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Validation of New COTMAN Compensation Capacity Value for Texas High Plains Using Plant Bug Induced Square Damage

Submitted by:

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Project Summary

A field study was conducted at the Texas Agricultural Experiment Station farm located near Lubbock to quantify the compensation ability of cotton to *Lygus* bug and cotton fleahopper induced fruit loss at two phenological stages: three weeks pre-flower and the first three weeks of flowering. Experiments were designed to achieve different levels of pre-flower square loss and the loss of fruiting structures (squares and bolls) during early flowering by augmenting natural populations of *Lygus* bugs and cotton fleahoppers with laboratory reared nymphs. Four treatments each were utilized for pre-flower (*Lygus* and fleahoppers) and during-flower (*Lygus*) stages: 1) 3 bugs per plant augmented (3PP), 2) 1 bug per plant augmented (1PP), 3) naturally occurring background density (NC), and 4) 0 bug achieved through insecticide spray applications (SC). Artificial infestations of *Lygus* bugs released at two different crop growth stages caused variable fruit loss. In 2005, percent fruit loss due to the highest infestation level of bugs (3 per plant) in the pre-bloom and early-bloom studies was 48 and 36%, respectively. Pre-bloom fruit loss was not compensated through yield, where there was a major loss in first position bolls in the bug-release treatments. In the pre-flower *Lygus* release test, reduction in yield was primarily due to plant's inability to compensate lost first fruiting positions because the first positions contributed to 80% of the total yield. A compensatory response of cotton was observed when *Lygus* bug treatments were established during the early-bloom stage. Particularly, loss due to *Lygus* released at one per plant was fully recovered and there was no significant difference in yield compared with sprayed and natural control treatments. In a similar *Lygus* study conducted in 2006, 30 and 34% fruit loss were observed when 3 bugs per plant were released during pre-bloom and early-bloom stages of cotton, respectively. Lower lint yields were recorded in all treatments during 2006 due to harsh drought conditions during the mid- to late portions of the growing season. No significant yield difference was observed across treatments in 2006. Nevertheless, second and third fruiting positions over compensated the yield loss caused by *Lygus* augmentation during the early bloom stage. Pre-flower fleahopper release study showed a considerable variation in percent early season fruit loss among the four treatments. An obvious stair-step trend in the percent fruit loss suggests that square loss is directly related to increased fleahopper populations due to fleahopper augmentations in 1PP and 3PP treatments. Plants were able to fully compensate the yield loss caused by fleahopper-induced fruit loss up to 26%. With an additional year of study in 2007, these data should produce some useful management recommendations for cotton producers and consultants in making a decision related to what extent the crop can tolerate a *Lygus* and fleahopper infestation without a significant economic loss.

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Introduction

In 2003, a three-year study evaluating the compensation capacity of cotton grown in the southern High Plains was completed utilizing PM 2326RR (Baugh et al. 2003). Results using manual square removal treatments ranging from 0-100% indicated irrigated cotton could lose 100% of first position squares with no loss in yield or fiber quality. Dryland cotton could 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 prior to bloom did not reduce yield but did cause a substantial delay in 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 indicated. Additionally we use 25-30 fleahoppers per 100 plants or one *Lygus* per 3 feet of row (about 8 per 100 plants) as an indicator of the need to treat. If cotton plants can truly compensate for loss levels exceeding 25% during the first three weeks of squaring, then action thresholds will 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 feeding nature of insects, where insects secrete enzymes or other chemicals besides feeding on plant parts (Sadras 1995).

The present research, conducted during 2005-2006 at the Texas Agricultural Experiment Station located near Lubbock, was adopted from the concept of previous work by different workers. The objective of this research was to validate and compare cotton plant response in terms of yield compensation resulting from manual fruit removal versus bug-induced injury.

Significance

Increases of producer expectations for higher yields have already resulted in a more aggressive management approach to early square protection by both consultants and growers. The results of a 3-year study have indicated that present management guidelines for early plant bug control are probably already too aggressive. If these results can be substantiated through the proposed study utilizing actual insects, this would result in the elevation of our economic thresholds and result in a reduction in insecticide use. This in turn would reduce the present impact insecticides are already having on the early development of natural enemy populations needed for suppression of developing cotton aphid, bollworm and armyworm infestations. These studies will also more clearly partition square loss due to insect damage from loss due to environmental stress.

Objectives

Objectives of this project were to:

1. Determine what level of plant bug-induced square loss can be compensated for without yield, fiber quality or earliness penalties.
2. Determine the relationship between early square loss and plant bug numbers (both cotton fleahoppers and *Lygus* bugs).
3. Quantify the square loss susceptibility of selected cotton cultivars in response to both fleahopper and *Lygus* bug damage.

Materials and Methods

Plant bugs. A *Lygus* bug colony was maintained in the Cotton Entomology Laboratory at the Texas Agricultural Experiment Station (Lubbock) from a nucleus culture received from the USDA-ARS laboratory at Phoenix, AZ. In order to minimize insect movement away from release sites, only second or third instars were used for field releases. In some instances, local field-collected *Lygus* nymphs were added to the released lots.

The cotton fleahopper was collected when it was hibernating as eggs in wooly croton, a weed prevalent in the College Station area of Texas. The collected plant material was kept in an incubator at 50-55^{o} F. Subsequently, prior to release the plant materials were soaked periodically for a few minutes and then kept in an open space at room temperature. Normally, after three to four days the first instars emerged from the plant material. Fleahopper nymphs were reared on a green bean diet until they were ready for the field release.

Cultivar. The cotton cultivar used in the study was PM 2326RR in 2005 and ST 4554B2R in 2006, mid-season stripper varieties well adapted for the Texas High Plains with consistent yield and good fiber package.

Experimental procedure. Two test sites were set up at the Texas Agricultural Experiment Station, Lubbock. Each test site was prepared for 16 experimental plots (8 rows x 75 ft long) following standard cultivation practices with furrow irrigation and supplemental fertilizer (80 lbs N/acre). The original design of the experiment called for the release of cotton fleahoppers for the first three weeks of squaring (pre-flower release study) and the release of *Lygus* bugs for three weeks following the initiation of flowering (early flower release study). However, an insufficient number of fleahoppers available from the laboratory-reared colony in 2005 constrained us to change the plan, resulting in both phenological stages receiving *Lygus* bug releases. However, in 2006, the fleahopper test was added to the two *Lygus* augmentation studies. Therefore, we had three separate studies for 2006, including pre-flower fleahopper, pre-flower *Lygus* and early flower *Lygus* studies. Each test consisted of four treatments including 3 bugs per plant (3PP); 1 bug per plant (1PP); 0 bugs (naturally occurring background density; NC) and no bugs achieved through insecticide applications (SC). Three consecutive weekly releases were made for each study (Table 1). Each treatment was replicated four times, so there were 16 plots each for pre-bloom and early-bloom *Lygus* (2005) and pre-bloom (*Lygus* and fleahopper) and early bloom (*Lygus*) studies (2006). An insecticide (Intruder® @ 0.6 oz/acre) was used to achieve the SC treatment which represents the sprayed control. 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 whichever was appropriate. Thus, each 1PP and 3PP plots received 60-70 and 180-210 *Lygus* or fleahopper nymphs per plot per release, respectively, with about 960 to 1,120 *Lygus* or fleahopper nymphs required for a single-day release for each study.

