# EVALUATION OF VARIETAL DIFFERENCES IN COTMAN COMPENSATION CAPACITY VALUES IN HIGH-INPUT COTTON SUBJECTED TO VARYING LEVELS OF *LYGUS*-INDUCED FRUIT DAMAGE

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## Abstract

Previous research on the ability of cotton to compensate for early fruit loss indicates that 40-50% of pre-flower square loss achieved through manual pinhead square removal could be fully compensated for in terms of lint yield and quality. Our continuing research indicates that insect-induced early fruit loss, specifically by *Lygus hesperus* Knight, can also be compensated for, but normally at a lower level than has been observed following manual removal. Further, higher available inputs are likely required to achieve this effect. The plant's ability to compensate for insect-induced fruit loss has previously correlated strongly with soil moisture, other input variables, and overall plant vigor. In the current study, two cultivars, DP 104 B2RF (early season) and DP 161 B2RF (full season), were evaluated for their responses to *Lygus*-induced fruit loss and yield compensation capability. Pre-flower square loss treatment levels were achieved by augmenting natural plant bug populations with laboratory-reared nymphs. Nymphs were released weekly during the first three weeks of squaring. Following the 2009 season, the number of *Lygus* bugs released in 2010 was increased because higher early season insect-induced fruit losses were preferred in order to more fully evaluate the cotton plant's ability to compensate in terms of lint yields and fiber quality. Insect release treatments included: 1) augmentation of 2 (2009) or 3 (2010) bugs per plant, 2) augmentation of 4 (2009) or 6 (2010) bugs per plant, 3) 0 bugs augmented (naturally occurring background density), and 4) 0 bugs as achieved through insecticide applications. The test was deployed in a 2 (cultivars) x 4 (insect release treatments) factorial arrangement with a randomized complete block design for two years. Both cultivars showed exceptional lint yield compensation for up to 20-26% and 40-54% early fruit loss during 2009 and 2010, respectively. In the bug-augmented plots, lower 2009 compensation percentages were observed because of lower percentages of early fruit losses (fewer bugs released). We were expecting a significant difference in fruit retention and compensation ability between these two cultivars in 2009, but those anticipated differences were not apparent, possibly due to an insufficient level of bug-inflicted fruit loss in these plants. In 2010 the early-terminating cultivar (DP 104 B2RF) compensated fully for both 40 and 48% pre-flower fruit loss, whereas the full-season cultivar (DP 161 B2RF) compensated for 52 and 54% fruit loss. In both cultivars, insect-induced early fruit loss appeared to cause fruit overcompensation. Upward shift and delayed cut-out, as is indicated by 2010 Squaremap data, resulted in compensation/overcompensation of 40-54% early fruit loss. Lint quality data have been collected for both 2009 and 2010 but have not been fully analyzed for reporting. Information generated through this project will quantify our economic thresholds based on variation in relative cultivar compensatory potential, and may potentially result in a reduction in insecticide use while minimizing secondary pest problems. The study will continue during the 2011 growing season.

## Introduction

A three-year study evaluating the fruit loss compensation capacity of cotton grown in the Texas High Plains (THP), using manual square removal treatments ranging from 0-100%, indicated irrigated cotton could withstand 100% first-position square removal with no observed loss in yield (Leser et al. 2004). Dryland cotton was observed to withstand 50% removal, with no significant impact on yield. Maturity was impacted under the most severe treatments. Nevertheless, while 100% square removal prior to blooming failed to impact yield, it did cause a substantial maturation delay. Leser et al. (2004) concluded that irrigated cotton could tolerate a 40% loss with no impact whatsoever. However, these data were generated based on manual pinhead square removal.

Previous researchers have indicated that plants exhibit differential reactions to insect-induced fruit loss, likely due to insect feeding behavior, for example, as a result of insect secretion of enzymes and other chemicals in the process of feeding (Sadras 1995). Using *Lygus hesperus* Knight nymphs, Barman et al. (2007) and Parajulee et al. (2008) demonstrated the unlikelihood that cotton is probably not capable of compensating more than 25-30% of insect-induced fruit loss under a more limited input/limited irrigation production system. In addition, the plant's ability to compensate for insect-induced fruit loss has correlated strongly with soil moisture and overall plant vigor. Our research has shown that cotton may compensate for up to 30% of insect-induced fruit loss if plants are not water-stressed, which is generally not the case under a limited-irrigation production system.

