

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

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Abstract

Western flower thrips [*Frankliniella occidentalis* (Pergande)] is an important pest of seedling cotton. Seed treatments, seed-bed applications of aldicarb or foliar applications of various insecticides, are common practices for managing this early-season cotton pest. However, available options for thrips management in organic cotton production systems are very limited. The efficacy of three organic products: Entrust® Naturalyte® Insect Control (spinosad microbial), PyGanic® Crop Protection EC 5.0 II (pyrethrum), and Surround® WP Crop Protectant (kaolin clay) were evaluated and compared to an untreated control. Treatments were initialized during the week of cotton seed germination and applied weekly for three weeks thereafter. In conjunction with treatment applications, cotton was sampled weekly via visual and absolute (plant washing) methods. In addition to thrips densities, cotton seedling total (above and below soil surface) biomass, leaf area, and leaf chlorophyll indices were recorded. Despite relatively low seasonal thrips densities, Entrust® was observed to be most effective in controlling thrips, followed by Surround®, PyGanic®, and the control. Cotton seedling total biomass was highest in Surround®-treated plots, followed by PyGanic®, Entrust®, and control.

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 (2011) reported that for 2010, Texas had an estimated total of 5,343,620 acres of cotton infested with thrips, which resulted in 8,937 cotton bale loss due to thrips damage.

Demand of organic cotton is increasing globally. 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 essentially 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 in the past conferred superb thrips control in conventionally grown cotton for a number of years, there exists a need for effective alternatives, including those which may have parallel uses in organic production systems. It was recently 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. 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.

In this study, a selection of available organic products were evaluated 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. 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 selected for evaluation in this study.

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, perhaps broadly, 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 10 May 2011 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 four treatments [three organic products - Entrust[®] Naturalyte[®] Insect Control (spinosad microbial), PyGanic[®] Crop Protection EC 5.0 II (pyrethrum), and Surround[®] WP Crop Protectant (kaolin clay) plus an untreated control] in order to achieve differential thrips densities in treated plots. Treatments were initiated during the week of cotton seed germination and applied weekly for three weeks thereafter. Simultaneously, adult and juvenile thrips were quantified via weekly visual sampling of ten plants per plot, via insect dislodgement into white polystyrene cups, facilitating observation by human samplers. In concurrence with and for verification of visual sampling data, adult and juvenile thrips densities were also quantified via “absolute” sampling, which involved whole-seedling immersion of ten plants per plot and subsequent, lengthy 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 a weekly basis for ten weeks. Plant biomass (root, leaf, branch, and reproductive plant parts) was measured weekly for ten weeks. Cotton crop fruiting profiles were assessed via weekly COTMAN[™] plant mapping. Lint yields were measured in each plot.

Results and Discussion

Record-breaking high temperatures and drought conditions during the 2011 growing season may have partially been the reason for the negligible (considerably below economic threshold levels) early-season western flower thrips densities in all of the experimental plots/treatments. Dry winters and springs result in poor germination and growth of small grain crops (wheat, rye, etc.) and roadside weeds, both of which provide non-cotton hosts for thrips densities to build up for later movement to small pre-squaring cotton plants. 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 organic product treatments, on plant root and shoot length, leaf area, and biomass of variously categorized plant parts.

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. However, thrips densities, as assessed weekly, decreased in all plots as the cotton plants grew older, indicating consistently decreasing cotton suitability as a thrips host across plots, perhaps due to unseasonably hot and dry conditions, which may have

reduced overall plant quality of the host. Consistent observations of decreasing thrips densities across plots suggests that any treatment effects on the thrips population were overcome by environmental or crop factors. However, despite relatively low overall thrips densities, the average number of thrips (adult+larvae and adults only) was significantly higher in untreated control plots than in Entrust®- and Surround®-treated plots (Fig. 1).

