COMPARISON OF SAMPLING TECHNIQUES FOR TARNISHED PLANT BUG AND PREDACEOUS ARTHROPODS

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RESEARCH PROBLEM

Estimating the abundance of arthropod pests is a difficult task, but it is vital for making informed pest-management decisions. The method used to sample for destructive or beneficial arthropods can be very critical. Failing to detect pest presence or to accurately estimate the level of infestation due to use of a poor sampling method could result in inappropriate insecticide applications or missed pest populations. Beat sheets and sweepnets are two sampling techniques used commonly to sample arthropods in cotton. A new sampling technique called KISS (keep-it-simple sampler) has been introduced and has shown promise as a useful sampling method in row crops. Information on the relative efficiency of beat sheet and sweepnet sampling as compared with KISS sampling for arthropods in cotton are limited.

BACKGROUND INFORMATION

Accurately sampling arthropod pests and their natural enemies in row crops is an essential component of informed pest-management programs. For years, researchers have searched for the "best" sampling technique that is acceptable and provides sound and informative data with the least amount of effort. In statistical terms, an acceptable method maximizes precision while minimizing costs (Cochran, 1977). Beat sheets and sweepnets are both inexpensive, quick, and easy to use while visual examination of individual plants can be very tedious and labor intensive. Sweepnets, however, have been criticized for their inefficiency in sampling crop ecosystems (Ellington *et al.*,1984). A new sampling method labeled KISS has been recently introduced to sample arthropods in row crops. Little work has been done to compare the efficiency of KISS to the other sampling techniques commonly used in cotton. The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) is a major concern of Arkansas and other mid-South cotton growers. Cotton fields in Arkansas also support a diverse fauna of predaceous arthropods that play an important role in suppressing pest population outbreaks. The study compared the effectiveness of beat sheets, sweepnets, and KISS for sampling the tarnished plant bug and predaceous arthropods and determined which technique results in the least variability.

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RESEARCH DESCRIPTION

This study was conducted in 1999 on the Southeast Branch Experiment Station near Rohwer. DPL NuCotn 33B was planted on 13 May 1999 in 38-inch rows at typical plant densities. Two sites were established in the cotton field and in each site four plots were assigned at random for arthropods sampling. Plots were 4 rows wide and 40 ft long. Mustard was planted between plots to ensure strong plant bug populations in the cotton plots. Plots were maintained using standard production practices but did not receive any insecticide applications for the duration of the study. Each plot was used to collect arthropods simultaneously by all three sampling techniques: beat sheets, sweepnets, and KISS (a hand-carried pneumatic keep-it-simple sampler). A 3-ft beat sheet (6 row ft per plot) sample was taken by beating plants from the two middle rows of the plot. Sweepnet samples consisted of 10 sweeps of a standard 15-inch diameter sweepnet using the single-row cross sweep on an outside row of the plot. KISS is a modified leaf blower (see Beerwinkle *et al.*, 1997, for a full description and specifications) for which samples were taken once weekly for 4 weeks using the leaf blower on the other outside row of the plot (40 row ft per plot). Arthropods were identified in situ, counted, then released.

Data analysis was done on immatures only and on immatures plus adults (Tables 1-4). The variance/mean ratio ($\sigma^2/\bar{x}$) was used as an index of precision for each sampling method. An analysis of variance (Proc GLM, SAS Institute, 1998) was computed on the weekly mean counts and on the $\sigma^2/\bar{x}$ ratios for each arthropod sampled in this study. A small $\sigma^2/\bar{x}$ ratio indicates that variance is small compared with the mean, allowing for the detection of smaller differences among means in an analysis of variance. An inflated $\sigma^2/\bar{x}$ ratio suggests that one sampling technique engenders a more sizable sampling error to the variance. A least significant difference test was used to test for significant differences in arthropods counts and in $\sigma^2/\bar{x}$ ratios with the three techniques. Data were analyzed by regression analysis (Proc REG, SAS Institute, 1998) for weekly means of arthropods from the three sampling techniques to check for correlation.

RESULTS AND DISCUSSION

Sampling the Tarnished Plant Bug

Similar counts of immature plant bugs were collected by KISS and beat sheets, which were significantly greater (< 0.05) than those collected by sweepnets (Tables 1 and 2). Numbers of tarnished plant bugs collected in sweepnets were generally low and frequently equaled zero throughout the study. Only 3.9% of all immature tarnished plant bugs were collected in sweepnet samples, while 50.4% and 45.7% were collected in KISS and beat sheet samples, respectively. All three sampling techniques had similar $\sigma^2/\bar{x}$ ratios, i.e., nonsignificant (data not shown). Therefore, we conclude that both KISS and beat sheets are the sampling technique of choice for the tarnished plant bug in cotton. Beat sheets are more economical than KISS and less time-consuming. KISS, however, can be used under conditions where using beat sheets is not possible, such as when the field is wet. In addition, beat sheets are generally poor sampling techniques for detecting arthropods at low population density. No significant correlation for im-

mature plant bug counts existed among any of the sampling techniques used in this study indicating that sampling methods were not proportionally affected by variations in uncontrolled variables associated with the comparison experiments.

