Comparison of *Lygus elisus* Van Duzee and *Lygus hesperus* Knight (Hemiptera: Miridae) Feeding Injury to Pre-bloom Cotton[1]

J. Scott Armstrong[2], Leonardo D. A. Camelo[3], Harlan G. Thorvilson[4] and Leslie D. Thompson[5]

USDA-ARS, Areawide Pest Management Research Unit, 2413 East Highway 83, Weslaco, TX 78596

Texas Tech University, Department of Plant and Soil Science, Lubbock, TX 79409 USA

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Abstract Feeding injury and abscission of 6th, 9th and 11th node, first-position cotton squares exposed to *Lygus hesperus* Knight and *L. elisus* Van Duzee for 24 h were investigated in field and laboratory studies in 2001 and 2002. Square abscission was not significantly different for *L. elisus* or *L. hesperus* in six separate field trials over 2 yrs; however, the control was significantly lower in abscission in two of the six trials. Final square abscission averaged across the 2 yrs was 82.5% for the control, 90.0% for *L. hesperus,* and 86.3% for *L. elisus.* Square injury, as measured by estimating the surface area affected by *Lygus* feeding, was significantly higher for *L. elisus* compared with *L. hesperus* in three of the six of trials (6th node in 2002, 11th node for 2001 and 2002) indicating that, in some cases, *L. elisus* damage is higher than *L. hesperus.* However, when seed-cotton yield was obtained from squares that did not abcise, there was no significant difference for the control or the two *Lygus* species. This result was similar to other published studies of infesting cotton with *L. lineolaris* (Palisot de Beauvois) where yield compensation negated any differences in yield when infested cotton was compared to the control. *Lygus elisus*, a little known and often misidentified plant bug pest of Texas High Plains cotton, should be considered as damaging as *L. hesperus.*

Key Words *Lygus hesperus*, *Lygus elisus,* Hemiptera, Miridae, cotton, plant damage

Lygus hesperus Knight (Hemiptera: Miridae), the western tarnished plant bug, and *L. elisus* Van Duzee, the pale legume bug, overlap in distribution within the western United States and Canada (Schwartz and Foottit 1998). Both plant bugs can be serious economic pests of many cultivated crops including cotton and alfalfa. The tarnished plant bug, *L. lineolaris* (Palisot de Beauvois), is found within the U. S., has the broadest host range of any plant bug, and is considered a serious pest of cotton from the mid-South to southeastern regions of the U. S. (Layton 2000). *Lygus elisus* is reported as a potential pest in many western state extension publications; however, most researchers credit *L. hesperus* as the more economically significant pest. Mc-

[1]Received 17 May 2004; Accepted for publication 10 August 2004.

[2]Address inquiries (email: jarmstrong@weslaco.ars.usda.gov).
[3]Current address: Washington State University, Department of Entomology, Pullman, WA 99164.
[4]Texas Tech University, Department of Plant and Soil Science, Box 42122, Lubbock, TX, 79409.
[5]Texas Tech University, Department of Animal and Food Science, Box 42141, Lubbock, TX 79409.

Gregor (1927) documented *L. elisus* infesting cotton in Arizona and California and described the shedding of squares, blooms and immature bolls. However, Diehl et al. (1998) suggested that *L. hesperus, L. lineolaris* and *L. elisus* infesting cotton in Arizona could be grouped as a complex, and management decisions would not require species identification.

An increase in *Lygus* problems on the Texas High Plains may be the result of mild winters that allow for the survival of over-wintering adults. Early spring precipitation generates weed hosts, with *Lygus* migrating to cotton and other crops when drought conditions persist. The acreage of other crop species such as alfalfa, potato and canola, has increased on the Texas High Plains. These hosts also generate higher *Lygus* numbers that migrate to cotton. All of these factors alone or in combination may be responsible for increased densities of *L. hesperus* and *L. elisus. Lygus* bugs reduced cotton yield 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, 2001).

Recent research on *Lygus* bug distributions on the Texas High Plains documented that from 1999-2001, *L. elisus* densities were higher on cotton than *L. lineolaris* and, in some cases, more dominant than *L. hesperus* (Armstrong and Camelo 2003). Management decisions for *Lygus* control on Texas High Plains cotton are based on *L. hesperus* densities per linear row-foot in relation to square retention (Muegge et. al. 2002) and does not differentiate between *Lygus* bug species. The Texas High Plains is the only cotton production region in the U.S. where *L. hesperus* and *L. elisus* have been documented to be similar in densities within a cotton field (Armstrong and Camelo 2003). Our study was designed to compare the damage caused by the two most common plant bugs infesting cotton on the Texas High Plains.

Materials and Methods

***Lygus* rearing.** *Lygus elisus* and *L. hesperus* were reared in the laboratory from adults collected from alfalfa (*Medicago sativa* L.) 6.4 km north of the Texas Tech University campus (Lubbock, TX). *Lygus* were held in 1 x 1m Lumite® (Synthetic Industries, Norcross, GA) cages and fed artificial diet as described by Cohen (2000), with 10% sucrose provided by cotton wick. Voucher specimens are deposited in the Texas Tech University Insect Museum.

