# INSECTICIDE TERMINATION RULE FOR WESTERN TARNISHED PLANT BUG IN THE TEXAS HIGH PLAINS

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## Abstract

*Lygus* is a cotton pest of increasing importance in the Texas High Plains region. *Lygus* adults and nymphs feed upon cotton flowers and fruit, which often results in fruit abortion, lower quality lint, and reduced yields. This study temporally ascertains and describes boll damage while comparing the damage potentials of *Lygus* adults and nymphs across bolls of various ages. Treatments consisted of cohorts of developing bolls at five target heat unit (HU based upon threshold of >60 °F) accumulation levels (150, 250, 350, 450, and 550 HU), and a control cohort. At each target HU, an individual adult or nymph (two separate tests) was released on each boll for 48 hours to feed, after which bolls were assessed. *Lygus* adults and nymphs both inflicted external lesions on bolls throughout boll development. However, *Lygus* generally could not inflict internal damage to bolls that were older than 350 HU under a no-choice field-cage study. Late-instar nymphs caused significantly more damage to maturing bolls than adults. Consequently, nymphs caused 23, 29, and 15% more loss in lint yield, seed weight, and seed counts per boll compared with that of adults. For *Lygus* management in West Texas, insecticide intervention is not necessary after 350 HU have accumulated beyond cut-out. However, under field conditions, *Lygus* may not cause significant damage to bolls beyond 250 HU.

## Introduction

Cotton, *Gossypium hirsutum* L., is a major cash crop in the Texas High Plains (THP) region. *Lygus* is a cotton pest of increasing concern in the region. In the THP, 2008 cotton yield losses due to arthropods were estimated at 3.9%, and among those arthropods, *Lygus* spp. caused more cotton yield loss (1.0%) across the cotton belt of the United States than did any other insect (Williams 2009). *Lygus* insect boll damage potential in the THP during cotton boll maturation phases has, until recently, been largely unknown. Temporal information regarding boll damage potential during boll development may elucidate a new basis upon which to formulate insecticide application strategies, improvements which might increase insecticide application effectiveness, provide better accuracy for application timing, and limit insecticide use in instances where application is genuinely unnecessary. One important question in this study is: At what point, if any, are maturing bolls (or the crop) "safe" from *Lygus* feeding damage, and consequently, is there a milestone during the growing season after which insecticide use is superfluous?

Producers may elect to employ insecticides in managing *Lygus* insects, with the intent of mitigating economic injury. Insecticides are expensive and occasionally produce undesirable ecological impacts. Producers may seek to increase insecticide use efficiency, or to increase effectiveness through knowledgeable application timing, and thus save financially or reduce the total pesticide load. Currently, producers follow guidelines tailored to sampling data and economic threshold levels. Various available sampling methods may be biased, favoring adults versus nymphs and vice-versa (Parajulee et al. 2006). As such, sampling information may be misleading. Because economic thresholds for *Lygus* management typically indicate a number of adults detected per sampling unit or total counts, such thresholds can be misleading with regard to characterization of an existing population. A greater understanding of differences in *Lygus* adult versus nymphal feeding damage potentials might improve establishment and interpretation of economic thresholds obtained via sampling. As such, this study compares *Lygus* adult and nymphal damage potentials across bolls of various ages to temporally ascertain and characterize boll damage.

