A COMPARISON OF SAMPLING TECHNIQUES FOR STINK BUGS IN COTTON

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Abstract

Common sampling methods for stink bugs in Georgia cotton were compared in commercial cotton fields ranging from 15 to 25 acres. Seven grower-owned fields, located in Tift and Colquitt counties, were scouted weekly starting when quarter sized soft bolls were available and ending when bolls were too hard to squeeze by hand. At a density of one sampling site per acre in each field, we compared 50 sweeps with a 15-inch sweep net, shaking 12-linear feet of row over a white drop cloth, and dissection of 20 soft bolls. Bolls were collected in plastic bags and brought to the laboratory where they were dissected for symptoms of internal feeding damage including warts, stained lint, and boll rot. Although acquisition of 20 bolls required only 2:05 minutes, subsequent dissection of these bolls required an additional 5 minutes making this the most time intensive sampling method. Fifty sweeps required 1:37 minutes while shaking 12-feet of row on a drop cloth required 1:07 minutes. Although it was more time consuming to process the bolls compared with sweep net or drop cloth samples, boll samples were 10-fold more sensitive at detecting positive hits (boll damage compared with detecting individual insects). The sample variance to mean ratio showed that boll damage and insect presence were aggregated across the fields.

Introduction

Stink bugs are currently regarded as the most important insect pest of cotton production in the Southeastern US. While Bt-transformed cotton cultivars offer good protection from caterpillar pests, these products offer no protection from stink bugs, which cause young bolls to fall off the plant, lint staining, reduced lint quality, and reduced yields. Georgia cotton producers sprayed the average field more than three times in 2005 in an effort to minimize damage from stink bugs. Currently, the University of Georgia Extension recommendations (CES/UGA 2006) are based on splitting bolls from each field to determine when stink bug damage reaches the economic threshold (when it is cost effective to spray). However, crop scouts and consultants don't like to split bolls because they feel this procedure is too time intensive. Consultants report that they rely on simple methodologies such as visual observations and the presence of insects. Studies are needed to demonstrate where stink bug populations are most likely to occur before reaching economically damaging levels, and what specific sampling method(s) should be used to estimate population density.

The scientific basis for implementation of Integrated Pest Management or IPM (Stern et al. 1959) is that pest populations must be monitored during periods of plant susceptibility to make cost effective decisions about pest management. The decision to spray should always be based on a cost/benefit analysis: expected damage attributed to the insect population versus the cost of the insecticide application (Onstad 1987). Grower profits will be marginalized if the sampling plan does not accurately elucidate the true insect population. For example, excessive spraying costs will result when pest estimates exceed the true population density. Likewise, when the pest population is underestimated a producer's profits would be suppressed because the pests inflict more economic damage than predicted.

Development of an effective sampling plan is the single most critical piece of information in the decision making process (Southwood 1978). Pest sampling plans require prior knowledge of the pest's spatial distributions in the field. For example, if the populations are highly aggregated they will require more samples than will be required to classify a normally distributed pest population. Scouts and producers would save time and money if they had an idea where to concentrate their sampling efforts. There is anecdotal evidence that stink bug populations may be more common near the field edge or in fields that border a specific crop like field corn and peanuts. Objectives of this project were to: 1) evaluate stink bug sampling methods including sweep net samples, drop cloth samples, and damage estimates obtained by splitting bolls, and 2) investigate the spatial and temporal relationships of stink bug presence and damage as it relates to field borders, neighboring crops and crop maturity in commercial cotton fields.

Methods

Field Selection. We worked with county extension agents to select seven commercial cotton fields in Tift and Colquitt Counties of southern Georgia. These fields ranged in size from 15 to 25 acres each and were planted with DPL 555 BG/RR cotton. Fields were selected based on representative size and proximity to different bordering crops, which included woods, corn, cotton, peanuts, and pecans. Field shape, cultivation practices, and management regimes were also varied. One field in Tift County was left unsprayed throughout the entire growing year to observe how an infestation typically moves across a field. Growers were provided with Tracer (Dow Agrosciences, Indianapolis, IN) or Denim (Syngenta Crop Protection) insecticide for early season worm control without interfering with stink bug populations. Most fields were planted in mid to late May, but the cotton did not emerge until early June on dryland fields. One field was planted behind wheat and the cotton did not emerge until late June.

Sampling Locations. Field margins were mapped using a handheld GPS receiver (FarmWorks, CTN data Service, Inc) and then a grid was overlaid on each field so that sampling locations would be 1-acre apart. Perimeter sampling locations were located approximately 104 feet from the edge of the field. At each sampling location, a 2-meter tall flag on a fiberglass pole was placed in the ground. The fiberglass poles would yield to farm equipment during the growing season without breaking. Each flag was each marked with a unique number so that technicians could record data specific to that location in each field.

