2012

Results of Insect Control Evaluations on Corn, Sorghum, Cotton, Sunflower, Pasture, and Stored Grain in Texas Coastal Bend Counties
COTTON SQUARE AND BOLL DAMAGE AND RESULTING LINT AND SEED LOSS CAUSED BY VERDE PLANT BUG

Michael J. Brewer 1, Darwin J. Anderson 1, and J. Scott Armstrong 2

1 Texas A&M AgriLife Research and Department of Entomology, Texas A&M AgriLife Research and Extension Center at Corpus Christi, Nueces County
2 USDA ARS, 1301 N. Western Rd., Stillwater, OK 74075

SUMMARY: Retention of bolls and squares (referred to as fruit retention), boll damage, and resulting cotton lint and seed weight loss were assessed when two (2010) and three (2011) age classes of fruiting branches with different ages of squares and bolls were exposed to verde plant bug in branch cages in the field. Fruit retention increased from the youngest to the oldest branch age treatment, and the effect was primarily determined by the age of the fruiting body. Fruit retention of young bolls < 7 days old was significantly lower ($P = 0.016$) than fruit retention of older bolls and squares within 2-3 days of bloom and younger. Similar to fruit retention results, damage of harvested bolls and lint and seed weight (using zero for abscised fruit) differed among the age of the fruiting body primarily for fruiting positions one (2010 and 2011) and two (2011) ($P < 0.0001$). Overall, verde plant bugs when given a feeding choice reduced fruit retention in young bolls < 7 days old, damaged retained bolls < 11 d old, and larger bolls and young squares at least 2-3 days from bloom incurred significantly less abscission and damage. These results supported the interpretation that low fruit retention and high damage of young bolls justified a focus on protecting young bolls in a pest management program.

INTRODUCTION AND OBJECTIVES: Insecticide use in cotton has been reduced following the success of Bt-cotton and boll weevil eradication. These advances have likely released stink bugs and plant bugs from indirect insecticide control. Associated cotton boll damage caused by stink bug feeding has increased during the last two decades. Selected plant bugs are also known to damage bolls, and the verde plant bug, Creontiades signatus, has emerged as a threat to cotton along the Gulf Coast of South Texas (Brewer et al. 2012, Fig. 1). Verde plant bug is also known as green plant bug and Creon bug in South Texas. Other plant bug pests of cotton, Lygus and cotton fleahopper, primarily damage squares. In response, research on plant sensitivity to verde plant bug feeding established insecticide use guidelines to protect bolls. Armstrong et al. (2013) found that bolls < 1 inch in diameter (equates to bolls about < 330 degree-days [60 ºF base] or < 12 days old from first day of bloom) were readily injured by verde plant bug feeding while older bolls incurred little injury. We considered here whether this boll protection guideline, which was based on no-choice tests with different boll ages, was applicable when verde plant bug has free choice to feed on squares and bolls. The specific objective was to evaluate retention of bolls and squares (referred hereafter as fruit retention), boll damage, and resulting lint and seed loss when cotton branches with different ages of squares and bolls where exposed to adult verde plant bug.

METHODS: Treatments representing two (2010) and three (2011) age classes of fruiting branches were caged in a field setting and exposed to verde plant bug for 72 hr, along with uninfested controls. Fruit retention, boll damage, and resulting lint and seed weight were evaluated on bolls and squares found along the branch from the first fruiting position nearest the main stem outward to the fourth position. FiberMax 840 RRB2 cotton (Bayer CropScience) was planted in early April at a field site of about 1 acre (Corpus Christi, TX). The planting was grown under dryland conditions, and no insecticide was used. Beginning one month after planting
during early bloom, colored tags were looped on cotton branches to designate selected branch age treatments in a randomized complete block of 11 to 15 (2010) and 28 to 30 (2011) replications. The fruiting branches were randomly chosen under the following guidelines: a) the branch had four fruiting positions with no abscised positions and was in good health, b) fruiting position one nearest the main stem was a bloom or will bloom the following morning (0-1 day old boll), and c) no more than one branch was chosen per plant. Cages made from white organza fabric with draw strings enclosed the branches.