## Materials and Methods

The study was conducted at the research farm of the Texas AgriLife Research and Extension Center at Lubbock, TX. Cotton cultivar ST 4554 B2RF was planted for this study based upon its good yield potential and fit for THP irrigated cotton situations. The experiment consisted of a randomized complete block design with six treatments and two blocks. Treatments were assigned as follows: Six cohorts, consisting of thirty bolls each, grouped by five temporally distributed cotton boll maturity levels, as indicated by heat unit (HU; based upon a threshold of ≥60 °F) accumulation, and a control group. Each set of thirty bolls represented a cohort of boll subjects with a treatment maturity level and testing component (damage, exocarp puncture force, and lint quality/yield) in common. Since there were three testing components, the total number of bolls per cohort was ninety. Boll HU accumulation levels were 150, 250, 350, 450, and 550 HU, plus the control group. To prepare for the test, a total of 1080 white blooms (6 cohorts x 90 bolls x 2 blocks) were caged securely *in situ* using ventilated polystyrene cup cages. White blooms were caged to preclude damage by other insects. Cages remained until the desired HU accumulation was achieved. HU accumulation was calculated daily from initial caging. At each target HU accumulation level, one adult *Lygus* was placed in each cage for a period of forty-eight hours. Boll injury (external lesions and internal injury spots) and boll growth (boll weight and diameter) were then recorded. An identical experimental setup was used in the same cotton field for nymphal-staged *Lygus*, to allow for damage comparisons between adults and nymphs. In the nymphal test, fourth-instar nymphs were used to infest bolls.

For each cohort, the first set of thirty bolls was collected for external and internal damage evaluation. External damage was evaluated by recording the number of dark, sunken lesions observed on the exocarp. Internal damage was evaluated by dissecting the fruit using a laboratory scalpel, and recording the number of discolored wart formations visible on the exocarp interior wall. The second set of thirty bolls were measured for weight and diameter, then tested for exocarp puncture force/pressure using a penetrometer (a motorized test stand equipped with a digital force gauge). The third set of thirty bolls per cohort (infested bolls) was left on the plants until harvest time. Harvesting was performed by hand. Lint quality and yield were then determined. In the control treatment, thirty bolls were caged at white flowering stage, but were never infested with insects. Only lint quality and yield data were collected for the control cohort. Data were analyzed using analysis of variance (ANOVA) by means of the PROC GLM procedure in SAS 9.2 (SAS Institute 2009). Means were separated by least significant difference (LSD) at $\alpha = 0.10$ level.

## Results and Discussion

A three-year study consistently showed that *Lygus* adults and nymphs could exert significant external injury to bolls throughout boll development, with 75-85% of the bolls externally injured up to 550 HU. However, they were unable to cause significant internal injury to bolls beyond 350 HU (Fig. 1). In contrast with >85% external boll injury, *Lygus* adults were able to inflict internal boll injury to 64, 48, and 23% of bolls at 150, 250, and 350 HU, respectively. Late-instar nymphs caused external injury to >90% of the bolls, and inflicted internal injury to 79, 55, and 34% of bolls at 150, 250, and 350 HU, respectively. These data clearly suggest that *Lygus* late-instar nymphs are more injurious to developing bolls at all susceptible stages.

*Lygus* nymphs also inflicted significantly greater injury (average number of lesions per boll) than adults. Although adults and nymphs were able to externally injure bolls of all ages, the number of external lesions per boll inflicted by nymphs (failed attempts at internal feeding) was significantly higher in bolls having accumulated up to 450 HU versus the number inflicted by adults (Fig. 2). Also, the number of instances of external probing correlated with the number of internal injuries, indicating high nymphal success in feeding attempts. That is, *Lygus* late-instar nymphs are capable of inflicting greater internal damage to maturing bolls than are adults, and this was especially true for 1-2-week old (younger; 150-250 HU) bolls (Jubb and Carruth 1971). It may be that rapid late-instar nymphal development creates a greater demand for food, or that some fitness change occurs as nymphs transition to adulthood.

