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BOLL WEEVIL TRAP CAPTURES AS A FUNCTION OF DISTANCE FROM BRUSH LINES

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Abstract

Programs to eradicate the boll weevil (*Anthonomus grandis* Boheman) rely heavily on pheromone traps for population monitoring and detection. Therefore, changes in protocols that improve trapping effectiveness would contribute to eradication efforts. We previously observed that association of traps with prominent vegetation resulted in increased weevil captures. However, the distances over which these effects occur are unknown. We examined the influence of trap distance from brush lines on captures in the Lower Rio Grande Valley of Texas. Each experimental replication (six traps) included traps established at 0, 10, and 20 m from both upwind and downwind edges of a brush line. Traps within a replication were arranged in a line oriented NE to SW in order to minimize competition among traps given prevailing southeasterly winds. The experiment included 10 replications, established 13 October 2004 and serviced weekly until 2 February 2005. Trapping data were analyzed using mixed-models ANOVA with trap position (upwind, downwind), trap distance (0, 10, 20 m), and their interaction as fixed effects. Mean weekly captures in traps on upwind sides of brush lines (13.6 weevils) tended to be higher than on downwind sides (11.6 weevils) but those differences were modest. More importantly, mean weekly captures of traps closely associated with brush (0 m, 18.4 weevils) were about twice those of traps at 10 (9.7 weevils) or 20 m (9.6 weevils) from the brush lines. These results suggest that trap effectiveness may be enhanced if traps are associated with prominent vegetative features when they are available.

Introduction

Eradication programs for the boll weevil (*Anthonomus grandis* Boheman) use pheromone traps as the primary means of detecting weevils and indicating the need for insecticide applications. However, relatively high sustained wind speeds in the Coastal Bend and Lower Rio Grande Valley production regions often interfere with the ability of traps to capture weevils. Consequences of reduced trap effectiveness may not be severe in the initial years of active programs because during those times weevil captures are generally high. In contrast, successfully avoiding or counteracting such negative environmental influences on the traps could be critical during the later years of active programs, or to maintenance programs. Thus, methodology to improve the effectiveness of traps should result in improved efficiency of eradication and maintenance efforts.

One area offering potential for improvement in trapping programs is trap placement relative to vegetational features. Spurgeon et al. (1998) showed that captures of weevils were increased when traps were closely associated with a variety of prominent vegetational structures compared with traps placed in more open areas. Sappington and Spurgeon (2000) reported that at least a part of this effect arose from moderation of wind speeds on the downwind sides of such structures. Neither of these studies investigated the distances over which the vegetational structures may exert influence. Therefore, our objective was to examine the relationship between trap captures and distance of the trap from prominent vegetation.

Materials and Methods

Experimental Procedure

Studies were conducted on the Russell Plantation near San Benito, TX, taking advantage of their extensive system of drainage canals that are lined by prominent vegetation (brush lines, predominantly mesquite and acacia). The factors investigated were trap location (upwind, downwind) and distance from the brush lines (0, 10, or 20 m). Thus, each experimental replication included six traps, and the study included 10 replications.

Depending on wind direction, wind speed, and trap spacing, adjacent traps within a line may interact, thereby influencing their respective captures (Sappington 2002). We arranged traps so as to minimize these interactions given a prevailing southeasterly wind direction. Within each replication, traps were arranged in a line oriented approximately perpendicular to prevailing winds (the line was oriented from SW to NE; 45±5° from magnetic North). To achieve this goal, trapping sites were restricted to brush lines oriented from 0 – 20° of magnetic north. Three areas of the plantation met these criteria and offered sufficient space to establish three or four adjacent trapping sites. Each of these areas was considered a block (designated as a group of replicates) in the experimental design. Because the orientation of different brush lines differed, distances between traps within respective replications ranged from 14 – 29 m. Replicates within each group were separated by ≥200 m to minimize the opportunity for interaction between replicates.

Southeastern Eradication Foundation traps (Technical Precision Plastics, Mebane, NC) were established on 13 October, 2004, and trapping continued until 2 February, 2005 (a total of 16 weeks). Each trap was supported about 1 m above ground level on metal conduit, and was baited with a standard 10-mg pheromone lure (Scentry Biologicals, Billings, MT) that was replaced weekly. Traps placed immediately adjacent to the brush lines (0 m) were located in small clearings (1 – 1.5 m radius) that were maintained clear of upright vegetation.

Each week, weevils were transferred from the traps to labeled vials of 70% isopropyl alcohol, and were subsequently counted in the laboratory. Traps were also examined for interference by spider webbing or predators. Data from traps obstructed by spider webs, containing weevil parts indicative of losses to predators, or that were knocked down by farming operations were excluded from statistical analysis.

