

COTMAN COMPENSATION CAPACITY VALUE FOR LYGUS-INDUCED PRE-FLOWER SQUARE LOSS IN COTTON**Megha N. Parajulee****Apurba K. Barman and****Stanley C. Carroll****Texas AgriLife Research and Extension Center****Lubbock, TX****Abstract**

A 3-year field study was conducted in the Texas High Plains to quantify the compensatory ability of cotton to pre-flower fruit loss induced by *Lygus hesperus*. Experiments were designed to achieve different levels of pre-flower square loss by augmenting natural populations of *Lygus* bugs with laboratory reared nymphs, including 3 bugs per plant augmented (3PP), 1 bug per plant augmented (1PP), naturally occurring background density or untreated control (UC), and 0 bug achieved through insecticide spray applications (SC). Percent fruit loss due to the highest infestation level of bugs (3 per plant) was 48, 30, and 37% in 2005, 2006, and 2007, respectively. Pre-bloom fruit loss was not compensated through lint yield in 2005, but 30 and 37% pre-flower fruit loss in 2006 and 2007 were fully compensated. The reduction in yield (significant reduction in 2005 and numerical reduction in 2007) was primarily due to plant's inability to compensate lost first fruiting positions. These data clearly demonstrate that the plants have potential to compensate about a third of the pre-flower square loss (up to 37% in 2007) caused by *Lygus* injury. While one needs to consider plant compensation potential, protection of 30% fruit shed during early squaring may not be necessary for the Texas High Plains.

Introduction

A three-year study evaluating the compensation capacity of cotton grown in the southern High Plains using manual square removal treatments ranging from 0-100% indicated that irrigated cotton could lose 100% of first position squares with no loss in yield or fiber quality (Leser et al. 2004). Dryland cotton was also shown to lose 50% with no significant impact on yield or fiber quality. Maturity was impacted under the most severe treatments. Even the removal of 100% of all squares (all fruiting positions) prior to bloom did not reduce yield but did cause a substantial delay in crop and fiber maturity. The authors concluded that irrigated cotton could tolerate a 40% loss without any impact whatsoever. The current recommended pre-flower management approach places an emphasis on early square protection with a cumulative retention level of 75% after three weeks. Clearly this is higher than what the compensation study based on manual fruit removal indicated. If cotton plants can truly compensate for loss levels exceeding 25%, then action thresholds may need to be elevated.

The question arises, whether the manual removal or mechanical injury to the fruiting bodies of cotton is similar to injury by plant bugs. Study on this aspect has been investigated by different workers (Pitman et al. 2000, Herbert and Abaye 1999, Mann et al. 1997, Phelps et al. 1997, Montez and Goodell 1994) and they inferred that there was a difference in plant response to square loss when injured by insect versus manually removed. Plant responses differ to feeding injury because of time, duration and the feeding nature of insects, where insects secrete enzymes or other chemicals besides feeding on plant parts (Sadras 1995).

The objective of this research was to quantify the cotton plant response in terms of yield compensation resulting from *Lygus* bug induced injury and fruit loss. The specific objective was to determine what level of plant bug-induced fruit loss can be compensated for without yield, fiber quality or earliness penalties.

Materials and Methods

A 3-year study was conducted at Texas AgriLife Research farm near Lubbock, Texas during 2005, 2006 and 2007. Cotton cultivars PM2326RR and ST4554B2RF were planted on 20 May 2005, 15 May 2006 and 4 June 2007, respectively, with seeding rate of ~50,000 seeds/A and 80 lbs N/A in a furrow-irrigated field. The field was prepared for 16 experimental plots (8 rows x 75 ft long) following standard cultivation practices. Different levels of pre-flower square loss were achieved by augmenting natural populations of *Lygus* bugs. Experimental treatments included 3 bugs released per plant (3PP), 1 bug per plant (1PP), 0 bugs released per plant (naturally occurring background density or untreated control, UC), and no bugs achieved through insecticide applications (SC). Each treatment was replicated four times. An insecticide (Intruder® @ 0.6 oz/acre) was used to achieve the SC treatment

which represented the sprayed control. Three consecutive weekly releases of *Lygus* bugs were made. The bug release area was restricted to 10 row ft on each of the middle two rows of any plot or about 30 to 35 plants per row. Thus, each 1PP and 3PP plots received 60-70 and 180-210 *Lygus* per plot per release, respectively.