In the Texas High Plains, water management is probably the most important input management issue, but our production technology has advanced to give our producers opportunities to utilize high-input resources to maximize their production yields and profitability. Current research at the Helms Farm near Plainview, Texas, has shown a tremendous opportunity for THP growers to utilize high-input resources such as high-yielding cultivars, near-100% irrigation efficiency (particularly subsurface drip irrigation systems), aggressive insect management regimes, and proper nutrient management. Our research has also suggested that cultivars differ in their ability to support plant bug infestations. This phenomenon is true for both *Lygus* bugs and cotton fleahoppers. It is also expected that some cultivars may be more susceptible to plant bug injury and subsequent square loss than others. There is a need to identify these potential differences as they pertain to the development of fruit loss-based plant bug thresholds.

The current study will quantify the yield-compensatory potential of several cotton cultivars (early-maturing versus full-season) following exposure to different levels of insect-induced fruit loss, thus allowing for further evaluation and refinement of current economic thresholds. Improved and refined economic thresholds may reduce the necessity for insecticide applications and, consequently, mitigate problems due to secondary pests.

## Materials and Methods

The study was conducted at the research farm of Texas AgriLife Research & Extension Center located in Lubbock County near New Deal, Texas. A 5-acre subsurface drip-irrigated field was selected for this experiment. Two cultivars, DP 104 B2RF (early season) and DP 161 B2RF (full season), were evaluated. Experimental plots were 12 rows wide and 100 ft long with 5-ft alleys separating the plots. Four central rows were selected in each plot for plant bug treatment deployment and plant mapping. Pre-flower square loss treatment levels were achieved by augmenting natural plant bug populations with laboratory-reared nymphs released weekly during the first three weeks of squaring. *Lygus hesperus* nymphal release treatments included: 1) augmentation of 2 (2009) or 3 (2010) bugs per plant (medium infestation); 2) augmentation of 4 (2009) or 6 bugs per plant (high infestation); 3) 0 bugs augmented (naturally occurring background density; low density); and 4) 0 bugs achieved through insecticide applications. Following the 2009 season, the treatment levels were increased in 2010 to encourage greater early season insect-induced fruit loss, as was preferred for a more complete evaluation of cotton lint yield and fiber quality compensatory ability. The test was deployed in a 2 (cultivars) x 4 (treatments) factorial arrangement with randomized complete block design. The test was replicated 4 times, resulting in a total of 32 experimental plots.

Bug releases were initiated upon initial pinhead-sized square observation in all plots. Plant bugs were aspirated from the laboratory colony (3$^{rd}$ - 4$^{th}$ instar) into 0.75-inch X 1.5-inch plastic vials. The bugs were carefully deposited on the mainstem terminal of each plant. *Lygus* nymphs were released on July 2, 7, and 13 during 2009, while 2010 releases occurred on July 1, 8, and 15. Plant monitoring was conducted using the SQUAREMAN component of the COTMAN program on July 1, 6, and 13 (2009), while 2010 monitoring was conducted on June 30, July 7, and July 14. Complete in-season plant mapping was conducted one week after the last of the three *Lygus* bug releases per study year (July 21, 2009 and July 26, 2010) (Fig. 1). In 2009, Orthene® was applied to remove insects from all the experimental plots immediately following the complete plant mapping, while in 2010, Carbine® and Holster® were tank-mixed and applied. COTMAN-SQUAREMAN plant mapping continued until physiological cutout (NAWF=5), after which heat unit accumulations were monitored in order to aid decisions related to the timing of harvest-aid applications. Harvest-aid chemicals were applied based on heat unit accumulation and percent open bolls for each cultivar. FirstPick® and DEF 6® (boll openers) were applied during 2009 in early- (DP 104 B2RF) and late-maturing (DP 161 B2RF) cultivars on September 30 and October 14, respectively. One week after the boll openers were applied, Gramoxone® was applied to “finish” the process of boll opening and leaf shedding. For 2010, both cultivars were defoliated and terminated by spraying a tank-mixture of Finish® plus DEF 6® on October 16, followed by an application of Gramoxone® plus 1.5% (by total spray volume) of non-ionic spray oil on October 21. Final pre-harvest complete plant mapping was conducted each study year immediately prior to harvesting (Fig. 1). Plots were harvested separately for early-maturing and full-season cultivars in 2009, whereas both varieties were harvested at the same time for 2010. Fiber samples were analyzed for lint quality parameters at the Cotton Incorporated Fiber Testing Laboratory (North Carolina).

