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SEASONAL ABUNDANCE PATTERNS OF THRIPS AND FLEAHOPPERS IN TEXAS HIGH PLAINS COTTON

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Abstract

The study was conducted at the AG-CARES farm in Lamesa, Texas to quantify the seasonal activity patterns of the western flower thrips, *Frankliniella occidentalis* (Pergande), and cotton fleahoppers, *Pseudatomoscelis seriates* (Reuter). Thrips infestation started from cotyledon stage. Thrips showed two distinct peak populations, one at 1-2 true leaf stage (20 DAP) and another at flowering stage (82-96 DAP). In the first peak, thrips numbers reached up to 6.1 total thrips per plant and the number slowly declined as the plant matured and began squaring. However, once cotton started flowering (75 DAP), thrips population began to grow and attained the second peak in the second week of August (96 DAP); the second peak was larger than the first peak. Fleahopper activity began 44 days after planting and showed only one peak in early square stage (103 DAP). Seasonal average fleahoppers were found significantly higher in late-planted cotton (2705 per acre) compared with that in timely planted cotton (1118 per acre). The tillage system and variety did not have a significant influence on abundance pattern of thrips or fleahoppers. Visual sampling method detected the highest abundance of fleahoppers (37,851 per acre) followed by beat bucket (17,086 per acre), drop cloth (8,378 per acre), vacuum (951 per acre), and sweepnet (798 per acre) sampling.

Introduction

Cotton is the most dominant crop in Texas. In 2001, 4.2 million acres of cotton were harvested that produced 4.2 million bales of lint and 1.7 million metric tons of seed cotton generating about $731,000,000 for Texas farmers (Ramirez 2002). New development in production practices and technological advances in seed genetics have given cotton farmers new options to reduce input costs. The gene from *Bacillus thuringiensis* var. *kurstaki* that produces the Cryl Ab or Cryl Ac protein that are toxic specifically to lepidopteron species were inserted into cotton plants by Perlak et al. in 1990 and the first *Bt* transgenic cotton variety (called Bt cotton) were commercially released in Australia (INGARD) and the United States (BOLLGARD) in 1996 (Olsen and Daily 2000). Now farmers have access to genetically modified cotton varieties, such as Bt cotton (containing *Bacillus thuringiensis* gene), Roundup Ready cotton (Glyphosate resistant), and stacked gene cotton cultivar (Roundup Ready + Bt) (Ward et al. 2002). Approximately 10% of Texas cotton acreage is under Bollgard cotton With the high adoption rate of Roundup Ready technology, the practice of conservation tillage system has become commonplace with cotton growers (Birdsong and Mitchell, 2002). Conservation tillage has been defined as a production system in which 30% or more of the soil surface is covered with residue (Reeder. 2000). In Texas, some form of a conservation tillage system is used on approximately 25% of the cotton acreage.

The western flower thrips, *Frankliniella occidentalis* (Pergande), and cotton fleahoppers, *Pseudatomoscelis seriates* (Reuter), are the primary early season pests of cotton in Texas. Western flower thrips is one of 13 species of thrips known to feed on seedling cotton, *Gossypium hirsutum* L. It is the most common species of thrips in Texas High Plains cotton (Rummel and Arnold 1989). Thrips damage to early season cotton results in significant leaf area reduction, delayed maturity, and retarded plant growth (Sadras and Wilson 1998, Harp and Turner 1976, Hawkins et al. 1966). While the presence of thrips has been observed throughout the cotton-growing season, the cotton plant is most vulnerable during the seedling stage. Thrips feed on the terminal area, disrupting normal plant growth (cause silvery stain, crumpled, crinkled, cupped and distorted leaves). Cotton plant responses to thrips feeding include pre-bloom square loss, reduced leaf area, poor root development, delayed crop maturity, and decreased lint yield (Johnson et al. 1996; Hawkins et al. 1966; and Fairbanks et al. 2000). Thrips infested approximately 93% of U.S. cotton and ranked third among the cotton pests in area infestation in 2001 (Williams 2002); however, crop damage sustained from this pest differs from year to year with respect to economic severity. As a result, most cotton producers utilize in-furrow insecticides or seed treatments at a cost of $10-15 per acre as an insurance policy against thrips infestation. In Texas, thrips infestations occurred in 4.3, 4.6, and 3.8 million acres causing 0.09%, 0.50% and 3.15% cotton yield loss in 1999, 2000 and 2001, respectively (Anonymous 2002).