Observations for fruit (square/boll) 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 which included plant density, plant height-to-node ratios, square retention, and Nodes Above White Flower (NAWF). 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) and 7 November (2006), hand stripping the entire area that received *Lygus* or fleahopper release treatments or equivalent areas in control plots. Cotton samples were ginned at the Texas A&M Agricultural Research and Extension Center, Lubbock.

Evaluation of cotton cultivar to plant bug susceptibility. The second part of this project was designed to quantify the square loss susceptibility of selected cotton cultivars in response to a combination of both naturally occurring fleahopper/*Lygus* population and augmented *Lygus* bug infestations. Four cultivars (PM 2266RR, PM 2145RR, FM 960RR, and NG 2448R) were planted in mid-May at the Texas Agricultural Experiment Station farm located at Halfway, Texas. The test consisted of four replications with plots of 12 rows x 125 feet. A 2-row strip of alfalfa was planted in mid-April on each side of the experimental plots to create a natural "reservoir" of *Lygus* Unfortunately this experiment had to be abandoned due to hailstorm (2005) and extremely hot and dry weather (2006) that prevented *Lygus* colonization in the plots. In the summer of 2007 this test will be repeated in a similar methodology.

Results

Pre-Bloom *Lygus* Release Test

Percent fruit loss. In this experiment, cotton was exposed to four different regimes of *Lygus* bug pressure including two augmented populations receiving 1 bug per plant (1PP) and 3 per plant (3PP). For both years, fruit retention in "bug free" treatment (SC) was 95% first week into the bloom (Fig. 1). Overall, bug-augmented plots had higher fruit shed rate compared with SC or NC 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 both 2005 and 2006 (Fig. 1, Table 2). 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 NC and SC treatments, respectively (Fig. 1). In 2006, 3PP, 1PP, NC, and SC treatments had 30, 19, 6, 5% fruit loss one week after the third release when a spray application was applied to remove plant bugs from all test plots.

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 (6.42 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 NC 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.

Lint yield. In 2005, plants were unable to compensate for fruit loss caused by *Lygus* augmented infestations due to plant's inability to compensate for lost first fruiting positions (Fig. 3). Total lint yield was 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 *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. For example, percent fruit loss was about 5% in the first week into bloom in the control plots, with 20 and 30%, respectively, in 1PP and 3PP plots (Fig. 4), but the pre-harvest fruit loss increased to 17 and 23% for SC and NC plots, respectively, while the pre-harvest fruit loss in 1PP and 3PP were similar to their respective in-season losses. These data clearly 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. We hope to gain more insight in this area of research in 2007.

Percent lint yield from 2nd and 3rd position bolls. Cotton produces fruit at several positions in a single nodal fruiting branch. In our study, we found the maximum to be a 4th position on a fruiting branch arising from a mainstem node, but most of the plants produced 2nd and 3rd position fruits. This is a strategy of plants to compensate their yield loss due to limiting factors. The results showed that percent lint yield from 2nd and 3rd position bolls contributed about 15% of the total yield, but a slightly higher value was observed in treatment 3PP (20%) which is not significantly different from the other treatments. This result leads us to conclude that a *Lygus* infestation did not have any effect in evoking more secondary fruiting positions and so the yield compensation. About 85% of the total yield came from first fruiting positions and yield losses due to *Lygus* were mainly a result of the loss of first position harvestable bolls per plant.

Early-Bloom *Lygus* Release Test

Percent fruit loss. In 2005, final fruit shed monitoring and spray application were deployed one week after the third release that resulted in 10, 24, 26, 36% fruit loss in SC, NC, 1PP and 3PP treatments, respectively (Fig. 5). In 2006, SC, NC, 1PP, and 3PP treatments had 15, 28, 32, 35% fruit loss one week after the third release when a spray application was applied to remove plant bugs from all test plots. As stated earlier, mid-summer in 2006 was hot and dry, resulting in 15% fruit shed in SC plots as opposed to 10% fruit loss in SC plots in 2005.

Harvestable bolls. Number of harvestable bolls per plant was similar across treatments in both 2005 and 2006 (Fig. 6). However, numerically there were 2.2 fewer bolls in 3PP compared with that in SC plots in 2005 although the differences were not statistically different. These data indicate that plants were able to either partially or fully compensate the fruit loss caused by bug augmentation treatments in the early bloom stage.

Lint yield. Lint yields from the *Lygus* early-bloom experiment showed identical trends between the two years, with bug-augmented treatments (3PP in 2005 and 1PP & 3PP in 2006) resulting in lower yields compared with control treatments (Fig. 7). An 85 lb/acre difference in control versus bug-augmented treatments in 2006 was not statistically significant. However, the 2.2 boll deficit in 3PP compared with that in SC in 2005 (Fig. 6) is reflected in a 127 lb/acre deficit in total yield in the 3PP treatment which was significant (Fig. 7). These data show that the plant was unable to fully compensate the 127 lbs/acre lint loss due to insect-induced fruit loss when 3 *Lygus* bugs per plant were introduced during the first three weeks of flowering. Further examining the lint yield by fruiting positions, the yield contribution of first position bolls in SC treatment was about 73% whereas the first position contribution in 3PP and 1PP treatments were 59 and 69%, respectively. Therefore, it is evident from this observation that there existed much higher contributions of 2nd and 3rd position bolls in total lint yield in insect-augmented treatments compared with that in the SC treatment. This result also leads to another question regarding contribution of first position boll with respect to time of *Lygus* infestation. At what stage can a cotton plant produce more secondary position bolls under bug pressure? As we have seen in the pre-bloom *Lygus* release experiment, all treatments had more than an 80% contribution from first position bolls towards total lint yield (Fig. 3). In the early-bloom release, the contribution of first position bolls to total lint yield ranged from 79 (SC) to 59% (3PP) (Fig. 7).