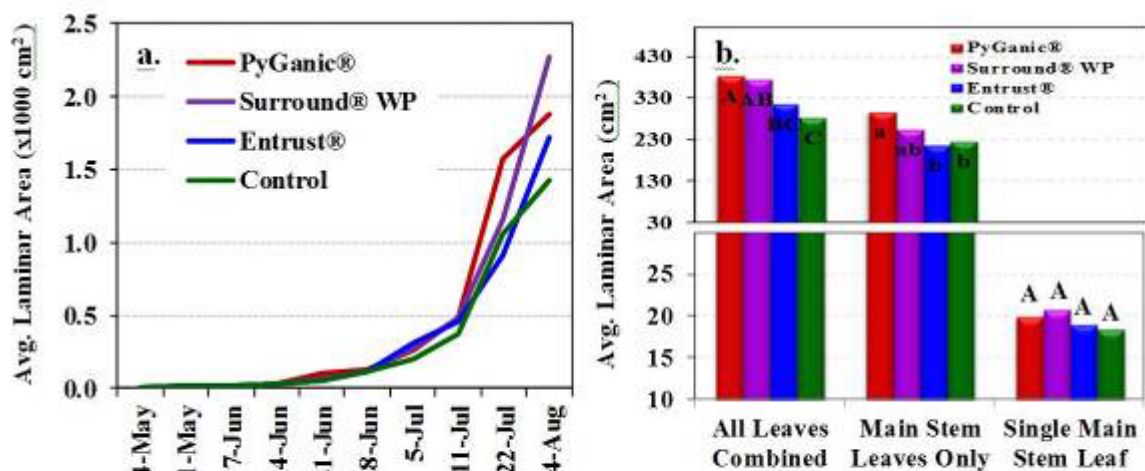


Figure 3. Influence of organic product application treatments on foliar growth; a) Weekly average leaf area per plant, and b) Leaf area per plant averaged over ten weeks.

Effect on Shoot and Root Lengths

Ten-week average data revealed that shoot lengths of plants in the Entrust®-treated plots exhibited significant stunting versus plants in Surround®- and PyGanic®-treated and untreated control plots (Fig. 2a), but root lengths (Fig. 2b) were statistically similar across treatments. Thrips feed on mesophyll intracellular materials, which results in surrounding epidermal collapse. More extensive injury completely disrupts leaf cellular structure, causing mesophyll and epidermal cell desiccation. Theoretically, high thrips densities should result in greater leaf damage, ultimately reducing photosynthesis in the infested plant, which, in turn, should negatively impact root and shoot growth. In conducting this experiment, thrips densities were observed to be relatively low, leading to the expectation of plant damage insufficient to produce statistically significant differences in cotton leaf chlorophyll content, which might, given greater observed thrips densities, have also impacted root and shoot lengths. Contrary to this extemporaneous expectation, while thrips densities in Surround® and Entrust®-treated plots were similar, the average height (shoot length) of Entrust®-treated plants was significantly lower than that of Surround®-treated plants, indicating a possible physiological effect of one of these two organic pesticide products on plant growth. This assertion needs further verification via a separate physiological study.

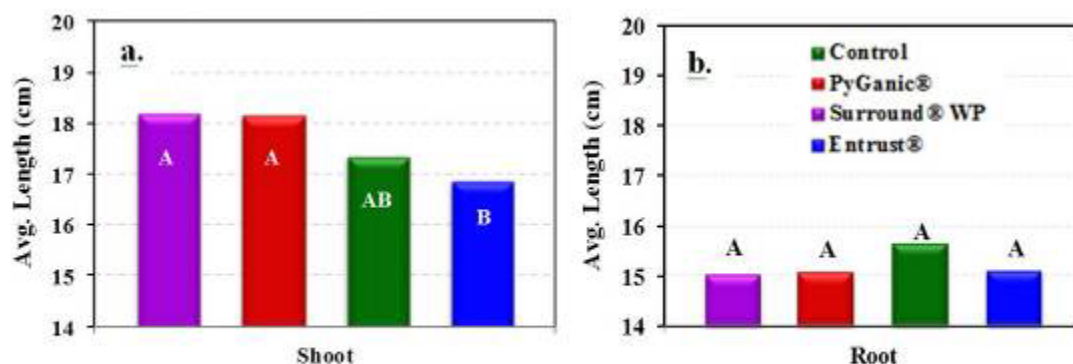


Figure 2. Average shoot (a) and root (b) lengths (n=10 weeks) as affected by selected treatments.

