THE IMPACT OF POPULATION DYNAMICS OF FLOWER INHABITING FRANKLINIELLA THRIPS ON COTTON HARDLOCK DISEASE

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Abstract

Cotton hardlock has become an important disease of the crop, reducing yield significantly in the southeastern part of the USA. Researchers have reported about an association of flower inhabiting *Frankliniella* thrips and the disease. However, no work has been reported on the impact of the population dynamics of these insects on the disease. Field studies were conducted during the summer/fall of 2006 and 2007 to evaluate this aspect of the disease epidemiology at two locations, Quincy and Marianna, FL. *Frankliniella* thrips species; *F. tritici*, *F. bispinosa*, and *F. occidentalis* were identified in the white flowers of the crop. However, *F. tritici* constituted >98% of the adult population in both locations. Peak populations of thrips occurred between late July and mid-August in both years, which also coincided with peak bloom at the two locations. In Quincy, a positive association was observed between thrips and the disease even though a very low R^2 value of 0.09 was recorded in these years. In Marianna, while a positive association was observed in 2006, a negative relationship was observed in 2007. The R^2 values observed in the respective years were 0.14 and 0.19. Even though these results tend to add credence to the association of *Frankliniella* thrips and the disease, it appears other factors play a more important role in the epidemiology of the disease.

Introduction

Thrips in the genus *Frankliniella* (Thysanoptera: Thripidae) are ubiquitous, polyphagous pests of vegetables, fruits and ornamental crops (Hansen et al. 2003). An even greater concern with *Frankliniella* thrips is the ability of some species to transmit many different pathogens (Kirk 1997, Mound 1997). A complex of *Frankliniella* species occurs throughout northern Florida and the southeastern USA (Salguero Navas et al. 1995, Eckel et al. 1996, Chellemi et al. 1994, Puche et al. 1995). All of these species are highly anthophilic (Cho et al. 2000) and inhabit flowers of a variety of cultivated and uncultivated plants (Chellemi et al. 1994). Despite their similarity in appearance and their overlapping host ranges, these species display different population dynamics (Cho et al. 2000, Baez 2002, Reitz 2003). In north Florida, *F. occidentalis* can be found year round and it is the most common species from winter to early spring when it is displaced by the increasingly abundant *F. tritici* and *F. bispinosa* (Reitz et al. 2003). Chellemi et al. (1994) reported the greatest number of *F occidentalis*, *F. tritici*, and *F. bispinosa* occurring in May when adults were found in the flowers of many wild plant species. Reitz (2003), who conducted the studies in northern Florida, reported that thrips rapidly colonize plants soon after the onset of flowering in early September, and that population peaked in mid-September and declined until the end of the month. Stavisky et al. (2002) reported that the population of thrips increased in early May, peaked in mid-May, and declined in early June.

Generally, there have been reported variations in the pattern of distribution. Tavella et al. (1996) showed that 96% of adult and larval *Frankliniella* spp. occurred in the flowers of greenhouse grown pepper (*Capsicum anuum* L.). But while Higgins (1992) found the majority of *F. occidentalis* adults in the flowers of greenhouse-grown pepper and cucumber (*Cucumis* sativa [L.]), he observed that the majority of larvae were found on the leaves. Studies by Funderburk et al. (2000) showed similar patterns reported by Tavella et al. (1996). These variations emphasize the need to study the population dynamics of thrips on various crops. Furthermore, thrips are believed to spread *F. verticillioides*, which is associated with hardlock in cotton by infecting flowers. It is estimated that the disease reduced cotton yield in the Panhandle of Florida by about 50-60% in 2002 (Wright et al. 2003). No work has been reported on the impact of the population fluctuations of thrips on the disease incidence. Information on the population dynamics of thrips in the flowers may contribute to the understanding of the role thrips play in the spread of the disease. This may provide a clue to the development of appropriate control strategies for thrips and subsequent control of cotton hardlock.

Therefore the objectives of this study were to determine;

1. the population fluctuations of *Frankliniella* thrip spp. in cotton flowers, and

2. how these fluctuations relate to the incidence of the disease.

Materials and Methods

Field plots

Cotton (DPL-555 BG/RR) was planted on two fields at the North Florida Research and Education Center (NFREC) in Quincy and Marianna (approximately 64 kilometers from Quincy), FL, in 2006 and 2007 summer/fall growing season. The Quincy fields were part of a cotton-peanut-bahiagrass rotation study while the Marianna field has had only bahiagrass maintained on it. Cotton plants were grown according to normal production practices recommended by the University of Florida Extension Services unless otherwise stated. Cotton rows were planted in a north-south direction. The field in each site consisted of four blocks in a randomized complete block design. Each field measured 100.6 m x 14.6 m with block size of 18 m x 14.6 m and between block distance of 4.6 m. Blocks consisted of 16 rows of plants, with a row spacing of 0.9 m. Planting was done after the application of 5-10-15 fertilizer at 225 kg/A three days prior to planting. No pesticides were applied throughout the study period.