Sampling Procedures. Fields were scouted weekly from the time the plants began setting bolls until acquisition of 20 soft quarter size bolls from a sampling location was not possible. This period generally lasted 6-8 weeks. For technician safety, commercial fields were not scouted for 5 d following insecticide applications.

Herbivorous stink bugs including the southern green stink bug, brown stink bug, and green stink bug were recorded at each site. Additional species were recorded but not analyzed due to low numbers. At each sampling flag, 2-sets of 25 sweeps with a 15-inch sweep net, 2-sets of drop cloth samples (6-linear feet of row on a white sheet), and collection of 20 quarter sized soft bolls were conducted. The insects captured in the sweep nets and shake cloth samples were identified to life stage and species and recorded. Bolls were labeled and brought back to the laboratory for dissection. Internal boll symptoms that were classified as stink bug feeding included warts, stained lint, and boll rot. To reduce bias caused by a specific sampling procedure, each method was executed on a different side of the flag and these assignments rotated by week. For example, sweep net samples were collected on the northern side of the flag, drop cloth samples on the southern side, and boll collection on the eastern side. During wk 2, these locations would be randomized so that bolls were not collected on the same side each week.

The time required to complete each sampling method at three locations in each field was recorded using a stop watch. Additionally, the time required to complete boll dissections was recorded. Data were modeled and analyzed using conventional regression techniques (TableCurve 2D software) and contour maps were created using SigmaPlot (Systat Software Inc.).

At this time we have completed boll dissections on 503 sampling observations (ca. 75% of the samples). Nevertheless, these observations form a robust data set composed of 25,150 sweeps, 6,036 linear feet of drop cloth, and 10, 060 bolls. There were very few stink bugs collected using the sweep net and drop cloth sampling methods; therefore, these captures were summed across species and the results are presented by 50-sweeps and 12-linear feet of row.

Results and Discussion

The time required to complete each sample, percentage of samples showing insect presence or damage, variance to mean ratio, and statistical distribution of damage or insect presence are summarized in Table 1.

Table 1. Comparison of sampling procedures. Asterisks (*) indicate a significant departure from zero ($P < 0.05$).

Sampling method[a]	Minutes per sample	% samples with damage or insect presence	Variance to mean ratio	Statistical distribution
Boll damage (20 bolls)	7:05	87.5%	1.84*	Aggregated
Sweep net (50 sweeps)	1:37	8.1%	6.88*	Aggregated
Drop cloth (12' of row)	1:07	4.5%	4.54*	Aggregated

[a]n = 506 observations per sampling method.

Although acquisition of 20 bolls required only 2:05 minutes, subsequent dissection of these bolls required an additional 5 minutes making this the most time intensive sampling method. Although it was more time consuming to process the bolls compared with sweep net or drop cloth samples, boll samples were 10-fold more sensitive at detecting positive hits (boll damage compared with detecting individual insects). We hypothesize that there are two confounding factors that may explain this discrepancy. First, time of day may have a direct impact on the position of feeding stink bugs on the individual plants. Terrestrial arthropods have developed behavioral adaptations to avoid direct sunlight during the hot portions of the day because preventing desiccation is critical. Therefore, we suspect that fewer individuals may have been present in the upper plant canopy during late morning and afternoons. Second, it is possible that sucking insect pests, other than stink bugs, may have contributed to the observed boll damage. Research is needed to elicit composition of species that may be contributing to warts and stained lint.

Scatter plots of mean damaged bolls (or mean population density) vs. the percentage of sample units from each field with positive hits for damage or insect presence are shown in Figs. 1-3. Each data point on these figures is a composite of all sampling units in that field for a given sampling date. Figures show that sample units with damage increased rapidly with modest increases of boll damage or population density. However, the most striking feature of these plots is the lack of data in the case of sweep nets (Fig. 2) and drop cloths (Fig. 3). There were 25 data points on the boll damage plot, 13 data points on the sweep net plot, and 7 data points on the drop cloth data set. The lack of data points on the latter two figures shows that these sampling methods were much less likely to detect insect presence than using bolls to detect damage. These data suggest that making pest management decisions using methods that rely on detecting the presence of insects (i.e. sweep net or drop cloth) would require many more samples than methods that detect boll damage. Perhaps reducing the number of bolls examined at each sampling location would be a practical compromise to reduce the time to sample.