Observations for square loss were recorded before and after each release. Plant height and number of nodes were recorded from 10 plants in each plot in order to determine differences due to treatment effects. Standard COTMAN sampling was conducted. One week after the third release, final counts on fruit retention were recorded and all plots were sprayed with an insecticide to kill any remaining plant bugs. Frequent monitoring occurred during the remainder of the season and necessary control measures were taken to avoid damaging insect infestations in the experimental plots. Plots were harvested on 12 November (2005), 7 November (2006), and 5 November (2007), hand stripping the entire area that received *Lygus* release treatments or equivalent areas in control plots. Cotton samples were ginned at the Texas AgriLife Research, Lubbock, and the lint quality analysis was performed at Cotton Incorporated, North Carolina.

Results and Discussion

Percent fruit loss

For all three years, fruit retention in the “bug free” treatment (SC) was 90-95% three weeks into squaring (Fig. 1). Overall, bug-augmented plots had a higher fruit shed rate compared with SC or UC plots, with significantly higher fruit shed rate in 3PP followed by 1PP and the lowest shed rate in control plots one week after the third release in all years (Fig. 1). In 2005, final fruit shed monitoring and spray application were deployed two weeks after the third release that resulted in 48 and 32% fruit loss in 3PP and 1PP treatments, respectively, compared with 17 and 10% fruit loss in UC and SC treatments, respectively (Fig. 1). In 2006, 3PP, 1PP, UC, and SC treatments had 30, 19, 6, and 5% fruit loss one week after the third release when a spray application was applied to remove plant bugs from all test plots. Pre-flower square loss in 2007 was similar to that in 2006, with 37, 21, 15, and 6% loss in 3PP, 1PP, UC, and SC plots, respectively. Average net square loss values in *Lygus*-infested plots (infestation in SC plots set to 0) were 10, 18, and 33% in UC, 1PP, and 3PP plots, respectively.

Harvestable bolls

If the early fruit loss is not fully compensated, one would assume that the percent fruit loss in the bug-augmented plots will reflect a corresponding reduction in harvestable bolls and final yield. In 2005, average number of harvestable bolls per plant was highest (9.2 bolls/plant) in SC plots and the lowest in 3PP (6.4 bolls/plant) (Fig. 2). There was a significant reduction in the number of harvestable bolls (2.8 bolls/plant) between the SC and 3PP treatments. However, number of harvestable bolls was similar between UC and 1PP treatments, indicating some level of compensation. In 2006, the number of harvestable bolls was similar across four treatments, suggesting a full compensation of the fruit loss. In 2007, SC plots had a significantly higher number of harvestable bolls (8.3 bolls/plant) compared to that in untreated or bug augmented treatments, with the lowest number of harvestable bolls in 3PP plots (5.3 bolls/plant).

Lint yield

In 2005, plants were unable to compensate for pre-flower fruit loss caused by *Lygus* augmented infestations due to the plant's inability to compensate for lost first fruiting positions (Fig. 3). Total lint yield was highest in SC plots (992 lbs/acre) and lowest in 1PP (766 lbs/acre) and 3PP (792 lbs/acre) plots, with no significant difference between the two bug-augmented treatments. The yield difference between the SC and 3PP treatments was about 200 lbs/acre. Also, the in-season fruit loss of 48% in 3PP due to the *Lygus* infestation (Fig. 1) resulted in 2.8 fewer harvestable bolls per plant in 3PP (Fig. 2). This reduced number of bolls (2.8 per plant) translated into a final lint yield reduction of about 200 lbs/acre (Fig. 3). Further, the average yield from first position bolls was reduced by 202 lbs/acre in 3PP as compared to the SC treatment while the second position contribution was similar across four treatments. These data suggest that plants were unable to compensate for the bug infestation damage under the prevailing condition.

