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SAMPLING EFFICIENCY OF THE KEEP-IT-SIMPLE-SAMPLER FOR ADULT BOLL WEEVILS

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Abstract

Early-season boll weevil (*Anthonomus grandis* Boheman) populations are difficult to sample because their levels are typically low and labor requirements for precise estimates are prohibitive. Recent studies suggest a hand-held pneumatic sampler (Keep-It-Simple-Sampler; KISS) may offer a less laborious alternative to hand-sampling, but detailed estimates of KISS collection efficiency in different phenological stages of cotton (*Gossypium hirsutum* L.) are not available. We used mark-and-release techniques to obtain preliminary estimates of KISS collection efficiency for boll weevils in pre-fruiting, pinhead square, and third-grown square stages of cotton. Observations of weevils released in pre-fruiting cotton indicated a majority of weevils (97%) remained on the cotton plants between the time of release and sampling with the KISS. Overall, recovery of weevils by the KISS 20 min after release was about 11%. Further, about 13% of marked weevils were dislodged from the plant but not collected by the KISS. In comparisons of collection efficiency among plant phenologies, the mean percentages of marked weevils recovered from pre-fruiting (19%), pinhead (21%), and third-grown square (12%) stage plants were not statistically different. The KISS detected weevils in most samples and the overall estimated collection efficiency was 17±12%. The low and variable recovery rates we observed suggest the KISS does not provide precise estimates of low-level boll weevil populations. Despite this shortcoming, the KISS remains a labor-efficient tool for detecting low-level populations, especially in the absence of practical alternatives.

Introduction

Early-season boll weevil (*Anthonomus grandis* Boheman) populations are difficult to sample because their levels are typically low and the labor required to obtain precise estimates is prohibitive (Parencia 1968; Kirk and Bottrell 1969). Consequently, pheromone traps are the primary method used to detect early-season boll weevil populations. However, pheromone traps become less effective as cotton begins to fruit (White and Rummel 1978). Tractor-mounted samplers have been evaluated as an alternative for estimating early-season boll weevil populations (Parencia 1968; Kirk and Bottrell 1969; Beerwinkle et al. 1997b; Raulston et al. 1997), but these devices have not been widely used because they are expensive and cumbersome to transport. Beerwinkle et al. (1997a) introduced a modified leaf blower, the Keep-It-Simple-Sampler (KISS), as an affordable and more portable tool for sampling boll weevils. However, detailed estimates of changes in KISS sampling efficiency relative to plant development are not available. We used mark-recapture techniques to obtain preliminary estimates of KISS collection efficiency for boll weevils in cotton at different phenological stages.

Materials and Methods

Sampling efficiency of the KISS was estimated in two experiments. Because Beerwinkle et al. (1997a) indicated many marked boll weevils left the plants between the time of release and the time of sampling, the first experiment also assessed the availability of released weevils for subsequent collection in pre-fruiting cotton. The second experiment estimated sampling efficiency of the KISS in three phenological stages of cotton. Cotton was planted at 2- to 3-week intervals to provide three distinct cotton phenologies for each sampling date.

Availability of Released Weevils for Collection in Pre-Fruiting Cotton

The proportion of released weevils that stayed on plants, and thus were available for subsequent collection, were estimated in cotton with 4 to 6 true leaves on four dates (30 May, 4-6 June). On each date, three 15-m lengths of row were selected based on uniformity of plant stand. An alley (1 m) was cleared at the end of each row (replicate) to discourage weevils from leaving the sample row.

Boll weevils were obtained daily from Southeastern Boll Weevil Eradication Foundation pheromone traps in the Brazos River Bottoms near College Station, Texas. Weevils were held at room temperature in screened cages and provided bolls, squares, and water for 2-7 d before release. One to three days before release, each weevil was marked with fingernail polish in a manner to fuse the elytra and prevent flight. A different color of fingernail polish was used on each sample date. Between 1100 and 1400 h (CDT) on each date, 15 weevils were released on the main stems of plants at about 1 m intervals in each sample row. Activity of each weevil was visually monitored for 20 min after which rows were sampled with the KISS. Immediately after sampling, collected weevils were placed in sealable plastic bags, and the plants and surrounding soil were searched for remaining weevils.

