2004 BELTWIDE COTTON CONFERENCES, SAN ANTONIO, TX – JANUARY 5-9

SAMPLING COTTON BOLLS TO ESTIMATE FEEDING DAMAGE CAUSED BY STINK BUGS

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Abstract

A study was conducted during the growing season of 2000 in an effort to develop a sample plan for estimating cotton boll damage caused by stink bug feeding activity. Quarter sized bolls were collected from several commercial cotton fields across far west Texas. Fixed precision sequential and fixed sample size binomial sample plans for estimating the proportion of bolls damaged by stinkbug feeding were developed. Results from this study indicate that at an action threshold of 20% damaged bolls, the sequential sampling plans require 44 and 100 samples at precision levels of 0.3 and 0.2 respectively and require from 22 to 51 minutes sampling time. Fixed sample plans requiring 60 and 120 quarter sized bolls were developed. Estimated operating characteristics of the two sampling plans show that only the 120 boll sample plan maintained the Type II error rate below 0.1, but would require a sample time of 61minutes compared to only 30minutes for the 60 sample plan.

Introduction

Several species of stink bugs occur across the cotton producing states that cause significant cotton lint quality and lint yield reduction. Estimated cotton bales lost attributable to stink bug feeding activity across the cotton-growing belt in 2002 was in excess of 118 thousand bales (Williams 2003). Feeding by stink bugs causes hyperplasic cell development on the carpal walls of the cotton boll and is commonly referred to as "warting". This feeding activity can lead to boll drop, boll deformities, stick-tights, and secondary infections that cause partial or complete boll rotting.

Methods for efficiently and accurately monitoring pest populations are central to integrated pest management (IPM) theory. Current monitoring programs for stink bugs vary from state to state, but generally focus on the drop cloth method for estimating stink bug population densities and or boll sampling to monitor stink bug feeding activity. In Texas, monitoring stink bugs using the drop cloth method is recommended. Based on personal experience and communication with producers, consultants and cotton scouts, direct estimation of stink bug population densities is considered unreliable and inefficient. Others have also questioned this method for monitoring stink bugs (Green and Herzog 2000, Roof and Arnette 2000). Reasons for this lack of confidence stems from the behavioral attributes (within and among plant and field mobility in response to environmental conditions) of this insect, thus rendering them difficult to sample. Additionally, at least in West Texas, sampling stink bugs may underestimate actual damage being caused, because direct sampling does not account for other seed-feeding insects that may be present in the field (lygaeids, largids, coreids). Indirect sampling of the damage caused by these insects could, in part, alleviate these problems. The purpose of this study was to develop a reliable sampling plan based on feeding symptoms caused by stink bugs and other seed-feeding pests in cotton.

Materials and Methods

Stink bug and boll samples were collected from 19 different producer fields located in El Paso, Hudspeth, Pecos, and Glasscock counties in far west Texas. Fields ranged in size from 10 to 90 acres. Each sample date consisted of 200 collected and examined bolls. To reduce edge effects, the sampler walked into a quadrate at least 30ft before beginning a sampling bout. The sampler examined each boll for feeding symptoms (warting), recorded the boll as damaged (1) or undamaged (0), and the time required to complete the sample bout. After each sampling bout the sampler walked approximately 15 sec before selecting a plant to begin the next sampling bout. Direct sampling of stink bugs was accomplished by using a 3ft^2 drop cloth placed between two rows of cotton plants. Plants from one approximately 3ft of row were shaken onto the drop cloth. This procedure was repeated 3 times in each quadrate. All collected stink bugs were counted and recorded.

Fixed precision sequential and fixed sample size binomial sampling plans were developed. The stop line for the fixed precision sequential binomial sampling plans was developed from the following equation given by Jones (1994).

$$a_n = 1[(1/n) + cv^2)]^{-1}$$

where a_n = total number of bolls with feeding damage, n = the total number of bolls in the sample, and cv^2 = coefficient of variation. The sampling plan requires continued sampling until the PI bolls breeches the stop line. Fixed sample size binomial plans were developed and evaluated at 60 and 120 boll samples and at an action threshold of PI=0.20. Evaluation of the sampling plans was accomplished using a resampling approach program (resampling validation for sampling plans) developed by Naranjo and Hutchison (1997).

Results and Discussion

Sequential sampling plans were developed at precision levels of 0.2 and 0.3 (Figs 1-2). Using boll data collected from three different fields from this study illustrates the utility of each sample plan. At the selected precision levels of 0.2 and 0.3 reasonable estimates were obtained at moderate to low mean PIs. At high PIs, low sample numbers increased variability about the mean PI. Regardless of precision level, this variability would not be a problem in a scouting program if action thresholds to be estimated were at PIs of 0.25 or lower. An action threshold of 20% damaged bolls has been developed based on studies of southern green stink bug in Georgia cotton fields (Green & Herzog 2000). This threshold is used here for illustrative purposes and may not be applicable to west Texas because of different seed-feeding insects, environmental conditions, cotton varieties, and farming practices. Further studies will be needed to address these issues. To estimate this action threshold would require approximately 100 and 44 boll samples at the precision levels of 0.2 and 0.3 respectively. The average time required (excluding walking time) to sample 44 and 100 bolls would be approximately 22 and 51min respectively.

