EFFICIENCY COMPARISONS OF THE KISS, A TRACTOR-MOUNTED SAMPLER, AND HAND SAMPLING FOR DETECTING BOLL WEEVILS IN PREBLOOM COTTON

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Abstract

Field experiments were conducted to compare the sampling efficacy, reliability, and efficiency of a hand-carried pneumatic keep-it-simple sampler (KISS) to that of a tractor-mounted sampler (TMS) and whole-plant hand sampling for detecting and quantifying the presence of boll weevils in prebloom cotton. The sampling efficacy of the KISS was about 50 % that of the TMS, and its reliability, as measured by replication sample variation, was comparable. Sampling efficacy and reliability of the hand sampling method were not determined. The overall sampling efficiency of the KISS, in terms of results reliability and cost in man time, was comparable to that of the TMS and greatly superior to that of the hand sampling method.

Introduction

Two pneumatic insect sampling machines were recently described (Beerwinkle et al. 1997a, 1997b) to supplement hand sampling procedures and enable scouting personnel to increase their accuracy and efficiency for characterizing early season field populations of boll weevils and other arthropods. The KISS (Fig. 1) is a portable unit that is constructed by modifying a conventional engine-driven leaf blower with the addition of a metal rod frame to support an insect collection net in front of the blower outlet nozzle. The KISS is hand-carried along a row of plants with the blower positioned so that high speed air from the nozzle dislodges insects from the plants and carries them into the net. The TMS (Fig. 2) uses a combination unidirectional pressure/vacuum high speed air stream to collect insects from plants as the machine moves along a row. Technical data describing the characteristics of the KISS and TMS are listed in Table 1. The hand sampling method involved visual whole-plant inspection to detect the presence of weevils (Fig. 3). Field experiments were conducted to compare the sampling efficiencies of the KISS, TMS, and hand sampling methods for characterizing boll weevil populations in prebloom cotton.

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Materials and Methods

The efficacy of the KISS, relative to that of the TMS, for collecting boll weevils in prebloom cotton with varying resident population densities of weevils was determined in twelve replicated sampling comparison experiments. A "Relative Variation" value [RV=(S/)(100); Ruesink 1980], which is a unitless ratio used to measure the spread among subsample observations to the mean value, was calculated from the number of weevils collected in the respective replications of each sampling experiment for each machine. Then an overall mean RV value was calculated for each machine from the individual RV values determined for the respective twelve sampling experiments. Sampling costs (C_S) in terms of man time per unit of sampled row length were determined for the KISS, TMS, and hand sampling methods by timed sampling of 650-ft rows of cotton on seven different dates (five replications/date/method) over a 42-day period, beginning with cotton at the 4-6 leaf stage and ending at first bloom. Sampling times for both the KISS and the TMS included times for collecting the respective samples and for visually inspecting the collected samples of insects and plant debris for the presence of boll weevils. Characteristic sampling efficiencies for the three sampling methods in terms of "Relative Net Precision" [RNP=100/(RV)(C_S)], where RV is the mean relative sampling variation and C_S is the unit cost in man time for the respective methods (Ruesink 1980), were determined and compared.

Results and Discussion

Linear correlation of the mean sample numbers of weevils collected by the KISS and the TMS in respective paired comparisons was positive and highly significant (r=0.92; $P<0.001$) indicating that weevil captures by the two machines were each proportionally affected by variations in uncontrolled variables associated with the comparison experiments. Regression of KISS values on TMS values with the intercept forced through the origin (Fig. 4) defined a model (KISS=0.48 TMS) that was highly significant (F=59.5; df=1,11; $P<0.001$) for characterizing the relative sampling efficacies of the two machines. Raulston et al.(1997) determined that a TMS, operationally identical to the TMS evaluated here, collected about 35% of the total weevil population in prebloom cotton with weevil collection trends closely tracking field population trends. By deduction, because of the high correlation between weevil collections by the two methods, it seems safe to infer that the trends in weevil collections by both the KISS and TMS in the present study also followed field population trends even though the KISS collected only about 48% as many weevils as the TMS.

A characteristic RV value for a sample is a measure of its reliability, and since there is generally no independent knowledge of true field population values, such a measure of "precision" or "reliability" is useful for evaluating a sample obtained with a given method (Ruesink 1980). According to Southwood (1978), an RV<25 is usually adequate for most extensive sampling programs. However, when sampling low, clumped field populations of insects such as encountered in this study, RVs<25 are difficult to achieve. In the twelve sampling comparisons here, the range of RVs for the KISS was 13.6-100.0 with one RV<25 and a mean RV=54.4; whereas, the range for the TMS was 7.9-60.0 with four RVs<25 and a mean RV=37.8 (Fig. 5). Thus, the mean RV for the KISS was slightly higher, but comparable to that of the TMS.

Cost in terms of man time and other expense for sampling must be considered in determinations of relative efficiency among sampling methods. In these experiments, the average costs in terms of man time required for sampling 650-ft rows of prebloom cotton for boll weevils by the KISS, TMS, and hand sampling methods were compared (Fig. 6). The average times for the KISS, TMS, and hand methods were 5.1, 7.1, and 92.4 min., respectively. The average hand sampling time was >10X the KISS and TMS times, and the TMS time was slightly greater than the KISS time primarily because of an increased time required to visually inspect the larger TMS-collected volume of plant debris for the presence of boll weevils.

