DETECTING OVERWINTERED BOLL WEEVILS[1/] IN COTTON

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ABSTRACT

Overwintered weevils infesting cotton at different levels were sampled in nine fields beginning at initiation of squaring. Probabilities for detecting the insect with various numbers of samples were developed from the data. Infestations of about 250 per ha (100 per acre) required the examination of four 30.5 m rows (four 100 ft rows) for about 95% certainty of detection. A level of 463 per ha (187 per acre) required two rows for the same probability.

INTRODUCTION

In the late 1940s and early 1950s a scheme for boll weevil, *Anthonomus grandis* Boheman, management for cotton on the Blackland Prairies of Texas was developed by Ewing and Parencia (1950). Essentially an old strategy (entomologists of the first years of this century attempted the same thing by mopping cotton that was just beginning to square with a conglomeration of syrup and various arsenicals; and by gathering and destroying the first fallen and infested squares) this approach utilized the new, and highly effective, organochlorine insecticides for overwintered weevils. One or two applications of these chemicals were to be made around the time of first one-third grown squares. From what was known then of the colonization by the overwintered generation on cotton, these treatments were expected to kill the preponderance of the brood surviving the winter, reducing then the size of the later summer generations of the pest. The need to treat for the later generations, following this logic, would be eliminated or lessened. And in many years the limited insecticide treatments did just that. Later studies showed that successful management of weevils by the early treatments was the product of limiting oviposition by the overwintered brood so that the first summer generation did not occur in injurious numbers; although damaging numbers of later second generation individuals might occur, the crop would be sufficiently mature to escape major damage (Walker and Niles 1971).

As the years passed, this strategy gained acceptance in other regions of Texas and is considered today as an imperative of integrated pest management. The system often works well; indeed the necessity for expensive multi-treatment programs of insecticide has been reduced. Still, the strategy is not without fault.

In the first place, there are seasons, and areas, where overwintered boll weevils continue to colonize cotton after termination of two or even three applications (L. Reed Green, personal communication). In this instance summer generation weevils may constitute such a problem that, in addition to the early applications, a number of late-season sprays are demanded. Second, information as to the areas and fields that require overwintered treatment in a given season has been hard to obtain. Obviously, where area-wide treatments are made for overwintered boll weevils, there are those fields that do not need treating, but which do and which do not are difficult to determine.

To consider this latter quandry is to take note of the population expression of the insect as it utilizes the cotton plant as an ovipositional substrate. Small numbers of overwintered weevils, seemingly inconsequential numbers, can in the course of a single generation reach yield damaging levels. Walker and Niles (1971) showed that a population of ca 124 overwintered weevil

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females per ha or about 50 per acre could oviposit sufficiently to produce a yield-damaging first generation: Hence, their work suggested that in order to escape damage from the first generation, numbers of overwintered females should be no more than 124 females per ha or 50 per acre. The study of Parker et al. (1980) supports these findings.

So the problem has been the quantification of tiny numbers of the pest in young cotton: How do you sample so you know with reliability that in the field in question there are less than 124 female overwintered weevils per ha (ca 248 males and females per ha). Since there are over 9790 m of rows in a ha (over 13,000 row ft in an acre) of cotton, it is apparent that the number of cotton plants that would have to be examined to afford a valid statistical estimate of the population size would be enormous, and prohibitive. If it were a matter of estimating 2400-5000 weevils per ha, the problem likely could be handled by sampling. Unfortunately, the threshold for the overwintered pest is far, far lower.

Taking this into account, the publication series of the Texas Agricultural Extension Service for the several cotton producing regions, "Management of Cotton Insects in the ...," recommends the use of insecticides for overwintered boll weevils ... "where weevils are found...". If this seems a less than adequate recommendation, it has emerged as the consensus view, and serves presently to guide the control procedures for overwintered weevils in Texas.

In the present paper we argue that it is not only the size of an overwintered weevil population that is difficult to quantify -- without adequate samples the very presence of weevils can go unnoticed. This paper concerns the probabilities of detecting overwintered boll weevils with various numbers of samples of cotton rows measuring 30.5 m in length (100 ft).