Effect on Leaf Area

Average leaf area per plant was low in all treatment plots for the first four weeks of growth (until mid-June), afterwards leaf area increased rapidly until mid-July. Leaf area increased most rapidly after mid-July (Fig. 3a). Generally, the first few weeks following cotton germination are considered to be the most critical thrips damage vulnerability window, but even during this well-known thrips-sensitive period, significant differences in plant leaf area between treatment plots were not observed. Average main-stem leaf size (Fig. 3b) was also statistically similar across all treatments. These results were found, likely, due to the relatively low (considerably below economic threshold) seasonal thrips population (Fig. 1a) and the associated negligible cotton crop damage. However, ten-week average data showed that average leaf areas in treated plots and untreated control plots differed significantly. Leaf area was significantly lower in control plots than in from PyGanic®- and Surround®-treated plots. Additionally, separation in average leaf area between treated and untreated plants was observed to have begun late during the season, specifically in July. With no observed treatment effect on leaf area during the first four weeks of cotton growth, late-season treatment effects were not expected, but data analysis clearly indicates that untreated plants exhibited lower average leaf area (Fig. 3). Residual organic pesticidal effects or peripheral effects resulting in plant physiological attenuation or enhancement are suspected contributors to this observation.

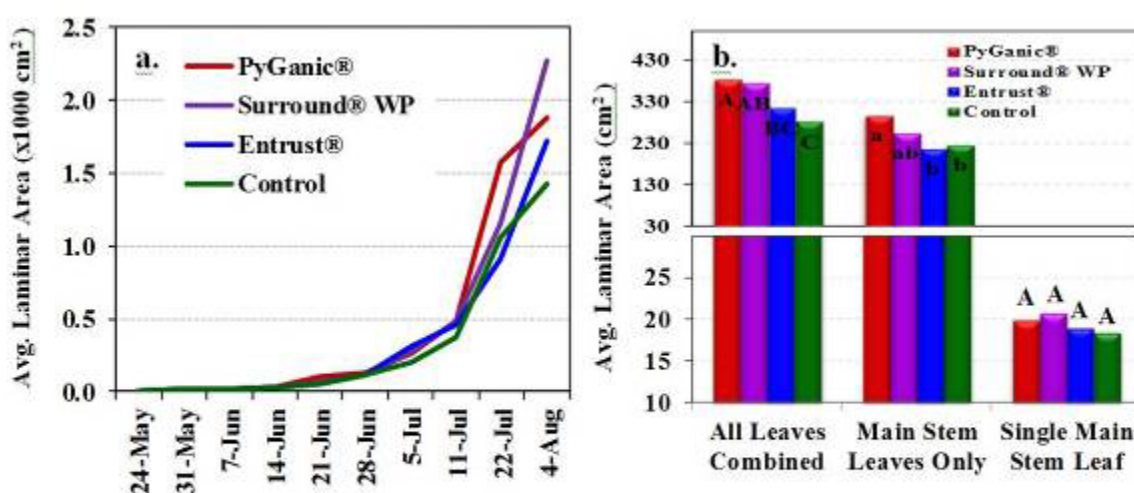


Figure 3. Influence of organic product application treatments on foliar growth; a) Weekly average leaf area per plant, and b) Leaf area per plant averaged over ten weeks.

