EVALUATION OF ORGANIC PESTICIDES FOR WESTERN FLOWER THRIPS MANAGEMENT IN SEEDLING COTTON: EFFECT ON PLANT PARAMETERS

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Abstract

Seed treatments and/or foliar applications of various insecticides are common practices for managing the western flower thrips [*Frankliniella occidentalis* (Pergande)] in seedling cotton in the Texas High Plains. However, available options for thrips management in organic cotton production systems are very limited. The efficacy of five organic products: Entrust® Naturalyte® Insect Control (spinosad microbial 2 oz/A), Aza-Direct® Biological Insecticide (Azadirachtin 1.2% 16 oz/A), Bugitol Concentrate (mustard oil 48 oz/A), Safe-T-Side™ Spray Oil plus Ecotec (0.5 lb + 0.5 qt/A), and NoFly WP Mycoinsecticide (HT6-100; 4 lb/A rate) were evaluated and compared to an untreated control. Treatments were initiated soon after cotton seed germination and applied weekly for three consecutive weeks. In conjunction with treatment applications, cotton was sampled weekly via absolute sampling (plant washing) method. In addition to thrips densities, cotton seedling total (above and below soil surface) biomass, leaf area, and leaf chlorophyll indices were recorded. Due to very high pressure of immigrant adult thrips and subsequent reproduction on cotton seedlings, none of the treatments proved effective when cotton was at the 1 true-leaf stage. Nevertheless, Entrust® significantly suppressed thrips populations and kept it below ET when cotton was at the 2-5 true-leaf stage. Plants from Entrust®-treated plots had significantly higher leaf areas compared with that in other treatment plots, likely due to lower thrips numbers on Entrust®-treated cotton plants. Plant biomass was significantly higher in Entrust® and Azadirachtin® treatments compared with that in other treatments.

Introduction

Western flower thrips, flower thrips, soybean thrips, onion thrips, and tobacco thrips are five common thrips species found in U.S. cotton (Cook *et al*. 2011). Albeldaño *et al.* (2008) have reported nine species of thrips from Texas cotton. Western flower thrips [*Frankliniella occidentalis* (Pergande)] is a key pest in Texas cotton (Greenberg *et al*. 2009) and causes severe damage to cotton seedlings in infested fields, which are generally vulnerable to thrips damage during the 4-5 true-leaf stage (Cook *et al*. 2011). Thrips cause leaf area destruction, delayed maturity, retarded plant growth and loss of apical dominance (Reed *et al.* 2001, Sadras and Wilson 1998, Harp and Turner 1976). Williams (2012) reported that for 2011, Texas had an estimated total of 2,648,547 acres of cotton infested with thrips, which resulted in 28,230 cotton bale loss due to thrips damage.

There has been an increased demand of organic cotton during the recent years. The Organic Trade Association's 2010 Survey report indicated organic fiber sales in the United States grew by 10.4% in 2009 over the previous year, reaching a sales total of $521 million. In response to rising consumer interest in organic cotton, organic production systems, though a specialized niche representing a fraction of the US cotton market, are garnering increasing cotton producer attention. Organic production poses new and unique problems for cotton producers in terms of arthropod pest and weed control issues as compared to conventional production systems where a variety of agricultural chemicals are available and allowed. This is due to pesticide use limitations imposed by organic, or, as is often debated, “sustainable” guidelines. Insect pest management practices under organic cotton production remain largely unexplored, and although numerous products approved and labeled for acceptable use in organic cotton production systems are available, a paucity of information directly comparing their efficacies against selected target key insect pests, such as thrips, represents an opportunity for beneficial, methodical scientific investigation. In addition, with the recent EPA/industry agreement to cancel all registered uses and remove aldicarb-containing products from the market, which for many years in the past conferred excellent thrips control in conventionally grown cotton, there exists a need for effective alternatives, including those which may have parallel uses in organic production systems. It has been announced that aldicarb will return to the market (new company, product trade name, labels and packaging) for an indefinite period of time with a restricted use classification, but the product has yet to appear on the market. This development will likely be beneficial to conventional cotton production systems, but uses of these types of pesticides is not allowed under organic cotton production systems, thus other alternatives remain needed at the present time.

Our objective of this study was to evaluate available organic products to determine their efficacy in managing thrips in early-season cotton, with the intention of possibly supplying growers in both conventional and organic production systems with information which may facilitate thrips management decision-making in early-season irrigated, conventional and/or organically produced cotton. In 2011, from among numerous products available for insect control (and successfully applied) in organic crops with potential efficacy against thrips in organically grown cotton, Entrust® Naturalyte® Insect Control (spinosad microbial), PyGanic® Crop Protection EC 5.0 II (pyrethrum), and Surround® WP Crop Protectant (kaolin clay) were evaluated with some mixed results (Shrestha et al. 2012, Vandiver et al. 2012). In 2012, we evaluated Entrust®, Aza-Direct®, Bugitol, Safe-T-Side™ + Ecotec, and HT6-100 compared to an untreated control.