Field experiments. PayMaster "2326BGRR" was planted in mid-May at the Texas Tech Research Farm, where plants were monitored every 2 to 3 d for first-position squares of the 6th, 9th and 11th nodes. The cotton squares were 6 to 8 mm at the widest point from the base to the tip of the carolla, commonly referred to as "one-third grown squares". Infesting the cotton squares followed procedures used by Russel (1999) for caging *L. lineolaris* on cotton bolls. *Lygus* bugs were individually placed into 20-ml transparent diet cups (Bio-Serv®; Chicago, IL) and transported to the field in a cooler to eliminate heat stress. One *Lygus* was enclosed in a 15.0 x 11.5 cm nylon mesh bag that also enclosed a square with a drawstring. The dates of infestation were recorded on a Snap-on-tags® (A. M. Leonard, Inc. Piqua, OH) and placed around the pedicels of the squares. The experiment was designed as a randomized complete block, each block containing 10 infested squares from three treatments within four linear m-row of cotton, and replicated four times. A control consisted of an enclosed square with no *Lygus.* Squares selected for infesting were of a similar fruiting position and developmental stage of adjacent plants. The squares were left for 24 h in the field before removing the enclosure bags and insects. The number of abscised squares was recorded at 3, 7, 14, 21, 28 and 35 d after infestation (DAI) and at the time of harvest. Harvestable bolls were processed using a hand-operated delinter, and seed-cotton weights recorded. Data for % square abscission were arcsine square-root transformed before analysis of variance, with means separated using Fisher's Protected LSD (SAS 1999). Seed-cotton yield data were not transformed, but the same statistical procedures were used.

Laboratory experiments. Each time a field-cage experiment was conducted, a laboratory experiment was conducted on the same first-position 6th, 9th and 11th node squares. The squares used for feeding injury assessment were collected from the same area as the field study and maintained on Oasis® (Oasis Craft Products, Kent, OH), an absorbent used to maintain cut flowers. The Oasis was placed in a pan of 10% sucrose water, where the pedicel end of the square was secured in a small indention of the Oasis. *Lygus* were individually isolated on a square by inverting a 20-ml diet cup over the insect. The experiment was designed with three treatments (*L. elius, L. hesperus* and a control) replicated 10 times in a completely randomized design. Feeding injury to each square was estimated after 24 h by the same procedure as Maredia et al. (1994) for evaluating cotton lines for resistance to *L. lineolaris.* The calyx and corolla of each square were removed to expose the anthers. The amount (%) of surface area damaged by feeding was then estimated. The damage was easily discernable because tissue affected by *Lygus* feeding enzymes turns dark brown or is dissolved. The anthers were rated from 0% (no damage) through 100% (maximum damage). Percent damage estimations were arcsine squareroot transformed, subjected to analysis of variance, and the means were separated with Fisher's Protected LSD (SAS 1999).

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) than for the control in 2001 (Table 1). In 2002, abscission was numerically lower in the control when compared to *L. elisus* or *L. hesperus*, but the overall model was not significant (Table 1) (F = 2.63, df = 11, P = 0.1358). Squares retained on the plant for 28 d after artificially infesting (DAI) were most likely to become harvestable bolls that resulted in seed-cotton. Mean seed-cotton weights for 6th node squares in 2001 and 2002 (Table 1) were not significantly different (F = 0.93, df = 11, P = 0.52; F = 0.29, df = 11, P = 0.9043, respectively) among the three treatments.

Significant differences among treatments were observed in 2001 for 9th node squares, with greater abscission on the *Lygus*-infested squares relative to the control treatment (F = 3.40, df = 11, P = 0.0084) (Table 1). Results for 2002 did not show the same trend for abscission (F = 2.57, df = 11, P = 0.1408). The 2002 results can be explained in part by water stress from an irrigation well that was not functioning for 4 to 5 wks. This caused an increase in abscission, which masked the effects of insect damage from *Lygus*-infested treatments. Yields at the 9th node among *L. elisus* and *L. hesperus* treatments in 2001 were not statistically different, but significantly lower than the control (F = 12.83, df = 11, P = 0.0037) (Table 1). However, due to high abscission in the control plots in 2002, there were no significant differences among treatments for yield (F = 0.31, df = 11, P = 0.8893) (Table 1).