Using the boll damage data only, we plotted the sample variance against mean damaged bolls per sample (Fig. 4). These data show that variance increased significantly with increasing density. The antilogarithm of the intercept, a factor dependent on the sample unit (Southwood, 1978) was 0.93. Finally, the slope value of the fitted linear equation was 1.33, which indicates that the distribution of the damaged bolls was aggregated.

We utilized spatial mapping to better visualize the distribution of captures or damage in a single field. Data from the unsprayed field in Tift County are presented by date and sampling method in Figs. 5-7. Early in the season on August 3, there was virtually no damage to bolls and no captures of stink bugs. Later in August, all three sampling methods demonstrated an infestation along the northern field margin, which bordered a peanut field. Less intense infestations were also evident near the center of the field, along the western edge (bordered cotton), and in the northeastern corner when using the boll damage sampling method; however, these infestations were not evident with the drop cloth and sweep net sampling methods. Moving later into the season on September 9, additional boll damage was evident along the northern edge and near the field center. However, sampling with drop cloths and sweep nets indicated only minor infestations at one point along the northern edge.

The differences exhibited on the spatial maps between the internal boll damage (Fig. 5) and the captures when using a sweep net (Fig. 6) or drop cloth (Fig. 7) are additional evidence of the sensitively difference among sampling methods. The areas on the boll damage sampling map that do not show up with the remaining sampling methods are the same data points that are missing on Figs. 2-3 when compared to Fig. 1. Additional research is necessary to determine if making spray decisions based on boll damage is prudent. We have not analyzed the data for the effects of neighboring crops and crop maturity. These analyses are pending as are additional data from South Carolina.

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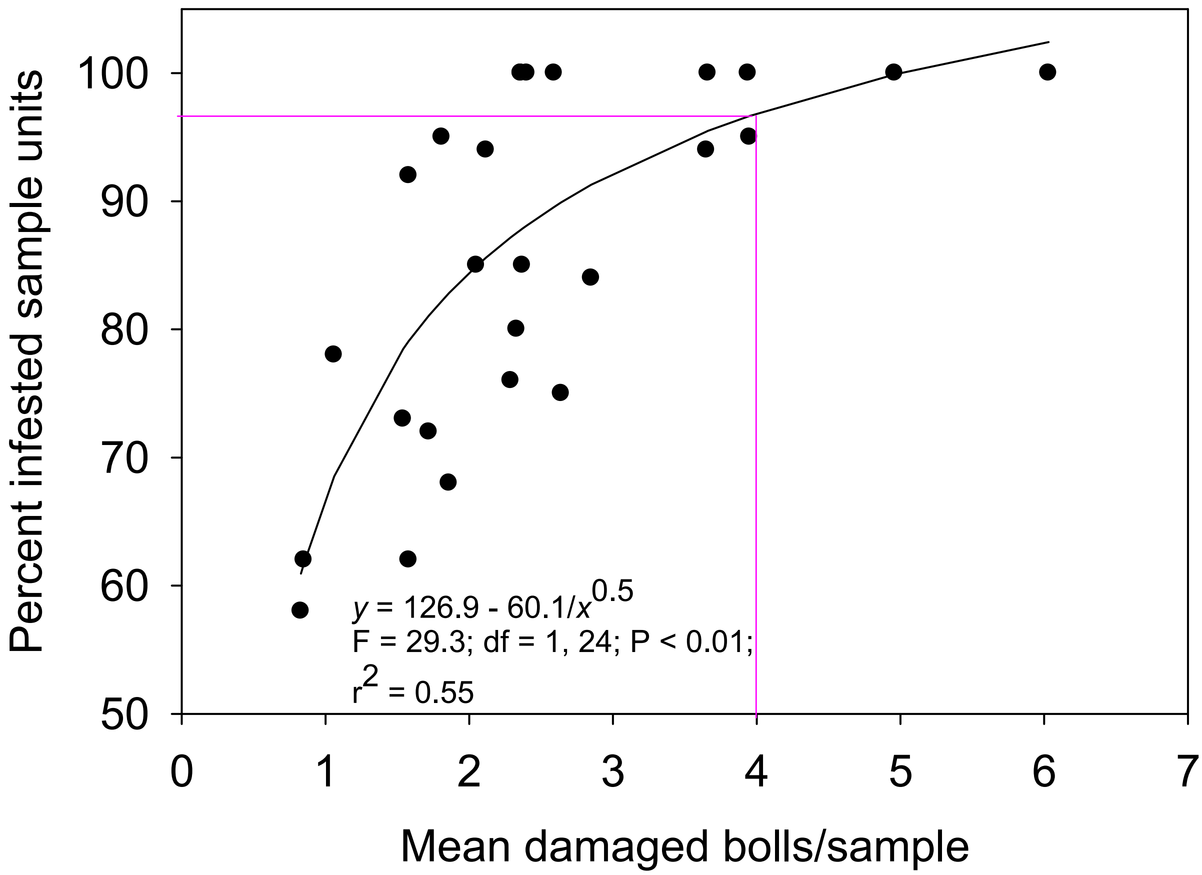


