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EUSCHISTUS QUADRATOR (HEMIPTERA: PENTATOMIDAE): A NEW PEST IN LOWER TEXAS GULF COAST COTTON

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Abstract

A survey was conducted in the Lower Gulf Coast region of Texas to determine the stink bug species composition in cotton. Results indicate the cotton-inhabiting stink bug complex in the Lower Gulf Coast Region of Texas to be different than that of other states. Preliminary data shows *Euschistus quadrator* (Say) and *Nezara viridula* (L.) to be the dominant species in the southern-most counties sampled. *Euschistus servus* (Say) were the dominant species present in the northern counties sampled, but there were also populations of *E. quadrator* and *N. viridula. Euschistus quadrator* and *E. servus* were found throughout all stages of bloom, but *N. viridula* was not present until late bloom.

A cage study was conducted to determine if *E. quadrator, E. servus,* and/or *N. viridula* cause similar boll damage and prefer bolls of similar size. *Euschistus quadrator* caused damage similar to that of *E. servus* and *N. viridula* and all three species favored small- to medium-sized bolls.

The insecticide efficacy results indicated dicrotophos (0.5 aia), lambda-cyhalothrin (0.0325 aia) and oxamyl (0.3299 aia) have the potential of providing excellent control of *E. quadrator.*

Introduction

Stink bugs were reported as pests of cotton in Texas as early as 1910 (Morrill 1910). For decades, heavy use of insecticides to control the boll weevil and the budworm/bollworm complex suppressed stink bug populations (Greene and Herzog 1999). Now, fewer broad spectrum insecticides are applied against cotton pests due to a combination of the adoption of Bt cotton cultivars, boll weevil eradication programs, and the use of selective insecticides (Barbour et al. 1988; Bachelor and Mott 1996; Greene and Turnipseed 1996; Turnipseed and Greene 1996). This decline in insecticide use has allowed secondary pests such as stink bugs to become annual mid-late season pests (Emfinger et al. 2001).

In 2003, stink bugs were the third most important pest in cotton throughout the United States after heliothines and *Lygus*. It was estimated that they infested 6.712 million acres of cotton, over a million acres more than in 2002, destroyed $64.5 million worth of cotton (206,675 bales), and reduced overall yield by 0.735%. In Texas, an estimated 674,264 acres were infested, about 2.5 times that of 2002, but only 92 bales were listed as lost. (Williams 2002).

Stink bugs cause damage by inserting their piercing-sucking mouthparts through the carpal walls of young bolls and feeding on developing seeds and lint (Barbour et al. 1988). Smaller bolls may become soft, yellow, and shed. Larger bolls do not shed, but form rough, cellular wart-like growths on the inside of the carpal wall. Seeds may be shriveled and stains may occur on the lint. Feeding punctures also allow for entrance of pathogens into the boll (Wene and Sheets 1964). External carpal wall symptoms of feeding do not always represent actual feeding and damage by stink bugs (Bundy et al. 1999), so internal inspections are required to determine if the stink bugs penetrated the carpal wall. Greene and Herzog (1999) showed that evidence of internal feeding is present within 24-48 hours of feeding. These symptoms develop quickly, so recent injury can be observed. For field scouting, 12-14 day old bolls should be examined so that old damage is not included in the evaluation. It has been shown that bolls are susceptible to stink bug injury from white bloom until they are 21-25 days old (Greene et al. 2001). In Texas, Fromme and Jahn (2002) showed that in single boll cages, adult *E. servus* can puncture bolls up to at least 26 days from bloom, but did not cause significant yield loss after bolls were 20 days old. Fifth instar nymphs have been shown to do more damage to bolls than adults or other instars, but adults can sometimes cause as much of damage as the fifth instars (Greene et al. 1998, Greene and Herzog 1999). This is very important to consider when sampling, determining thresholds, and making management decisions. Pyrethroids provide good control of green stink bug, but give poor control of brown stink bug (Greene and Capps 2002), so species composition must also be factored into management decisions.