In 2006, total lint yield was similar across the four treatments, suggesting the plant's ability to compensate early square loss up to 25%. Nevertheless, the environmental stress (high heat and drought) prevented cotton from realizing its full yield potential in SC plots in 2006 and it appeared that SC and 3PP were similar in yield with 25% additional fruit loss in 3PP. We suspect that the results could have been somewhat different had the 2006 summer been a more typical year. These data indicate that the perceived “full compensation” in bug-augmented treatments in 2006 may be spurious. In fact, it is safe to say that SC and NC plots underwent physiological shedding of more fruit

and “equalized” their fruit load with 1PP and 3PP treatments in response to the environmental stress. Nevertheless, pre-flower bug-induced fruit loss of 20-30% did not result in any yield penalty. Thus, if environmental conditions are not favorable for cotton growth and reproduction, 25-30% fruits will be shed physiologically so the insecticide intervention to save up to 30% early squares may not be necessary.

In 2007, total lint yield was similar across treatments, suggesting that plants were able to fully compensate up to a 37% early square loss (Figs. 1 and 3). However, there was a 102 lb yield deficit in 3PP treatment compared with that in SC treatment, although this difference was not statistically significant (Fig. 3). First fruiting positions produced 1077, 1045, 971, and 988 lbs/acre in SC, UC, 1PP, and 3PP, respectively. Second and subsequent fruiting positions produced 343, 332, 422, and 330 lbs/acre in SC, UC, 1PP, and 3PP, respectively. Data demonstrate that the numerical deficit in total lint yield in 3PP compared with that in SC occurred primarily in the first fruiting positions.

Averaged over three years, percentage net square losses in bug infested plots were 10, 18, and 33%, respectively, in UC, 1PP, and 3PP (Fig. 4). Based on these square loss values, the expected total lint yield in UC, 1PP, and 3PP treatments would have been 1016, 919, and 750 lbs/A, respectively, whereas the observed lint yield values were 1070, 1024, and 1020, respectively. These data clearly indicate that plants showed a tremendous ability to compensate early square loss in the amount of 18-20% above the loss in SC plots. However, plants were unable to fully compensate the net square loss of 18 and 33%, with about a 9% yield deficit in both cases (Fig. 4). This deficit in yield was primarily due to the plant’s inability to compensate for lost vertical positions (Fig. 5). Yield contribution by vertical position (first positions) was significantly lower in 1PP and 3PP (Fig. 5), whereas lateral position fruits overcompensated the yield by 7% (Fig. 6).

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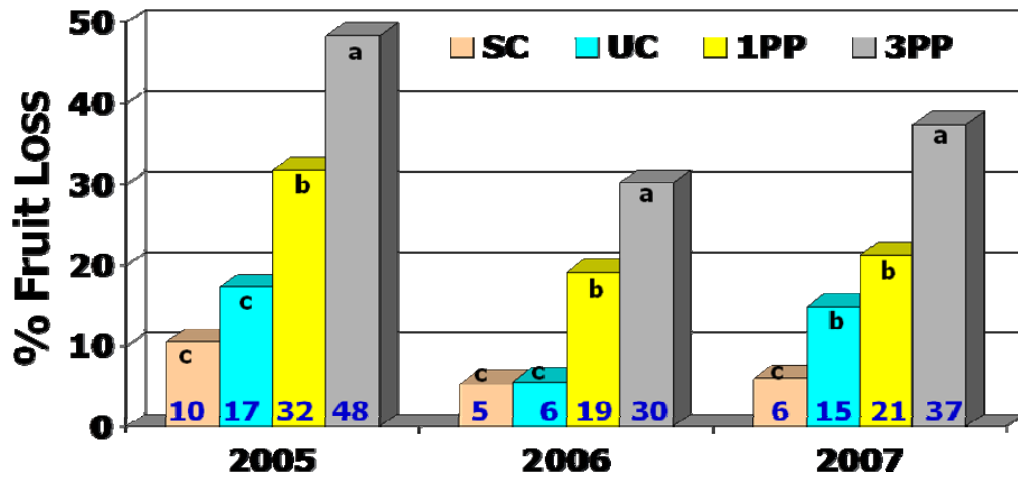


Figure 1. Percent fruit loss in cotton plots receiving various levels of *Lygus* bug releases during the pre-flower fruiting period, Lubbock, TX, 2005-2007. Bars within a year with different letters are statistically different ($P < 0.10$).