The cotton fleahopper (Hemiptera: Miridae) is considered a key pest in the eastern part of Texas. In the western part of the state, the cotton fleahopper may increase to damaging populations occasionally. Both adults and nymphs feed on new growth, including small squares (Leigh et al. 1996, Parker 1996). Squares up to pinhead size are susceptible to damage and the plant is most susceptible during the first three weeks of fruiting (Muegge et al. 2001). Its importance among cotton pests is increasing as losses due to boll weevil and bollworm/budworm decline due to boll weevil eradication and the adoption of Bt cottons, respectively (Knutson et al. 2002). Fleahoppers infest approximately 41% of the U.S. cotton and ranked sixth among cotton pests in area infestation in 2001 (Williams 2002). In Texas, fleahoppers infested 4.8, 4.4 and 1.7million acres causing 6.58%, 0.4% and 0.13% cotton yield loss in 1999, 2000 and 2001, respectively (Anonymous 2002).

Tillage system and other cultural practices have shown to affect arthropod species diversity and population densities. For example, conservation tillage system has resulted in occasional, but severe insect pests problems in the southern region of the United States (Leonard and Emfinger, 2002). Because thrips and cotton fleahoppers are becoming more important pests and the cotton agro-ecosystem is changing due to adoption of Bt cotton and conservation tillage systems in the Texas High Plains, we attempted to characterize the seasonal abundance pattern of thrips and fleahoppers. The objective of our study was to quantify the influence of planting date, tillage practice, and cotton cultivar on seasonal activities of thrips and cotton fleahoppers. As part of this study, we also evaluated the efficacy of different sampling methods in fleahopper detection. The information generated in this study will be useful in making appropriate pest management decisions by the area cotton producers.

Materials and Methods

The study was conducted at the Agricultural Complex for Advanced Research and Extension System (AG-CARES) farm, near Lamesa, Texas. The experiment consisted of three cropping system treatments (tillage system, cotton variety, and planting date) at two levels each. The test was replicated three times. The two tillage system treatments included conventional and conservation tillage and the two cotton variety treatments included conventional and transgenic Bt cotton. Planting dates included an optimum planting date (recommended for the southern High Plains), hereinafter referred to as timely planting, and a late planting date that represents the crop insurance replanting cut-off date for the region. The test was deployed in a randomized complete block design within each tillage system. Conservation tillage system also known as minimum tillage included shredding of cotton stubble, drilling rye seed (55 lb/acre) under cotton stubble in winter and chemically terminating rye one month before cotton planting, furrow-diking once in mid July and hoeing three times for the control of weed. Conventional tillage system included shredding cotton stubble, thrice breaking (spring tooth), bedding, pitching out, furrow diking, rod weeding, hoeing two times and furrow-diking three times during the season. Timely planting plots were planted on 9 May which is within the area's optimal cotton planting window where as the late planting plots were planted on 10 June, the last date of planting for insurance purposes. The stacked gene cotton variety PM2326 BGRR was used as the Bt cotton and Roundup Ready cotton PM2326RR was used as the non-Bt cotton variety.

