IMPACT OF LEAF HAIRINESS AND PLANTING DATE ON TARNISHED PLANT BUG, *LYGUS LINEOLARIS* (PALISOT DE BEAUVOIS)

W. Wood
J. Gore
D. Cook
J. Krutz
Mississippi State University
Delta Research and Extension Center
Stoneville, MS
A. Catchot
D. Dodds
Mississippi State University
Starkville, MS

Abstract

The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), has become the primary pest of Midsouth cotton over the past decade. Numerous foliar insecticide applications have to be made during the growing season to suppress the tarnished plant bug and to protect cotton from extensive yield loss caused by this pest. New methods of control are needed to conserve grower's money, improve yields, and lower the amount of insecticide resistance that is occurring in tarnished plant bug populations. Experiments were conducted at the Mississippi State University Delta Research and Extension Center, located in Stoneville, Mississippi, to determine the impact of tarnished plant bug infestation on yield and maturity of cotton. Weeks within the flowering stage from two separate planting dates were tested to determine the critical period when cotton is most susceptible to damage from the tarnished plant bug. Also, a trial including smooth, semi-smooth, and hairy leaf varieties were planted to determine the effect of leaf pubescence on tarnished plant bug densities.

Introduction

Since it was first introduced in Florida in 1556, cotton has been a major economic crop in the Mississippi Delta (National Cotton Council 2012). The uses of cotton range from apparel, furniture, and household commodities to the seed oil in animal and human food. There are three varieties of cotton, but Upland Cotton, *Gossypium hirsutum* (L.), makes up the majority planted in Mississippi during mid-April through the end of May. Cotton undergoes five growth stages. These stages include germination and emergence, seedling establishment, leaf area and canopy development, flowering and boll development, and maturation (Jenkins et al. 1990). A degree day model (Maximum temp.+Minimum temp./2 – Development Threshold) can be used to follow and effectively predict cotton growth stages based upon heat unit accumulation (Jenkins et al. 1990). Cotton has indeterminate growth, where vegetative growth will continue after the reproductive process has begun (Silvertooth et al. 1999). Due to this indeterminate growth, cotton has a longer flowering period than most other crops and can flower greater than eight weeks in Mississippi. The indeterminate growth also leaves the plant susceptible to pests for an extended period of time (Silvertooth et al. 1999). Once flowering has begun, cotton growth can be measured by counting nodes above white flower (NAWF). NAWF is determined by counting the number of main stem nodes above the highest first position white flower (Bourland et al. 1992). A first position flower can be defined as the uppermost fruiting branch that possesses a white flower at the first position from the main stem. Cotton possesses phenotypes of varying levels of pubescence, that are described as smooth, hirsute (moderate pubescence) or pilose (dense pubescence). Pubescence refers to the presence of trichomes, which are unicellular outgrowths from the epidermis of leaves (Nawab et al. 2011). The degree of pubescence or trichome density on the leaves of cotton is related to varying degrees of resistance/susceptibility to various sucking pests (Meagher et al. 1997). However, the glabrous trait is typically associated with neutral to positive yields, while the pilose trait usually coincides with lower yield capabilities. During the course of a season, numerous arthropod pests such as *Frankliniella occidentalis* (Pergande), *Tetranychus urticae* (Koch), *Acrosternum hilare* (Say), *Nezara viridula* (Linnaeus) and *Helicoverpa zea* (Boddie) can infest cotton fields; however, the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), has become the most important pest in the Mid-South during the last decade.

The tarnished plant bug is the most economically important pest of cotton in Mississippi (Williams 2012). These true bugs have a broad host range, with over 385 plants documented (Young 1986). Host plants range from wild plants and weeds to fruits, vegetables, and agronomic crops. Tarnished plant bug populations will typically pass one to two generations on early season wild hosts (Fleischer and Gaylor 1987) such as *Lolium* ssp., *Vicia* ssp., *Conyza sumatrensis* (Retz.) and *Amaranthus* ssp. As these hosts begin to senesce in late spring, populations move into agronomic crops (Layton 1995). This generally coincides with the flowering stages of corn and early planted soybeans and tarnished plant bugs will use these crops as reproductive hosts during the early summer (Snodgrass et al. 2009). Tarnished plant bugs prefer to feed on the reproductive structures of plants. They will move from plant to plant depending on the phenological stage of the specific host (Snodgrass et al. 1984). The intensity and extent of populations moving into cotton will vary between years, but appears to be correlated with the amount of alternative hosts available and the presence of reproductive structures (Layton 1995).