The latest Texas Cooperative Extension publication for cotton, *Managing Cotton Insects in the Southern, Eastern, and Blackland Areas of Texas 2004*, indicates that an average of one or more stink bugs per six feet of row can cause excessive loss of small bolls and may stain lint (Parker et al. 2004). This recently updated publication states that at least fifty small bolls (the diameter of a quarter) should be examined. If twenty percent of the small bolls have evidence of internal feeding and stink bugs are present, treatment should be considered. Thresholds based on evidence of internal feeding have made their way into most of the insect control management guides of the states throughout the Cotton Belt, but these thresholds are based mostly on research from other Southeastern states such as Georgia and Arkansas and have not been validated in Texas where there are differences in cultivars, growing conditions, production practices, timings of stink bug infestations, and stink bug complexes. *Identification, Biology, and Sampling of Cotton Insects* (Bohmfalk 1996), another Extension publication, identifies two stink bugs species as pests in Texas: the green stink bug (*Acrosternum hilare* [Say]) and the conchuela stink bug (*Clorochroa ligata* [Say]). This publication was last updated in 1996 before stink bugs had become a common pest in Texas cotton, so it does not address the stink bug species that are currently found. The most prevalent species in Texas gulf coast cotton are the southern green stink bug (*Nezara viridula* [L.]), the brown stink bug (*Euschistus servus* [Say]), and to a lesser extent the green stink bug. Another species of brown stink bug, *Euschistus quadrator* (Say), is becoming common along the Texas Gulf Coast (Mike Treacy; Danny Fromme, personal communications). Stink bug virulence between species has been compared in cotton, and there were no significant differences in damage among *N. viridula*, *E. servus,* and *A. hilare* (Bundy et al. 1979).

Treatment thresholds for stink bugs have been established in other states (Greene and Turnipseed 1996; Greene et al. 1997; Greene et al. 1998), but the threshold of one stink bug per six row feet is not embraced by some due to the difficulties of scouting for stink bugs in cotton (Greene and Herzog 1999). Stink bugs are very sensitive to disturbances caused by light, shadow, or plant movement (Wene and Sheets 1964), and this can cause difficulty when estimating population densities. These densities are determined by using the drop-cloth method, which is cumbersome and time consuming. Drop cloth does not lend itself to use by independent crop consultants, especially during inclement weather conditions or when plants are tall. The relationships of visual inspection of stink bugs and evidence of internal feeding to actual stink bug densities are not well known. Both of these sampling methods are potentially more cost-effective and would be beneficial if they could be employed efficiently in measuring stink bug densities.

The objectives of this research were to identify the species of stink bugs present in cotton grown along the lower Texas Gulf Coast and to establish economic injury levels/treatment thresholds for these stink bug pests. This research consisted of (i) making a qualitative/quantitative assessment of the different cotton-associating stink bugs of this area, (ii) comparing accuracy and efficiency of selected stink bug sampling methods, (iii) quantifying virulence between different stink bug species, (iv) measuring economic injury levels/treatment thresholds based upon evidence of internal feeding, and (v) comparing efficacy of selected insecticides against these stink bug pests. Data on comparing different sampling methods and economic injury levels are not yet analyzed and will be reported in a future paper.

This research yielded both long-term, fundamental, and immediate, practical benefits. For the long term, knowing the species composition of the stink bug complex, the damage that each species causes, and their seasonal distribution in Gulf Coast cotton facilitates future research on sampling and management of this pest complex. For the immediate term, practical stink bug thresholds for protecting cotton from economic losses were evaluated and three stink bug sampling methods were compared in terms of efficacy, including economics. Together, the information generated by this research should contribute to developing effective guidelines for producers and independent consultants in making decisions regarding management of stink bugs. Results of this study should be used to validate and improve the management recommendations provided in the Texas Cooperative Extension guidelines for managing insect pests in cotton as well as throughout the Cotton Belt.