![Fig. 1](image1.png)

**Fig. 1.** Nymph (A) and adult (B) of Verde plant bug, *Creontiades signatus*, which causes cotton boll damage in the form of boll abscission and lint and seed deterioration, seen in green (C) and open (D) cotton bolls. Photo credits: R. Coleman, USDA ARS (A), S. Armstrong (B, C), M. Brewer (D). Also known as green plant bug and Creon bug.

In 2010, plants were infested 7-8 days and 11-12 days post bloom of fruiting position one on June 22. In 2011, the protocol was modified to cage all branches at the same time and infest at different times which allowed an additional branch age treatment meeting, by infesting at 3-4 days (June 10), 9-10 days (June 16), and 14-15 (June 21) days post bloom of fruiting position one. Uninfested cages served as a control. Adult verde plant bugs used for infesting were
obtained from a laboratory colony recently established from field collections in South Texas. Two days before each infestation date, the branches were sprayed with short-residual pyrethrin. On the designated infestation date, cages were infested with ten adult verde plant bugs excluding uninfested control cages. The assumption that a new bloom is expected along the branch approximately every six days was used to estimate the square and bolls ages on the first four fruiting positions relative to expected bloom. Therefore the two branch age treatments in 2010 were designated (listed from the first oldest to the fourth youngest fruiting body position) a) bolls 8 day old—squares 11 day prebloom and b) bolls 12 day old—squares 7 day prebloom. In 2011 the treatments were designated a) bolls 4 day old—squares 15 day prebloom, b) bolls 10 day old—squares 9 day prebloom, and c) bolls 15 day old—squares 4 day prebloom (Table 1). The infestations were terminated after 72 hr by application of pyrethrins.

The cages were left on the branches until the bolls were fully opened and ready for harvest. The caged branches were clipped from the plants the fourth week of July (about 100 days post emergence). Fruiting positions on each branch were observed for fruit retention. Insect damage on bolls present at harvest was scored using a five class locule damage scale. The scale ranged from 0 representing no damage detected; 1, 2, and 3 representing a progression of damage from localized in one locule to damage in most locules; and 4 representing severe damage in all locules (Fig. 2). Plant productivity loss due to square and boll injury was assessed, setting yield measures to zero when a fruiting position abscised. Seed cotton was hand-harvested. In 2010, lint and seed were separated by hand and weighed. In 2011, lint and seed were separated using a roller gin and weighed.

Mean percent fruit retention, damage score of harvested bolls, and lint and seed weight were calculated by fruiting position for the branch age treatments and the uninfested control. The branch mean for percent fruit retention and the boll damage score, and the total lint and seed weight for the branch, were also calculated. An analysis of variance and contrast statements between treatments were used to detect differences in overall branch means and totals among the branch age treatments and control for each year. Analyzes also were done separately by fruiting position.

Table 1. Estimated age of fruiting bodies (squares and bolls) relative to when first bloom occurs on two (2010) and three (2011) age classes of fruiting branches exposed to verde plant bug for 72 hrs in a field setting, Nueces County, TX.

