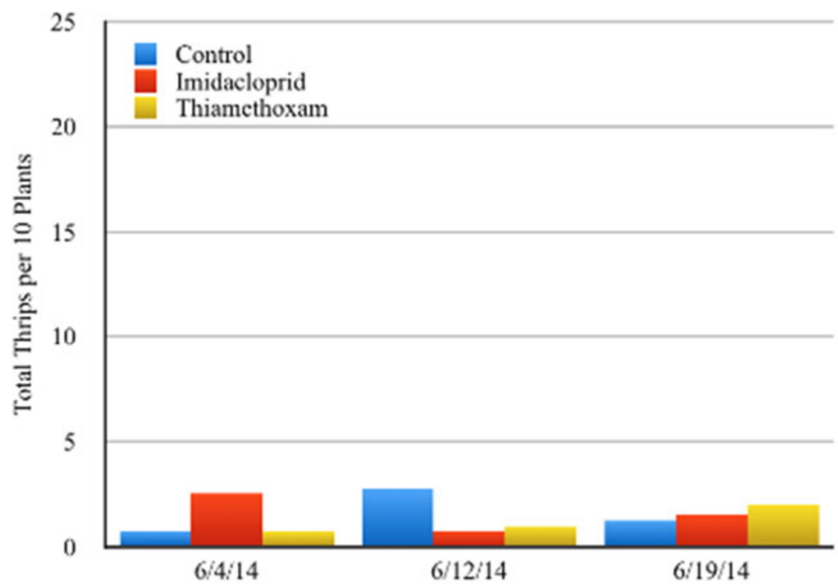

Fig. 8. Total number of thrips per 10 plants at 2 separate sampling dates at the Chillicothe site. There are 3 treatments, a control, imidacloprid, and thiamethoxam at each sampling date. Lack of letters shows that there was no significant difference between treatments within sampling dates.

The College Station site was the only one that reached the threshold for thrips at any point during the season. This was also the only site we observed a difference in yield between the treatments. Imidacloprid treated plots produced a higher yield than did the control plots, and thiamethoxam showed no significant difference compared to imidacloprid or the control (Fig. 9).

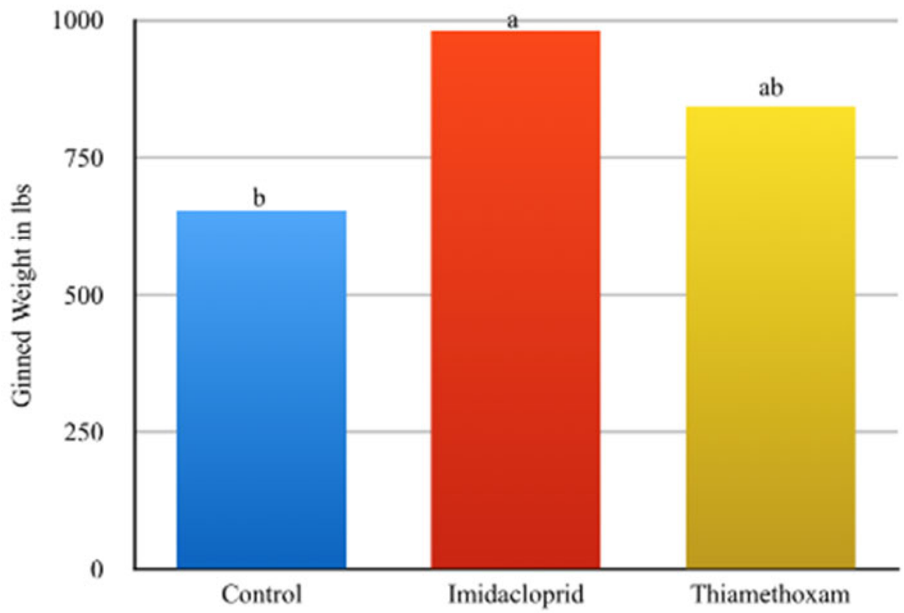

Fig. 9. Yield per acre in pounds from the College Station site. A 38% turnout was used to calculate the approximate ginned weight. Letters note significance between treatments.

Summary

In conclusion, the seed treatments reduced thrips populations in Kress, Halfway, and College Station. The efficacy of these treatments decreased over time, as expected. Only one location, College Station, had thrips populations to reach threshold and influence yield significantly. At the College Station site, imidacloprid treated seed outyielded the control. Our greenhouse data did not show significant treatment effects, likely due to methodological reasons with potting soil selection. In the future, we plan to repeat the greenhouse trials with field soil instead of potting soil, and repeat the field trials in the same locations next year.

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