Fig. 1. Nonlinear relationship between percent infested sample units with one or more damaged bolls and the mean number of damaged bolls per sample. The pink drop lines show the current economic threshold (20% damaged bolls), which suggests that at this density approximately 95% of the sample units would exhibit at least one boll with internal damage.

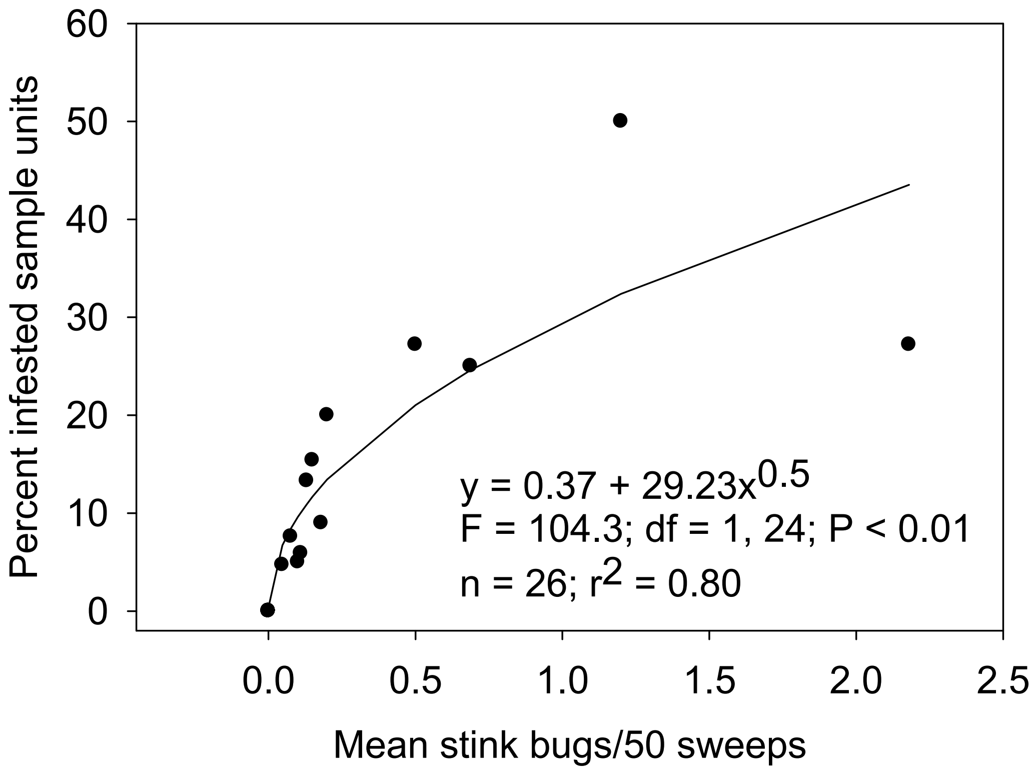


Fig. 2. Nonlinear relationship between percent sample units with one or more insects recovered and the mean number of individuals per sample when using 50 sweeps with a 15-inch sweep net.