Thrips sampling

Forty white flowers from 40 plants (one from each plant) from each field were collected and put into separate 60 ml wide-mouth "HDPE" sample bottles containing 70% ethyl alcohol. The flowers were inverted when being placed in the sample bottles such that insects inhabiting them got dislodged and dropped to the bottom of the bottle. These were taken to the laboratory for processing. Thrips were extracted and adult species and their sexes were determined and counted under a stereomicroscope at 40x based on their taxonomic features. Larval thrips were counted as a group. Flowers were randomly checked under the stereomicroscope to make sure all thrips were extracted.

Impact of thrips population dynamics on hardlock severity

On the day of sampling each week, 100 white flowers from 100 plants (one from each plant) from each field (25 flowers from each block) were tagged and that was used to assess thrips numbers and hardlock. Labeled ribbons of different colors were used for the tagging. At the time of assessing hardlock, only 40 open bolls for a given tagging date were used for the assessment. Tags with dates having <40 open bolls as a result of severe boll or flower abortion were not included in the assessment of hardlock. In addition, the general hardlock severity for the season was determined by rating 40 plants in each field. The total number of locules with hardlock was divided by the total number of locks in all the bolls on all 40 plants, giving a percent index for each field. Hardlock was assessed two weeks before harvesting was done.

Data analysis

The data were subjected to analysis using SAS (8.1) GLM procedure and analysis of variance performed at the 5% probability level. Tukey's procedure was used to separate means, and linear regression analysis was used for the relationship between thrips and hardlock.

Results and Discussion

Population dynamics of *Frankliniella* thrips

Frankliniella spp., *F. bispinosa, F. occidentalis* and *F. tritici* were recorded in both Quincy and Marianna. However, *F. tritici* accounted for >98% of the adult thrips population at both locations and larval thrips per flower were <1 during the entire life of the plant. Adult thrips inhabited the leaves when there were no flowers but preferred the latter to the former when blooming began. Thrips population began to increase rapidly on the plants with the onset of bloom, peaking around mid-season which also coincided with peak bloom. In both locations, peak densities of adult *F. tritici* in flowers occurred around late July to mid-August (Figs. 1, 2 and 3). Mean densities of 19.6 and 18.28 per flower of this species were recorded in 2006 and 2007, respectively in Quincy while 33.7 and 24.18 per flower were recorded, respectively in Marianna. With a few exceptions, >90% adult thrips occurred in the flowers during blooming. More larval thrips inhabited the leaves at the initial stages of bloom but this proportion declined in favor of the flowers with time.

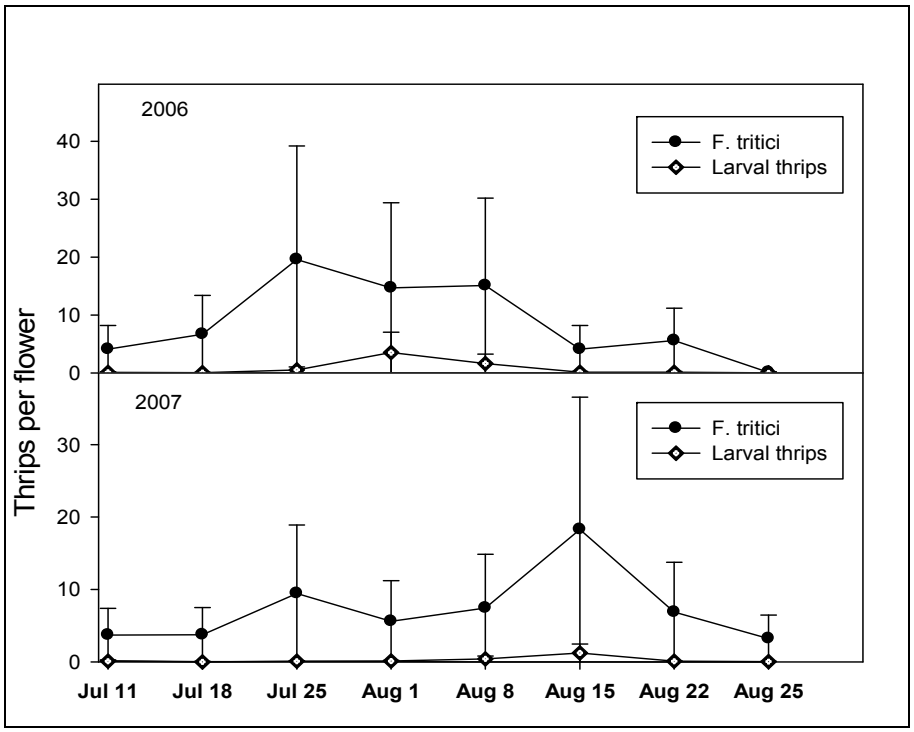

Figure 1. Mean densities (±SEM) of *Frankliniella* thrips in cotton flowers from 11 July through 25 August of 2005, 2006 and 2007 in Quincy, FL.