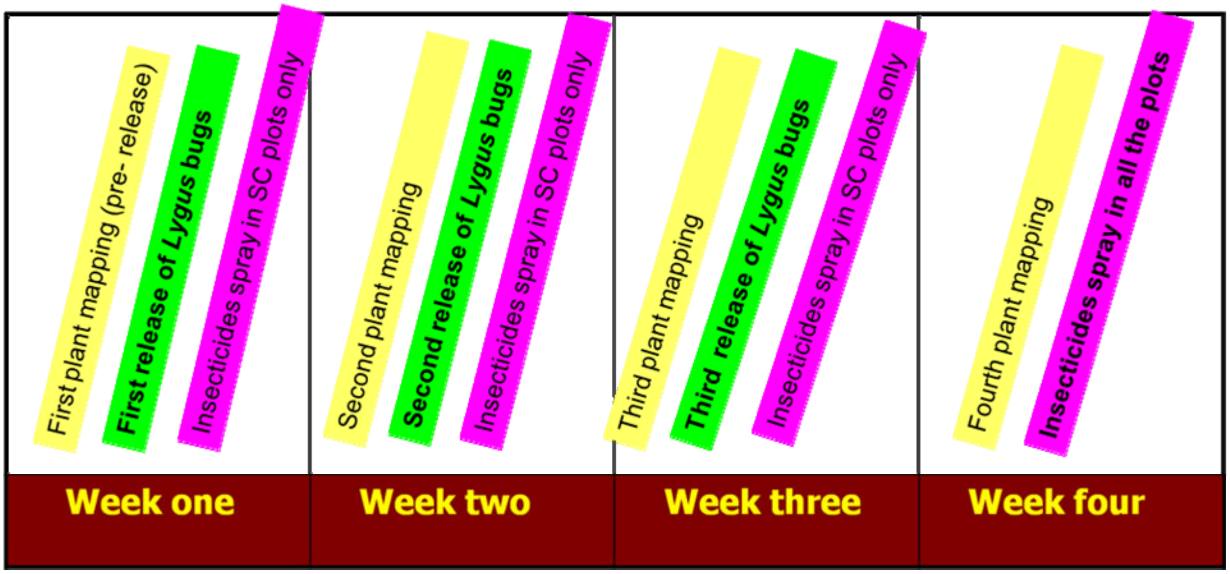


**Figure 1**. Sequence of experimental activities related to the release of *Lygus* bugs and cotton fruit loss monitoring. Lubbock, TX

## Results and Discussion

### Percent Fruit Loss and Lint Yield

In 2009 and 2010, the *Lygus* augmentation during pre-flower cotton growth consistently resulted in significantly higher percentages of fruit loss in both cotton cultivars (Fig. 2). At four weeks into the cotton squaring stage, complete plant mapping indicated that the highest 2009 fruit losses for DP 104 B2RF and DP 161 B2RF were 22.1% (4 bugs/plant/week) and 25.7% (4 bugs/plant/week), respectively, while in 2010, the highest fruit losses were 47.8% (6 bugs/plant/week) and 54.1% (6 bugs/plant/week), respectively. Higher percent fruit losses observed in 2010 treatments are likely due to the higher *Lygus* augmentation rate and cooler and wetter conditions during 2010, which may have favored higher *Lygus* survival and crop injuriousness.

In both years, the cotton plants compensated, in terms of final yield, for fruit loss due to *Lygus* augmentation treatments in both cultivars (Fig. 3). Cotton was able to compensate for 22-26% of early fruit loss in 2009, but compensated for 48-54% of fruit loss in 2010 (Figs. 2 and 3). Given sufficient nitrogen and water availability, it's apparent that plants were able to transcend augmented *Lygus*-induced square loss. Within each year, both cotton cultivars produced similar lint yields, despite numerically higher percent fruit loss exhibited by the full-season cotton cultivar (DP 161 B2RF) (Fig. 3).

In most cases, the cotton plants compensated their lint yields with both first position and lateral (2+) position fruits (Fig. 3). In other words, cotton plants responded to pre-flower fruit loss by growing taller (adding more first position fruits) and wider (adding more 2+ position fruits on lateral branches). Plants in bug-augmented treatments did not appear to invest extra energy in vegetative growth as a result of bug-induced fruit loss. Instead, plants appeared to allocate a greater proportion of their energy into producing more fruits. Plant heights were similar across all four treatments within the individual cultivars, whereas the proportion of lateral position fruits was significantly higher in bug-augmented plots.