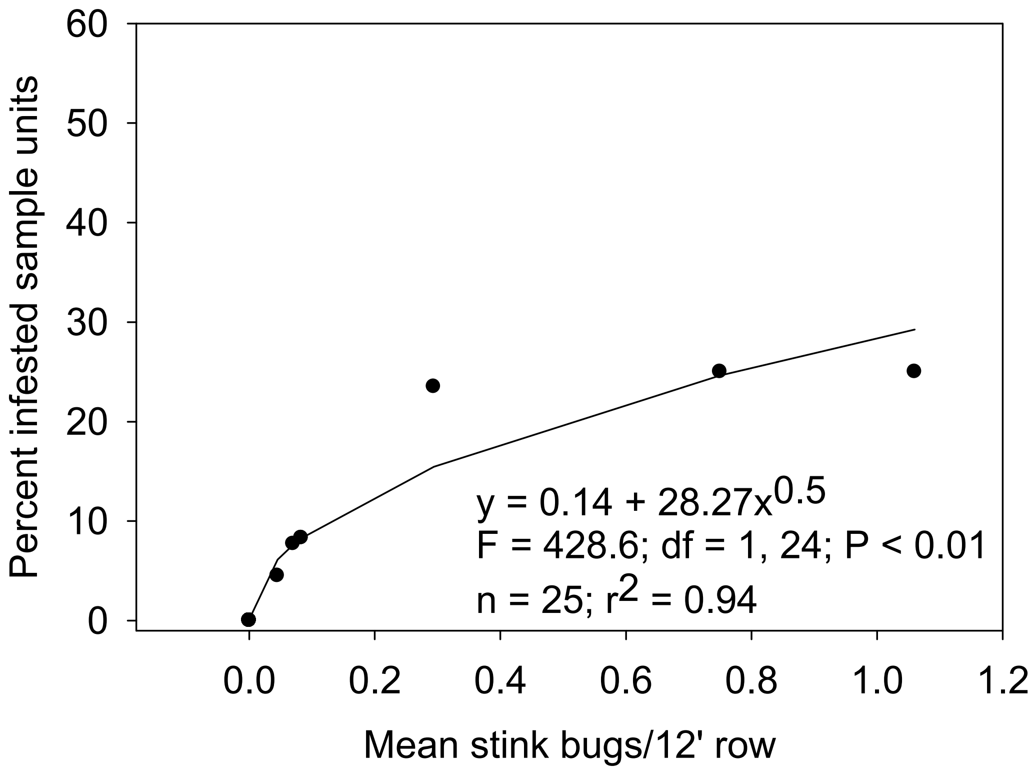


Fig. 3. Nonlinear relationship between percent sample units with one or more insects recovered and the mean number of individuals per sample when sampling 12-linear feet with a drop cloth.