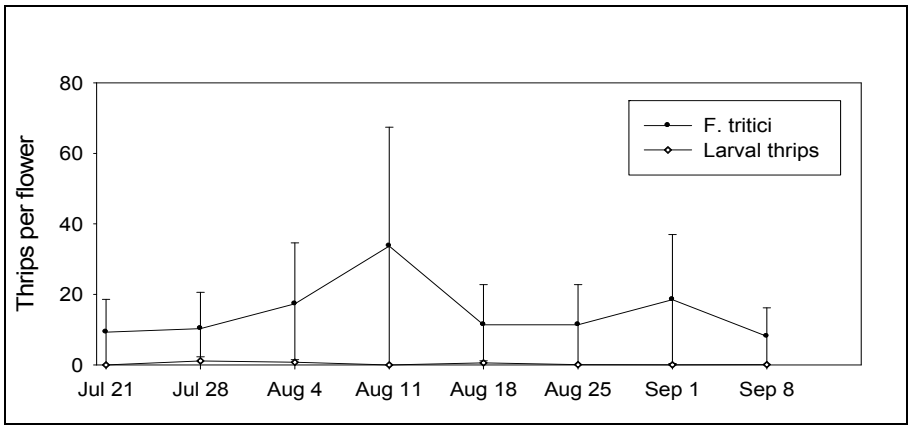

Figure 2. Mean densities (±SEM) of *Frankliniella* thrips in cotton flowers from 21 July through 8 September in 2006 in Marianna, FL

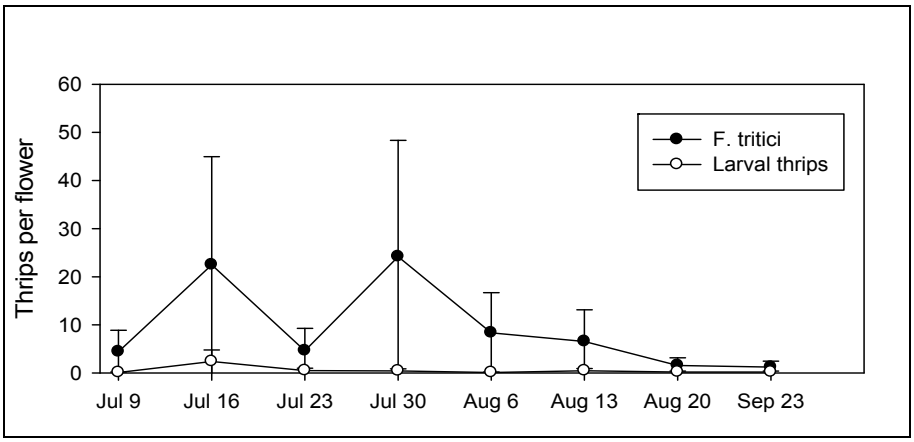

Figure 3. Mean densities (±SEM) of *Frankliniella* thrips in cotton flowers from 9 July through 23 September in 2007 in Marianna, FL.

Population dynamics of thrips and hardlock

There appears to be an association between thrips population dynamics and hardlock disease. In Quincy, a positive association was observed between thrips densities over time and the disease even though a very low R^2 value of 0.09 was obtained in both years (Fig. 4). Both were not significant with P-values of 0.62 and 0.63. The association was variable in Marianna. While a positive one was observed in 2006, a negative association was observed in 2007. The R^2 values in the respective years were 0.04 and 0.18 with P-values of 0.53 and 0.47, respectively (Fig. 5). Excluding one outlier in the Marianna 2007 data reversed the negative association previously obtained. However, 2007 was one of the driest seasons recorded in several years, suggesting that weather conditions were not favorable for the disease. Across the years and locations, removing one outlier in each case increased the R^2 values but still tested not significant. When a linear regression was performed on the yearly hardlock incidence and yearly mean thrips densities per flower, a negative association was obtained and it was also not significant thus high thrips densities for a season did not translate into higher hardlock incidence.

