LYGUS HESPERUS FEEDING ON MATURING COTTON BOLLS: ADULTS VERSUS NYMPHS

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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 potential 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 and nymph was released on each boll for 48 hours to feed, after which bolls were assessed. Approximately 100% of bolls incurred external lesions while 60% incurred internal lesions at 150 HU, while internal damage was virtually undetectable after 350 HU. This study revealed that *Lygus* late-instar nymphs are capable of causing greater damage to maturing bolls than are adults. This was especially true for bolls aged 150 HU (approximately one week). Feeding by *Lygus* adults and nymphs produces external lesions on bolls throughout boll development. *Lygus* bugs were unable to exert significant internal injury to the bolls when bolls required >0.69 lb/ft^2 pressure to penetrate the exocarp (350 HU). Combining this pressure information with the observed treatment damage assessments suggests that bolls are safe from damage once the exocarp achieves the proper thickness, indicating that insecticide use for controlling *Lygus* is unnecessary when bolls exceed an accumulation of 350 HU, typically 2-3 weeks into boll development.

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. *Lygus* bugs damage cotton plants via direct feeding, using its rostrum to pierce tissues of plant parts, typically young squares and bolls, and exploit nutritious juices for sustenance. Feeding by *Lygus* insects can cause fruit abortion and internal boll injury, damaging developing lint, impacting yield, and resulting in economic losses (Godfrey et al. 2009). In the THP, cotton yield losses due to arthropods are estimated at 3.9%, and in 2008, *Lygus* spp. caused more cotton yield losses (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 is largely unknown. Temporal information regarding boll damage potential during boll development may elucidate a new basis upon which to formulate insecticide application strategies, improvements in 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 do maturing bolls (or the crop as a whole) become “safe” from *Lygus* feeding damage, and consequently, when does insecticide use become unnecessary?

Producers may elect to employ insecticides in managing *Lygus* insects, with the intent of mitigating economic injury. Insecticides are expensive and sometime 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. Different sampling methods may be biased, favoring adults versus nymphs and vice-versa (Parajulee et al. 2006). As such, sampling information may be misleading. Since economic thresholds for *Lygus* management typically indicate a number of adults detected per sampling unit or the total counts, such thresholds can be misleading with regard to characterization of an existing population. A greater understanding of differences in the potential damage of feeding by *Lygus* adults versus nymphs might improve establishment and interpretation of economic thresholds obtained via sampling. As such, this study compares the damage potential of *Lygus* adults and nymphs across bolls of various ages to temporally ascertain and describe boll damage.

Materials and Methods

The study was conducted at the research farm of 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 five treatments and two replications. Treatments were assigned as follows: Six cohorts, consisting of thirty bolls each, grouped by five temporally spaced 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 replications) were caged securely *in situ* using ventilated Styrofoam® cups covered with fine-mesh tulle cloth. White blooms were caged to eliminate 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, 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 boll diameter) were then recorded. An identical experimental setup was used in the same cotton field for nymphal-staged *Lygus*, to allow for damage comparisons of adults versus 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 Wagner Instruments Model FDIX Force One Multi-Capacity Digital Force Gauge (with RS232 bi-directional output) mounted to a Mark-10 Model ESM Force Test Measurement Stand and matching control unit, with a 1 mm-diameter force tip. The third set of thirty bolls per cohort was left on the plants until harvesting. Harvesting was performed by hand. Lint quality and yield were then determined. In the control treatment, ninety 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

Lygus adults and nymphs were both able to exert significant external injury (lesions) to bolls throughout boll development. However, *Lygus* (both adults and nymphs) generally did not cause internal damage to bolls that were older than 350 HU (Fig. 1). In fact, beyond an accumulation of 350 HU, internal injury was virtually non-existent (Figs. 1 and 2). Thus, a 350 HU accumulation for bolls appears to be a physiologically important phase in boll development, wherein the capability of *Lygus* in inflicting internal damage diminishes and disappears. This study has revealed, interestingly, that *Lygus* late-instar nymphs are capable of inflicting greater internal damage to maturing bolls than are adults, and this is especially true for 1-week old (younger; 150 HU) bolls (Jubb and Carruth 1971; Fig. 2). It may be that the rapid development of late-instar nymphs creates a greater demand for food, or that some fitness change occurs once nymphs transition to adulthood. It was also observed that tested late-instar nymphs were able to induce greater damage in terms of lint yield than adults, specifically at the 150 HU stage (Fig. 3). Lint yield was decreased by damage caused by *Lygus* adults, although to a lesser extent than was seen from nymphs, at 150 HU and 250 HU (Fig. 3). It may be that a brief period of intense feeding by late-instars might have produced such damage, while adult feeding produced less intense damage over a greater period of time. Nonetheless, once the experimental bolls reached 350 HU, yield appeared to stabilize, and was then consistently observed at ~2 g lint/boll (Fig. 3).

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.

Summary

Lygus adults and nymphs were both able to inflict significant external injury to bolls throughout boll development. However, *Lygus* generally did not cause internal damage to bolls that were older than 350 HU (Fig. 2). Thus, 350 HU appears to be a physiologically important phase in boll development (**Oosterhuis and Kim 2004**). It appears that *Lygus* late-instar nymphs can cause more damage to maturing bolls than adults, especially for one-week old bolls (150 HU bolls; Fig. 2). Correspondingly, the late-instar *Lygus* nymphs caused significantly higher lint yield loss versus adults, particularly for small bolls (150 HU; Fig. 3).

