EVALUATION OF A TRACTOR MOUNTED SAMPLER FOR BOLL WEEVIL SAMPLING

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Abstract

A tractor mounted sampler combining positive air flow across the cotton plant and negative pressure in the specimen receptacle was evaluated for boll weevil collecting efficiency. The mechanical sampler was as efficient as the drop cloth technique for boll weevil sampling. Of three sampler modifications tested (ground speed, air flow speed, and receptacle area reduction), only receptacle area reduction significantly increased efficiency. In fruiting cotton, >56% of the adult weevils were found within the bracts of squares and our tests indicated that this segment of the population could not be sampled effectively with mechanical or drop cloth techniques. Regression analysis showed that trends in mechanical sampler collections of adult boll weevils closely reflected population trends.

Introduction

The difficulties associated with sampling low density boll weevil populations represent a major constraint to determination of early season adult colonization and temporal redistribution patterns, as well as other research efforts requiring large-scale sampling. Several tractor mounted devices have been designed and evaluated for sampling boll weevils (e.g., Parencia 1968, Kirk and Bottrell 1969, McCoy and Lloyd 1975). Although the designs vary considerably, each of these systems consists of a forced air flow (supplied by a high volume centrifugal blower) directed across the cotton plant into a receptacle fitted with a bag for specimen collection. The system designed by McCoy and Lloyd (1975) incorporated an additional receptacle, mounted behind the forced air system and attached to the inlet of the blower, providing a vacuum collector. McCoy and Lloyd (1975) estimated that one hour of sampling with their "insect scout" was equivalent to 26 to 158 man-days of sampling. Beerwinkle *et al.* (1997) designed a tractor mounted sampler which directed forced air from a centrifugal blower through a nozzle into a receptacle attached to the inlet of the blower, thus providing a negative pressure (vacuum) in the receptacle. We report here an evaluation of that sampler for sampling adult boll weevils in cotton.

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Materials and Methods

The tractor mounted sampler was evaluated in cotton plots (0.6 to 1.5 acres) planted at the Subtropical Agricultural Research Laboratory, Weslaco, Texas between 13 Feb and 3 June 1996. No insecticides were applied to the plots to facilitate production of large populations of adult boll weevils. When evaluations were performed within a particular plot, plant phenology data (plant height, number of punctured and unpunctured squares, blooms, and punctured and unpunctured bolls) were recorded. Plant phenology data were collected at 1-7 day intervals by inspecting 5-10 plants in each of the 6-8 sample rows (40-60 plants/observation).

Data comparing the relative efficiency of the mechanical sampler to drop cloth sampling were collected on 24 occasions between 5 July and 15 Aug. On each occasion, 10 row meters of cotton were sampled with the mechanical sampler in each of 8 rows. The sampler was operated at a ground speed of either 1.2 or 2.5 mph and a nozzle air speed of either 8,400 or 9,400 ft/min. On adjacent rows, 10 row meters were sampled using the drop cloth method. This was accomplished by placing a 1-m^2 drop cloth on the ground, vigorously shaking the plants over the cloth, and collecting all dislodged adult boll weevils.

Mitchell and Mistric (1965) reported that 88% of observed adult boll weevils were located on the squares, blooms and bolls of fruiting cotton. McCoy and Lloyd (1975) suggested that squares afforded a refuge to adult weevils that may impact mechanical sampler efficiency. A test was conducted to determine the effect of fruit presence on sampler efficiency. In this experiment, 3-4 rows of fruiting cotton, each 25 m long, were sampled with the mechanical sampler (ground speed=1.2 mph, nozzle air speed=8,400 ft/min). Immediately following mechanical sampling, each row was re-sampled with a drop cloth, then all fruit with bracts large enough to conceal boll weevils were stripped from the plants and transported to the laboratory where adult boll weevils were removed and counted. Mechanical and drop cloth samples were collected concurrently in an additional set of 3-4 rows where all fruit had been removed the previous day. Marked weevils (10/row) were released on all rows the day prior to sampling. Adult weevils for marking were trapped or field- collected and maintained in laboratory cages where they were provided 10% sucrose and squares as food for $\geq$2 days prior to release. Weevils were marked with selected colors of fingernail polish applied to the caudal area of the elytra. The hardened polish essentially eliminated the ability of the weevil to fly. This experiment was repeated 7 times between 4 and 21 June.