Cotton was planted in 40-inch rows with a plant density of 62,100 plants per acre in the sandy loam soil of Lamesa without application of any insecticide in-furrow but a synthetic pyrethroid (Karate) was applied by aerial spray at small square stage for the control of cotton bollworm and beet armyworm on11 July, 2002. Plot size was variable (average plot size was 485 square feet) due to the pie shape of the field and 16 rows of cotton were planted in each plot. Crop was irrigated (13.91 inches) by center pivot system equipped with LEPA (low energy precision application) nozzles.

Thrips and fleahoppers were sampled weekly from May 21 to October 22. Thrips were sampled only by visual sampling method whereas cotton fleahoppers were sampled by visual, beat bucket, vacuum, dropcloth and sweepnet sampling methods. Thrips sampling was done by inspecting 5-10 plants per plot. Plants were thoroughly observed and white paper plates and hand lenses were used to tap the plants and count immature thrips. The two-cycle backpack aspirator equipped with 21.2 cc engine (Model 1612, John W. Hock Company, Gainesville, FL) was used for 30 second per plot to vacuum fleahoppers from 500 cotton plants from each plot. Standard size (14.5 inch diameter) sweepnet was used to sweep 604 plants in 100 sweeps from each plot. A white plastic bucket of 12-inch height and 15 inch diameter was used to beat three plants at once from a sampling location and four samples per plot were taken with a total of 12 plants per plot sampled by beat bucket method. White dropcloth of 36.5x28.5 inches was used to shake 10 plants (5 plants from each side of a cotton row) from each sampling site and 4 samples per plot were taken with a total of 40 plants per plot sampled by dropcloth method. In visual, drop cloth, and beat bucket methods, fleahoppers were counted and the numbers were recorded on the spot in the field where as vacuum and sweep net samples were collected in plastic bags from each plot and brought to the laboratory for counting and recording.

Thrips data were recorded as the number of adults and nymphs per plant while fleahopper data were converted into numbers per acre. Data were analyzed using an analysis of variance and means were compared using the least significant difference method (SAS Institute 2000).

Result and Discussion

A. Thrips

1. Abundance Pattern. Thrips infestation began in cotyledon stage of cotton. Mostly migratory adult thrips were observed in the first week of cotton germination (12 days after planting, DAP). Thrips were mostly found on bud and lower surface of young true leaves and reproduced rapidly (4.6 per plant) by 1-2 true leaf stage (20 DAP). Since thrips are very minute, highly motile and are mostly hidden under unfolded leaves in cotton buds, special care should be taken not to miss and double count the thrips, while monitoring their populations. Thrips population showed two distinct peaks, the first in early 1-2 true leaf stage (20 DAP) and the second peak at flowering stage (82-96 DAP) (Fig. 1). In the first peak, thrips numbers reached up to 6.1 total thrips per plant and the number slowly declined as the plant matured and began squaring. However, once cotton started flowering (75 DAP), thrips population began to grow and attained the second peak in the second week of August (96 DAP); the second peak was larger than the first peak. Thrips were mostly found inside the flowers during the second peak. Thrips numbers began to decline rapidly after 110 DAP (third week of August) and reached to undetectable level in early September when cotton plants attained >50% boll opening stage (124 DAP).

2. Effect of Tillage. For the first three weeks of observation (i.e., 12, 20 and 27 DAP or cotyledon to 4 true-leaf stage), conventional tillage plots had significantly more thrips compared to the conservation tillage plots. However, for the rest of the growing season, thrips abundance was similar between conventional and conservation tillage plots. Although seasonal average number of thrips in conventional tillage system (4.3 per plant) was higher than that in conservation tillage (3.6 per plant), these values were not significantly different (Fig. 4 a). Thrips abundance patterns in both tillage systems were similar in seasonal activity patterns as well. Both conventional and conservation tillage showed two population peaks, one 20 DAP and the next 96 DAP.

3. Effect of Variety. Thrips abundance did not vary between non-Bt and Bt cotton varieties. Seasonal average abundance of thrips in Bt cotton plots (3.7 per plant) was only slightly lower than that in non-Bt cotton plots (4.2 per plant) (Fig. 4 a). Thrips abundance patterns in both varieties were similar. Both varieties showed two population peaks 20 DAP and 96 DAP. Thrips abundance was not affected by tillage and variety interaction.