Natural abscission of 11th node squares was high for all treatments, including the control, resulting in no significant differences among treatments (Table 1) in 2001 and 2002 (F = 3.00, df = 11, P = 0.13 for 2001; F = 0.32, df = 11, P = 0.8844 for 2002). High abscission for all treatments of the 11th node were reflected in seed-cotton yield

Table 1. Damage comparison of *Lygus hesperus* and *Lygus elisus* from field and laboratory trials of infesting first-position, one-third grown (6–8 mm), 6th, 9th, and 11th node, cotton squares in 2001 and 2002

	Field experiments				Laboratory trials	
	Square abscission (%) ± SEM		Yield (g lint plus seed) ± SEM		Square injury (%) ± SEM	
Treatments	2001	2002	2001	2002	2001	2002
			6th Node, first position square			
Control	12.5 ± 2.5 a	22.5 ± 4.8 a	36.3 ± 1.9 a	31.1 ± 2.1 a	2.50 ± 1.7 a	0.0 ± 0.0 a
L. Hesperus	22.5 ± 4.8 b	27.5 ± 2.1 ab	33.2 ± 5.4 a	29.9 ± 3.7 a	26.8 ± 5.8 b	13.0 ± 4.4 b
L. elisus	27.5 ± 6.3 b	32.5 ± 4.8 b	32.6 ± 4.6 a	27.7 ± 1.9 a	34.8 ± 4.7 b	27.0 ± 6.7 c
			9th Node, first position square			
Control	55.0 ± 2.0 a	62.5 ± 7.5 a	25.2 ± 4.9 a	16.1 ± 2.2 a	0.0 ± 0.0 a	0.50 ± 1.6 a
L. Hesperus	65.0 ± 2.9 b	65.0 ± 10.4 a	15.3 ± 7.5 b	14.2 ± 3.6 a	25.5 ± 6.5 b	25.5 ± 7.6 b
L. elisus	67.5 ± 4.8 b	57.5 ± 6.3 a	15.3 ± 5.4 b	19.9 ± 4.6 a	21.0 ± 6.9 b	29.0 ± 5.4 b
			11th Node, first position square			
Control	82.5 ± 4.8 a	85.0 ± 5.0 a	7.1 ± 1.5 a	5.6 ± 2.6 a	0.0 ± 0.0 a	0.0 ± 0.0 a
L. Hesperus	92.5 ± 4.8 a	87.5 ± 6.3 a	3.2 ± 1.9 a	5.4 ± 3.3 a	13.0 ± 3.9 b	15.0 ± 2.9 b
L. elisus	82.5 ± 6.3 a	90.0 ± 7.1 a	6.5 ± 1.9 a	4.6 ± 2.7 a	39.5 ± 10.6 c	23.5 ± 3.9 c

Column means within a node, followed by the same small letter are not significantly different, while those followed by a different letter are significantly different by Fishers LSD, ($P < 0.05$). Data were analyzed with arcsine square-root transformation for % square abscission and % square injury but actual means are shown.

for 2001 and 2002 ($F = 4.31$, $df = 11$, $P = 0.88$ for 2001; $F = 0.56$, $df = 11$, $P = 0.7307$ for 2002) (Table 1).

Cotton squares that abscised did so within 28 DAI, regardless of treatment or node position. After that period, squares were retained and developed into harvestable bolls.

Feeding injury assessments. Square feeding injury to 6th node squares was statistically higher for *L. hesperus* and *L. elisus* compared to the control 2001 (Table 1) ($F = 14.35$, $df = 29$, $P = < 0.001$). In 2002, all three treatments were significantly different from one another with *L. elisus* injury being 2 times greater than *L. hesperus* injury, and no damage was recorded for the control (Table 1) ($F = 8.53$, $df = 29$. $P = 0.0013$).

The 2001 and 2002 laboratory studies for 9th node squares 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 1). Square feeding injury from the control (0.5%) in 2002 originated from insect feeding in the field previous to square removal (Table 1).

From the six independent laboratory feeding trials for 11th node, first-position squares for 2001 and 2002, three (6th node 2002, 11th node 2001 and 2002) resulted in significant treatment effects where *L. elisus* feeding injury was higher than *L. hesperus*, which was significantly higher than the control (Table 1). The remaining three treatment comparisons resulted in the control being significantly lower than *L. hesperus* and *L elisus*, but not significantly different between the two *Lygus* bugs.

Feeding injury from insect pests, and the subsequent damage to cotton fruit, may or may not result in economic loss. Economic and plant physiological studies of this type are much more numerous for the tarnished plant bug, *L. lineolaris*, (Layton 2000) followed by *L. hesperus*, (Leigh et al. 1988, Gutierrez and Leigh 1977, Jubb and Carruth 1971), and none for *L. elisus*. Early-season square loss from *L. lineolaris* field-cage studies did not result in significant yield losses, nor did field-cage studies using *L. hesperus* (Jubb and Carruth 1971). Tugwell et al. (2000) evaluated simulated growth-hormone and actual insect-induced stress to demonstrate that, regardless of the cause for square abscission, the cotton plant can tolerate a high rate of square shed without yield loss.

On the Texas High Plains, *L. elisus* is as prevalent as *L. hesperus* in cotton and on other host-plants associated with the cotton production landscape (Armstrong and Camelo 2003), but published information on the damage potential of the former species is not available. Based on the results of this study, we found that *L. elisus* is as damaging a pest as *L. hesperus*, and in three out of six laboratory trials, caused significantly more feeding injury to first-position squares from the 6th and 11th nodes. However, feeding injury from either plant bug resulted in a significant seed-cotton yield loss in only one (9th node first position, 2002) of six comparisons over the 2 yrs of study.

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