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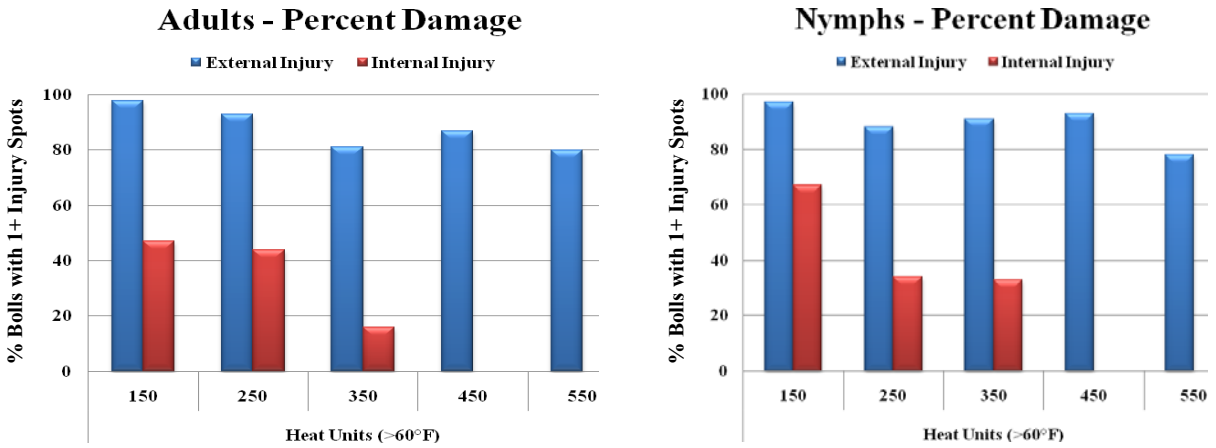

Figure 1. External and internal injury caused by *Lygus* adults and nymphs.

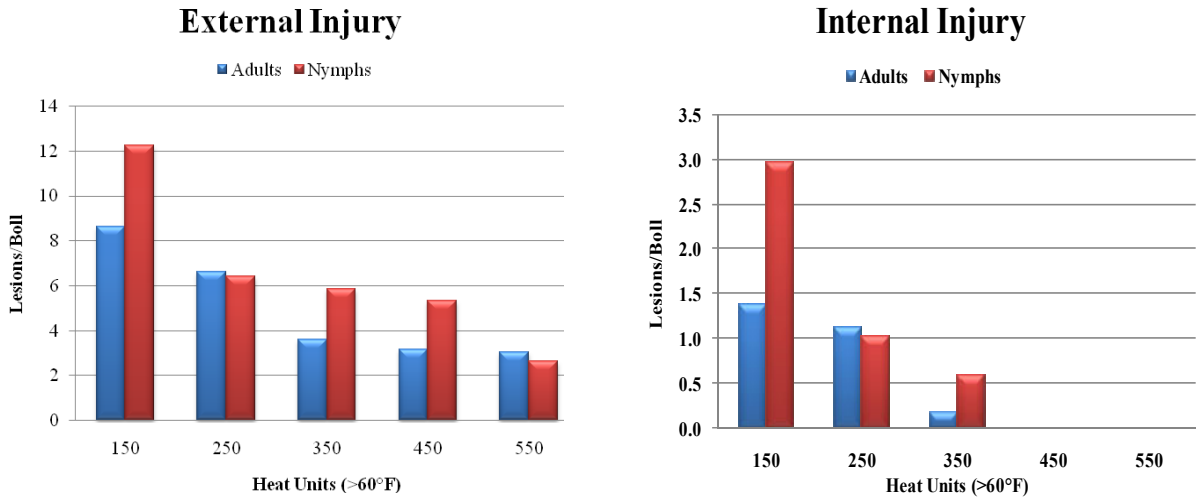

Figure 2. Average number of external and internal lesions.

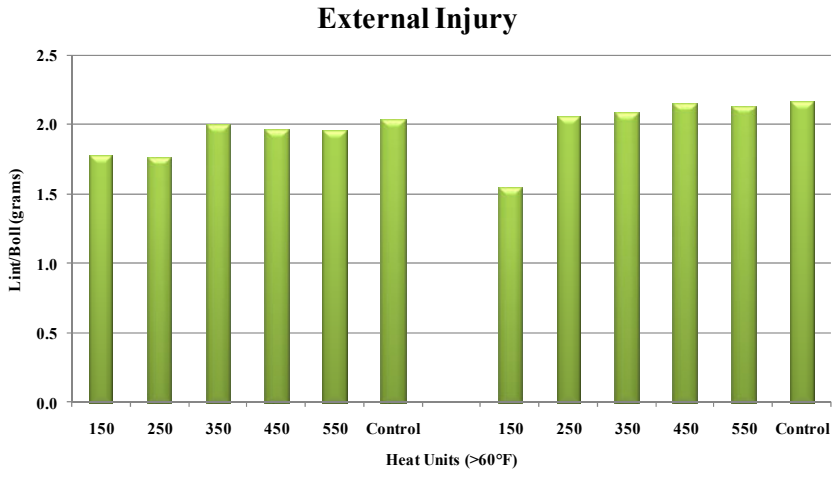

Figure 3. Comparison of lint yield as affected by *Lygus hesperus* adult and nymphal damage of caged boll cohorts.