Fixed sample size plans were developed at 60 and 120 samples and an action threshold of 20%. Evaluation of the sampling plans using our field data resulted in the estimated OC curves (Fig. 3). The 60 sample plan Type II error rate was 0.159. This result indicates that > 15% of the time a needed treatment would not be applied. Increasing the sample size to 120 samples reduced the Type II error rate to <0.09. This error rate would be more acceptable in a scouting program, but would require double the sampling effort.

Literature Cited

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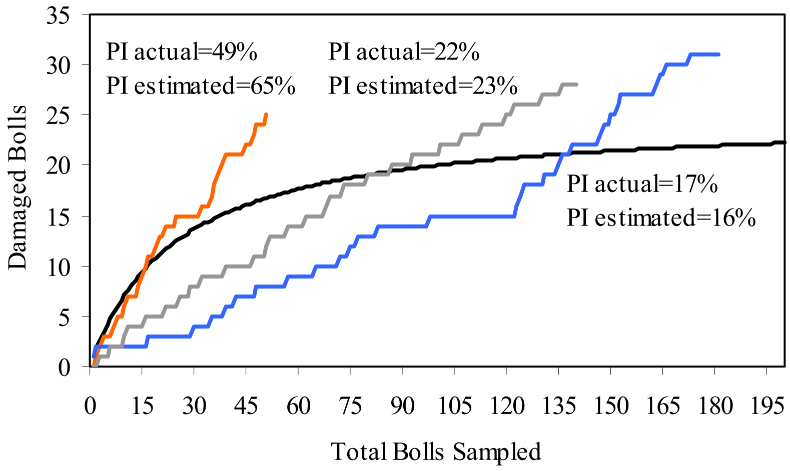
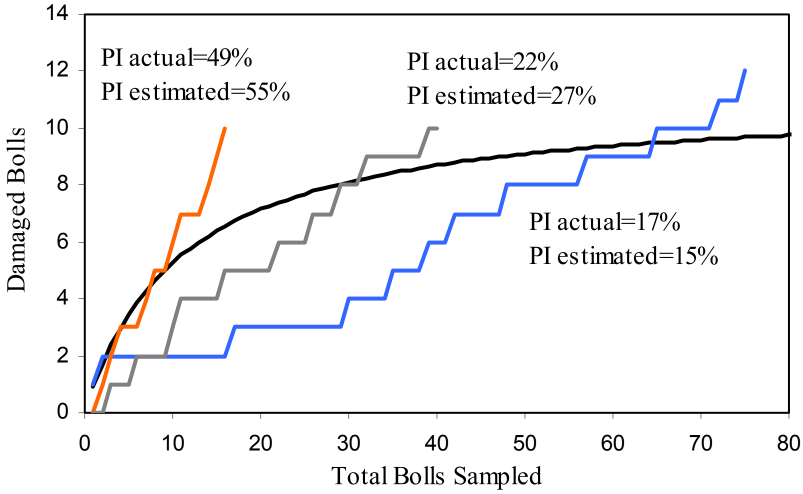


D=0.20, PI=Porportion Infested.

Figure 1. Fixed Precision Sequential Binomial Sampling Plan for Estimating the Proportion of Boll Damaged by Stink bug feeding.



D=0.30, PI=Proportion Infested.

Figure 2. Fixed Precision Sequential Binomial Sampling Plan for Estimating the Proportion of Boll Damaged by Stink bug feeding.

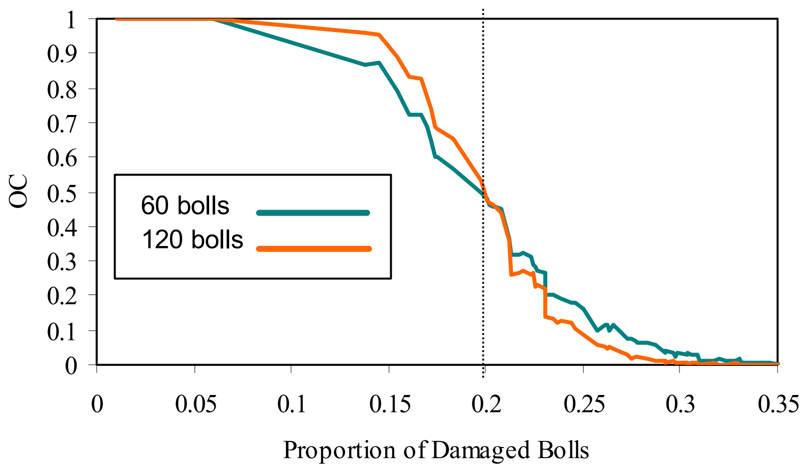


Figure 3. Estimated OC curves for fixed sample size binomial sample plan at sample sizes of 60 and 120, and an ET=20%.