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COMPARISON OF *LYGUS ELISUS* AND *LYGUS HESPERUS* DAMAGE TO ONE-THIRD GROWN SQUARES OF TEXAS HIGH PLAINS COTTON

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Abstract

The pest status of *Lygus* on the Texas High Plains is becoming more important. An increase in Bt cotton acreage, several mild winters and some new insecticide technologies are some of the factors that may contribute to increased densities during the cotton production season. The two species of *Lygus* of economic concern on the Texas High Plains are *Lygus hesperus* Knight and *Lygus elisus* Van Duzee (Armstrong, unpublished data). Field and laboratory experiments were conducted to compare the feeding injury and damage potential of *L. hesperus* with *L. elisus* to one-third grown cotton squares during the 2001 and 2002 cotton seasons. In the field studies, first position cotton squares from the 6, 9 and 11th nodes were enclosed with both species for 24 hrs. Each infested square was observed for abscission and followed to seed-cotton yield. Laboratory experiments involved enclosing Lygus species on the same position squares as the field-study but conducting it in the laboratory where the anthers were dissected after 24 hr. A rating system was developed to determine the effects of the digestive enzymes on the developing anthers. Results from field and laboratory studies indicate that *L. elisus* can cause similar or greater damage to cotton anthers compared to *L. hesperus.* Cotton will compensate from feeding injury from both species, masking yield losses from square abscission. Both species have a very similar damage potential as a pest of Texas High Plains cotton.

Introduction

Lygus Hesperus Knight, the western tarnished plant bug, and the pale legume bug, *Lygus elisus* Van Duzee are western species that overlap in distribution within the state of Texas, while the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is found in Texas but considered a serious pest of cotton from the mid-south to southeast regions of the United States (Schwartz and Foottit, 1998). *Lygus elisus* is mentioned as a potential pest in many western state extension publications, however, most credit *L. hesperus* as the leading pest. In 1927, McGregor documented *L. elisus* infesting cotton in Arizona and California and described the shedding of squares, blooms and young bolls. Diehl et. al. (1998) suggested that *Lygus* bugs infesting cotton in Arizona were a complex of *L. hesperus, L. lineolaris* and *L. elisus*, and that management decisions would not require identification to species.

An increase in *Lygus* problems on the Texas High Plains is possibly a result of several mild winters that allows for the survival of over-wintering adults that reproduce the following spring. Precipitation in early spring will generate weed hosts, but *Lygus* migrate to cotton and other crops when drought conditions persist. The acreage of other crops species such as alfalfa, potato and canola has increased on the Texas High Plains, which might help generate higher numbers to threaten cotton. All of these factors combined together could be responsible for increased densities of *L. hesperus* and *L. elisus*. *Lygus* species combined reduced cotton production by an estimated 115,781 bales in 1999, 4,570 in 2000 and 13,913 in 2001 on the Texas High Plains (Williams, 1999, 2000 and 2001). Recent research on *Lygus* species distributions on the Texas High Plains has documented that from 1999-2001, *L. elisus* is significantly more prevalent than *L. lineolaris,* and in some cases, more predominant than *L. hesperus*. Management decisions for *Lygus* control on the Texas High Plains are based on *L. hesperus* densities per linear row foot in relation to square set (Muegge et. al., 2002). The threshold does not consider combinations of other *Lygus* species, and assumes that they all cause the same amount of damage. The Texas High Plains is the only cotton production region in the United States where *L. hesperus* and *L. elisus* have been documented to be similar in densities within a cotton field. A comparative assessment of the damage needs to be conducted to determine if thresholds should be adjusted.

Materials and Methods

Rearing Lygus for Field and Laboratory Studies

Lygus elisus and *Lygus hesperus* used in these experiments were reared in the laboratory from adults collected from alfalfa (*Medicago sativa L.).* Lygus were held in 1x1m Lumite® cages and fed artificial diet as described by Cohen (2000). Sugar water (10% sucrose solution) was provided to the insects by sticking cotton wick in the end of small glass vials. Lygus were maintained in the laboratory so mortality from physical injury and disease could be reduced.

Field Experiments

Cotton plants were monitored regularly until first position squares of the 6th, 9th and 11th node were estimated to be one-third grown. Infesting procedures for one third grown squares followed that used by Russel (1999) for caging *L. lineolaris* on cotton bolls. *Lygus* were placed into 20 ml. diet cups and transported to the field in an ice cooler to eliminate heat stress. One *Lygus* was enclosed in a 15 cm. x 11.5 cm. nylon mesh (#280) bag that also enclosed a one-third grown square with a draw-string. The dates of infestation were recorded on a snap-on-tag® placed on the pedicel of each infested square. The experiment was designed as a randomized block, with each block containing 10 infested squares down four linear m row of cotton, and replicated four times. A control treatment consisted of enclosing a square with no *Lygus*. Squares selected for artificial infesting were of a similar fruiting position and developmental stage of adjacent plants. Infestation levels consisted of zero and one adult Lygus on each square and allowed to feed for 24 hours. The number of abscised squares was recorded at 3, 7, 14, 21, 28 and 35 days after infestation (DAI) and at the time of harvest. All harvestable bolls were collected and seed-cotton weights were recorded. The data was analyzed with PROC ANOVA and means separated with Fisher's Protected LSD (SAS Institute 1989).