Tarnished plant bugs feed by injecting digestive salivary enzymes into the plant tissue that allows for the ingestion of nutrients (Layton 1995). Damage occurs to the plant in two ways. Mechanical damage to plant cells occurs at the feeding site. Yet, the disruptive effects the enzymes have on plant tissues are likely more important (Layton 1995). Tarnished plant bugs prefer to feed on small, pinhead squares, and this feeding typically results in the abscission of the square within a few days. Feeding on larger squares will occur; however, this usually does not cause the square to abscise. A single tarnished plant bug can cause 0.6 to 2.1 squares to abscise per a day due to feeding (Gutierrez et al. 1977, Mauney and Henneberry 1979, Wilson 1984). Feeding symptoms of the tarnished plant bug can be seen as yellow staining on the square or in the bloom, brown or black anthers in the flower, and the presence of black necrotic spots on the outside of bolls. There is little to no effect on yield when less than 30% of anthers are damaged from tarnished plant bug feeding (Pack and Tugwell 1976), however, higher rates of damaged anthers can lead to malformed or aborted bolls (Layton 2000) that can reduce yield.

Recent experiments conducted by a Mississippi State University graduate student showed that foliar applications to control tarnished plant bug can be significantly reduced by utilizing an early planting date and an early season variety (Adams 2012). Also, research that was conducted by USDA-ARS discovered that applying a selective herbicide during the spring to control host plants, such as *Lamium amplexicaule* (L.) and *Capsella bursa-pastoris* (L.), of the tarnished plant bug had a significant economic impact later during the growing season by lowering the cost of control for the tarnished plant bug (Gore et al. 2010). Greater tarnished plant bug densities and crop injury is usually seen in field edges, especially when these edges are adjacent to corn. To aid in reducing this edge effect, cotton should be planted in large contiguous blocks and minimize planting to other crops that tarnished plant bugs use extensively (Gore et al. 2010).

Materials and Methods

An experiment was conducted at the Delta Research and Extension Center in Stoneville, Mississippi to determine the weeks during flowering when tarnished plant bug causes the greatest yield losses. Plot size was 8 rows by 70 ft. long. A full season Bollgard II cotton variety (Deltapine 1050 B2RF) was planted at 113,668 seeds/ha for both planting dates. Treatments were in a split-plot arrangement in a randomized complete block design with four replications. The main-plot factor was planting date. Two planting date were used that included April 26, 2013 and May 28, 2013. The sub-plot factor was insecticide application timings. The timings included automatic insecticide applications initiated or terminated at different times during the flowering period. Prior to flowering, the entire test area was sprayed to manage all insect pests based on current thresholds in the Mississippi State University Extension Service Insect Control Guide (Catchot 2013). Once flowering began across the area of one of the planting dates, treatments were initiated for that specific planting date only. For the initiation treatments, plots were sprayed at designated weeks of flowering. The weeks of flowering were the second, fourth, sixth, and eighth weeks. Once sprays were initiated, those treatments were sprayed once a week until physiological maturity. For the termination treatments, plots were sprayed once a week, beginning at first flower, until the designated termination timing. When a treatment was terminated, that specific treatment did not receive insecticide applications for tarnished plant bug control for the remainder of the season. The termination treatments included the same weeks of flowering as the initiation treatments. Treated plots were sprayed using insecticide mixtures at their highest labeled rates designed to maximize the control of tarnished plant bug. Rows 2 and 3 were harvested and rows 4-7 were used for sampling. Plots were sampled twice a week for tarnished plant bug densities. Twenty-five sweeps with a standard 38 cm diameter sweep net was used to determine tarnished plant bug adult and nymph densities during the pre-flowering stages. During the flowering period, tarnished plant bug densities were determined by taking two drop cloth samples in each plot with a 0.76 m black drop cloth. Square retention and node above white flower counts were also conducted once a week in all plots. Sequential harvesting was conducted in all plots by marking off 3 meters in row

7 with flagging tape. Once open bolls were present within each plot, all open bolls were harvested by hand once a week within the marked three meters. The seedcotton weight and number of bolls were recorded for each plot every week within the specific planting date. At the end of the season rows 2 and 3 of each plot were harvested mechanically and seedcotton weights were recorded. All sampling and yield data were analyzed with Analysis of Variance, Proc Mixed SAS 9.3. The replication by planting date interaction was considered random and served as the error term for planting date. Replication was also considered random and served as the error term for treatment and residual error. Planting date and treatment were considered fixed effects in the model. Degrees of freedom were estimated using the Kenward-Roger method. Means were separated based on the LSMEANS and separated according to Tukey's studentized range test.

To determine the effect of leaf pubescence on tarnished plant bug populations, an experiment was conducted at the Delta Research and Extension Center in Stoneville, Mississippi. Treatments were in a randomized complete block design with six replications. Treatments consisted of three varieties of cotton that were planted; hairy leaf (Stoneville 5288), smooth leaf (Delta Pine 1050), and semi-smooth leaf (Phytogen 499). The three varieties were planted on May at 113,668 seeds/ha. Plot size was 4 rows by 40 ft. long. Tarnished plant bug populations were sampled once a week. During the pre-flowering stages tarnished plant bug densities were determined by taking 25 sweeps with a standard 38 cm diameter sweep net. Throughout the flowering period, tarnished plant bug densities were sampled by taking two drop cloth samples with a 0.76 m black drop cloth in each plot. Square retention and node above white flower counts were also conducted once a week in all plots. No insecticide applications were made to any plot at any point during the growing season. At the end of the season rows 2 and 3 were mechanically harvested and the seedcotton weight recorded. All data were analyzed with Analysis of Variance, Proc Mixed SAS 9.3.