Three mechanical sampler modifications were evaluated for their effect on efficiency. The modifications were: 1) ground speed (1.2 vs. 2.5 mph); 2) nozzle air speed (8,400 vs. 9,400 ft/min) and; 3) surface area of receptacle (78 vs. 108 in^2). The surface area of the receptacle (6 in. W X 18 in. L) was reduced by covering the upper 5 in. of the mouth with a sheet metal baffle. Four 10-m long sections of row were sampled by each paired modification on each sample date. Weevils marked as previously described (10/row) were released on each row 2-3 hours prior to sampling. Each paired comparison was repeated 7-8 times between 3 July and 13 Aug.

Efficiencies of sampling methods and modifications were compared by analysis of variance or regression analysis, using the SAS procedures PROC GLM or PROC REG, respectively (SAS Institute, 1988). Means of analyses of variance were separated using the Duncan option of PROC GLM.

Results

The comparison between mechanical and drop cloth sampling techniques was performed in cotton with the following phenological characteristics (from 5 July to 15 Aug.): mean height, 10.9-22.8 in.; mean squares ($\geq$1/3 grown)/plant, 0 (5 July), 3.3 (maximum on 5 Aug.), 0.9 (15 Aug.). Presence of bolls were first observed on 5 Aug. There was no significant difference in the number of adult boll weevils collected by the two methods (mechanical sampler mean=6.3, drop cloth mean=5.7; $F=2.21$; df=1, 336; $P=0.14$). Capture varied significantly among days ($F=15.2$; df=23, 336; $P<0.01$) and there was a significant day by method interaction ($F=3.72$; df=23, 336; $P<0.01$) indicating that temporal changes in sampling efficiency differed between the two methods. The number of adult boll weevils collected with both sampling methods increased through time (Fig. 1). Further, the trends were similar for both methods except for a period between days 220-224. Collections by the mechanical sampler indicated a population peak during this period that was not detected by the drop cloth. This difference may have produced the significant day by method interaction.

During the experiment to determine the effect of fruit presence on mechanical sampler efficiency (4 to 21 June) mean plant height ranged from 13.0-22.3 in.; mean squares/plant from 2.4-6.4 and; mean total fruit/plant from 4.9-8.2. Collections of unmarked weevils differed significantly among sampling methods ($F=29.95$; df=2, 65; $P<0.01$). Weevils collected from the stripped fruit accounted for 56.1% of the total collection even though both mechanical and drop cloth samples were taken immediately before fruit were removed (Table 1). Mechanical sampling, which occurred immediately prior to drop cloth sampling accounted for significantly more weevils than the drop cloth. A significant difference was also observed among sampling methods in the collection of marked and released boll weevils ($F=39.51$; df=2, 67; $P<0.01$) and fruit stripping accounted for 76.1% of the total weevils collected (Table 1). Although the mechanical sampler collected a numerically higher number of marked weevils compared to the drop cloth, this difference was not statistically significant.

Regression analysis indicated a significant relationship between the number of unmarked boll weevils collected with the mechanical sampler and the total number of weevils collected by combined mechanical, drop cloth, and fruit stripping techniques ($F=162.68$; df=1, 22; $P<0.01$; $r^2=0.88$) (Fig. 2). Assuming the combined collection represents the total population, these data indicate that changes observed in mechanical sampler collections accurately reflected changing boll weevil population levels.

Stripping of fruit 1 day prior to mechanical sampling significantly affected the collection of boll weevils with the sampler (unmarked weevils: $F=18.42$; df=1, 42; $P<0.01$; marked weevils: $F=4.32$; df=1, 42; $P=0.044$). Fruit stripping significantly reduced collection of unmarked weevils and significantly increased collection of marked and released weevils (Table 2). Reduction in collection of unmarked weevils in the stripped plots resulted from a reduction in the population through the stripping process. Collections may have been further reduced by reduction in the attractiveness of this cotton to remaining weevils. Removal of fruit as a refuge, however increased the collection of released weevils by almost 2 fold (Table 2).

Of the 3 mechanical sampler modifications, only 1 (addition of a baffle to the receptacle) significantly increased sampling efficiency of marked and released weevils (baffle comparison: $F=3.29$; df=1, 42; $P=0.002$; air flow comparison: $F=3.41$; df=1, 48; $P=0.056$; ground speed comparison: $F=1.36$; df=1, 55; $P=0.23$) (Table 3). Addition of the baffle improved sampling efficiency by increasing negative pressure (vacuum) at the mouth of the receptacle.