Lint yield from 2nd and 3rd position bolls. The contribution of 2nd and 3rd position bolls towards total lint yield ranged from 40% in 3PP to 27% in SC in 2005, whereas it ranged from 10% in 3PP to 7% in SC in 2006. These data clearly indicate that the 2006 season was environmentally very harsh for the growth and development of lateral branches and second/third fruiting nodes. Nevertheless, it is apparent that the compensatory fruit production in 3PP was through horizontal contribution by as much as 13% in 2005 and 3% in 2006. In 2005, 13% over-compensation was not sufficient to fully compensate the total insect-induced fruit loss in this treatment. In 2006, plants were perceived to have the loss fully compensated while in fact the environmental stress did not allow plants to realize the full yield potential. As speculated in the *Pre-bloom study* above, we suspect that the compensatory response could have been different in the 2006 *Early-bloom study* had the 2006 summer been not so abnormally hot and dry. For example, percent fruit loss was about 15% the fourth week into bloom in SC plots with 28, 32, and 35%, respectively, in NC, 1PP and 3PP plots (Fig. 8), but the pre-harvest fruit loss in SC plots increased to 29% while the pre-harvest fruit loss in NC, 1PP, and 3PP were similar to their respective in-season losses (Fig. 8).

Pre-Bloom Cotton Fleahopper Release Test

Percent fruit loss. This study was conducted in 2006 only. Percent fruit shed in SC plots ranged from 2 to 6% while the shed rates ranged from 4 to 8% in NC plots, indicating a very low level of natural infestation of fleahoppers in our study plots in 2006 (Fig. 9). Fleahopper augmentation caused 13 to 18% fruit loss as a result of three consecutive releases of 1PP while 3PP resulted in 22 to 35% fruit loss (Fig. 9). COTMAN analysis indicated a significant stress with a right shift in the growth curves away from the Target Development Curve resulting in low yield potential (lower apogee at first flower) (Fig. 10). Limited water resources during a period of drought or other stresses can prevent plants with early fruit loss from being able to compensate the loss or can cause plants with heavier fruit loads to shed fruit. We observed this phenomenon in the 2006 *Lygus* studies (discussed above) as well.

Lint yield. Plants were able to fully compensate (Fig. 11) the fruit loss due to fleahopper infestations during the first three weeks of squaring (Fig. 9). Also, there was no nodal position difference in the level of compensation, suggesting plant's response to compensate for the fleahopper induced loss through vertical as well as lateral fruiting positions.

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Table 1. Calendar of field research activities during compensation studies, 2005 and 2006, Lubbock, TX.

Year	Activities	Pre-bloom	Early-bloom
2005	Plant mapping	6, 13, 20, and 27 Jul, 6 Aug	16 and 23 Jul, 2 and 11 Aug
	Insect release (1PP and 3PP)	7, 14, and 21 Jul	16 and 23 July, 3 Aug
	Insecticide spraying (SC)	28 Jun, 5, 22, and 29 Jul	6, 13, 20, and 28 Jul, 4 Aug
2006	Plant mapping	28 Jun, 5, 13, and 22 Jul	20 and 27 Jul, 7 and 14 Aug
	Insect release (1PP and 3PP)	29 Jun, 6 and 13 Jul	24 Jul, 1 and 7 Aug
	Insecticide spraying	23 Jun, 3, 7, and 23 Jul	27 and 31 Jun, 7 and 16 Jul

Table 2. Fruit retention and loss in each nodal position after three releases of *Lygus* bugs, 2006, Lubbock, TX.

		Treatment	All positions	First position	Second position	Third position
Pre-bloom study: 2006	Fruit intact	SC	12.30a	7.62a (61.9)	4.20a (34.1)	0.45a (3.6)
		NC	12.75a	6.62a (51.92)	4.65a (36.47)	0.47a (3.6)
		1PP	9.97b	6.40b (64.19)	2.85b (28.6)	0.72a (7.2)
		3PP	8.02b	5.32c (66.33)	2.35b (29.3)	0.35a (4.3)
	Fruit loss	SC	0.7c (5.3)	0.57c (4.4)	0.1b (0.8)	0.02a (0.1)
		NC	0.8c (6.0)	0.67c (5.0)	0.12b (1.0)	0a (0.0)
		1PP	2.42b (19.5)	1.37b (11.0)	1.02a (8.0)	0.02a (0.5)
		3PP	3.52a (30.6)	2.35a (20.4)	1.07a (9.3)	0.1a (0.9)
Early-bloom study: 2006	Fruit intact	SC	13.02a	8.55 a (65.6)	2.97a (22.81)	1.20a (9.0)
		NC	11.10a	7.32 ab (65.94)	3.07a (27.65)	0.57a (5.1)
		1PP	9.52a	7.25 ab (76.15)	1.90a (19.9)	0.37a (3.8)
		3PP	10.52a	6.82b (64.82)	2.85a (27.1)	0.80a (7.6)
	Fruit loss	SC	2.17b (14.92)	0.80b (5.2)	1.1a (7.2)	0.22a (1.4)
		NC	4.3a (28.26)	2.17a (14.1)	1.82a (11.8)	0.30a (1.9)
		1PP	4.4a (31.58)	2.45a (17.3)	1.85a (13.1)	0.12a (0.8)
		3PP	5.07a (34.27)	2.87a (18.4)	1.67a (10.7)	0.45a (2.8)

Values in parentheses are percentage contribution by each nodal position (fruit intact) and percentage fruit loss (fruit loss). Values within columns within each plant parameter (pre- or early bloom) study followed by different letters are significantly different (P<0.10).