METHODS

During the seasons of 1961-64 in each of nine different cotton fields in the Brazos Valley, we marked off an area that measured ca one square 0.4 ha (one square acre). Cotton here was just initiating squaring. No insecticidal treatments for boll weevils were applied. At each of the nine sites we randomized within the square configurations 60 sections of 30.5 m cotton rows (sixty 100 ft rows). Thus, about one-half of the cotton in these arrangements was included in the marked rows. Each of these rows was then examined and overwintered weevils recorded.

The data were arranged in tabular form, and the frequencies of the various numbers of weevils encountered tabulated. Mean, variance and standard deviation were calculated for each of the nine fields. Data were not transformed. Using the probabilities of 0 counts in the fields, we calculated the probability for encountering 0 weevils where different numbers of rows were examined. That is, if 31 out of 60 rows examined showed 0 weevils, the probability for finding no weevils where a single row was examined would be .52; if two rows were examined the probability would be $.52^2$... for three rows $.52^3$, and so on. This calculation is derived from the expansion of a binominal to the power equivalent to the number of rows examined: a = probability of finding no weevils where 60, 30.5 m rows were examined, b = the probability of detecting weevils in that same examination.

RESULTS

The data in Table 1 show the different statistical calculations. Note the increasing size of the variance with regard to the mean as populations of weevils increase. This suggests a contagion effect, that some influence effecting aggregation took place in certain samples.

Table 2 presents the probabilities for detecting weevils where different numbers of samples were taken. Note that while a two row sample would reasonably mark the presence of weevils where 463 per ha (187 per acre) occurred, that sample would miss the presence of weevils about one-half the time in fields infested with 124 per ha (50 per acre). In such fields six rows would require examination to furnish about 0.9 assurance of finding weevils. For 32 weevils per ha, (13 per acre), even a seven a row-sample would detect the insect only about one-half of the time.

TABLE 1. Frequencies of Numbers of Overwintered Weevil Numbers in Sixty 30.5 m Rows (sixty 100 ft rows) in Each of 9 Cotton Fields.

	Field number								
	1	2	3	4	5	6	7	8	9
Weevils per acre	4.	13.	13.	50.	85	98.	102.	109	187.
Weevils per ha	10	32	32	123.5	209.9	242	253	269.2	463
No of weevils encountered				-Frequency					
0	58	54	54	41	31	34	31	29	19
1	2	6	6	15	22	15	15	19	16
2				4	5	5	10	6	16
3					1	4	4	5	3
4					1	2		1	2
5									3
6									1
Variance	.03	.09	.09	.37	.7	1.16	.90	1.04	2.13
Standard deviation	.18	.3	.3	.61	.84	1.08	.95	1.02	1.46
Mean per 30.5 m (100 ft)	.03	.1	.1	.38	.65	.75	.78	.83	1.43

TABLE 2. Probability for not Detecting Overwintered Boll Weevils in Fields Infested with Various Numbers.

		No. rows examined; 30.5 m (100 ft)						
Weevils per ha	Weevils per acre	1	2	3	4	5	6	7
10	4	.96	.93	.88	.84	.81	.78	.75
32	13	.90	.81	.72	.65	.59	.53	.47
123.5	50	.68	.46	.31	.21	.14	.09	.06
209.9	85	.51	.26	.13	.06	.03	.01	.008
242	98	.56	.32	.17	.09	.05	.03	.01
253	102	.51	.26	.13	.06	.03	.01	.008
269.2	109	.48	.23	.11	.05	.02	.01	.005
463	187	.31	.10	.02	.009	.002	.0008	.0002

Obviously, from the data in Table 2, detecting overwintered boll weevils at the lower populations requires a great deal of sampling, likely a prohibitive amount. In fact, to detect the presence of weevils in a field infested with ca 250 males and females per ha (125 females per ha) the amount of sampling required seems beyond reason considering time and expense. Four rows were required in the present study. Perhaps the recently published system for anticipating injurious levels of the pests with pheromone traps will turn out as a more realistic means to guide the use of insecticidal treatment (Rummel et al. 1980).

LITERATURE CITED

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