B. Fleahoppers

1. Abundance Pattern. Fleahopper infestation began 44 days after cotton planting (6-8 true leaf stage). On average, 98 adults and 78 nymphs per acre were found in the first week (44 DAP). Fleahoppers were mostly found on newly growing buds and young squares and reproduced rapidly (>200 nymph per acre) during 54 to 63 DAP. As cotton began squaring and advanced to blooming stage, fleahopper nymphal numbers declined slowly and reached to undetectable level 75 DAP. Fleahopper abundance showed only one population peak (3,198 fleahoppers per acre) 103 DAP (Fig. 2). No fleahoppers were detected at and after 135 DAP (95% boll opening stage).

2. Effect of Planting Date. Fleahopper abundance was often higher in late-planted cotton compared with that in timely planted cotton (Fig. 3). The seasonal average number of fleahoppers in late-planted cotton (1911 per acre) was significantly higher (p-value 0.0001) than in timely planted cotton (790 per acre). The highest abundance (3,167 per acre) of fleahoppers in timely planted cotton was observed on August 20 (103 DAP), whereas the highest abundance (7,493 per acre) in late planting was observed on August 27 (78 DAP).

3. Effect of Tillage. Fleahoppers showed a single population peak in soft boll stage (103 DAP) in both tillage systems, with population peaks of 2,567 and 3,830 per acre in conservation and conventional tillage systems, respectively. After reaching the peak, fleahopper abundance slowly declined as the plant matured and boll began hardening, and the numbers reached to undetectable level 135 DAP (>95% boll opening stage) in both tillage systems. Seasonal average numbers of total fleahoppers were 2114 and 1708 per acre in conventional and conservation tillage systems, respectively. In most of the sampling dates, average fleahopper numbers in conservation tillage plots were slightly lower than in conventional tillage plots, but the tillage did not have significant influence on abundance patterns of fleahoppers. (P =0.14) (Fig.4 b).

4. Effect of Variety. The analysis of variance revealed no significant difference (P= 0.17) in fleahopper abundance between transgenic-Bt (1665 fleahoppers per acre) and non-Bt (2158 fleahoppers per acre) cotton varieties (Fig. 4 b).

5. Efficiency of Sampling Methods. Sampling methods varied significantly in their ability to capture fleahoppers (P=0.0001). Although visual sampling method was more time-consuming than other methods, it detected the most fleahoppers (Fig. 5). Visual sampling method captured 37,851 fleahoppers per acre followed by beat bucket (17,086 per acre), drop cloth (8,378 per acre), vacuum (951 per acre), and sweepnet (798 per acre) sampling.

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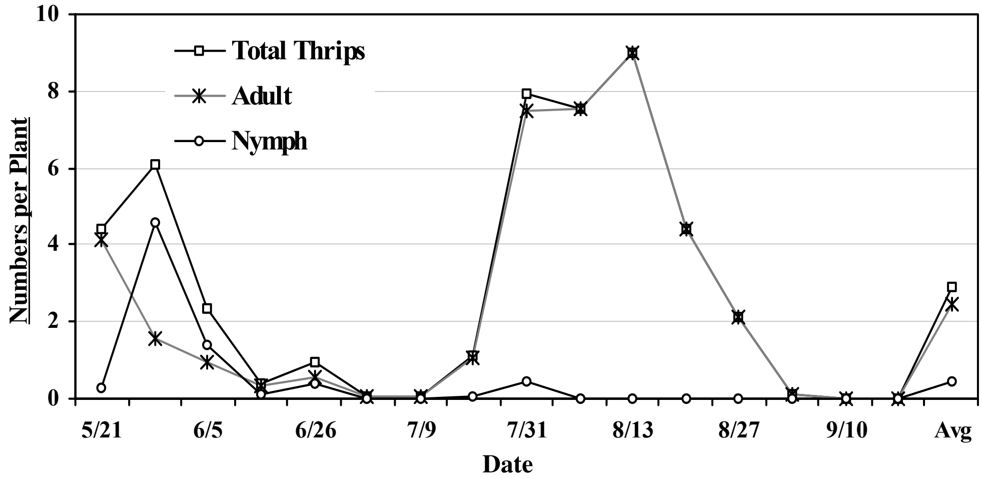