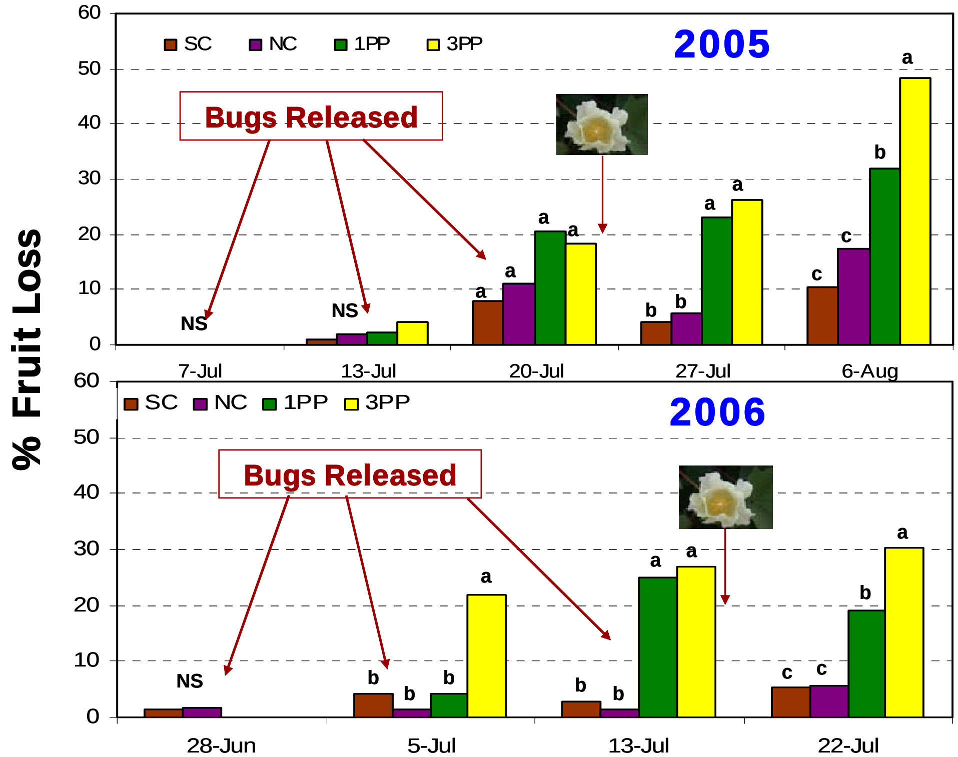


Figure 1. Percent fruit loss in cotton plots receiving various levels of *Lygus* bug releases during the pre-bloom fruiting period, Lubbock, TX, 2005 (upper panel) and 2006 (lower panel). Bars within a year and sampling date with different letters are statistically different (P <0.10); NS = no statistical differences.

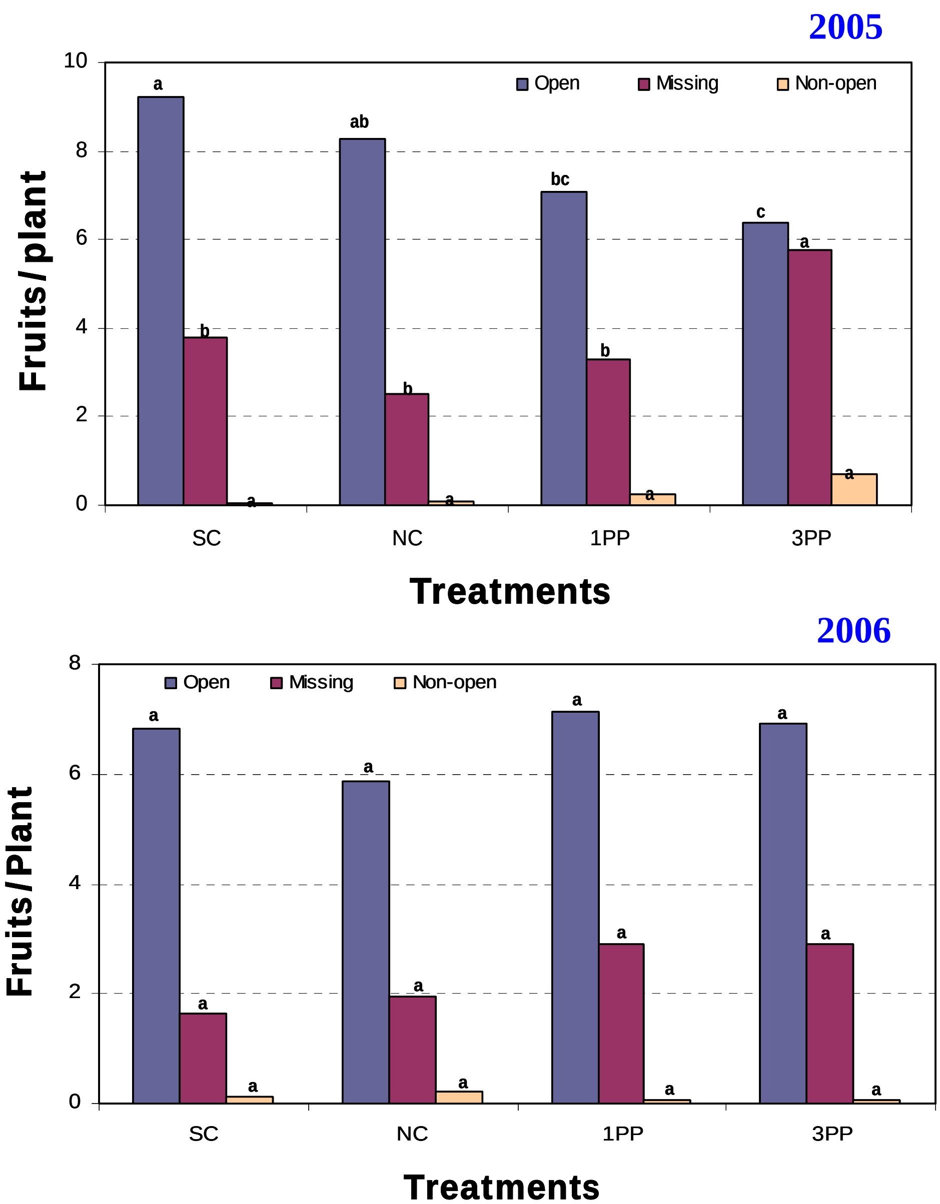


Figure 2. Average number of harvestable bolls, missing fruits, and non-harvestable, green bolls/plant in cotton plots receiving various levels of *Lygus* bug releases during the pre-bloom fruiting period. Lubbock, TX, 2005 (upper panel) and 2006 (lower panel). Bars within a fruit type (open, missing, or non-open) and study year with different letters above bars are statistically different ($P<0.10$).