<table>
<thead>
<tr>
<th>Year: Branch Age</th>
<th>Position one</th>
<th>Position two</th>
<th>Position three</th>
<th>Position four</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010: Bolls 8 d old - squares 11 d prebloom</td>
<td>Bolls 7-8 d old</td>
<td>Bolls 1-2 d old</td>
<td>Squares within 4-5 d of bloom</td>
<td>Squares within 10-11 d of bloom</td>
</tr>
<tr>
<td>2010: Bolls 12 d old - squares 7 d prebloom</td>
<td>Bolls 11-12 d old</td>
<td>Bolls 5-6 d old</td>
<td>Squares within 0-1 d of bloom</td>
<td>Squares within 6-7 d of bloom</td>
</tr>
<tr>
<td>2011: Bolls 4 d old - squares 15 d prebloom</td>
<td>Bolls 3-4 d old</td>
<td>Squares within 2-3 d of bloom</td>
<td>Squares within 8-9 d of bloom</td>
<td>Squares within 14-15 d of bloom</td>
</tr>
<tr>
<td>2011: Bolls 10 d old - squares 9 d prebloom</td>
<td>Bolls 9-10 d old</td>
<td>Bolls 3-4 d old</td>
<td>Squares within 2-3 d of bloom</td>
<td>Squares within 8-9 d of bloom</td>
</tr>
<tr>
<td>2011: Bolls 15 d old - squares 4 d prebloom</td>
<td>Bolls 14-15 d old</td>
<td>Bolls 8-9 d old</td>
<td>Bolls 2-3 d old</td>
<td>Squares within 3-4 d of bloom</td>
</tr>
</tbody>
</table>

* A new bloom is expected approximately every six days. d = day.
RESULTS AND DISCUSSION: Fruit retention averaged across the fruiting branch positions varied among treatments in 2010 ($P = 0.015$) and 2011 ($P < 0.0001$). In 2010, there were no detectable differences in mean fruit retention between the two infested branch age treatments ($P = 0.49$), but average fruit retention of infested branch age treatments was lower than that of the uninfested control ($P = 0.005$) (Fig. 3A). The greatest fruiting body loss occurred from bolls 1 to 6 day old on position two of the two infested branch age treatments compared to the control even though retention was < 50% on position two (control contrast: $P = 0.002$) (Fig. 3A). Fruit retention of bolls > 7 day old on position one was very high (> 90%) and not different among branch age treatments ($P = 0.53$) (Fig. 3A). In 2011, mean fruit retention increased from the bolls 4 day old—squares 15 day pre-bloom treatment to the bolls 15 day old—squares 4 day pre-bloom treatment ($P = 0.024$), and the control had higher fruit retention than the average fruit retention of infested treatments ($P < 0.0001$) (Fig. 3B). The lowest fruit retention relative to the control was on bolls 3-4 day old on position one (bolls 4 day old—squares 15 day prebloom treatment) and two (bolls 10 day old—squares 9 day prebloom treatment) ($P < 0.016$) (Fig. 3B). In contrast, fruit retention for bolls > 8 day old and squares within 2-3 day of bloom about as high as in the control (at least 75%) (Fig. 3B). The fourth position for both years was not considered in this and other measures because of very low retention (< 20%) in all treatments and the control. Overall, a strong upward trend was observed in fruit retention from the youngest to the oldest branch age treatment for both years, and differences in fruiting retention were primarily determined by the age of the fruiting body on positions one and two. Low fruit retention was mostly seen in young bolls < 7 day old and not older bolls and young squares at least 2-3 days from bloom.

Mean lint and seed weight followed similar trends across the fruiting positions, and varied among the age classes of infested branches and uninfested controls in 2010 ($P < 0.002$) and 2011 ($P < 0.0001$). In 2010, there were no detectable differences in lint and seed weight between the two infested branch age treatments ($P > 0.33$). But total lint and seed weight of the infested branch treatments were on average lower than weights of the uninfested control ($P < 0.006$). Lint and seed weight in the infested branch age treatments was lower than in the uninfested control for fruiting positions one and two ($P < 0.04$) (Fig. 5). Lint and seed weight for all treatments was low in position two because of high fruit abscission (Fig. 3A). In 2011, lint and seed weight increased from the bolls 4 day old—squares 15 day prebloom treatment to the bolls 15 day old—squares 4 day prebloom treatment ($P < 0.04$), and the uninfested control had the highest total lint and seed weight ($P < 0.0001$) (Fig. 6). Lint and seed weight increased as age of the fruiting bodies increased from 3-4 day old bolls to 14-15 day old bolls on position one ($P < 0.0001$). On position two, lint and seed weight loss was greatest for bolls 3-4 day old, while squares within
2-3 day of bloom and bolls 8-9 day old were less affected by verde plant bug feeding ($P < 0.0002$) (Fig. 6). Lint and seed weight in the infested branch age treatments was lower on average than those of the uninfested control for positions one and two ($P < 0.0001$) and to a lesser degree for position three ($P < 0.025$) (Fig. 6).