Over-the-top organic or inorganic pesticide spray applications may affect cotton seedling growth and development in several ways. First, the pest population may be regulated, which may, in turn, alter the level of crop injury, the effects of which may be observed in terms of plant health, growth, and development. Second, the active ingredient of the product, or some other property of the product itself may directly alter plant photosynthesis, respiration, or transpiration, as examples. Third, these phenomena may manifest cumulatively or simultaneously. In addition to evaluating the thrips control efficacies of the products mentioned, a secondary objective of this study involved assessing, under an irrigated organic cotton production system, the effects of various levels of early-season thrips infestation, as actuated by the subject products, on cotton plant vegetative and reproductive development and yield.

In evaluating the two study objectives, it was hypothesized that the selected organic products would suppress thrips densities in irrigated organic cotton differentially, and assuming as much, that the resulting differential thrips densities would facilitate evaluation of subsequent seasonal cotton growth, development, and yield parameters.

Materials and Methods

An irrigated organic cotton field was planted with cultivar FM 958 on 1 May 2012 near Muleshoe, Texas. The crop was cultivated using standard northern Texas High Plains organic cotton production practices. The experiment was deployed in a randomized complete block design with six treatments [five organic products - Entrust® Naturalyte® Insect Control (spinosad microbial 2 oz/A), Aza-Direct® Biological Insecticide (Azadirachtin 1.2% 16 oz/A), Bugitol Concentrate (mustard oil 48 oz/A), Safe-T-Side™ Spray Oil + Ecotec (0.5 lb + 0.5 qt/A), and NoFly WP Mycoinsecticide (HT6-100; 4 lb/A rate) plus an untreated control] in order to achieve differential thrips densities in treated plots. Treatments were initiated during the week of full cotton seed germination and reasonable plant stand (May 19) and applied weekly for two weeks thereafter (May 25 and June 1). Simultaneously, adult and juvenile thrips were quantified for 7 weeks via “absolute” sampling, which involved whole-seedling immersion of ten plants per plot and subsequent, elaborate processes of sieve “washing” and vacuum filtration, followed by visual quantification under 10X or higher magnification. In addition, leaf chlorophyll, leaf area, plant height, and root length were measured on June 12 and 21. Plant biomass (root, leaf, branch, and reproductive plant parts) was also measured on June 12 and 21. Because of some herbicide drift issues, the influence of organic products on plant phenology and growth behavior was terminated only after two measurements on June 12 and 21. Lint yields were measured in each plot.

Results and Discussion

The overall thrips abundance in our test study site was relatively higher in 2012 than in average years, but it was much higher than in 2011. Under ideal conditions, growth and development parameters would be carefully evaluated in reference to normal or “expected” background thrips densities, yet the 2011 growing season provided the unique opportunity to evaluate the effects of differential thrips densities, as actuated by the selected product treatments, on plant growth parameters under a very low thrips regime. Likewise, the 2012 season afforded us the opportunity to evaluate these products under a heavy thrips pressure situation.

Effect on Thrips Density

In untreated control plots, thrips densities were expected to increase seasonally due to the potential for thrips reproduction and, further, due to persistent immigration from nearby source habitats. It was certainly true for the 2012 growing season. We had intense thrips pressure during the cotyledon stage of cotton (Fig. 1). The densities were so high that the first spray application of organic products failed to suppress the thrips population and all the experimental plots had thrips densities above ET following the first application of the test products. However, the second application suppressed the thrips densities across all treatments. It appears that some of the adult thrips dispersed out of the field following the second application because the overall thrips densities were reduced including that in untreated control plots. Similarly, the thrips densities declined following the third application of these products. It is, however, noteworthy that only Entrust® significantly suppressed thrips populations and kept it below ET when cotton was at the 2-5 true-leaf stage. Due to very high pressure of immigrant adult thrips and subsequent reproduction on cotton seedlings, none of the treatments proved effective when cotton was at the 1 true-leaf stage. Also, average thrips abundance was significantly lower in Entrust® treated plots compared with that in the remaining treatments (Fig. 1). This suppression in Entrust® treated plots was largely due to reduction in juvenile thrips, clearly suggesting that Entrust® suppressed thrips reproduction in seedling cotton.

