OBSERVATIONS OF BOLL WEEVIL RESPONSE TO THE BWACT

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Abstract

The Boll Weevil Attract-and-Control Tube (BWACT) is a controversial control technology whose role in boll weevil management is poorly understood. This study evaluated how aging of BWACTs in the field influenced weevil mortality and response behavior. BWACTs were assayed after field aging for 0, 1, 3, 5, and 7 weeks. Efficacy against naturally responding weevils was estimated through intense observations in which landing weevils were captured at departure and held to determine mortality after 24 and 48 h. Traps were used to capture weevils for assay by forced contact for 30 sec on the same BWACTs observed in the field, and to obtain weevils for the unexposed controls. Average duration of weevil exposure to the BWACT increased with BWACT age from 1.73 min (0-wk-old) to 7.94 min (7-wk-old). Most weevils remained on the BWACT for <5 min but the proportion of weevils in this group decreased with increasing BWACT age. Mortality by either natural response or forced contact decreased with increasing BWACT age, but a maximum mortality rate of 10% was observed (0-wk-old BWACT, natural response after 48 h). No mortality was observed by any method for BWACTs aged for longer than 1 wk. Seventy-four percent of weevils responding naturally to the BWACT pheromone did not land on the BWACT. Low observed mortality and the failure of most weevils to land on the BWACT raise serious doubts regarding the usefulness of the current BWACT in boll weevil management programs.

Introduction

The Boll Weevil Attract-and-Control Tube (BWACT) is a device that uses a pheromone lure and attractive color to attract adult boll weevils, and a cottonseed-based feeding stimulant to retain the weevils and deliver a malathion toxicant. Reports of BWACT efficacy and even procedures used to evaluate efficacy have spurred controversy (Spurgeon et al. 1998). Because of the many of the assumptions and ambiguities associated with assays evaluating the ability of the BWACT to suppress field populations, Spurgeon et al. (1998) examined the behavior and mortality of individual weevils responding to the BWACT. Their results generated additional controversy and field studies because they indicated the BWACT was not effective against naturally responding weevils, and that the traditional forced contact assay did not accurately reflect the level of BWACT-induced mortality achieved in the field. However, the BWACTs used in their study were stored in the laboratory between observation sessions, and thus were of known age only during initial observations.

The BWACT has recently been suggested as the primary control technology for use by suppression programs in sensitive areas where conventional ULV malathion treatments are impractical or inappropriate. These suggestions have received support from recent projections of BWACT efficacy which were extrapolated from forced contact assays against laboratory strain weevils (Villavaso et al. 1998). Thus, it is imperative that issues surrounding the effectiveness of the BWACT and the appropriateness of these assays be resolved. Objectives of the present study were to better understand the capabilities of the BWACT as a control technology by evaluating the relationship between duration of BWACT aging in the field and mortality and selected behaviors of responding weevils.

Materials and Methods

BWACTs (Plato Industries, Inc., Houston, TX) were obtained during mid-June from Mid Valley Chemical Co., Weslaco, TX. The accompanying product label indicated a manufacture date of April, 1998. Upon receipt, 60 BWACTs were divided into 20 groups of 3. Each group was sealed within two heavy-duty plastic garbage bags, numbered, and stored at 50°F in an environmental chamber until they were placed in the field for aging. Groups of BWACTs were randomly assigned to age classes of 0, 1, 3, 5, and 7 wk of field aging. BWACTs were aged in a mowed, grassy area adjacent to the laboratory in order to minimize contamination by blowing soil. Selected groups were placed weekly in the aging area, beginning with a 7-wk aged group on 22 June, such that all age groups could be assayed simultaneously during the four weeks between 10 August and 4 September. The 0-wk groups were not placed in the field until the respective weeks of their assay.

Field assays of naturally responding weevils were conducted using two or three individual observation stations separated by about 50 m on a canal bank in the vicinity of a plowed cotton field. Observation sessions were conducted between 0900-1100 h and 1300-1500 h. During initial assays, both BWACT age, and individual BWACT within age class, were selected randomly without replacement for each 1.5 to 2 h observation session. On later dates, preference was afforded age classes for which sample sizes were smallest. BWACTs were baited with 60-mg BWACT pheromone lures which were maintained in a freezer to prevent pheromone loss when not in use. Each observation station was manned by two or three observers, positioned equidistantly around and about 4-5 m from a single BWACT, who recorded the landing of responding weevils, timed the duration of weevil exposure, and captured

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departing weevils. Captured weevils were placed individually with a water-saturated cotton ball in plastic 1 oz. rearing cups with labelled cardboard lids and held in a chilled cooler until they were returned to the laboratory where they were maintained for 48 h at room temperature (-75°F). Mortality was assessed at 24 and 48 h after capture. Because of difficulties associated with measuring exposure of more than one weevil at a time, weevils were included in efficacy samples for which no estimates of exposure were obtained.