KISS Sampling Efficiency in Different Cotton Phenologies

The proportion of marked weevils recovered by the KISS was evaluated in pre-fruiting (primarily 4 to 6 true leaves), pinhead square, and third-grown square stage cotton on four dates (18-20, 22 June). The experimental design was similar to that previously described except that on each sample date nine rows were sampled (three replications of three plant phenologies). Experimental procedures were also the same as previously described except that observations of weevil movement were not conducted and rows were sampled 2 h after weevil release.

Data Analyses

In the study of weevil availability after release, the percentage of weevils that stayed on the plants between times of release and sampling with the KISS was estimated. Based on counts after sampling, respective percentages of weevils collected by the KISS, remaining on the plants, remaining on the soil surface, and those that could not be located were estimated.

In the comparison of KISS collection efficiencies among cotton plant phenologies, the proportions of weevils recovered by the KISS were arcsine-square root transformed (arcsine $\sqrt{p}$; Zar 1984) and analyzed using PROC MIXED (SAS Institute 2001). Phenology was the only fixed effect in the model; date and the date by phenology interaction were random effects. The LSMEANS statement and the PDIFF and ADJUST=TUKEY options were used for means separation of the transformed proportions of recovery, however, untransformed means (± SD) of percent recovery are presented.

Results and Discussion

Availability of Released Weevils for Collection in Pre-Fruiting Cotton

Observations indicated most marked weevils (97%; n = 180) remained on the plants between the time of release and sampling with the KISS. The mean percentage of weevils remaining on plants that was recovered by the KISS was 11±12%, with one or more marked weevils recovered in 67% of the samples (n = 12). The percentages of weevils recovered from individual rows ranged from 0-40%. Most weevils present on the plants at the time of sampling with the KISS remained on the plants after sampling (77%), usually under folded leaves or at the junction of petioles with the main stem. Also, 5% were on the ground and 8% of the released weevils could not be located after sampling with the KISS. These observations indicate that recovery by the KISS was relatively low, but this low recovery was not caused by escape of marked weevils from the sample rows after release. Because a high proportion of weevils remained on the plants after release, subsequent estimates of recovery by the KISS were not adjusted to account for the loss of marked weevils.

KISS Sampling Efficiency in Different Cotton Phenologies

The percentages of weevils recovered by the KISS two hours after release were similar for pre-fruiting, pinhead square, and third-grown square cotton (F=0.95; df=2, 6; P=0.44; Table 1). As in the previous experiment, the percentages of weevils recovered from individual rows were highly variable (Table 1). One or more weevils were recovered in 92, 75, and 83% of the samples from pre-fruiting, pinhead square, and third grown square stage cotton, respectively. The average percentage of weevils recovered from all plant phenologies was 17±12%.

Our observations regarding the numbers of weevils remaining on plants after release were not consistent with the report of Beerwinkle et al. (1997a), who indicated many marked weevils left the plants between time of release and sampling time. However, these authors did not quantify movement from the plants or specify the time interval between release and sampling. Beerwinkle et al. (1997a) also reported high variability in recovery (50-100%) and high KISS collection efficiencies (73 and 70%) for marked weevils in 4- and 6-leaf cotton, respectively. However, Beerwinkle et al. (1997a) did not indicate how collection efficiency was calculated. We also observed considerable variation in weevil recovery by the KISS, but our estimates of collection efficiency were much lower than those previously reported (Beerwinkle et al. 1997a).

The low recovery rates we observed did not occur because weevils left the sampling row after release. Low recovery rates and high variability in recoveries among samples suggest the KISS does not provide reliable estimates of low-level weevil populations. Despite this shortcoming, the KISS remains a labor-efficient tool for detecting low-level populations, especially considering the absence of practical alternatives.

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Table 1. Recovery rates (%) of the KISS in cotton phenologies sampled 2 h after release of marked boll weevils.

Cotton Phenology	**Mean ± SD**	**Range**
Pre-fruiting	19 ± 9 a	0 – 33
Pinhead square stage	21 ± 16 a	0 – 47
Third-grown square stage	12 ± 10 a	0 – 33

Within a column, values followed by the same letter are not significantly different (Tukey Studentized Range, α=0.05).