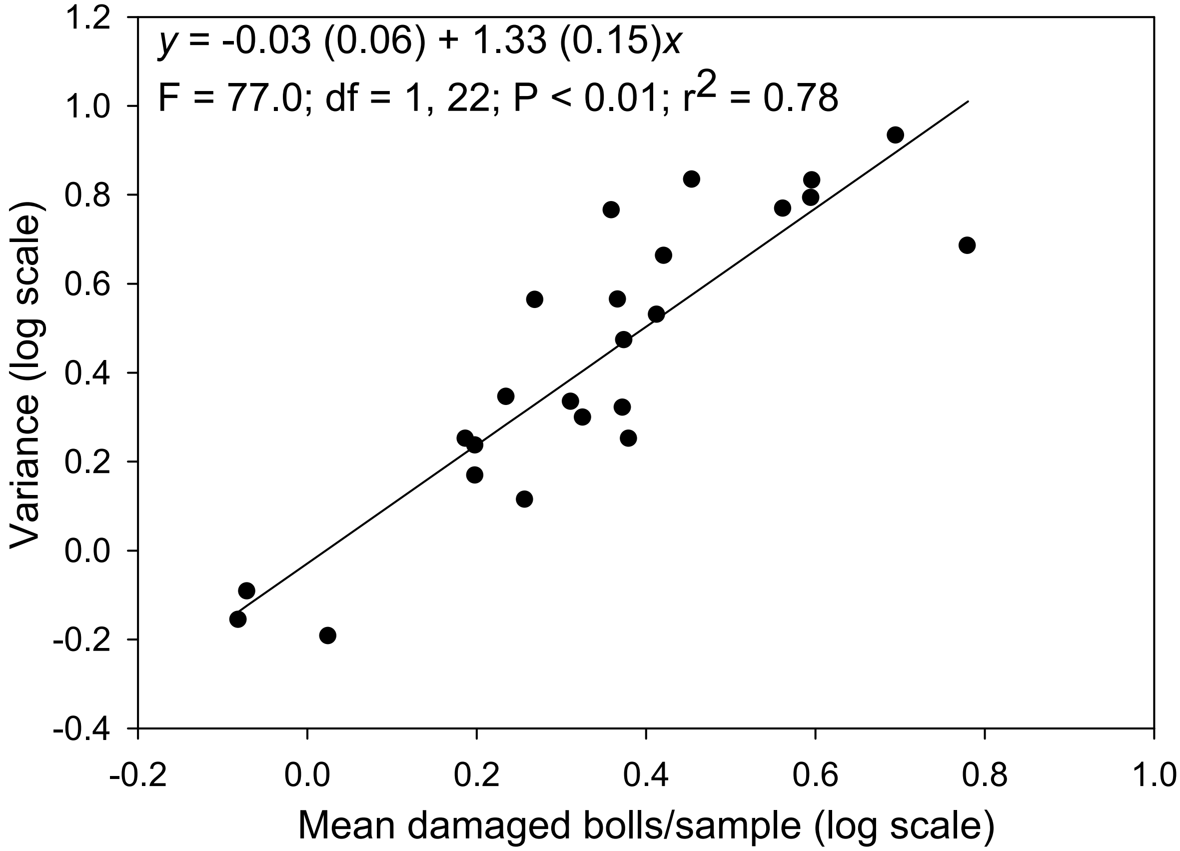


Fig. 4. Linear regression showing the relationship between sample variance and mean damaged bolls per sample. Each sample unit was comprised of 20 bolls.

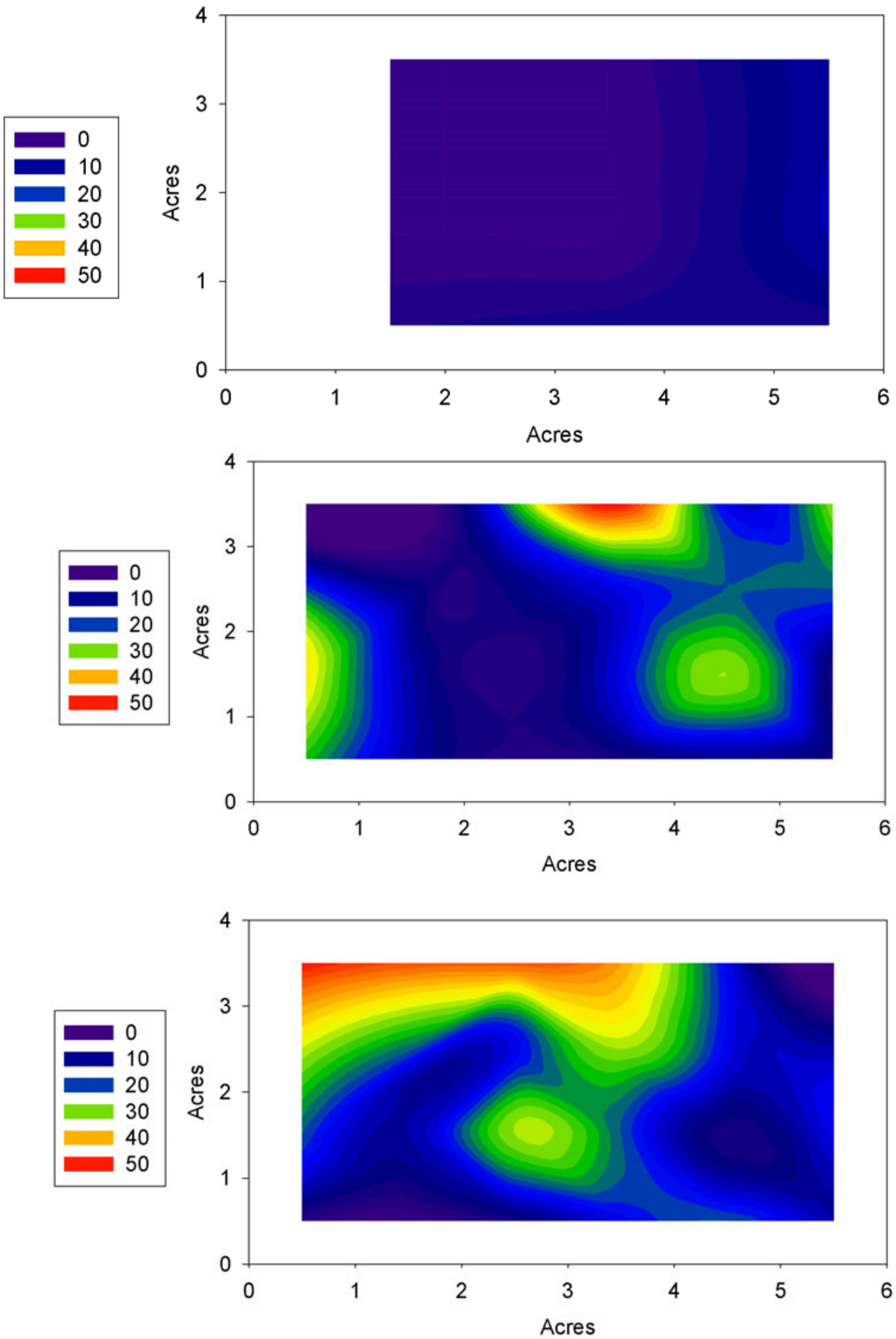
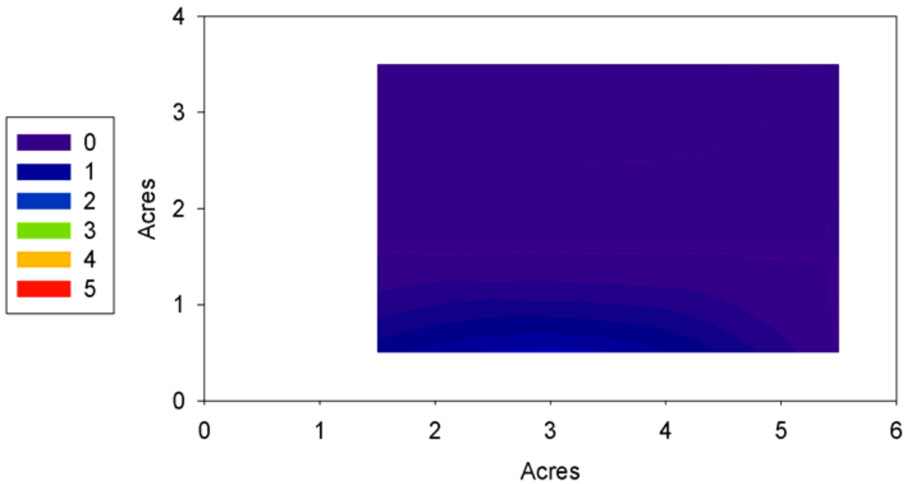
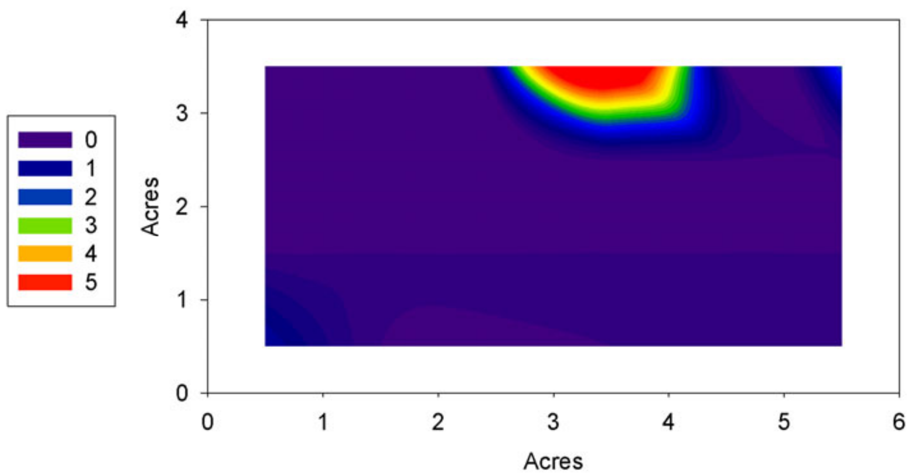