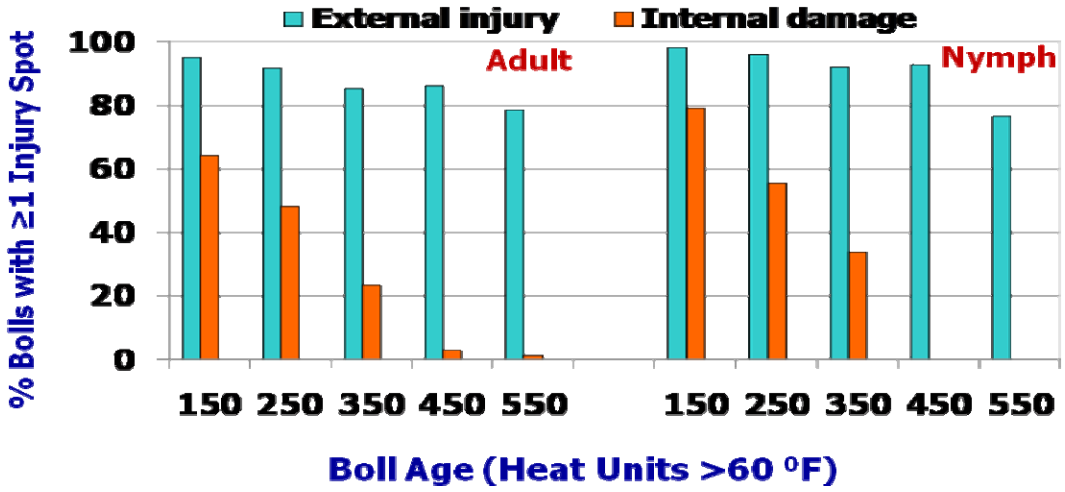


Figure 1. Average (+SE) percentage of bolls in a cohort with 1 or more external lesions or internal damage per boll exerted by an adult or fourth-instar *Lygus hesperus*, 2008-2010.

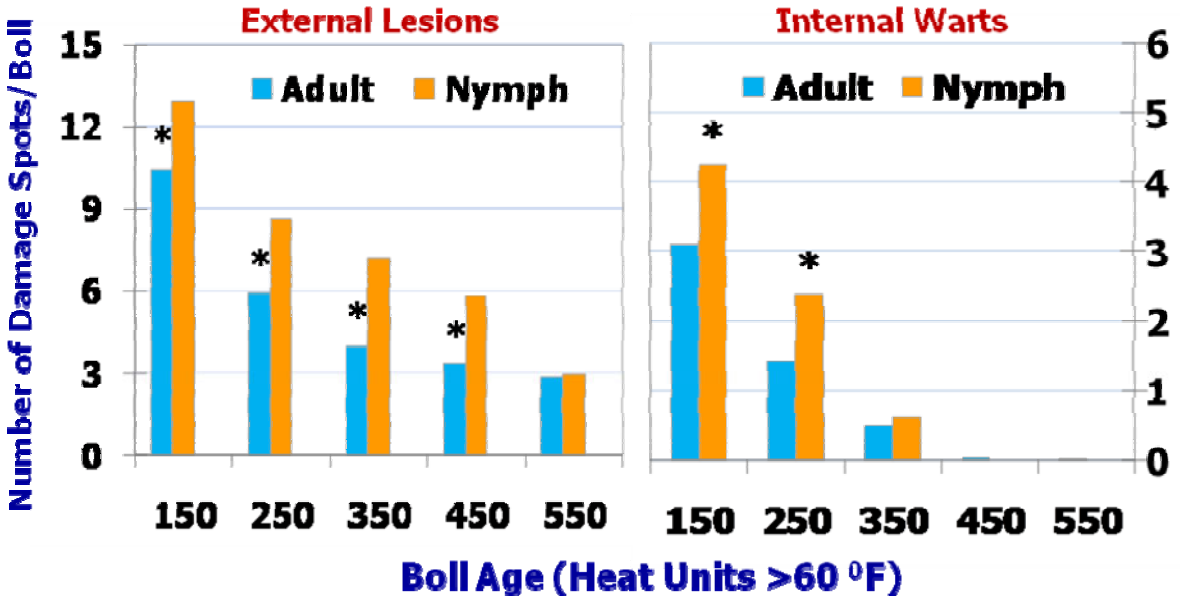


Figure 2. Average number of external lesions and internal damage spots per boll exerted by a single *Lygus hesperus* adult or nymph in 48 h, 2008-2010.