Results

There was no significant interaction between planting date and treatment for yield ($F=1.47$; df=9, 58; $P<0.17$). Therefore, all data were pooled across planting dates. Treatment ($F=40.41$; df=9, 58; $P<0.01$) had a significant effect on yield. The initiation 2nd week (1211 lbs/acre), termination 4th week (1167 lbs/acre), termination 6th week (1291 lbs/acre), and the termination 8th week (1270 lbs/acre) treatments did not yield significantly different than the season long control (1188 lbs/acre). The initiation 4th week (741 lbs/acre), and the termination 2nd week (977 lbs/acre) treatments both yielded significantly lower than the season long control but significantly higher than the untreated control. Initiation 6th week (485 lbs/acre), and initiation 8th week (481lbs/acre) treatments did not yield significantly different than the untreated control (506 lbs/acre). Sequential harvest showed that there was no delay in cotton maturity. However, the initiation 6th week, initiation 8th week, termination 6th week, and the untreated control treatments showed an advancement in maturity when compared to the season long control.

Treatments for leaf pubescence had a significant effect on square retention ($F=43.69$; df=2; $P<0.01$) and tarnished plant bug nymph densities ($F=4.55$; df=2; $P<0.01$). The hairy leaf variety retained the highest amount of squares (87.2%), with the semi-smooth variety being significantly lower (78.6%), and the smooth variety being the least (60.4%). For tarnished plant bug nymph densities, the hairy leaf variety had significantly more number of nymphs than the smooth leaf variety. The semi-smooth was not significantly different than either of the varieties.

Table 1. Yield and LSD lettering for individual treatments.

Treatment	Yield	LSD Group
Termination 6	1,291	A
Termination 8	1,270	A
Initiation 2	1,211	AB
Season Long	1,188	AB
Termination 4	1,167	AB
Termination 2	977	BC
Initiation 4	741	CD
UTC	506	D
Initiation 6	485	D
Initiation 8	481	D

Table 2. Sequential harvest percentages for sampling week by treatment.

Treatment	First	Second	Third	Fourth	Fifth	Sixth	Total
SL	12.277	14.2207	22.65555	26.72651	19.17298	4.947259	100
I-2	9.17486	13.79579	19.48875	30.40492	18.63666	8.499017	100
I-4	14.31323	22.51599	11.80366	14.42022	31.95511	4.991797	100
I-6	24.5525	33.00804	21.26503	12.25684	5.267722	3.649871	100
I-8	17.87708	27.09803	23.51342	20.45159	8.367157	2.692727	100
UTC	20.11328	24.46471	20.5277	23.92596	7.197127	3.771239	100
T-2	10.14928	23.90248	21.39034	20.97871	18.81813	4.761064	100
T-4	11.05305	21.73877	18.19961	21.04308	19.57824	8.387247	100
T-6	17.9383	21.8115	22.57483	23.22508	11.61254	2.837757	100
T-8	10.89743	19.90194	22.30292	19.78429	20.86811	6.245317	100

Discussion

Planting date and insecticide application timings during the flowering period both significantly affected yield. An early planting date allows for less insect pressure during the reproductive period of the crop and can result in lowered amount of insecticide applications that would need to be made. The most critical weeks during the flowering period appear to be the first through fourth weeks. Because there was no significant interaction between planting dates it can also be assumed that these weeks would be the same for an early or late planting date. It is within these weeks that thresholds should strictly be followed to reduce yield loss because cotton is not able to compensate for the damage it receives at this time. Results also show that if no insecticide applications are made after the fourth week of the flowering period no significant yield loss would be observed. Reducing the number of insecticide applications made during the growing season would not only conserve money, but also reduce the amount of insecticide selection pressure that is put on tarnished plant bug population year in and year out. Sequential harvest showed that tarnished plant bug damage received during the flowering period will not delay cotton maturity. While past research has shown that damage received during the squaring period will cause a delay in maturity, feeding damage received within the flowering period will cause no such delay in maturity. This can mainly be attributed to the fact that cotton does not have the required time to compensate for the damage received during flowering, so no delay in maturity occurs. However, cotton will portray advancement in maturity due to damage during the flowering period, simply due to the inability to overcome the sustained feeding damage and loss of fruit. Also, the hairy leaf variety of cotton possessed the highest numbers of tarnished plant bugs, over twice the recommended threshold, yet still retained the most amount of squares. To aid in tarnished plant bug management, a hairy leaf variety could be planted and thresholds strictly adhered to in the first four weeks of the flowering period.

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