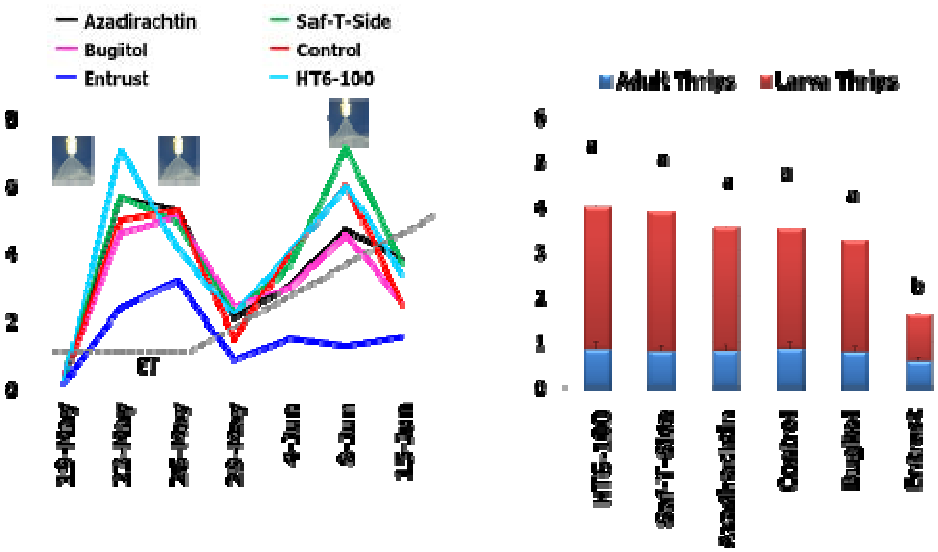

Figure 1. Effect of organic products on thrips abundances; a) Weekly thrips population dynamics, and b) Seven-week average densities of adult and larval thrips.

Effect on Shoot and Root Lengths

Two-week average data indicated no significant effect of test products on plant shoot or root growth behavior (Fig. 2). It is possible that the effect of product applications might not have manifested in root/shoot growth by the time the sampling was terminated due to herbicide drift from an outside source. In 2011 study, we had speculated some evidence of possible physiological effect of one of these organic products on plant growth.

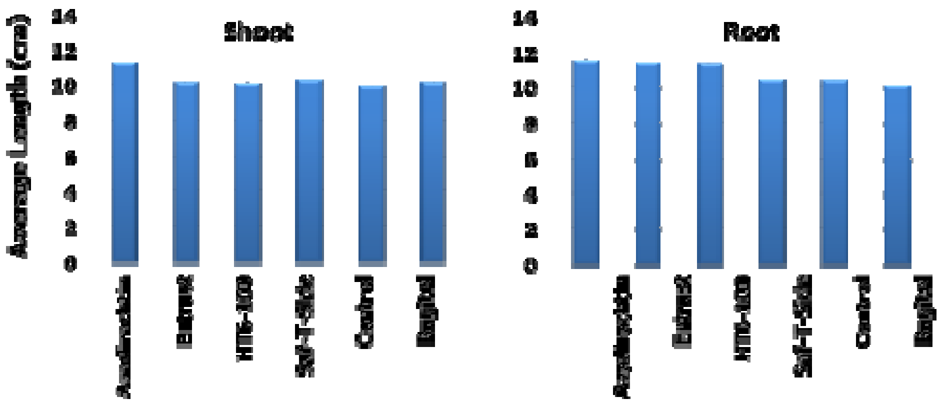

Figure 2. Average shoot and root lengths (n=2 weeks) as affected by selected treatments.

Effect on Leaf Area and Leaf Chlorophyll

Average leaf area (per plant) varied with organic product treatments, with significantly higher leaf area on Entrust®-treated plots, followed by Azadirachtin, with lowest leaf area on Bugitol and Saf-T-Side plots (Fig. 3). The significantly enhanced leaf area on Entrust®-treated plots compared with that in other treatment plots may be attributed to lower thrips numbers on Entrust®-treated cotton plants (Fig. 1). This phenomenon was also clearly evident in 2011 (Shrestha et al. 2012). Nevertheless, treatments did not significantly influence the leaf chlorophyll content among the six treatments (Fig. 3).