Boll size increased sharply from 150 to 350 HU, nearly doubling, and remained constant thereafter (Fig. 3). As expected, boll weight also increased sharply from 150 to 350 HU, then either slightly decreased or stabilized through the remainder of boll development (Fig. 3). Thus, the 350 HU accumulation level for bolls appears to be a physiologically important phase in boll development (Oosterhuis and Kim 2004), wherein the capability of *Lygus* in inflicting internal damage diminishes and disappears. The penetrometer study showed that *Lygus* were unable to exert significant internal injury to bolls once >0.72 lb./ft$^2$ pressure became necessary to penetrate the exocarp (Fig. 4), a pressure level corresponding to the boll age of approximately 350 HU.

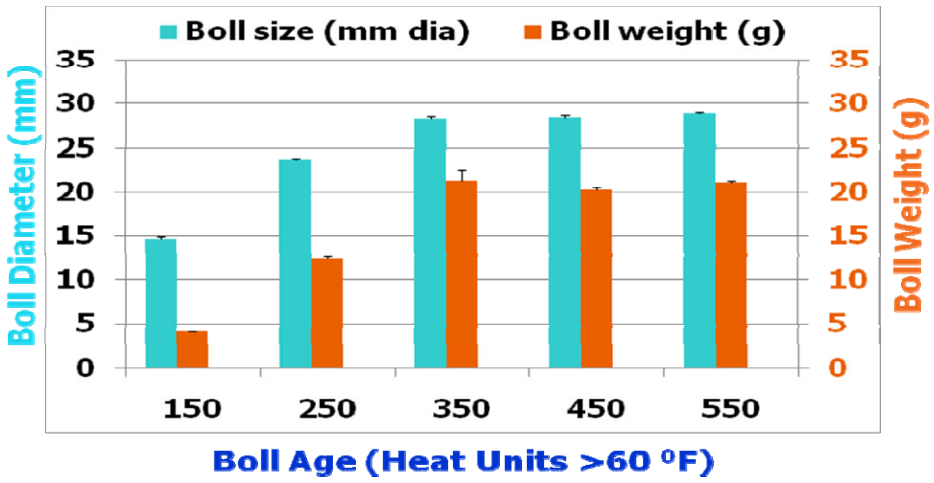


Figure 3. Average boll diameter (mm) and boll weight (g) in relation to boll age (HU), 2007-2010.

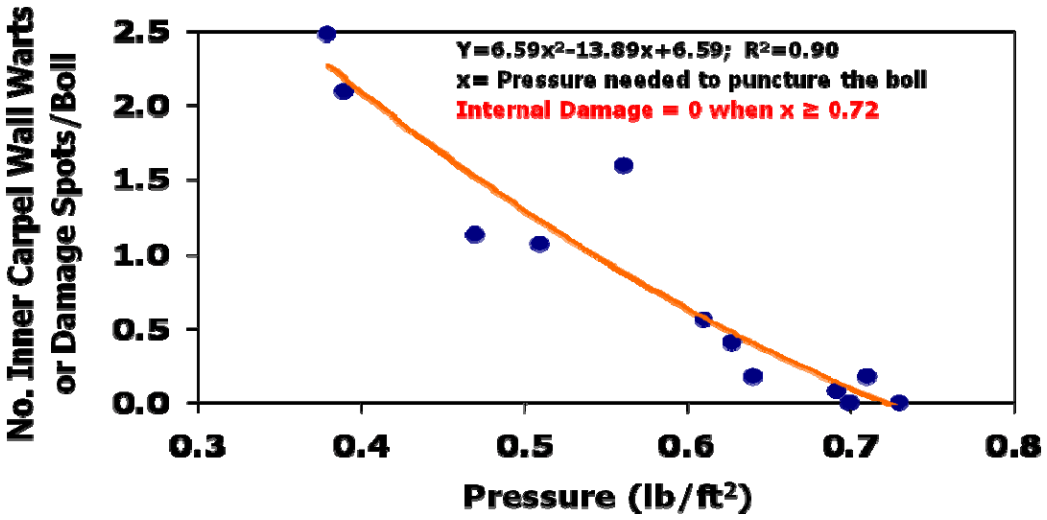


Figure 4. Relationship between number of inner carpel wall damage spots per boll caused by adult *Lygus hesperus* and the amount of pressure required to penetrate the carpel wall using a penetrometer, 2007-2009.