Figure 1. Seasonal abundance patterns of thrips detected by visual sampling, Lamesa, Texas, 2002.

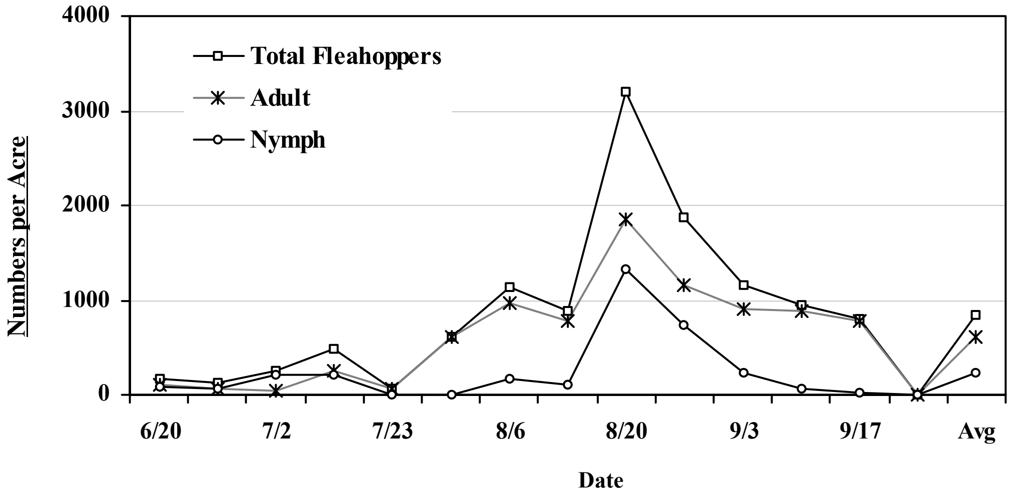


Figure 2. Seasonal patterns of fleahoppers detected by vacuum sampling, Lamesa, Texas, 2002.

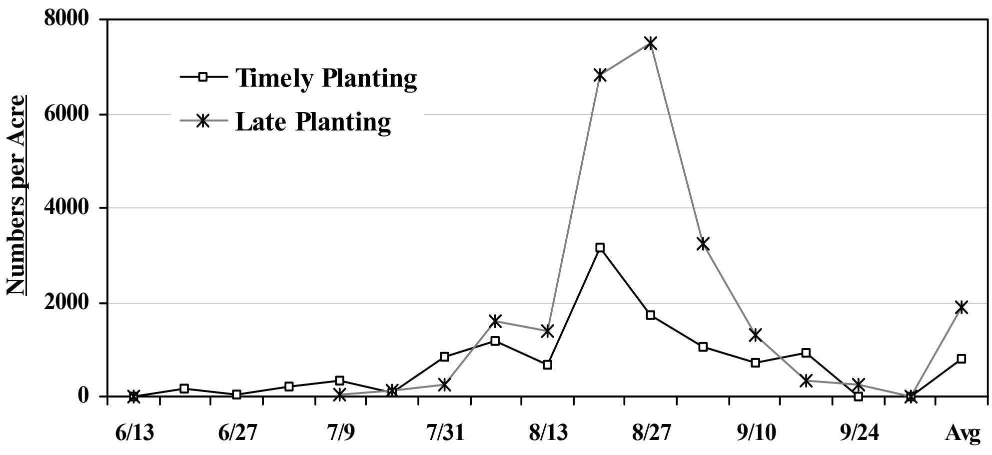
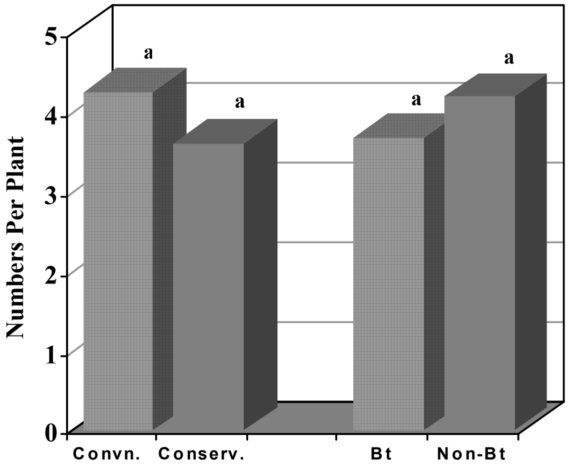