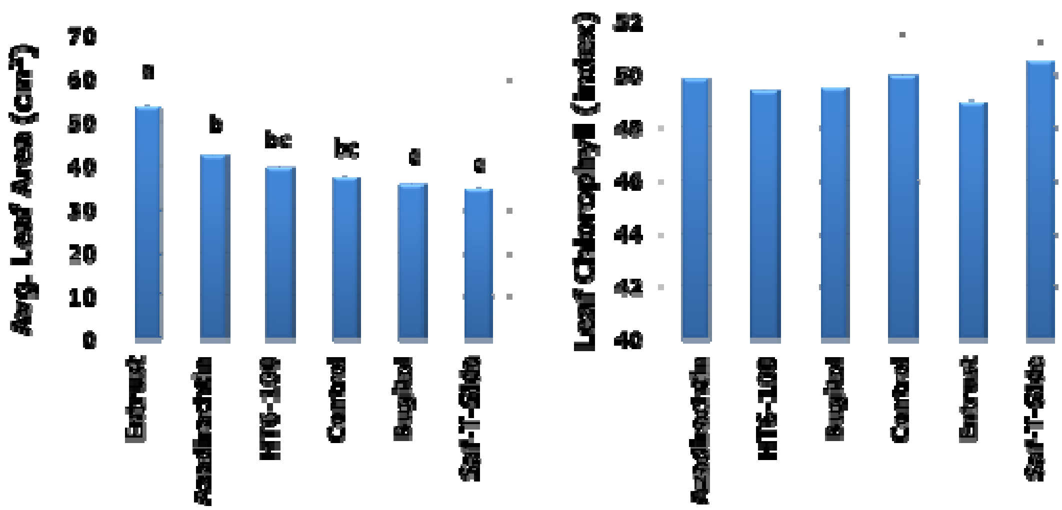

Figure 3. Influence of organic product application treatments on average leaf area per plant and leaf chlorophyll content, June 12 and 19, 2012.

Effect on Plant Biomass

Plant biomass measurements, as assessed, were observed to have followed a pattern generally similar to that of leaf area. That is, Entrust® and Azadirachtin treated plots had significantly higher whole-plant biomass compared to the other treatments (Fig. 4). This was congruent with expectations, particularly given the importance of foliage in plant growth and development. A significantly higher dry biomass (Fig. 4) in Entrust® plots could be related to lower thrips densities in that treatment (Fig. 1), but there may be other physiological reasons for Entrust® and Azadirachtin both to contribute to increased biomass. Lint yield did not significantly vary across six treatments, suggesting that plants must have compensated for any early season variations in plant growth parameters manifested by these products.

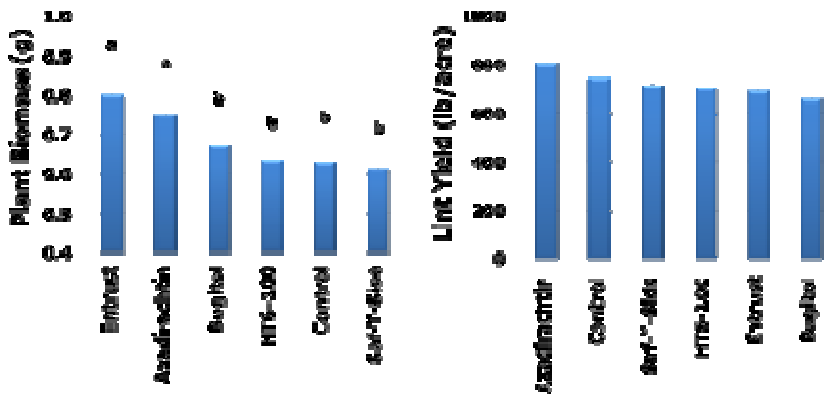

Figure 4. Influence of organic product treatments on cotton plant biomass (June 12 and 19, 2012) and lint yield.

Summary

Overall, 2012 thrips pressure was higher than usual in our study. The first pesticide application did not result in thrips suppression, but the second and third applications showed significant reduction in thrips densities for about 4 days. Only Entrust® significantly suppressed thrips populations and kept densities below the ET when cotton was at the 2-5 true-leaf stage. Due to very high pressure of immigrant adult thrips and subsequent reproduction on cotton seedlings, none of the treatments proved effective when cotton was at the 1 true-leaf stage. Data analysis indicated that shoot and root length did not vary with organic product treatments. Plants from Entrust®-treated plots had significantly higher leaf areas compared with that in other treatment plots, likely due to lower thrips numbers on Entrust®-treated cotton plants. However, there was no significant treatment effect on leaf chlorophyll content. Plant biomass was significantly higher in Entrust® and Azadirachtin® treatments compared with that in other treatments. Even though Entrust® significantly reduced thrips densities, all tested organic products resulted in similar lint and seed yields. The 2012 data showed no yield benefit of application of the five organic pesticides evaluated. However, we plan to repeat this study in 2013 with possible addition of new available chemistries for organic production.

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