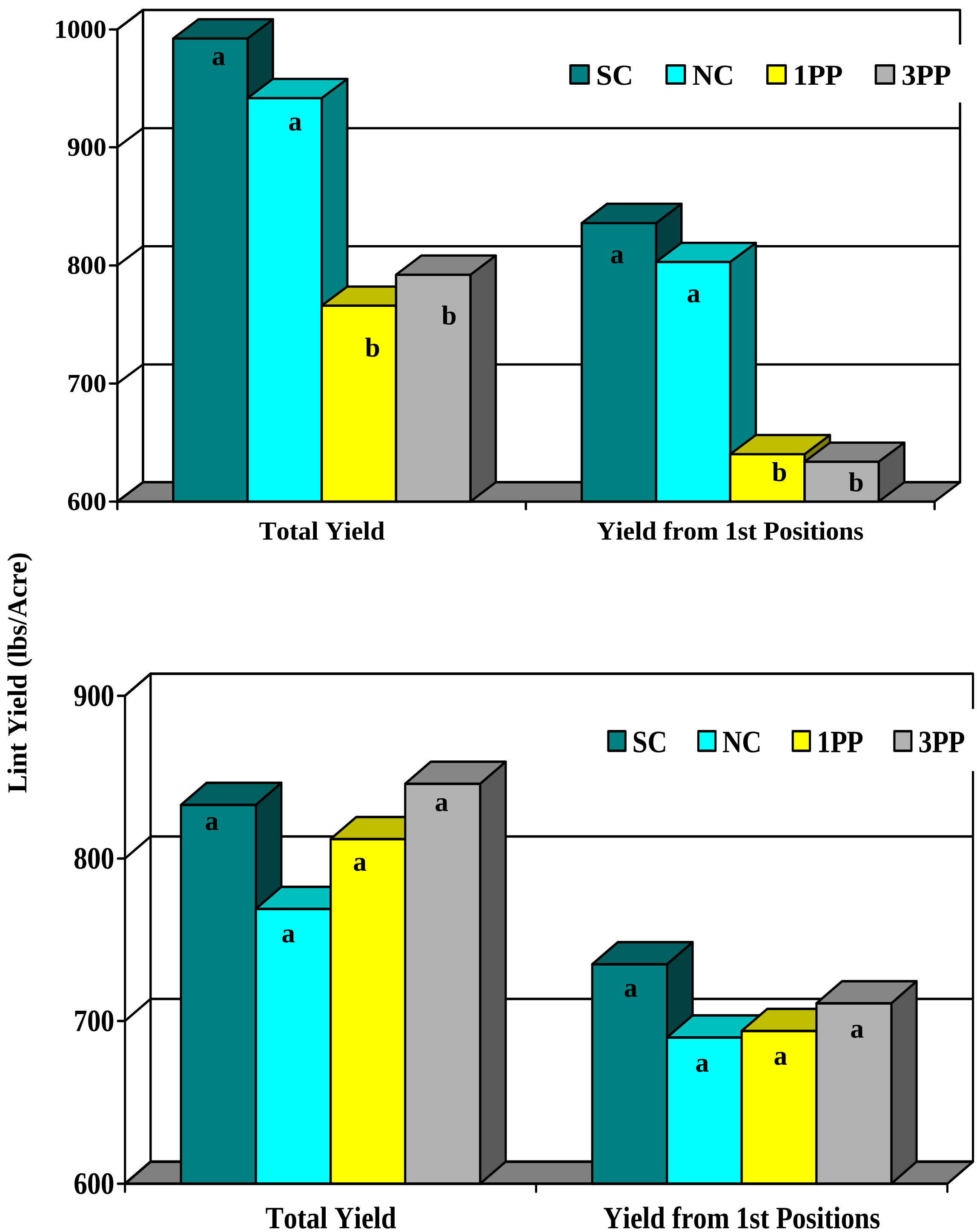


Figure 3. Total lint yield and yield from 1st-position bolls in cotton plots receiving various levels of *Lygus* bug releases during the pre-bloom fruiting period in 2005 (upper panel) and 2006 (lower panel), Lubbock, TX. Bars within a lint source and study year with different letters are statistically different (P<0.10).

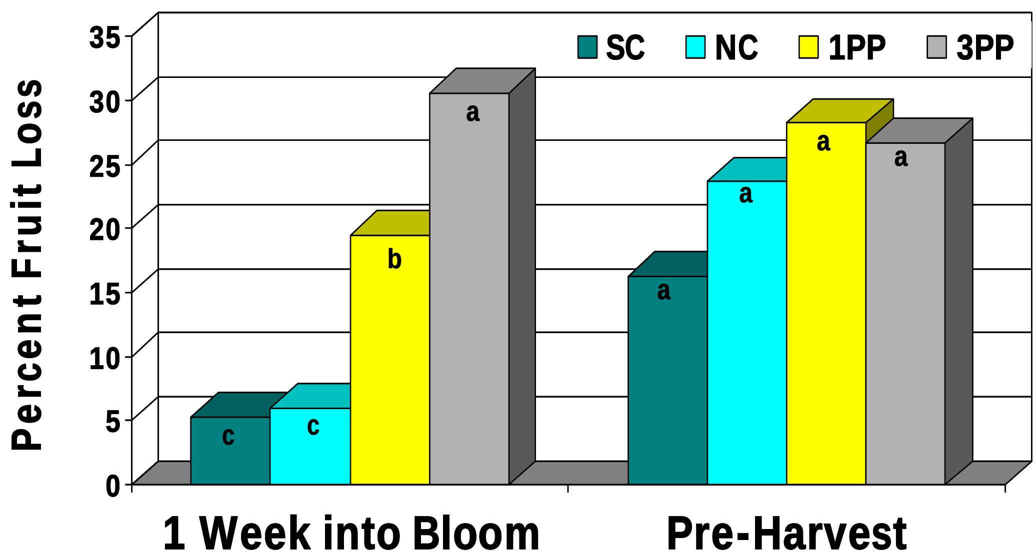


Figure 4. Percent fruit loss during the first week into flowering and at harvest in cotton plots receiving various levels of *Lygus* bug releases during the pre-bloom fruiting period, Lubbock, TX, 2006. Bars within a plant mapping period with different letters are statistically different (P<0.10).