Sampling Beneficial Arthropods

Similar counts of immature predaceous arthropods were collected by KISS and beat sheets, which were significantly greater (< 0.05) than those collected by sweepnets (Table 1). About 52.8, 38.8, and 8.4% of predators were collected in KISS, beat sheet, and sweepnet samples, respectively. KISS caught significantly more ladybird beetles, big-eyed bugs, spiders, and lacewings than sweepnets, but only caught more spiders than beat sheets (Table 1). Beat sheets caught significantly more ladybird beetles and big-eyed bugs than sweepnets (Table 1). Variance/mean ratios for total predators caught and for all predaceous groups were similar, and not significantly different, among all three sampling methods (data not shown). There was no significant correlation for predator counts among the sampling methods used in this study, which is partly due to their dissimilar manners in collecting insects.

Sampling Technique Selection

Two factors influence our decision in selecting a sampling method: reliability and costs. Reliability of the estimated density increases as the sample size increases but, obviously, cost is the limiting factor. Thus, we have to define the proper balance between the reliability of the estimate and the cost of obtaining it. Costs can be expressed in terms of human hours, in addition to other costs, required to collect arthropod samples, visually inspecting the collected samples, identification, and counting. In our study, both KISS and beat sheets collected more tarnished plant bugs and more beneficials than sweepnets, while all sampling methods produced similar variabilities as indexed by $\sigma^2/\bar{x}$ ratios. KISS and beat sheets captured 11.3 and 12.5 times more tarnished plant bugs, respectively, than sweepnets but the $\sigma^2/\bar{x}$ ratios obtained with KISS and beat sheets was only 2.2 and 2.3 times those of sweepnets, respectively. Sweepnets may not be reliable sampling methods for some arthropods in cotton especially at low population density. The factor that might make sweepnets more favored and appealing to some is the fact that it takes less time to gather data than with sweepnets than with other sampling methods. KISS samples required severalfold more time to process than sweepnet samples simply because more arthropods and plant materials and debris were collected. Also, KISS requires two individuals to operate efficiently.

PRACTICAL APPLICATION

None of the sampling techniques tested will adequately sample all common arthropods in cotton because each technique samples only part of the habitat or only some of the life stages. Beat sheets, for example, are generally best for slower moving arthropods that dislodge from plants when disturbed such as immature hemipterans. Moreover, the effectiveness of each method may be affected by a wide array of factors such as plant variety, weather, etc. For example, sweepnets may underestimate abun-

dance if plants are wilted from drought. Also, beat sheets can not be used when the field is wet. KISS and beat sheets collected more plant bugs and more beneficials than sweepnets but the variability associated with the three sampling methods was similar based on the $\sigma^2/\bar{x}$ ratios. The sweepnet appears to be a poor sampling technique for tarnished plant bug and some beneficials and less efficient than KISS or beat sheets especially at low population densities.

LITERATURE CITED

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Table 1. Seasonal mean count of tarnished plant bug and various predaceous arthropod groups collected by KISS, beat sheets, and sweep nets. Rohwer, AR, 1999.

	Arthropods (Immatures)[z]		
Arthropod Group	KISS	Beat Sheet	Sweep Net
	---------- No./sample ----------		
Tarnished Plant Bug	1.8 a[y]	2.0 a	0.16 b
Ladybird Beetles	4.8 a	4.4 a	0.47 b
Big-Eyed Bugs	1.9 a	1.4 a	0.25 b
Spiders	2.6 a	1.1 b	0.69 b
Lacewings	0.50 a	0.34 ab	0.16 b
Pirate Bugs	0.06 a	0.03 a	0.0 a
Damsel Bugs	0.09 a	0.0 a	0.0 a
Total Beneficials	9.9 a	7.3 a	1.6 b

[z] Beat sheet, sweep net, and KISS samples taken on 21 June, 1 July, 9 July, and 15 July 1999.
[y] Means within rows followed by the same letter are not significantly different (P=0.05).

Table 2. Season mean count of tarnished plant bug and various predaceous arthropod groups collected by KISS, beat sheets, and sweep nets. Rohwer, AR, 1999.

	Arthropods (Adults + Immatures)[z]		
Arthropod Group	KISS	Beat Sheet	Sweep Net
	---------- No./sample ----------		
Tarnished Plant Bug	2.8 a[y]	2.4 a	0.34 b
Ladybird Beetles	8.7 a	6.4 a	1.6 b
Big-Eyed Bugs	3.8 a	2.4 a	0.81 b
Spiders	2.6 a	1.1 b	0.69 b
Lacewings	0.56 a	0.38 ab	0.2 b
Pirate Bugs	0.40 a	0.18 ab	0.04 b
Damsel Bugs	0.18 a	0.11 ab	0 b
Total Beneficials	16.3 a	10.6 b	3.3 c

[z] Beat sheet, sweep net, and KISS samples taken on 21 June, 1 July, 9 July, and 15 July 1999.
[y] Means within rows followed by the same letter are not significantly different (P=0.05).