Similar trends in the population dynamics of thrips in both Quincy and Marianna suggest the similarities of the conditions prevailing in both locations. *F. tritici* appears to be the most abundant *Frankliniella* spp. on cotton during the summer/fall season. This is consistent with Reitz et al. (2002) that *F. occidentalis* is displaced by *F. tritici* and *F. bispinosa* as the spring season approaches. Our results that >90% of the adult population are found in the flowers are consistent with the findings of Tavella et al. (1996), who reported that about 96% of adult *Frankliniella* spp. was found in pepper flowers. Generally more thrips were recorded in Marianna than in Quincy and the presence of very large cotton and peanut fields adjacent to our field in Marianna may account for this. That may have offered opportunity for constant migration of thrips between the two fields. Thrips seem to play some role in the epidemiology of the cotton hardlock and the positive association obtained between the two in this study adds some credence to this. The debate has been the extent to which thrips influence the disease incidence and spread. The very low R^2 values and the fact that statistical tests prove not significant seem to suggest a rather small contribution of the insects to the disease incidence. It appears some factors make more important contributions to the disease incidence and severity. Our data seems to suggest that the thrips role may be minor but when conditions favoring the disease are present then thrips role may be important. It may explain why hardlock severity does not really depend on the seasonal mean densities of thrips per flower but probably on the interaction of activities of some flower inhabiting insects including thrips and environmental conditions. Thus high thrips densities per season do not directly mean severe hardlock and vice versa.

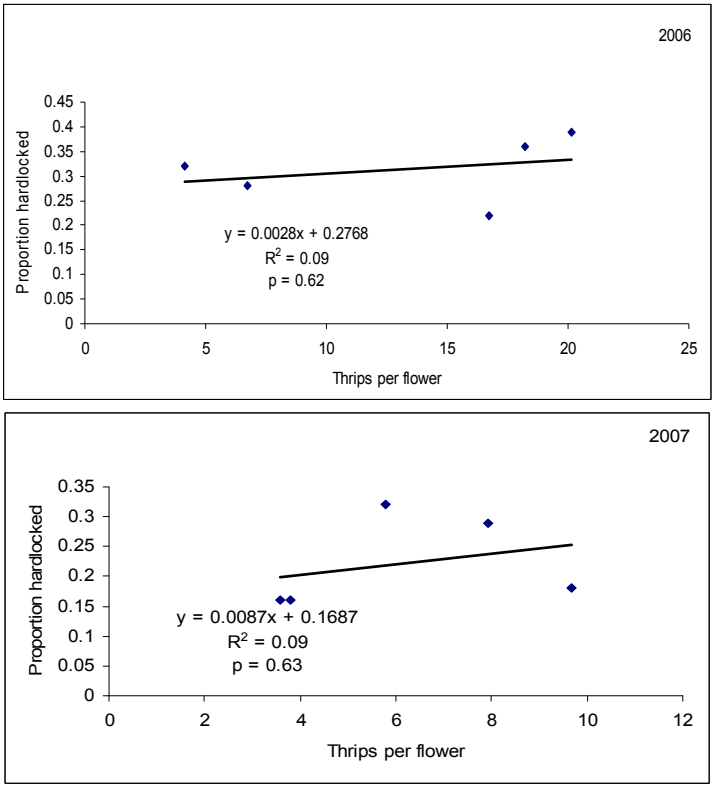

Figure 4. Regression of thrips with hardlock in Quincy, FL.

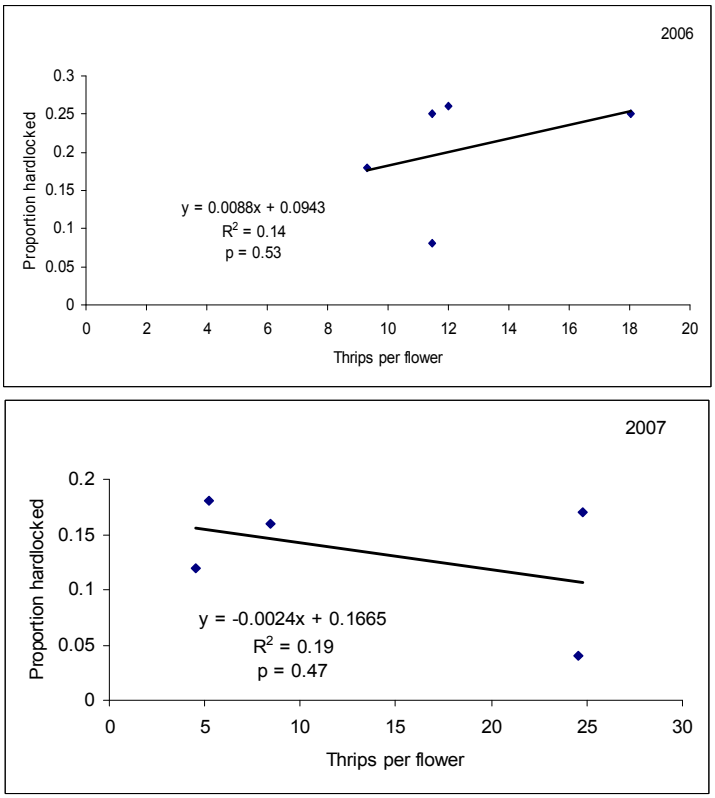

Figure 5. Regression of thrips with hardlock in Marianna, FL.

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