Laboratory Experiments

Squares of identical age and position from the field study were artificially infested in the laboratory for 24 hr then dissected to estimate the amount of injury. Damage of *Lygus elisus and Lygus hesperus* was compared using the methods of Maredia et. al. (1994) for identifying resistant lines of cotton to plant bugs. It requires slicing a square into two pieces at the point of maximum diameter with a razor. By gently pressing the top end of the sliced square using the thumb and the forefinger, with a rolling action, the anthers will be removed from the calyx and corolla and be exposed. The squares used for damage assessment were maintained on Oasis®(Oasis Craft Products, Kent, OH), an absorbent used to maintain cut flowers. One *Lygus* of either species was isolated on a square by inverting a 20 ml diet cup (Bio-serve® supplies, Chicago, IL) over the top of a *Lygus.* The experiment was designed with three treatments (*L. elius, L. hesperus* and a control) replicated ten times in a randomized block design. Every time a field-cage experiment was conducted, a laboratory experiment was conducted on the same position squares (6th, 9th and 11th node, first fruit position). Damage to each square (anther) was estimated after 24 hr feeding by removing the calyx and corolla to expose the anthers and reveal the surface area of the anther tissue damaged. The estimates were easily discernable because the tissue affected by the *Lygus* feeding enzymes turns dark brown or is dissolved and no longer present. The anthers were rated from 0 (no damage) trough 100 (maximum damage). The damage estimations were analyzed with PROC ANOVA, and means separated with Fisher's Protected LSD (SAS Institute 1989).

Results and Discussion

Field Experiments

Square abscission at the 6th node was significantly greater on Lygus-infested plants (F = 11.25, df =11, P = 0.0053) in 2001 (Table 1). In 2002, abscission was significantly lower in the control when compared to *L. elisus*-infested plants, but abscission caused by *L. hesperus* was intermediate (Table 1) (F = 2.63, df = 11, P = 0.1358). Squares retained on the plant for 28 days after artificially infested (DAI) were most likely to become harvestable bolls that resulted in seed-cotton yield. Mean seed-cotton weights for 6th node squares in 2001 and 2002 (Table 2) were not significantly different (F = 0.93, df = 11, P = 0.52; F = 0.29, df = 11, P = 0.9043, respectively). Bolls that remained on the 6th node accounted for a higher weight in *Lygus*-infested plants as a compensation for *Lygus* feeding.

Significant differences were observed in 2001 for 9th node square abscission, with greater abscission on the *Lygus*-infested treatments when compared to the control treatment (F = 3.40, df = 11, P = 0.0842) (Table 2). Results for 2002 did not show the same trend, and no significant difference was recorded for any treatments (F = 2.57, df = 11, P = 0.1408). Water stress from an irrigation well that was not functioning for 4-5 weeks caused an increase in abscission, which masked the affects of insect damage from *Lygus*-infested treatments. Yield at the 9th node on *Lygus elisus* and *Lygus hesperus*-infested treatments in 2001 were statistically equal to each other but significantly lower than the control treatment (F = 12.83, df = 11, P = 0.0037) (Table 2). However, due to high abscission from the control, results were not the same in 2002, and no differences were found in yield across treatments (F = 0.31, df = 11, P= 0.8893) (Table 2).

Natural abscission from 11th node bolls was high for all treatments including the control resulting in no significant differences (Table 2) in 2001 and 2002 (F = 3.00, df = 11, P=0.13; F = 0.32, df=11, P = 0.8844, respectively). The control group averaging 83.75% abscission for both years. High abscission for all treatments of the 11th node were reflected in seed-cotton yield for 2001 and 2002 (F = 4.31, df =11, P = 0.88; F = 0.56, df =11, P = 0.7307; respectively) (Table 3).

Laboratory Trials

Injury estimates for 2001 were significantly higher for both *Lygus*-infested treatments when compared to the control group (Table 2) (F = 14.35, df = 29, P = <0.001). Some injury (2.5%) was present in the control group in 2001 due to insect feeding in the field previous to square removal from the field. For 2002, significant difference was observed in the control group compared to *L. elisus*-infested squares, however *L. hesperus*-infested treatments were not significantly different from the control (Table 2.1) (F = 8.53, df = 29. P = 0.0013). The variance was high resulting in no significant damage from *L. hesperus*.