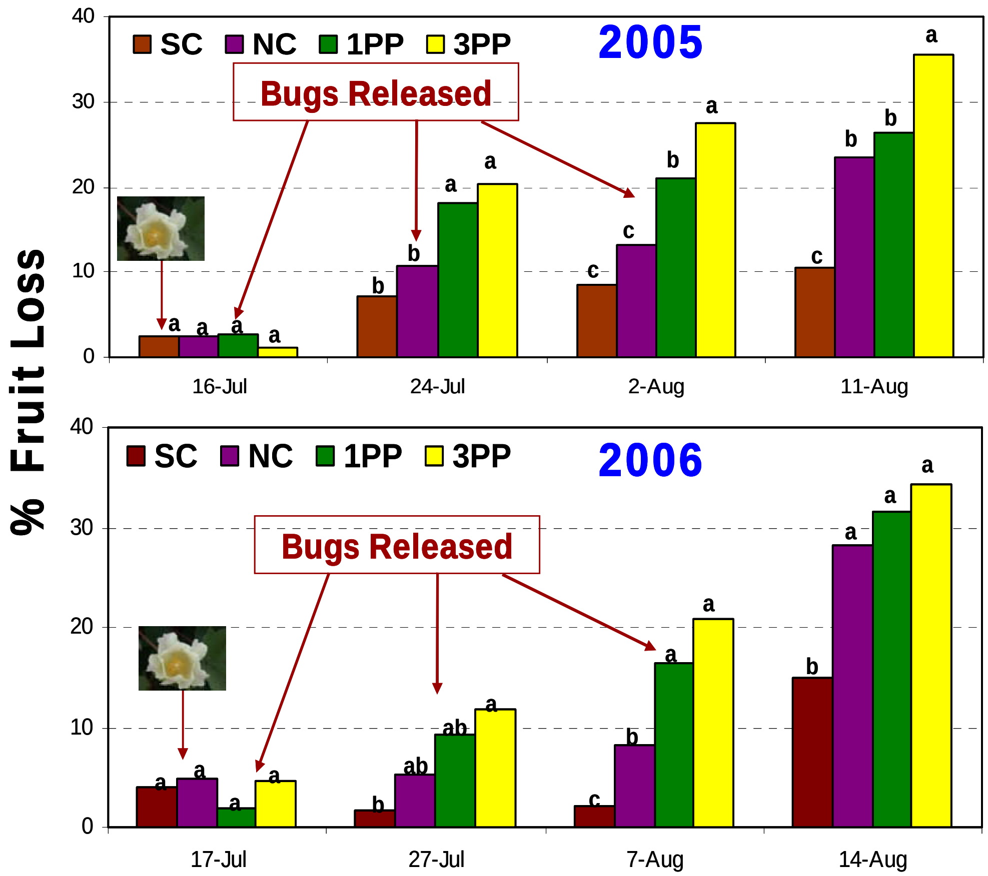


Figure 5. Percent fruit loss in cotton plots treated with various levels of *Lygus* bug releases during the early-bloom period, Lubbock, TX, 2005 (upper panel) and 2006 (lower panel). Bars within a year and sampling date with different letters above the bars are statistically different (P <0.10).

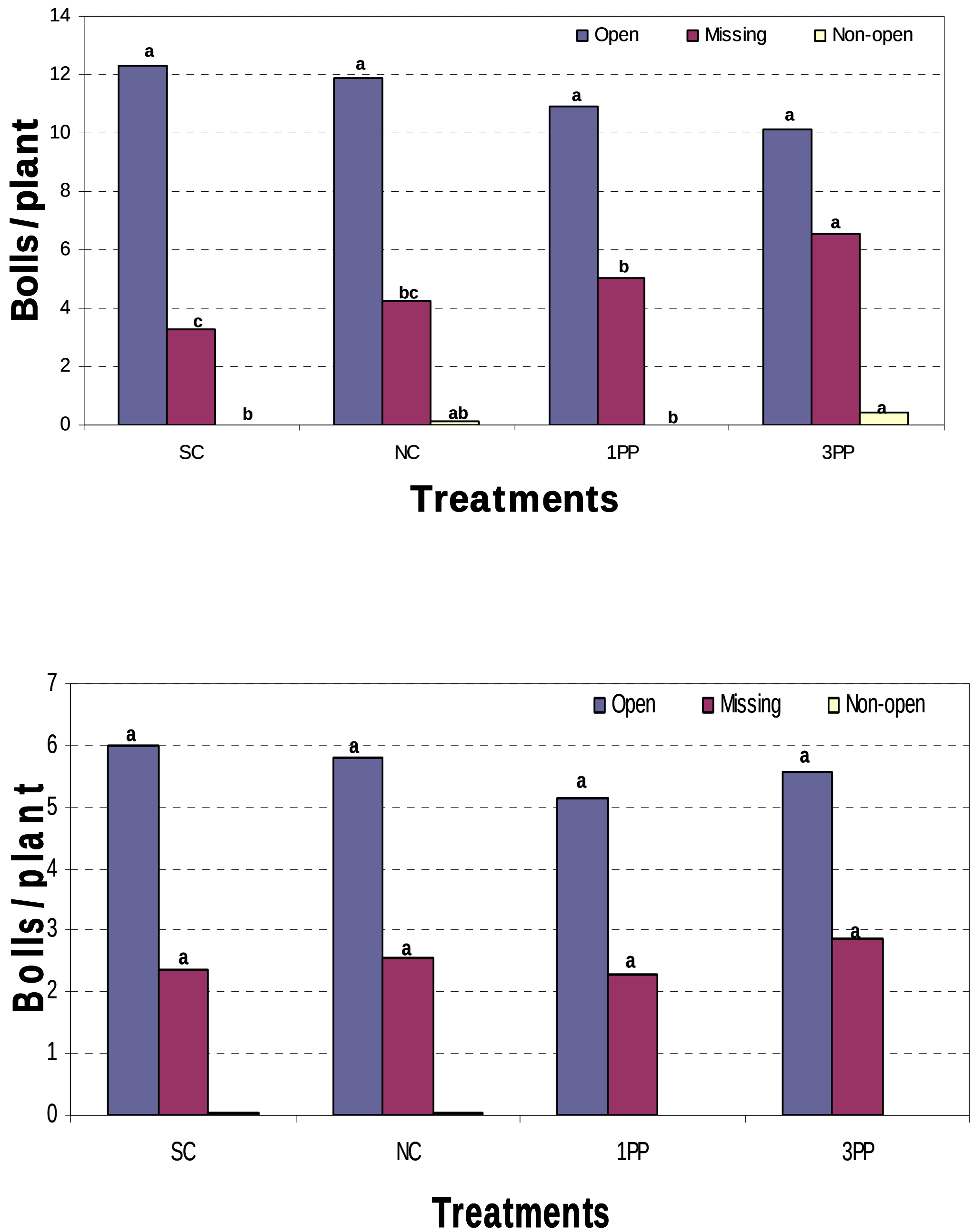
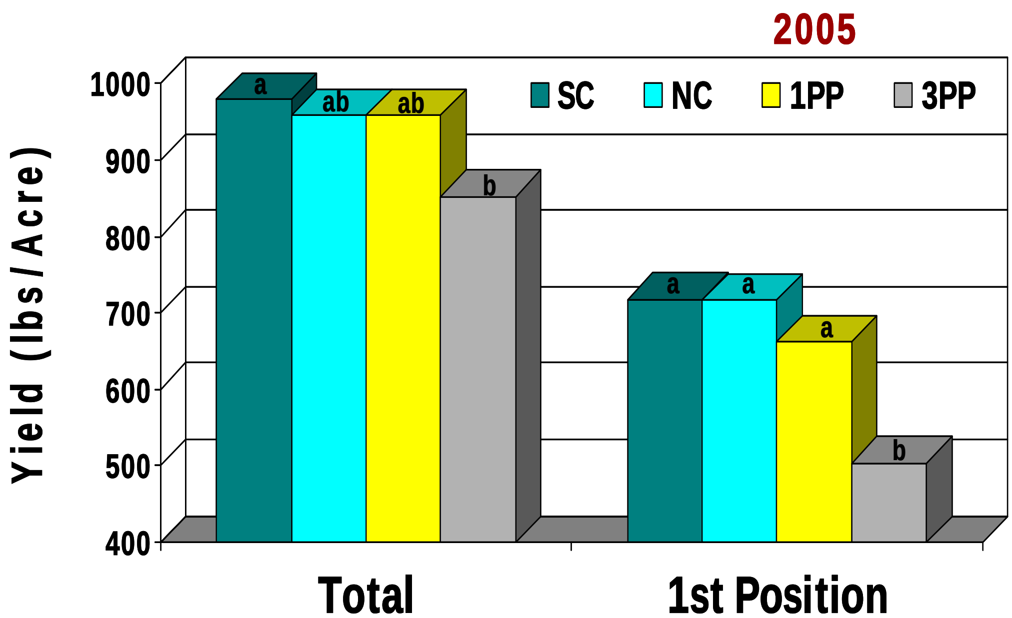