Effect on Plant Biomass

Plant biomass measurements, as assessed, were observed to have followed a pattern similar to that of leaf area. This was congruent with expectations, particularly given the importance of foliage in plant growth and development. For the first five weeks following seedling emergence, the rate of cotton plant biomass accumulation was slow, but began to increase rapidly at the end of June to a peak during the second week of July (Fig. 4a). Significant influence of organic product spray application treatments on cotton plant biomass accumulation were not observed until after eight weeks of crop growth, after which differences became obvious, approximately in late July and early August. Given an expectation of strong treatment effects, anticipating observed early-season differences would have been reasonable, but an observation of treatment effects only during the late season is difficult to explain. One possibility is that treatment effects may have been slight in magnitude but enduring in terms of plant growth, however; this hypothesis requires evaluation with formal experiments. Overall dry biomass (Fig. 4b) was significantly lower in plants from control plots than plants from Surround®-treated plots. Root, branch, leaf, and fruit biomasses were significantly lower in the control plots, likely due to higher thrips densities (Figs. 1 and 4), which may have suppressed plant growth. Harsh environmental conditions in 2011 and concurrent, relatively low thrips densities inhibited proper evaluation of the effects of early thrips injury on plant parameters. This study will be repeated over the next two years to better elucidate these relationships.

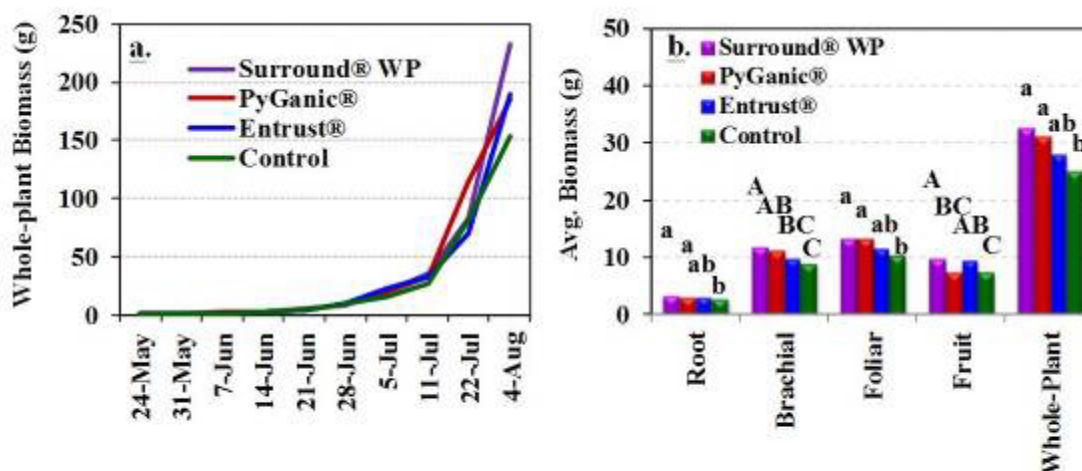


Figure 4. Influence of organic product treatments on cotton plant biomass; a) weekly average plant biomass, and b) ten week average biomass of different plant parts.

Summary

Record-breaking high temperatures and drought conditions during the 2011 growing season may have resulted in early-season western flower thrips densities considerably below those observed during more seasonable years, and certainly well below economic threshold levels. Higher densities would obviously have provided a more suitable situation for evaluation of differential thrips densities on cotton plant growth, development, and yield parameters. Nonetheless, despite seasonal drawbacks pertaining to the subject pest population, the average number of thrips (adult+larvae or adults only) was observed to be significantly higher in untreated control plots versus Entrust®- and Surround®-sprayed plots. Plants from Entrust®-treated plots were significantly stunted versus Surround®- and PyGanic®-treated plots. Total leaf area and overall dry biomass were significantly lower in plants from control plots than plants from Surround®-treated plots. Specifically, root, branch, leaf and fruit biomasses were significantly lower in the control plots, likely due to higher thrips densities in control plots. Under higher thrips densities, differences might have been more pronounced. Root length, average mainstem leaf size, and lint yields (data for which are not shown) were statistically similar across all treatments. More seasonable climatic conditions might have facilitated evaluation of the effects of early-season thrips injury on plant parameters. For more thorough investigation, two more years of study are planned.

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