Fig. 5. Spatial mapping of internal boll damage in a single unsprayed field when sampled using internal boll damage. Data shown are percent damage (20 bolls dissected per sampling location). Sampling dates shown include August 3 (top), August 31 (middle), and September 9 (bottom).





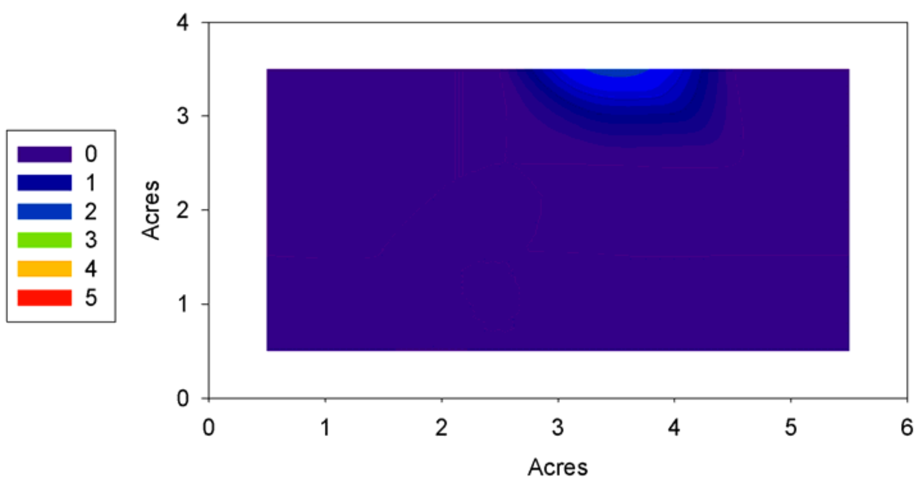


Fig. 6. Spatial mapping of stink bug individuals recovered in a single unsprayed field when sampled using 50 sweeps with a 15-inch sweep net at each sampling location. Sampling dates shown include August 3 (top), August 31 (middle), and September 9 (bottom).