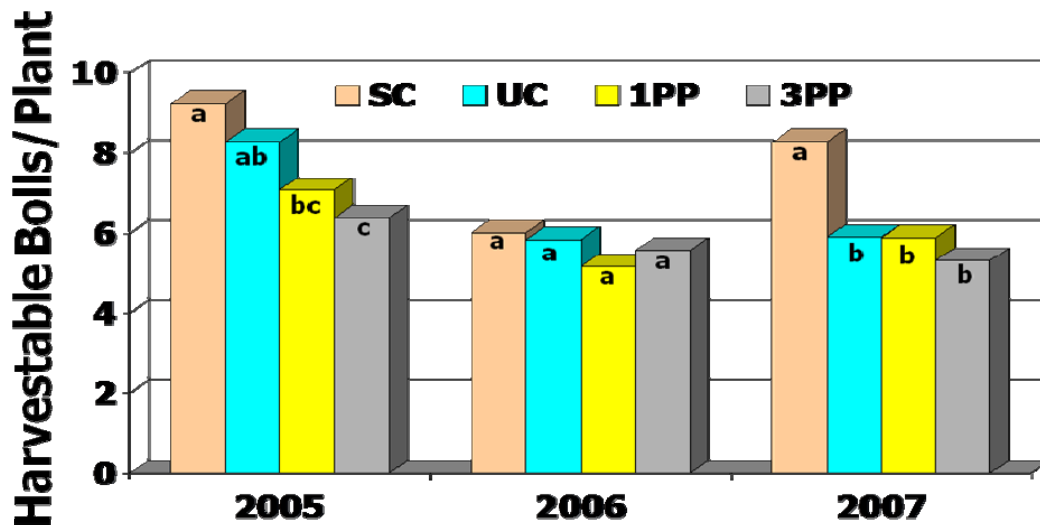


Figure 2. Average number of harvestable bolls/plant in cotton plots receiving various levels of *Lygus* bug releases during the pre-flower fruiting period. Lubbock, TX, 2005-2007. Bars within a year with different letters are statistically different ($P < 0.10$).

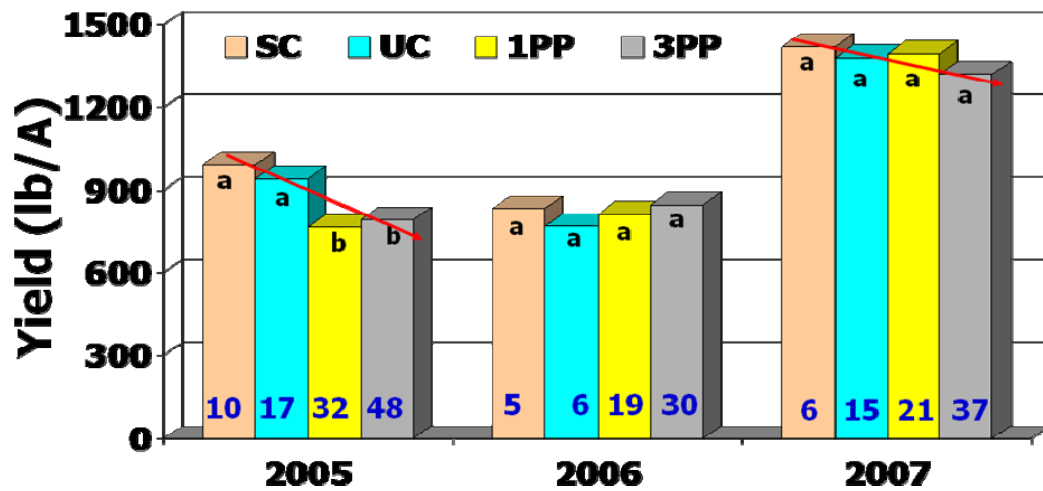


Figure 3. Total lint yield in cotton plots receiving various levels of *Lygus* bug releases during the pre-flower fruiting period, 2005-2007, Lubbock, TX. Numbers noted on the bars are the average percentage square loss values for corresponding treatments (Figure 1). Bars within a year with different letters are statistically different ($P < 0.10$).