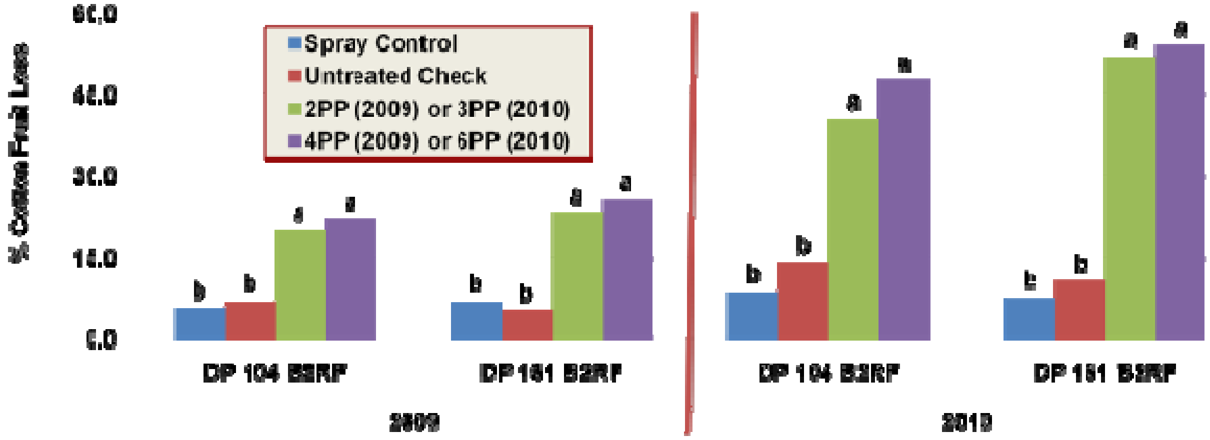


**Figure 2**. 2009 and 2010 observed percent cotton fruit loss one week after final *Lygus* release in DP 104 B2RF and DP 161 B2RF cotton cultivars. Columns within each year and cultivar with the same lowercase letter are not significantly different (P > 0.10), Lubbock, TX.