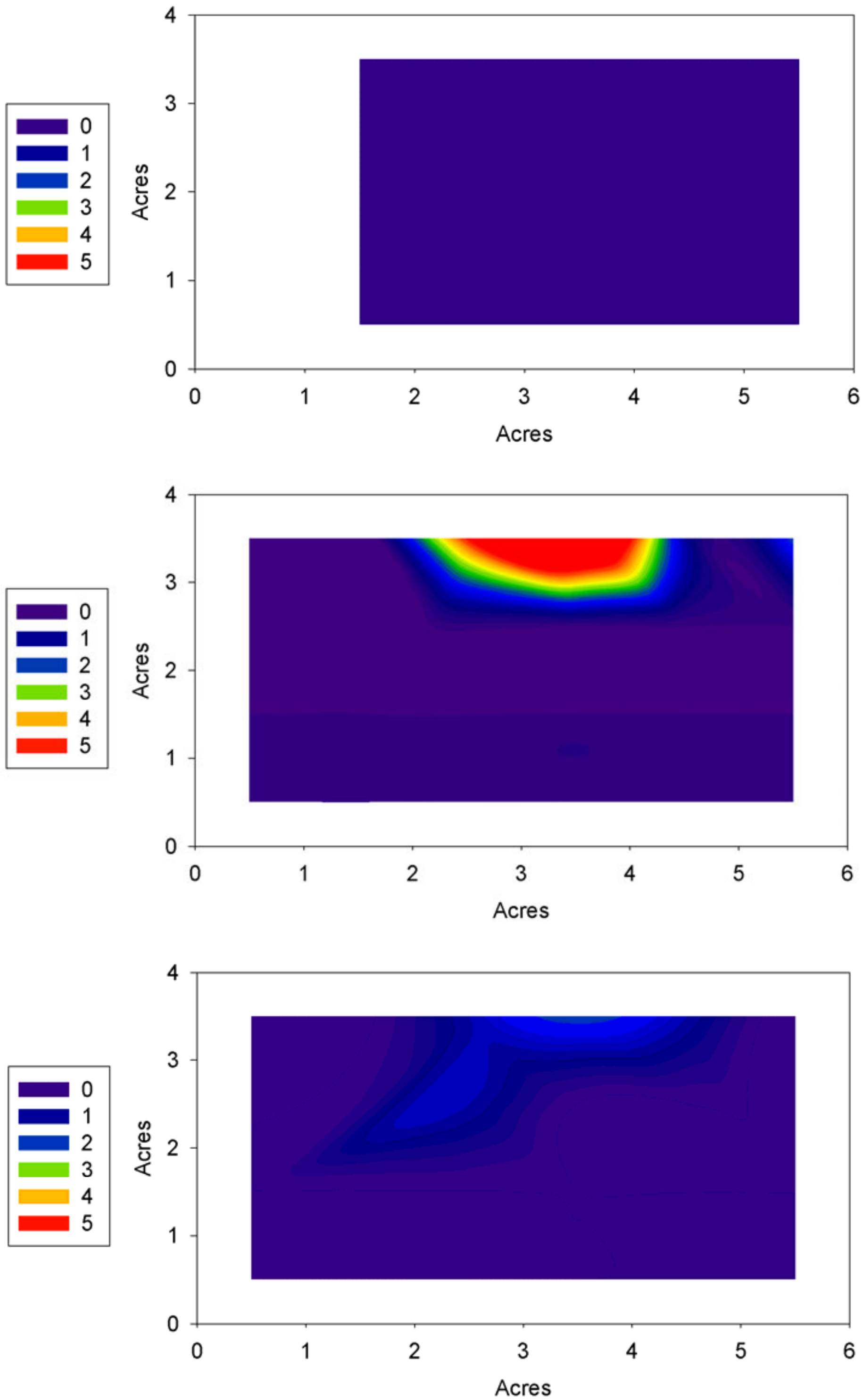


Fig. 7. Spatial mapping of stink bug individuals recovered in a single unsprayed field when sampled using 12-linear feet of row shaken over a drop cloth at each sampling location. Sampling dates shown include August 3 (top), August 31 (middle), and September 9 (bottom).