The calculated RNP values (Fig. 7) combine the "Reliability" and "Cost" factors in a relationship that reflects the relative efficiencies of the respective methods (since the relative variation for hand sampling was not determined here, a conservative estimate of RV=25.0 was used to calculate the RNP for this method). In such comparisons, the greater the RNP, the more efficient the method in terms of reliable results per unit cost. The RNP values for the KISS and TMS methods were near equal, and they both exceeded the RNP of the hand method by >9X.

Conclusions

The sampling effectiveness of the KISS for detecting and quantifying early-season populations of boll weevils in prebloom cotton is comparable to that of the TMS, and the sampling efficiencies of both the KISS and TMS are greatly superior to hand sampling. The greater portability and lower equipment costs of the KISS, in comparison to the TMS, should make it the preferred method in many sampling applications.

Disclaimer

Mention of a trade name or a proprietary product is for specific information only and does not constitute a guarantee or warranty of the product by the U. S. Department of Agriculture and does not imply endorsement of the product over other products not mentioned.

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Table 1. Technical data for the KISS and TMS pneumatic insect samplers.

Parameters (Units)	KISS	TMS
Air Volume Flow Rate (ft^3/min)	300	1200
Blower Nozzle Outlet Area (in^2)	3.5	18.0
Nozzle Outlet Air Speed (mph)	150	105
Collection Reciever Area (in^2)	77	108
Average Ground Speed (ft/sec)	3.55	3.37
Approximate Cost ($)	400	4000*

* Not including cost of tractor

Figure 1. Portable pneumatic keep-it-simple (KISS) sampler.

Figure 2. Tractor-mounted (TMS) pneumatic pressure/vacuum sampler.

Figure 3. Whole-plant hand sampling by visual inspection.

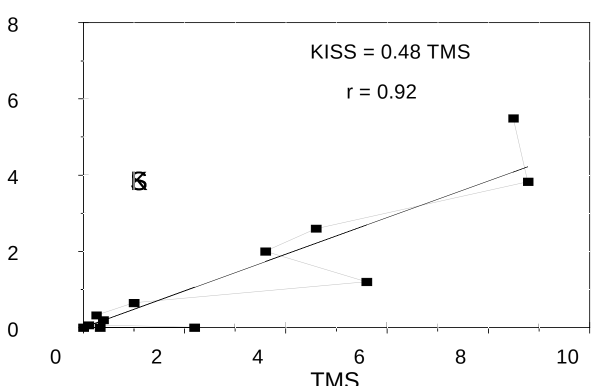

Figure 4. Relationship between sample numbers of boll weevils collected per 650-ft row of cotton with the KISS and TMS.

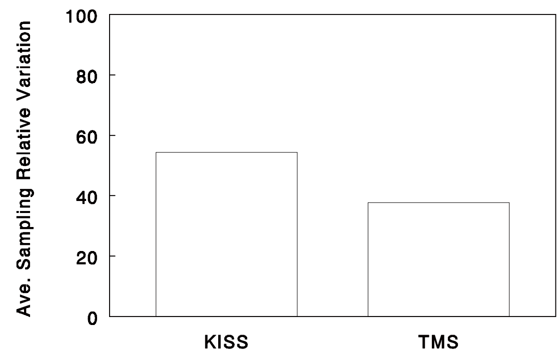

Figure 5. Average relative sampling variation (RV) for the KISS and the TMS.

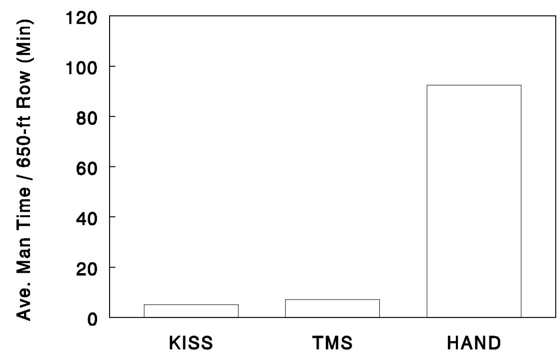

Figure 6. Costs for sampling with the KISS, TMS, and hand methods.

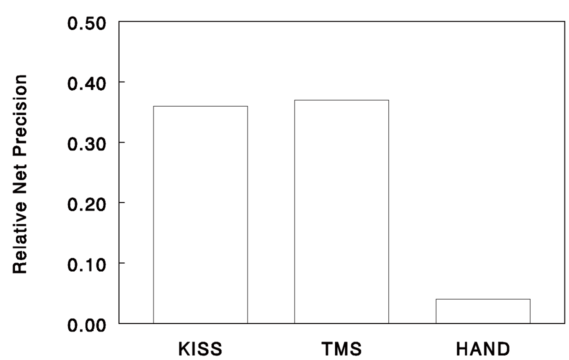

Figure 7. Relative efficiencies (RNP) of the KISS, TMS, and Hand methods.