Statistical Analysis

The numbers of boll weevils captured each week were analyzed by mixed-model ANOVA using the SAS procedure PROC MIXED (SAS Institute 2003). The ANOVA model contained fixed effects of trap location (upwind, downwind), trap distance from the brush line (0, 10, or 20 m) and their interaction. Groups of traps, replications nested within groups, and week of trapping were all random effects. Degrees of freedom were adjusted using the Kenward-Rogers correction (DDFM=KR option of the model statement), and differences among least-squares means corresponding to trap distances were separated using the Tukey-Kramer adjustment to control the Type I error rate (ADJUST=TUKEY option of the LSMEANS statement). Simple effects within the interaction of main effects (comparisons among trap distances within trap locations; comparisons between trap locations within trap distances) were examined using the SLICE option of the LSMEANS statement. Contrasts were used to compare weevil captures among levels of significant simple effects. Results are reported as least-squares means of weevils $trap^{-1}$ wk^{-1} ± SE.

Results and Discussion

Of a total of 960 observations, 50 were discarded because of interference by spiders or other predators, or because traps were knocked down. The numbers of weevils captured in traps were significantly influenced by trap location (upwind, 13.6 ± 4.2 weevils wk^{-1}; downwind, 11.6 ± 4.2 weevils wk^{-1}; $F = 5.76$; df = 1, 880; $P = 0.02$) and distance from the brush line (0 m, 18.4 ± 4.2 weevils wk^{-1}; 10 m, 9.7 ± 4.2 weevils wk^{-1}; 20 m, 9.6 ± 4.2 weevils wk^{-1}; $F = 49.94$; df = 2, 880; $P < 0.01$). However, the trap-location*trap-distance interaction ($F = 4.50$; df = 2, 881; $P = 0.01$; Table 1) indicated the effects of trap distance from brush varied with trap location. Examination of simple effects indicated that trap distance exerted a significant influence on numbers of captured weevils both upwind ($F = 39.16$; df = 2, 880; $P < 0.01$) and downwind ($F = 15.79$; df = 2, 881; $P < 0.01$) of the brush. In both cases, captures by traps placed immediately adjacent to the brush lines were nearly twice as high as those of traps separated from brush (Table 1). Also, captures of weevils by traps closely associated with the brush lines (0 m) tended to be higher on the upwind side of the brush compared with the downwind side ($F = 10.80$; df = 1, 880; $P < 0.01$; Table 1), although these differences were comparatively modest. Similar influences of trap location were not demonstrated at other distances from the brush lines (10 m, $F = 0.87$; df = 1, 881; $P = 0.35$; 20 m, $F = 3.52$; df = 1, 880; $P = 0.06$).

Although the influences of wind speed moderation demonstrated by Sappington and Spurgeon (2000) were clear, those effects were restricted to periods when winds were ≥10 km/h, and also varied with the density of adjacent brush. Our observations were not separated into groups by wind speed values, but rather represent a composite of conditions occurring over the entire study period. Spurgeon et al. (1998) also found increased trap captures for traps associated with several types of vegetation despite trapping both upwind and downwind sides of studied habitats. Therefore, our findings of increased captures on upwind, compared with downwind, sides of brush lines suggest vegetative influences beyond those caused by wind speed moderation. One plausible explanation for increased captures on upwind, compared with downwind, sides of brush lines would be that weevils during the fallow season either inhabit these prominent vegetative features, or are using them as movement corridors. In either case, because the pheromone from lures is displaced downwind, upwind traps should have increased opportunity to attract weevils compared with traps on the downwind side. Additional data collection may provide clearer insight into these findings.

Our preliminary findings clearly indicate that association of boll weevil pheromone traps with prominent vegetative features results in increased captures, and that the influences of vegetation are operable over a relatively small spatial scale. Although it seems likely that trap placements that increase the magnitudes of weevil captures may also improve detection efficiency when weevil populations are very small, this association has not been demonstrated. Therefore, additional data are being collected from within the active eradication program. If close association of boll weevil pheromone traps with prominent vegetation leads to improvements in detection efficiency consistent with observed improvements in numbers of weevils captured, current trapping protocols can be modified to maximize the effectiveness of maintenance trapping programs.

Table 1. Predicted mean (±SE) numbers of captured boll weevils corresponding to different combinations of pheromone trap placement (leeward, windward) and distance (0, 10, or 20 m) with respect to brush lines, San Benito, TX.

Trap Location	Distance (m)	Number of captured weevils
Upwind	0	20.8 ± 4.3
	10	9.0 ± 4.3
	20	10.9 ± 4.3
Downwind	0	16.1 ± 4.3
	10	10.4 ± 4.3
	20	8.2 ± 4.3

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