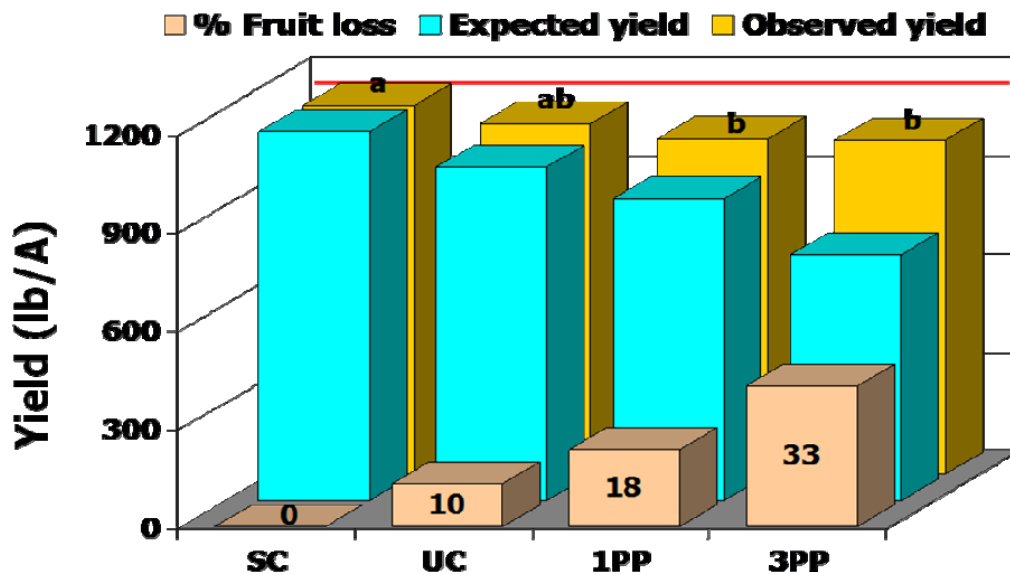


Figure 4. Average (2005-2007) net (SC reset to zero) percentage square loss, expected lint yield based on percentage square loss, and observed lateral position lint yield in cotton plots receiving various levels of *Lygus* bug releases during the pre-flower fruiting period, 2005-2007, Lubbock, TX. Observed yield bars with different letters are statistically different ($P < 0.10$).