Materials and Methods

The composition of stink bug species infesting cotton and their seasonal occurrence were determined by sampling twenty-two commercial Bt cotton fields in eight to ten places on a weekly basis for approximately six weeks beginning at first bloom and ending at open boll. These fields were distributed throughout the following counties along the lower Texas Gulf Coast: Kleberg, Nueces, San Patricio, Refugio, Victoria, and Calhoun. Sampling was conducted using the drop cloth method for six row-feet and samples were taken approximately twenty five rows into the field. The drop cloth (40 in. wide by 36 in. long) was placed between two rows of cotton and the plants on each row beside the cloth were shaken over the drop cloth to dislodge stink bugs. Stink bug specimens collected from each individual field were identified to species.

The most prevalent stink bug species found during the survey were used to compare virulence between species. This included the southern green stink bug, the brown stink bug, and the lesser brown stink bug complex of *E. quadrator* and *E. obscurus.* Each cage was considered a single replicate and there were twenty replications for each treatment. The stink bugs used for this study were collected from the field and held overnight on green beans before infesting. Based on the identification of a subsample of the collected lesser brown stink bug complex, the individuals used in this treatment were approximately 50% *E. quadrator* and 50% *E. obscurus*. Damage levels caused by individual stink bug species were assessed by exposing individual cotton plants in the field to one stink bug adult in whole plant cages for 24 hours. Cages were removed and oversprayed using a CO_2 backpack sprayer with dicrotophos (0.5 aia) to kill the stink bugs that were present. Percent evidence of internal feeding shows up within 24-48 hours, so bolls were evaluated 48 hours after the cages were removed. All of the bolls from each plant were separated into three categories, small (<10 days old, <24mm), medium (10-18 days old, 24-32mm), and large (>18 days old, >32mm), and percent evidence of internal feeding was determined for each species on each individual boll size as well as overall. The resulting data were compared using ANOVA and LSD ($p<0.05$) (Gylling).

Whole plant cages were used to compare the efficacy of selected insecticides on *E. quadrator.* Five treatments were compared: dicrotophos (0.5aia), lambda-cyhalothrin (0.026 aia), lambda-cyhalothrin (0.0325 aia), oxamyl (0.3299 aia) and an untreated. Each cage contained one plant and each treatment was replicated six times. Stink bugs were collected from the field and were held on green beans overnight before being placed on the cotton plants. Cages were opened and placed around the base of the plants prior to treatment. The insecticides were applied using a CO_2 backpack sprayer, the cages were pulled over the plants and closed, and then three stink bugs were placed in half of the cages and two in the other half (there were not enough stink bugs available for three in each cage). Stink bugs were evaluated for mortality three days after treatment. The resulting data were compared using ANOVA and LSD ($p<0.05$) (Gylling).

Results

The lower Texas gulf coast region appeared to have a stink bug complex that is different from that reported elsewhere in the Cotton Belt. *Euschistus quadrator* and *N. viridula* were the dominant species present in the southern counties that were surveyed. *Euschistus servus* was the dominant stink bug present in the northern counties surveyed, but there were also populations of *E. quadrator* and *N. viridula* present. Other *Euschistus* species (*E. obscurus*, *E. ictericus*, *E. crassus*) were found in this area but in fewer numbers. The *Euschistus* species were present in the field throughout all stages of bloom, but *N. viridula* was present only during the latter weeks of bloom. Additionally, there were high numbers of spiny-soldier bugs (*Podisus* spp.) and rice stink bugs (*Oebalus pugnax*) present, but they neither cause damage to cotton and the former is actually a predator (Roger Leonard; Mike Treacy, personal communication).