Discussion

These data indicate that in this study, 56-76% of the boll weevil population are located within the bracts of fruit and were not available for collection by the mechanical or drop cloth sampling methods. However, the mechanical sampler was 68.4-75.9% efficient in collecting those weevils not associated with fruit, assuming that the combination of mechanical and drop cloth sampling removed all weevils available to these techniques. The mechanical sampler detects population trends. Thus it is an acceptable sampling technique for obtaining relative population estimates between treatments or fields of similar plant phenology. Further investigations of effects of weather, weevil population age structure, fruit density and infestation rate, plant height, and diel activity patterns of the weevil on mechanical sampler efficiency will be necessary to fully define the capabilities and limitations of this sampling method.

References

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Table 1. Mean numbers of boll weevils collected from 25 m of cotton row sampled with tractor mounted sampler followed by drop cloth and stripped fruit sampling.

Type of Weevil Collected	Sample Method: Mechanical	Drop Cloth	Stripped Fruit
Unmarked	8.5a	2.7b	13.8c
Marked	1.3a	0.6a	4.8b

Means within rows followed by the same letter are not significantly different (P>0.05, Duncan's Multiple Range Test).

Table 2. Mean numbers of boll weevils collected by tractor mounted sampler from 25 row meters of normal and fruit-stripped cotton.

Type of Weevil Collected	Status of Plants: Stripped	Nonstripped
Unmarked	3.3a	8.5b
Marked	2.1a	1.3b

Means within rows followed by the same letter are not significantly different (P>0.05, Duncan's Multiple Range Test).

Table 3. Effects of sampler modification on collection of marked and released boll weevils by tractor mounted sampler.

	Modification					
	Ground speed		Air flow		Baffle[1]	
	High	Low	High	Low	With	Without
No. Marked Weevils Collected	2.6	3.1	2.6	1.9	3.0	2.2

[1]Significantly different at P=0.002 level.

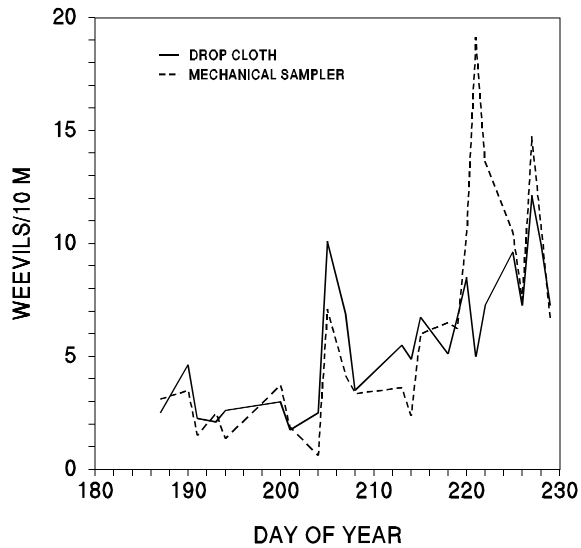

Fig. 1. Comparison of boll weevil population estimates by mechanical and drop cloth sampling techniques.

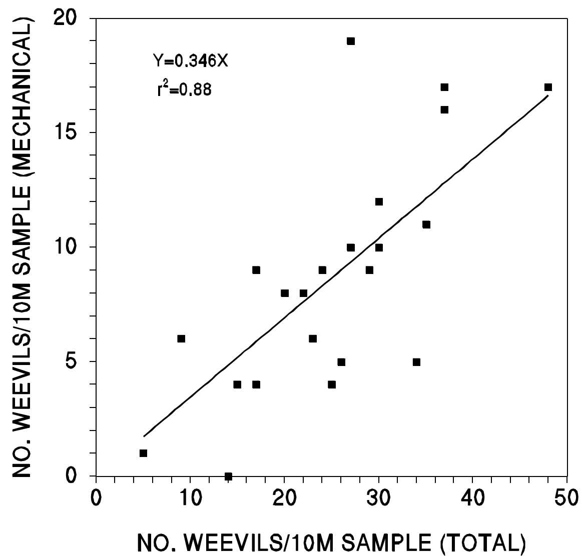

Fig. 2. Relationship between mechanical sampler collections of boll weevils and total numbers of boll weevils collected by mechanical, drop cloth, and square stripping techniques.