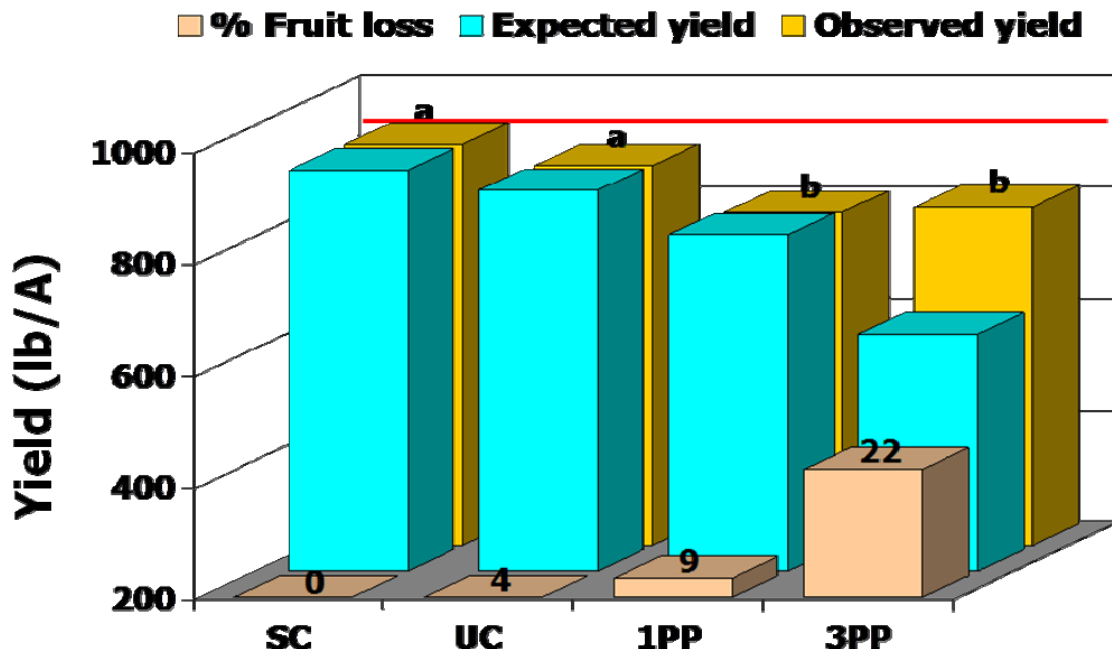


Figure 5. Average (2005-2007) net (SC reset to zero) percentage square loss, expected lint yield contributed by first fruiting positions based on square loss, and observed lateral position lint yield in cotton plots receiving various levels of *Lygus* bug releases, 2005-2007, Lubbock, TX. Observed yield bars with different letters are statistically different ($P < 0.10$).

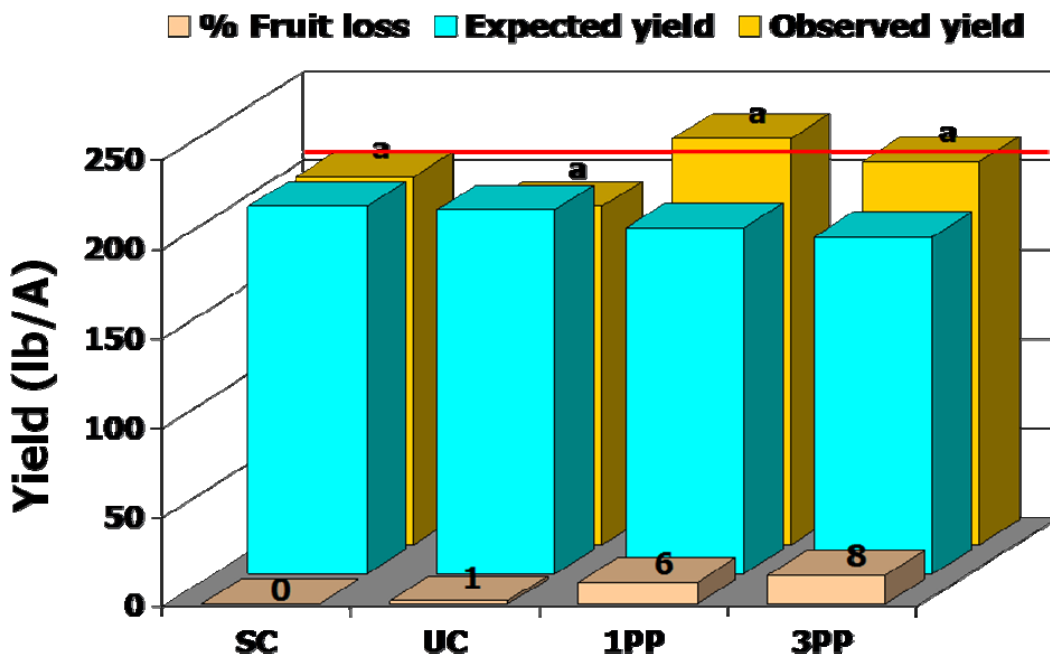


Figure 6. Average (2005-2007) net (SC reset to zero) percentage square loss, expected lint yield contributed by lateral fruiting positions based on percentage square loss, and observed lateral position lint yield in cotton plots receiving various levels of *Lygus* bug releases, 2005-2007, Lubbock, TX. Observed yield bars with different letters are statistically different ($P < 0.10$).