Figure 6. Average number of harvestable bolls, missing fruits, and non-harvestable, green bolls/plant in cotton plots receiving various levels of *Lygus* bug releases during the early bloom fruiting period. Lubbock, TX, 2005 (upper panel) and 2006 (lower panel). Bars within a fruit type (open, missing, or non-open) and study year with different letters above bars are statistically different (P<0.10).



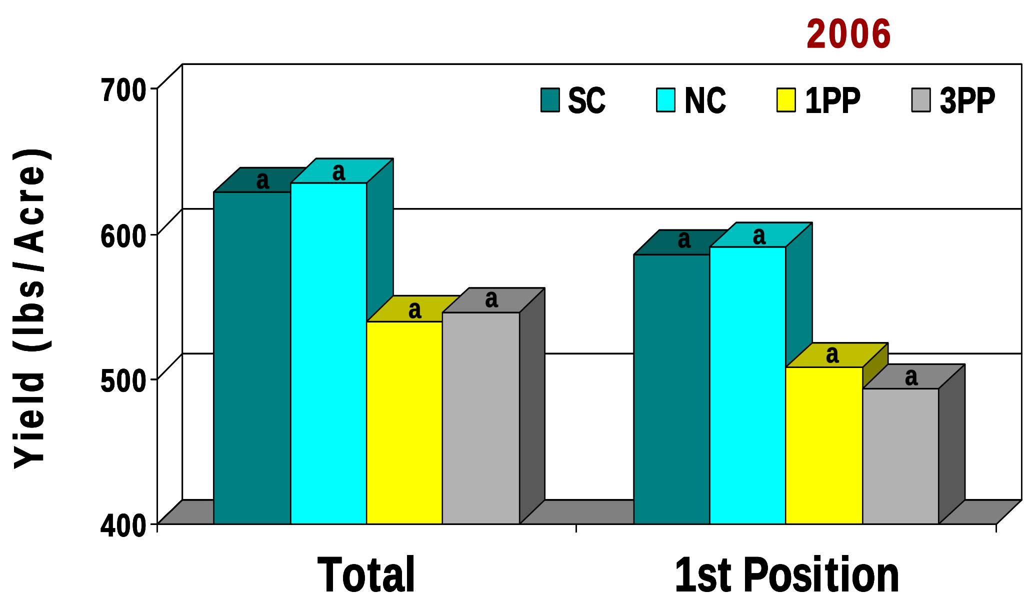


Figure 7. Total lint yield and yield from 1st-position bolls in cotton plots receiving various levels of *Lygus* bug releases during the early-bloom fruiting period, Lubbock, TX, 2005-2006. Bars within a lint source and study year with different letters are statistically different (P<0.10).

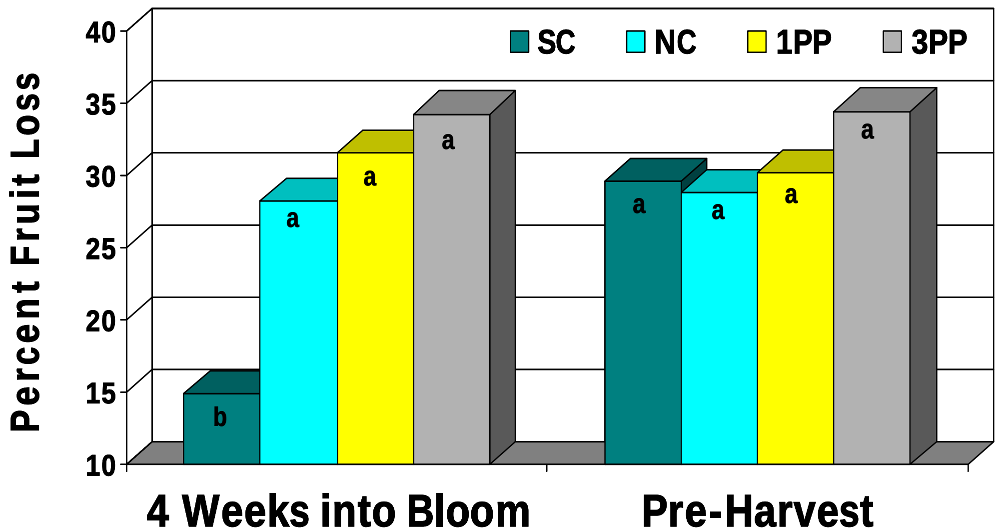


Figure 8. Percent fruit loss four weeks into bloom (after three consecutive releases of bugs in bug treated plots) and the pre-harvest fruit loss profile in cotton plots receiving various levels of *Lygus* bug releases during the early-bloom fruiting period, Lubbock, TX, 2006. Bars within a plant mapping period with different letters are statistically different ($P<0.10$).

