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DEVELOPMENT OF A RELIABLE AND EFFICIENT SAMPLING PLAN FOR COTTON FLEAHOPPER AND LYGUS PLANT BUGS USING THE BEAT BUCKET SAMPLING METHOD

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Abstract

Several commercial cotton fields from several locations in Texas were sampled in 2000 and 2001 in order to develop an efficient and reliable sampling plan based on the beat bucket sampling method. Results indicate that one sampling plan could be used to sample both cotton fleahopper (CFH) and lygus plant bugs (LPB). To estimate 0.3 CFH/LPB per plant an average of 53 samples would be required. The average time needed to take 53 samples was 37 minutes. Relative to the visual sample method the beat bucket sample method increased efficiency in excess of 70%.

Introduction

Several species of insects occur across the cotton producing states that cause significant cotton lint quality and lint yield reduction. Cotton fleahopper and Lygus plant bug (LPB) have consistently been some of the most destructive insect pests of cotton. Estimated cotton yield loss attributable to CFH and LPB feeding activity across the cotton-growing belt was in excess of 108, 86, and 249 million dollars in 1997, 98, and 99 respectively (Williams 1998, 1999, 2000). Imperative to the reduction of cotton yield loss attributable to these insect pests is the development and implementation of an efficient and reliable monitoring method to make cost effective, intelligent pest management decisions.

Sampling CFH and Lygus plant bugs using different sampling methods intuitively increases sampling effort. In addition, visual sampling has shown to be more time consuming in time required per sample and number of samples required to estimate various beneficial arthropod population densities relative to the sweepnet and beat bucket methods (Knutson and Wilson 1999). Thus, the primary object of this proposed study is to develop an efficient and reliable sampling plan for both CFH and TPB by developing a beat bucket sample plan and comparing the results to the commonly used visual sample method. Presented herein are preliminary results from data collected during the 2000/2001 season.

Materials and Methods

A total of 19 commercial cotton fields and 1 research cotton field were sampled for cotton fleahopper (CFH) and (LPB) in 2000 and 2001. Each cotton field was divided into 4 approximately equal quadrates to ensure more uniform sampling from the entire field. From each quadrate 5 beat bucket and 3 visual sample bouts were taken. A single beat bucket and visual sample bout consisted of 5 randomly selected two plant samples in a row and 10 randomly selected plants in a row respectively, so that a total of 100 beat bucket and 120 visual samples were taken per field. Each sample bout x sample method was timed using a stopwatch. Sampling began the first week of squaring and ended at first flower for CFH, and continued well into the growing season for LPB. Data recorded included the number of CFH and LPB per sample, time required per sample bout, approximate size of field, location of field sampled, sample date, and cooperator.

Spatial statistics for CFH and LPB and each sample plan were determined from Taylor's Power Law (Taylor 1961). To evaluate the fit of Taylor's regression models to the field data, expected and observed variances were computed for each sample method standardized to a common mean CFH, LPB, and pooled plant bug density and regression analysis performed. Analysis of variance was performed on coefficients obtained from Taylor's power law in a nested design by year, field, sample method, and pest species (CFH and LPB) to determine if the coefficients significantly differed among the dependent variables. Spatial statistics for CFH, LPB and pooled plant bug were used to develop Green's fixed precision sequential sampling plan (1970).

Sampling plans were evaluated using a resampling approach program (resampling validation for sampling plans) developed by Naranjo and Hutchison (1997). Data sets used to evaluate the sample plans were taken in the same manor and from the same fields as those used to develop the sample plans. The resampling program randomly selects values from a specified data set until the mean density is estimated at the specified precision level and minimum sample number. This procedure was repeated 500 times for each data set.

Results and Discussion

Relative to the visual sampling method, use of the Beat Bucket resulted in a 17.5% fewer CFH collected per plant, but an increase of 78.3% LPB collected per plant (Table 1). These results are attributable, at least in part, because of the size of the cotton plant sampled and the ability of the sampler to find CFH and LPB during visual examination of the plant. Sampling small cotton plants using the beat bucket sample method resulted in slightly fewer CFH collected relative to the visual sample method. This difference was dramatically reversed as cotton plants became larger. This effect was especially pronounced for LPB, which, unlike CFH were collected from cotton plants of all ages. The results of this study clearly demonstrated the inefficiency of the visual sample method when used on older cotton plants.

Significant differences among computed Taylor's coefficients "a" and "b", were not found, regardless of sample year, field, method, or species of plant bug (Table 2). Thus sample data were pooled across years, fields, and plant bug species to construct the sample plan. Sample data were not pooled across sample methods in order to further illustrate the inefficiency of the visual sample method relative to the beat bucket sample method.

Regardless of pest density, the beat bucket sample method required fewer samples to estimate pest population densities relative to the visual sample method. The visual sample plan would require approximately 111 samples to estimate plant bug density at an ET of 0.3 plant bugs/plant, while the beat bucket sample method would require only 53 samples at the same density.

Validation of the sample plans revealed the stochastic nature of Green’s fixed precision sample plan. These results have been documented previously and were not unexpected (Naranjo and Hutchison 1996, Hutchison 1994, Hutchison et al 1988). Although, precision variability occurred among sample plans, actual average precision levels were maintained at the desired precision level of 0.34 across the plant bug densities that would be estimated in an IPM scouting program, thus optimization was not necessary. Precision levels, however, were generally higher than needed at high plant bug population densities.

Average sample times for each method were 21 and 69 seconds/plant for the beat bucket and visual sample methods respectively. Based on sample time per sample and required sample number to estimate pest density at an ET of 0.3 pests/plant, the beat bucket method would require 37 minutes, while the visual sample method would require 127 minutes (excluding walking time within the field). The beat bucket sample method in this study was more efficient in both time and sample numbers required to estimate plant bug population densities. Accounting for both time and required sample number the beat bucket sample plan reduced sampling effort in excess of 70% relative to the visual sample plan.

References

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Table 1. Taylor's coefficients a and b and associated correlation coefficient r^2 obtained from beat bucket and visual sample data of CFH, LPB, and Pooled Plant bugs.

Plant Bug	Sample Method	mean/plant	a	b	r2
Cotton Fleahopper	Beat Bucket	0.342	1.057	1.114	0.993
Lygus plant Bugs	Beat Bucket	0.413	1.003	1.568	0.963
Pooled Plant bugs	Beat Bucket	0.486	0.986	1.091	0.981
Cotton Fleahopper	Visual	0.417	1.138	1.112	0.853
Lygus plant Bug	Visual	0.179	0.808	0.949	0.929
Pooled Plant bugs	Visual	0.290	1.075	1.117	0.835

Correlation coefficients were calculated from regressing observed against predicted variances.

Table 2. ANOVA of Taylor's coefficients "a" and "b" nested across sample year, field, method and species.

	Taylor's coefficient a				
Source	***df***	***SS***	***MS***	***F***	***P>F***
Year	1	0.0121	0.0121	0.13	0.720
Field(year)	14	1.4274	0.1234	1.37	0.282
Method(Field Year)	14	1.6823	0.1202	1.33	0.298
Species(Method Field Year)	12	0.7926	0.0660	0.73	0.701
	Taylor's coefficient b				
Year	1	1.5479	1.5479	2.97	0.107
Field(year)	14	6.8989	0.4928	0.95	0.540
Method(Field Year)	14	5.9232	0.4231	0.81	0.648
Species(Method Field Year)	12	4.6880	0.3907	0.75	0.687