Plants caged with one of the lesser brown stink bug complex of *E. quadrator* and *E. obscurus* had a mean of 12.7%, 33.5% and 30.1% of the bolls with evidence of internal feeding due to stinkbugs (Table 1). This level of damage was similar to that caused by brown and southern green stink bug (Table 1). The brown and southern green stink bugs caused significantly more damage to small bolls compared to the boll damage in plants without stinkbugs. There was a very strong trend for the lesser brown stink bug complex as well when compared with the untreated controls (Table 1). Although infestations of all three species resulted in more damage of medium bolls, there were no significant differences. The lack of significant differences among treatments for medium bolls was apparently due to the relatively high level of pre-existing stink bug damage in the control (no stink bugs present) prior to the initiation of the study. When data for the small and medium bolls were pooled, the brown and lesser brown stink bugs caused significantly more damage and there was a strong trend for the southern green stink bugs to cause more damage than seen in the untreated. In all three of these size comparisons, the brown stink bug caused more damage than the southern green or lesser brown, but these differences were not significant. There were no differences between the three species in damage caused to large bolls, but this was to be expected because at the time of infestation, these bolls were already larger than the stink bugs typically feed on.

One application of dicrotophos, cyhalothrin at 0.0325 aia and oxamyl resulted in 100%, 89% and 81% mortality of adult E. quadrator on caged plants three days after application of the insecticide (Fig. 1).

Discussion

Euschistus quadrator is one of the most common stink bug pests in cotton in the lower Texas gulf coast. It is very similar in appearance to the brown stink bug and the other smaller *Euschistus* species that were also present (*E. obscurus*, *E. ictericus*, *E. crassus*). The smaller *Euschistus* species are now being called the 'Lesser Brown Stink Bug complex' to help discern them from the true brown stink bug, *E. servus*. The spined-soldier bug also is somewhat similar in appearance to the brown stink bug and the lesser brown stink bug complex. It is typically smaller than the true brown stink bugs and larger that the lesser brown stink bugs. The shoulder spines are more pronounced on the spined-shoulder bug than on most brown stink bug species, but some still closely resemble this predator. The best way to distinguish between a plant-feeding and predatory stink bug is to look at the mouthparts. If the proboscis is roughly twice the width of an antenna and is stout, it is a predatory species. If the proboscis is slender and about the width of an antenna, then the stink bug is a phytophagous species (Knutson and Ruberson 1997). This can be problematic when sampling for stink bugs and great care must be taken to ensure that identification is correct.

Overall, there were no differences among the brown stink bug, southern green stink bug, lesser brown stink bug complex, and the damage they cause to cotton. All species damaged small- to medium-sized bolls. Even though the lesser brown stink bug complex is comprised of species that are physically smaller, this complex caused similar damage to the same size of bolls as the brown and southern green stink bugs.

Commercial rates of organophosphates such as dicrotophos and methyl parathion provide acceptable control of most stink bug species (Greene and Capps 2002, 2003). Pyrethroids provide good control against some stink bug species, but poor control of others (Emfinger et al. 2001, Greene and Capps 2003). Unlike the true brown stink bug, *E. quadrator* was adequately controlled with the mid-label rate of the pyrethroid lambda-cyhalothrin. This magnifies the importance of correct stink bug identification, correct sampling techniques, and correct economic thresholds when managing the stink bug complex in the lower Texas gulf coast.

This research will be continued for another year in order to further validate these results and to obtain more data so that the results of the other studies above may be completed.

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Table 1. Percent of bolls with evidence of internal feeding by stink bugs after exposure to one stink bug for 24 hours on caged plant. .

	% eif small bolls	% eif medium bolls	% eif sm/med bolls
Euschistus servus	**27.28 a**	**44.09 a**	**39.12 a**
Nezara viridula	**19.93 a**	**31.56 a**	**27.74 ab**
Euschistus quadrator/ obscurus	**12.66 ab**	**33.48 a**	**30.85 a**
untreated	**0.00 b**	**18.80 a**	**12.84 b**

Figure 1. Percent mortality of adult E. quadrator after 3 days exposure to plants treated with one of four insecticides or untreated.