Figure 3. Seasonal patterns of fleahoppers as affected by planting date, Lamesa, Texas, 2002.

A. Seasonal average of thrips



B. Seasonal average of fleahoppers

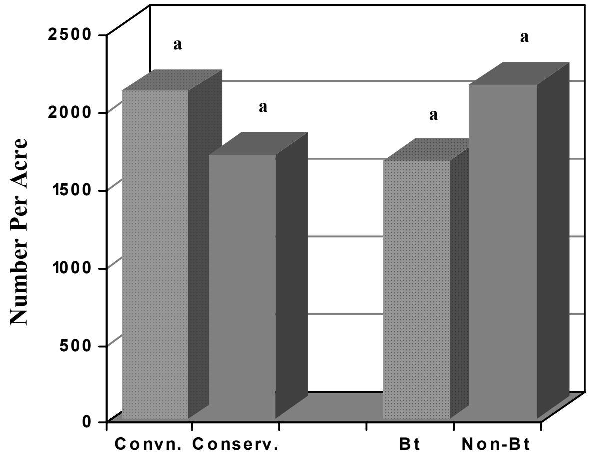


Figure 4. Influence of tillage system and variety on abundance of thrips and fleahoppers.

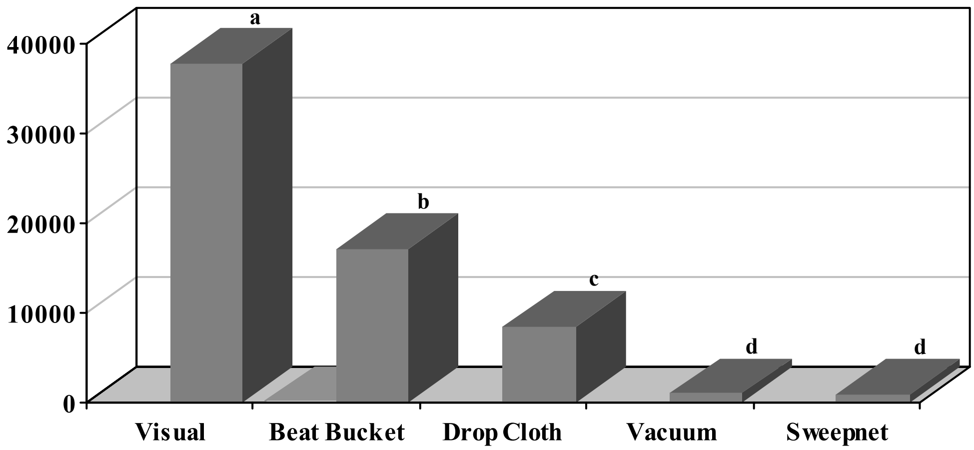


Figure 5. Seasonal average of fleahoppers detected by different sampling methods.