INTERACTIONS BETWEEN TRAP PLACEMENT AND BOLL WEEVIL COLONIZATION OF COTTON

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Abstract

Eradication programs rely heavily on pheromone traps, placed in close proximity to cotton (*Gossypium hirsutum* L.) fields, for monitoring populations of the boll weevil (*Anthonomus grandis* Boheman). It is known that such traps do not capture all responding weevils. Thus, trap placement with respect to field borders may influence weevil colonization patterns in adjacent cotton. We examined the influence of trap placement on colonization of early-season cotton in the Lower Rio Grande Valley of Texas. Fourteen replications of paired trap placements (0.8 m and approximately 8 – 9 m from the outermost row of cotton) were established on either the northern or western sides of cotton fields. These sides were selected so traps would be downwind from cotton given prevailing wind direction. Each week, two 20-m row sections centered on each trap were sampled using a pneumatic (KISS) sampler. Plant phenology (vegetative, pinhead square, ≥matchhead square) was also monitored in each sampled row. A given sample area was considered infested if a weevil was recovered from either row. The probability of infestation was modeled using trap position and plant phenology as explanatory variables. Preliminary results indicated trap position did not influence weevil colonization during pinhead and later phenological stages. However, for vegetative plant stages the probability of infestation associated with the close trap placement (0.41) was increased compared to the more distant trap placement (0.12). Therefore, trap placement may play an important role in weevil colonization patterns, and eradication programs may benefit from increasing the distance between traps and cotton.

Introduction

Eradication programs for the boll weevil (*Anthonomus grandis* Boheman) rely almost exclusively on pheromone traps for monitoring weevil population levels. These traps are typically placed in close association with fields of cotton (*Gossypium hirsutum* L.). However, the potential influences of traps on weevil immigration into early-season cotton are unknown. Some evidence suggests that many weevils attracted to the traps are not captured (Ridgway et al. 1976). Snodgrass et al. (1979) estimated that only about 50 – 60% of weevils landing on Leggett traps were subsequently captured, but those estimates ignored weevils responding to the pheromone but failing to land on the trap. Spurgeon (2001) observed weevil response to the bait stick, which is a device that like the trap is baited with a synthetic pheromone lure. Those observations indicated that most responding weevils failed to contact the bait stick. Finally, Mitchell and Hardee (1974) found more oviposition punctured squares in close association with traps placed within the field, compared with areas away from the traps, suggesting the traps attracted female weevils that infested surrounding cotton instead of being captured in the traps.

Traps in eradication programs are often situated within, or immediately adjacent to, the outer rows of cotton. In many cases, such traps could be easily placed across the turnrow to avoid close association with the crop. Our objective was to examine the influence of trap placement, immediately adjacent to cotton or separated from the crop by a short distance, on the probability of early-season infestation by the boll weevil.

Materials and Methods

Experimental Procedure

Studies were conducted in the Lower Rio Grande Valley of Texas using Southeastern Eradication Foundation traps (Technical Precision Plastics, Mebane, NC) and the standard 10-mg pheromone lure (Scentry Biologicals, Billings, MT). Each trap was supported about 1 m above ground level on metal conduit. Weevils were removed from the traps weekly and lures were replaced biweekly.

An experimental replication included two traps, one located 0.8 m outside the outermost row of cotton and the other separated from cotton by the turnrow (about 8 – 9 m). Positions of traps within a replication were separated by about 50 m and were randomly assigned. The distance separating traps was intended to minimize interaction between adjacent traps (Sappington 2002). A sampling area delineated within the adjacent cotton field was associated with each trap. Each sampling area was 20 m long, centered on the trap, and extended seven rows into the field. The 7-row sample areas were further divided into 3-row sets of sample rows (set 1, rows 1-3; set 2, rows 5-7) separated by a buffer row that was not sampled (row 4). Fourteen replications (a total of 28 traps) were distributed among five fields (1 – 4 replications per field). Replications within a field were separated by ≥50 m (measured from the ends of respective sample areas). Replications were situated on either North or West field margins so traps would be downwind from the cotton given the prevailing southeasterly wind direction.

Each week, one row of each row set was selected for sampling with a pneumatic sampler (KISS, Beerwinkle and Coppedge 1998). Sample rows were randomly selected without replacement to avoid sampling the same row on consecutive weeks. During sampling, the sampler moved slowly (about 9 – 12 m/min) to ensure maximal captures of weevils. Contents of the KISS samples were placed in labeled sealable plastic bags and transported to the laboratory where the numbers of collected weevils were counted. Immediately following collection of KISS samples, two plants were examined from each sampled row to determine plant phenology (vegetative, pinhead square, ≥matchhead square). Because the observed response to trap placement may be influenced by wind direction, monthly weather summaries were obtained from the National Weather Service (Preliminary Local Climatological Data for Brownsville, TX; available at http://www.srh.noaa.gov/bro/climate.htm). In addition, wind direction was noted at the time of sampling. Data were subsequently excluded from analysis when the predominant wind direction on either the day before sampling, or the day of sampling, was parallel to the trapped field margin or resulted in traps being on the upwind side of the field.