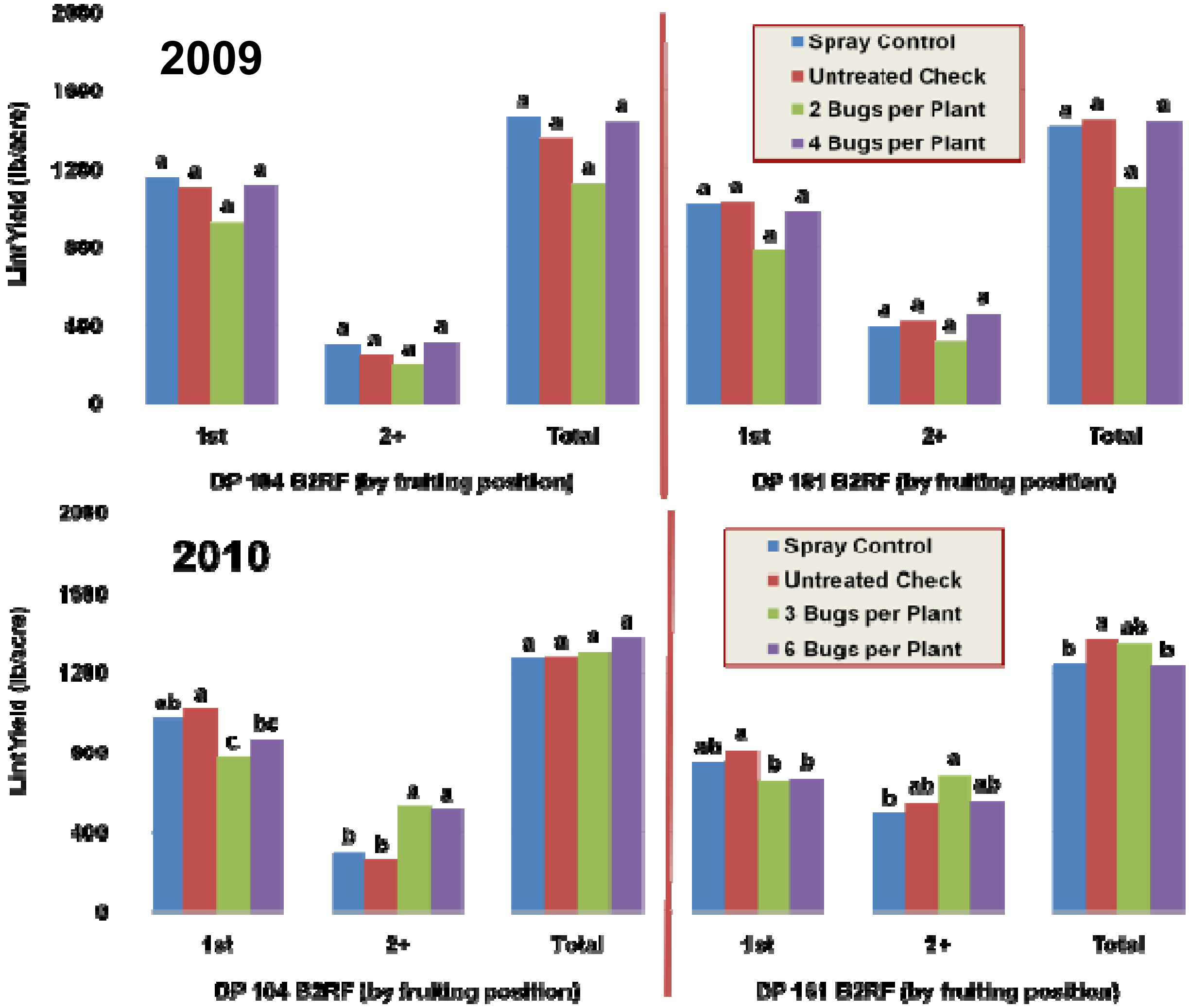


**Figure 3.** 2009 (top) and 2010 (bottom) lint yields from cotton plots receiving varied levels of *Lygus* infestations. Columns within a year, cultivar and fruiting position with the same lowercase letter are not significantly different (P > 0.10), Lubbock, TX.

**COTMAN Target Development Curve (TDC) and Fruiting**

Cotton development and squaring initiation generally tracked the COTMAN Target Development Curve (TDC) or were earlier, but peak fruiting was much lower than the TDC in 2009 (Figs. 4 and 5). In 2009, the SQUAREMAN curves reached their peaks about 10 days later in DP 161 B2RF as compared to DP 104 B2RF, indicating a varietal difference in reproductive profile and crop maturity (Fig. 4).

In 2009, DP 104 B2RF approached physiological cut-out (NAWF=5) ≈5 days earlier than did DP 161 B2RF (Fig. 4), whereas in 2010, both cultivars showed similar crop maturity timing (Fig. 5). In 2009, *Lygus* augmentation treatments did not significantly affect the cotton crop maturity profiles of either cultivar, whereas in 2010, the *Lygus* augmentation was clearly observed to cause significant delays in peak squaring and crop cutout (Figs. 4 and 5).

Although a cotton crop can compensate for damage caused by early-season *Lygus* injury, delayed crop maturity may occur, potentially resulting lint quality discounts. As of writing, the 2010 quality parameter data were unavailable for analyses and reporting. Quality parameters for both years will be reported in a future publication.

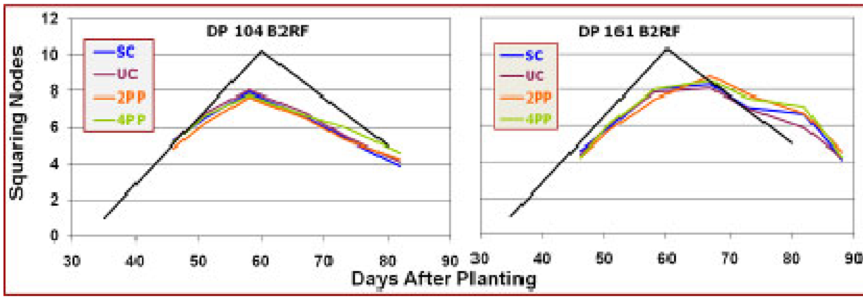


**Figure 4. 2009**: Cotton fruiting profile (SQUAREMAN) as influenced by *Lygus*-induced fruit loss, and target development curve (black line).

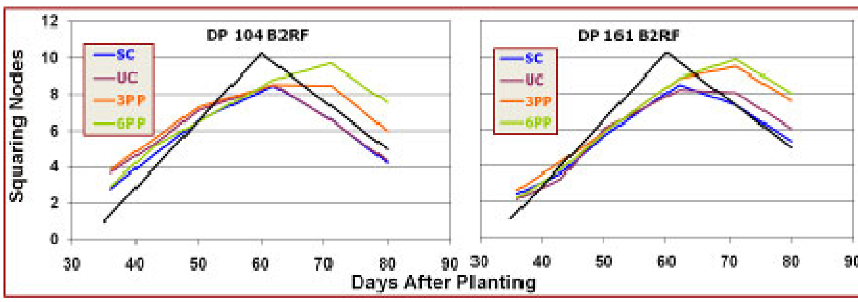


**Figure 5. 2010**: Cotton fruiting profile (SQUAREMAN) as influenced by *Lygus*-induced fruit loss, and target development curve (black line).

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