The 2001 and 2002, 9th node, laboratory studies provided similar results in which both *Lygus*-infested treatments were not significantly different from one another and significantly greater than the control group (F = 6.13, df = 29, P = >0.00; F = 8.27, df = 29, P = >0.0016, respectively) (Table 2). Damage of the control group in 2002 (0.5%) originated from insect feeding in the field previous to square removal from the field (Table 2).

Damage estimates from the 11th node squares showed *L. elisus* damage was significantly greater than both the control and the *L. hesperus* treatments (F = 9.61, df = 29, P = 0.0007) (Table 2.3). For 2002, each treatment was significantly different from the other with *L. elisus*-infested treatment damage being greater than *L. hesperus*, and *L. hesperus* damage greater than the control group (F =18.18, df =29, P = <0.0001) (Table 2.3). High variance of the means within each treatment resulted in no significant differences for *L. hesperus* and the control group in 2001 (Table 3).

Lygus elisus should be considered as threatening a pest to Texas High Plains cotton as *Lygus hesperus*. Damage to first position 6th and 9th node squares was similar in field and laboratory studies, however, *Lygus elisus* caused significantly more damage to first position 11th node squares in laboratory studies where damage was assessed from 24 hr feeding trials.

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Table 1. Damage comparison of *Lygus hesperus* and *Lygus elisus* from field and laboratory trials of infesting one-third grown, 6th node, first position, cotton squares, 2001 and 2002.

	Field Experiments				**Laboratory Trials**	
	Square abscission (%) ± SE		**Boll yield (g) seed-cotton ± SE**		**Square injury (%) + SE**	
Treatment	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**
Control	12.5 ± 2.5a	22.5 ± 4.8a	36.3 ± 1.9a	31.1 ± 2.1a	2.50 ± 1.7a	0.0 ± 0.0a
L. hesperus	22.5 ± 4.8b	27.5 ± 2.1ab	33.2 ± 5.4a	29.9 ± 3.7a	26.8 ± 5.8b	13.0 ± 4.4a
L. elisus	27.5 ± 6.3b	32.5 ± 4.8b	32.6 ± 4.6a	27.2 ± 1.9a	34.8 ± 4.7b	27.0 ± 6.7b

Column means followed by the same small letter are not significantly different, while those followed by a different letter are significantly different by Fishers LSD, ($P < 0.05$).

Table 2. Damage comparison of *Lygus hesperus* and *Lygus elisus* from field and laboratory trials of infesting one-third grown, 9th node, first position, cotton squares, 2001 and 2002.

	Field Experiments				**Laboratory Trials**	
	Square abscission (%) ± SE		**Boll yield (g) seed-cotton ± SE**		**Square injury (%) + SE**	
Treatment	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**
Control	55.0 ± 2.0a	62.5 ± 7.5a	25.2 ± 4.9a	16.1 ± 2.2a	0.0 ± 0.0a	0.50 ± 1.6a
L. hesperus	65.0 ± 2.9b	65.0 ± 10.4a	15.3 ± 7.5b	14.2 ± 3.6a	25.5 ± 6.5b	25.5 ± 7.6b
L. elisus	67.5 ± 4.8b	57.5 ± 6.3a	15.3 ± 5.4 b	19.9 ± 4.6a	21.0 ± 6.9b	29.0 ± 5.4b

Column means followed by the same small letter are not significantly different, while those followed by a different letter are significantly different by Fishers LSD, ($P < 0.05$).

Table 3. Damage comparison of *Lygu shesperus* and *Lygus elisus* from field and laboratory trials of infesting one-third grown, 11th node, first position, cotton squares, 2001 and 2002.

	Field Experiments				**Laboratory Trials**	
	Square abscission (%) ±SEM		**Boll yield (g) seed-cotton ± SEM**		**Square injury(%) +SEM**	
Treatment	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**
Control	82.5 ± 4.8a	85.0 ± 5.0a	7.1 ± 1.5a	5.6 ± 2.6a	0.0 ± 0.0a	0.0 ± 0.0a
L. hesperus	92.5 ± 4.8a	87.5 ± 6.3a	3.2 ± 1.9a	5.4 ± 3.3a	13.0 ± 3.9a	15.0 ± 2.9b
L. elisus	82.5 ± 6.3a	90.0 ± 7.1a	6.5 ± 1.8a	4.6 ± 2.7a	39.5 ± 10.6b	23.5 ± 3.9c

Column means followed by the same small letter are not significantly different, while those followed by a different letter are significantly different by Fishers LSD, ($P < 0.05$).