Traps were installed one week before the first sampling. Sampling was initiated when plants were at least 4 – 6 cm in height, and was terminated at or immediately before first bloom. The first samples were collected on 30 March, and the last samples were collected on 5 May, 2005. Because all fields were not planted at the same time, only 9 replicates were sampled on the first sampling date, and 13 replicates were sampled during the final week.

Statistical Analysis

The collection data were analyzed by mixed-model ANOVA specifying a binomial distribution in PROC GLIMMIX (SAS Institute 2003). For the purpose of analysis, if one or more weevils were collected from either sampled row in a sample area, the sample area was considered infested. Thus, we modeled the probability of sample area infestation with presence or absence of weevils as the response variable. Fixed model effects were trap distance from cotton and plant phenological stage. Random effects included field, site nested within field [site(field)], and week of sampling. Because the factor of plant phenology was nested in other effects, the term phenology(field*site*wk*trap-distance) was included as a random term. Degrees of freedom were adjusted using the Kenward-Rogers correction (DDFM=KR) and simple effects within interactions were examined using the SLICE option of the LSMEANS statement. Because analysis using the binomial distribution uses a logit link function, the ILINK option of the LSMEANS statement was used to obtain probabilities and associated approximate standard errors in the original metric.

Results and Discussion

Data from the 5th week of sampling (27 April) were excluded from analysis because of north winds associated with passage of a cold front. Also, northeasterly winds during the last week of sampling (4 May) resulted in usable data from only six of the replications.

Analyses did not provide statistical evidence that trap distance ($F = 0.00$; df = 1, 92; $P = 0.98$) or plant phenological stage ($F = 0.70$; df = 2, 20.01; $P = 0.51$) influenced the probability of sample area infestation. However, the test of the trap distance*phenology interaction was inconclusive ($F = 2.65$; df = 2, 92; $P = 0.08$). Examination of simple effects contained in this interaction indicated no differences in the probability of plot infestation among plant phenological stages for either trap distance (adjacent to cotton, $F = 1.34$; df = 2, 38.54; $P = 0.27$; separated from cotton, $F = 0.75$; df = 2, 37.01; $P = 0.48$). Likewise, no significant influence of trap placement was detected when cotton plants were in pinhead or matchhead and later stages (Table 1). However, differences between trap placements in the probability of infestation were detected during the vegetative plant stage (Table 1).

Absence of differences among plant stages in the probability of infestation does not reflect seasonal patterns of weevil colonization because most of the sample areas received at least one insecticide application for overwintered weevils. In addition, collection efficiency of pneumatic samplers is known to diminish with the presence of fruit (Raulston et al. 1998). Such diminishing sampling efficiency would mask differences among plant stages, and would also decrease the ability to detect differences associated with trap location at the later stages of plant development. In addition, considerably less data were collected when plants were fruiting compared with the vegetative plant stages. This was partially a consequence of the rapidity with which plants proceed from the pinhead to matchhead and later stages, and partly because unfavorable wind directions resulted in the exclusion of much of the data during the last two weeks of sampling. Still, at least some evidence of a trap placement effect on boll weevil colonization of vegetative stage cotton was found. If this evidence were correct, then a trap position immediately adjacent to the cotton crop would seem to enhance weevil colonization. A plausible explanation for this effect would be that some weevils that responded to the pheromone but failed to land on or be captured by the trap instead alit on nearby cotton plants. These results are clearly preliminary and additional data collection is planned. If additional study confirms the observed influences of trap placement on weevil colonization, eradication program operations may be enhanced by avoiding trap placement directly on field margins when possible.

Table 1. Estimated probabilities (±SE) of cotton plot infestation by boll weevil adults corresponding to pheromone trap placements adjacent to (near) or separated from (far) the field margin, Lower Rio Grande Valley of Texas, 2004.

Cotton Phenology	Trap Location	Probability of infestation	*F*-value	df	*P*-value
Vegetative	Far	0.119 ± 0.092	4.14	1, 92	0.04
	Near	0.412 ± 0.185			
Pinhead	Far	0.413 ± 0.177	0.13	1, 66.7	0.72
	Near	0.353 ± 0.164			
≥Matchhead	Far	0.364 ± 0.188	1.31	1, 92	0.26
	Near	0.112 ± 0.123			

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