Overall, verde plant bugs when given a feeding choice reduced fruit retention in young bolls < 7 day old, damaged retained bolls < 11 day old, and larger bolls and young squares at least 2-3 d from bloom incurred significant less abscission and damage. Fruiting body abscission was the main contributor to plant productivity differences seen in lint and seed weight. These results were consistent with and added to the previous finding that mature bolls 12 days or older incurred negligible damage from verde plant bug feeding in a no-choice test (Armstrong et al. 2013). This tendency for more damaged younger bolls, including significant abscission of young bolls, may have been magnified by a feeding preference for younger bolls in our feeding choice experiment. Three to 6 day old bolls had the lowest retention in the first two fruiting positions (10—60%) (Fig. 3). In contrast, other plant bugs, Lygus and cotton fleahopper, are very damaging to squares and new growth.

Currently, verde plant bug infests cotton in the coastal cotton growing region of south Texas around mid-bloom, and management programs have focused on boll protection because maturing bolls are abundant and will be major contributors to yield. Based on results from this study, losses from verde plant bug feeding is expected to be highest when verde plant bug infests cotton from early to mid-bloom (when young bolls are abundant). Infestations beginning later in bloom (when harvestable bolls are older) and any infestations detected before first bloom (when young squares predominant) are expected to be of less concern. These results supported the interpretation that low fruit retention and high damage of young bolls justified a focus on protecting young bolls as recommended by Armstrong et al. (2013), especially during early to mid-bloom when young bolls are abundant.

**ACKNOWLEDGEMENT:** We thank Jonathan Martinez and Charlene Farias for providing field and other technical support. This work was partially supported by a Texas State Support Committee, Cotton Incorporated, award (11-845TX) to MJB and JSA.

**REFERENCES CITED:**


Fig. 3. Percent fruit retention when treatments representing two (A: 2010) and three (B: 2011) age classes of cotton branches were caged and exposed to 10 verde plant bugs for 72 hr, along with uninfested controls. Data were taken on the fruiting positions along the branch. Data for positions three and four in 2010 and four in 2011 were not used to calculate the branch mean because of poor retention. Lines above bars are SEMs.
Fig. 4. Boll damage score (0 to 4 scale, 0 = no damage and 4 = damage of all locules) when treatments representing two (A: 2010) and three (B: 2011) age classes of cotton branches were caged and exposed to 10 verde plant bugs for 72 hr, along with uninfested controls. Data were taken on the fruiting positions along the branch. Data for positions two to four in 2010 and four in 2011 were not used to calculate the branch mean because of poor boll retention. ‘X’ indicates data deleted from analysis. Lines above bars are SEMs.
Fig. 5. Lint (A) and seed (B) weights (in grams, 1 gram = 0.035 ounce) for the 2010 test when treatments representing two age classes of cotton branches were caged and exposed to 10 verde plant bugs for 72 hr, along with uninfested controls. Data were taken on the fruiting positions along the branch, and weights were set to zero for abscised bolls. Data for positions three and four were not used to calculate the branch total because of poor retention. Lines above bars are SEMs.
Fig. 6. Lint (A) and seed (B) weights (in grams, 1 gram = 0.035 ounce) for the 2011 test when treatments representing three age classes of cotton branches were caged and exposed to 10 verde plant bugs for 72 hr, along with uninfested controls, 2011. Data were taken on the fruiting positions along the branch, and weights were set to zero for abscised bolls. Data for positions four was not used to calculate the branch total because of poor retention. Lines above bars are SEMs.