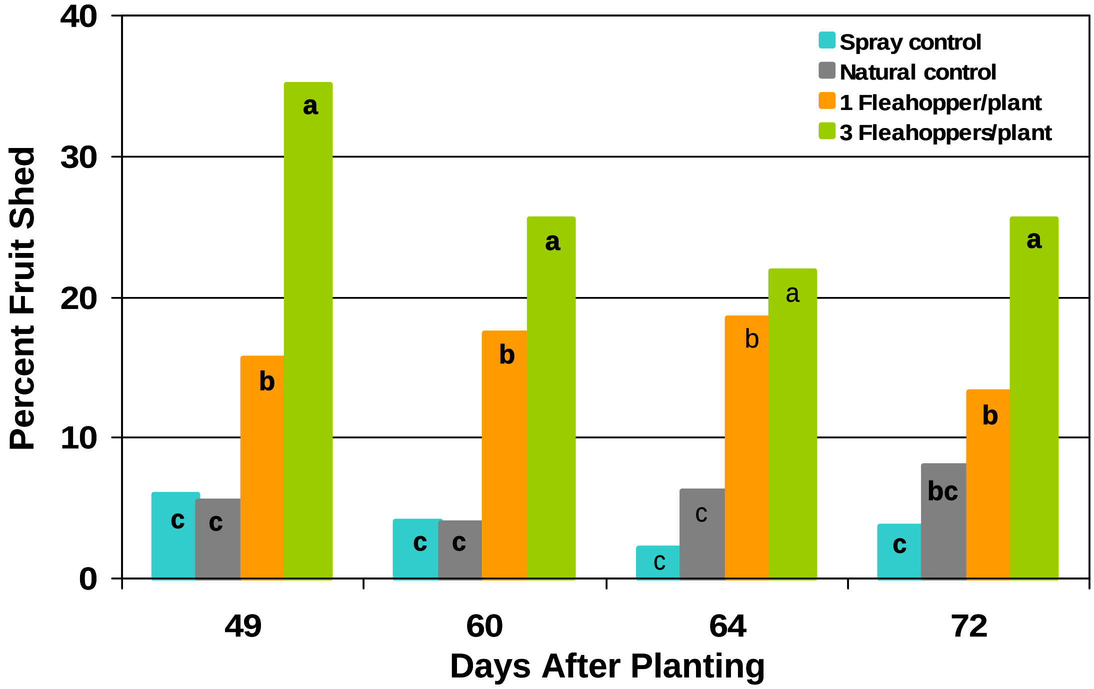


Figure 9. Percent cotton square shed as affected by fleahopper augmentation treatments, Lubbock, TX, 2006. Bars within a sampling date with different letters are statistically different (P<0.10).

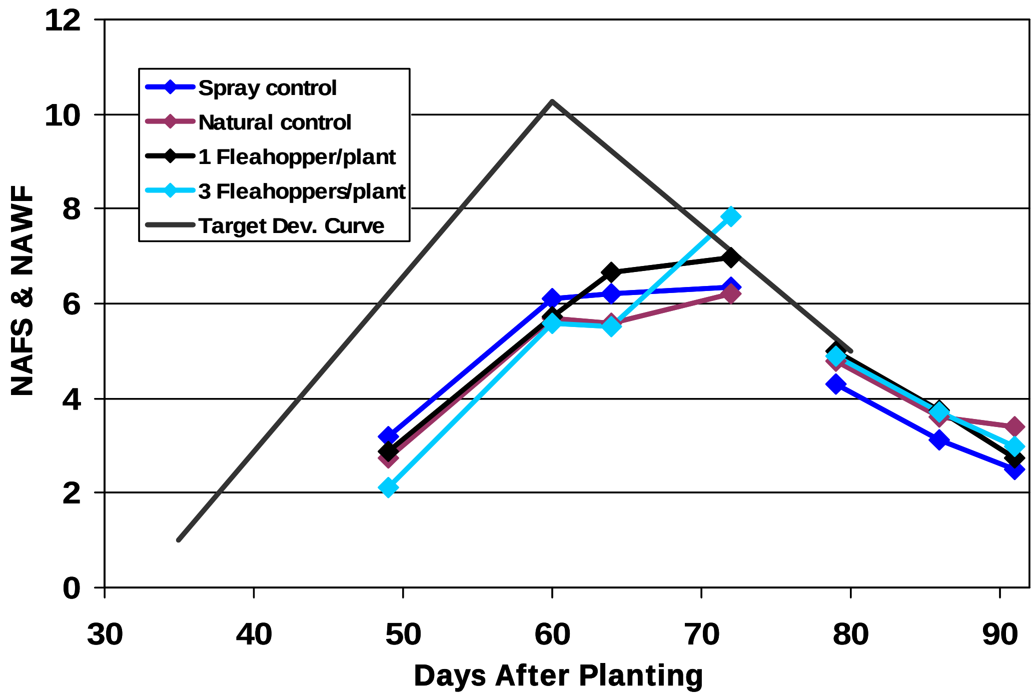


Figure 10. Nodes above first square (NAFS) and nodes above white flower (NAWF) as affected by fleahopper augmentation treatments, Lubbock, TX, 2006.

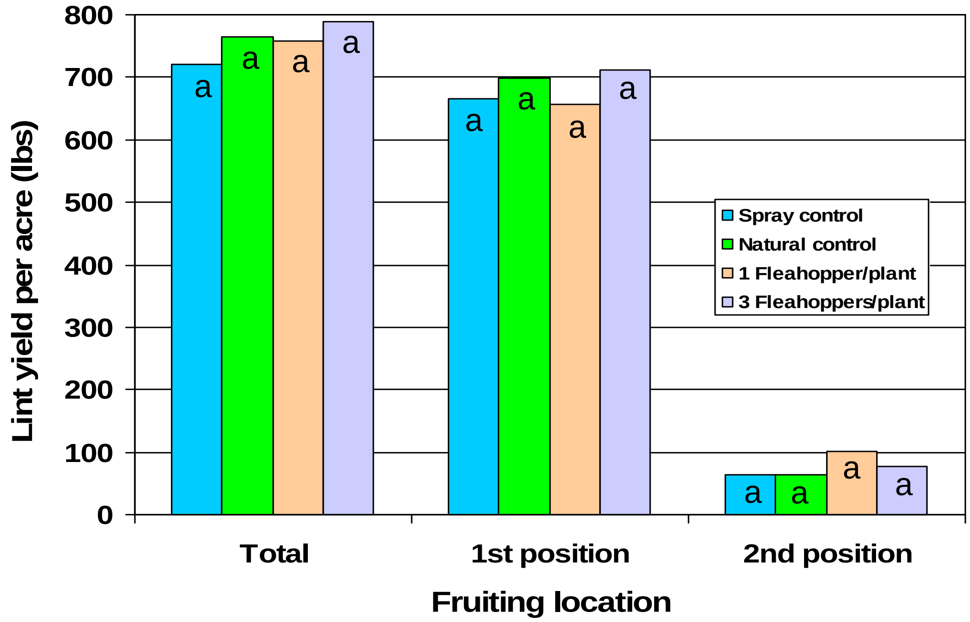


Figure 11. Final cotton lint yields (by fruiting position) as affected by fleahopper augmentation treatments, Lubbock, TX, 2006. Bars within a lint source with different letters are statistically different (P<0.10).