As expected from internal injury data, adult *Lygus* infestation did not significantly reduce lint yield beyond 250 accumulated heat units (Fig. 5). Nymphs were able to reduce lint yield at 350 HU (Fig. 5). Lint weight (g per boll) of adult- and nymph-infested bolls increased with boll maturation (Fig. 5). Actual boll weights for susceptible bolls were 1.99, 2.33, and 2.46 g/boll in adult-infested bolls and 1.77, 2.34, and 2.48 g/boll in nymph-infested bolls at 150, 250, and 350 HU, respectively (Fig. 5). Using control cohort lint yield data as a baseline for calculation, adults reduced 23, 9, and 4% lint yield in 150, 250, and 350 HU cohorts. Nymphs impacted lint yield more so than did adults, inflicting 37, 16, and 11% reductions in lint yield at 150, 250, and 350 HU, respectively. It may be that a brief period of intense feeding by late-instar nymphs might have produced such damage, while less-intense adult feeding produced less damage. Nonetheless, once the experimental bolls accumulated 350 HU, yield appeared to stabilize, and was then consistently observed at ~2.5-2.8 g lint/boll (Fig. 5).

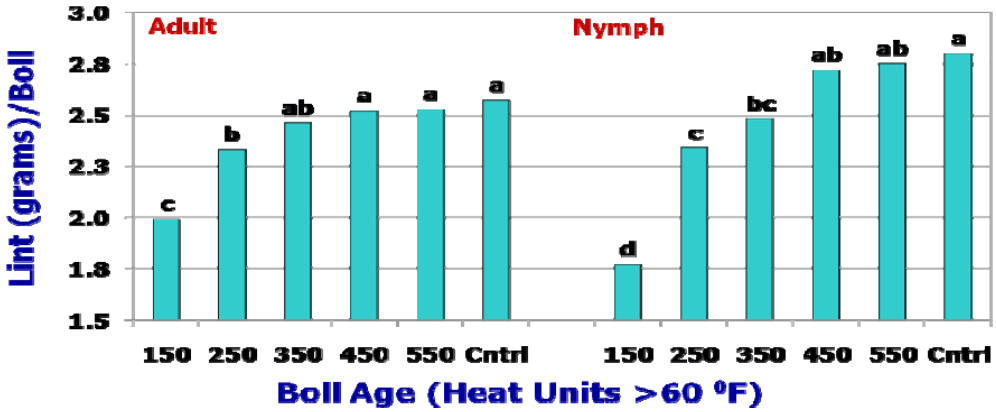


Figure 5. Comparison of lint yield as affected by *L. hesperus* adult and nymphal damage of caged boll cohorts, 2008-2010.

While 350 HU appears to be the point at which factors such as exocarp thickness and hardness result in bolls becoming "safe" from internal damage due to *Lygus* feeding, important considerations affect this conclusion. For example, under THP conditions, cotton plants can compensate for 20-25% of pre-bloom *Lygus*-induced fruit losses in terms of yield, although a penalty is incurred in terms of lint maturity and thus quality (Parajulee et al. 2008). It is unclear precisely what level, if any, of compensation occurs during the post-blooming period. However, newer fruits set by plants in compensation for early fruit loss may take a longer period of time beyond physiological cutout to mature than those set earlier, thus, early compensation can affect boll maturation.

## Acknowledgements

Cotton Incorporated/Texas State Support Program and Plains Cotton Growers, Inc. provided funding for this study. Kamala Adhikari, Swagat Parajulee, Poma GT, Diwash Neupane, and Owen McSpadden provided the technical support.

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