Weevils were collected from standard Hercon Scout traps (Hercon Environmental Company, Emigsville, PA) and discarded at the beginning of each observation session, and newly captured weevils were collected at the session end. Trap captured weevils were used in forced contact assays using the same BWACTs observed in the field, and as unexposed controls. Initial observations indicated that weevils introduced directly to the treated portion of the BWACT often fell repeatedly and failed to grasp the treated surface. Thus, forced contact assays were conducted by introducing the weevil to the untreated base of the BWACT and prompting the weevil to walk onto the treated surface. During these assays, weevils were allowed 30 sec of exposure to the BWACT after which they were removed with forceps. Weevils occasionally flew from the BWACTs and in those instances timing was stopped until the respective weevils were recaptured and reintroduced to the BWACT. Forced-contact and control weevils were held and assessed using the same procedures as for those from the natural response assay.

On seven dates (26-28 and 31 August, 1, 2, and 4 September) the author recorded additional data regarding the proportion of weevils responding to the BWACT but not landing. Weevils flying between the observers and the BWACT and not landing, or landing on the observers, cooler, or soil around the BWACT, were recorded as responding but not landing. In no instance were these weevils observed to subsequently land on the BWACT, although they often continued to fly in the vicinity and even circle the BWACT. Any contact whatsoever with the BWACT was considered as landing.

The relationship between duration of contact and BWACT age for naturally responding weevils was examined in a contingency table (PROC FREQ, SAS Institute 1988) with BWACT age class as rows and exposure time expressed in 5-min classes as columns. Because of low cell counts for most time classes >10 min, the table was collapsed into two time classes (<5 min; >5 min). Sources of differences in the table were interpreted with assistance of the CELLCHI2 option of PROC FREQ (SAS Institute 1988). Extremely low mortality limited statistical analyses that could be applied to the mortality data. Examination of the propensity of responding weevils to land or not land on the BWACT was similarly hampered by low numbers of weevils landing. Thus, analyses of these data consisted of estimation of 95% confidence intervals for the respective proportions (Zar 1984).

Results

Of 275 boll weevils observed to land on the BWACTs, duration of exposure was recorded for 181 weevils. Mean time of exposure appeared to increase with increasing BWACT age (Table 1) although a wide range of exposure times was observed for all ages of BWACT. The contingency table analysis indicated that as BWACT age increased a smaller proportion of the weevils tended to remain on the BWACT for <5 min ($\chi 5=18.815$, df=4, $p<0.01$; Table 1).

Mortality of boll weevils exposed to the BWACTs was extremely low regardless of the method of assay. At 24 h after exposure, maximum mortality was observed for BWACTs that were 0-wk-old for both the forced contact (1.67%) and natural response (5%) assays, while mortality in the controls was 1.04% (Fig. 1). At 48 h, mortality increased only slightly with maxima again occurring for the 0-wk-old BWACTs (forced contact, 6.67%; natural response, 10%; control, 3.13%) (Fig. 2). Three of the four weevils dying in the natural response assay were exposed to the same BWACT assayed on the 1st day of the experiment. Mortality resulted from exposure to BWACTs older than 0 wk only for the forced contact assay (1-wk-old BWACT, 4.88% mortality after 48 h). Confidence intervals computed for proportions of weevils dying from exposure to different ages of BWACT were broadly overlapping with each other and the control.

An average of 74.25% of boll weevils responding to the BWACT pheromone did not land on the BWACT. The proportion of weevils responding but not landing varied among days from 50% (1 September, *n*=6) to 81.1% (27 August, *n*=74). The proportion responding but not landing was >68% on all observation dates when >20 weevils were observed. These estimates were considered conservative because efforts to time and capture landing weevils likely resulted in failure to detect some responding weevils during these activities. Computed confidence intervals for these proportions were all broadly overlapping.

Discussion

Much of the projected potential of the BWACT for suppression of boll weevil populations has been extrapolated from observations of attractiveness of the device relative to traps and estimates of mortality from forced contact assays. Stewart and Williams (1997) reported that adhesive-coated BWACTs captured twice as many weevils as did traps during the early-season. Spurgeon et al. (1998) estimated that adhesive-coated BWACTs captured 2-4 times as many weevils as similarly coated traps. Finally, Villavaso et al. (1998) estimated that 2.2-3.4 times as many weevils were captured on adhesive-coated BWACTs as were captured in conventional traps. However, present observations regarding trends in duration of exposure in relation to BWACT age, combined with the high proportion of responding weevils that did not land on the device, suggest that the BWACT may be repellent to weevils. Thus, estimates of weevil response based on captures by adhesive-coated BWACTs may be overestimates because the adhesive coating would reduce the exposure of the malathion-treated surface. Additional observations of weevil response to uncoated BWACTs relative to response to coated BWACTs and traps will be necessary to determine the extent and importance of any repellency.

The low levels of mortality observed in response to forced contact assays were not consistent with reports of forced contact assays by Spurgeon et al. (1998) and Villavaso et al. (1998). Both earlier studies indicated nearly complete mortality from forced contact with the BWACT. However, only recently has detailed information been supplied regarding the procedure for introducing weevils to the BWACT surface (Villavaso et al. 1998). In both previous studies weevils were introduced directly to the treated BWACT surface. In the present study, weevils were introduced onto the untreated portion of the BWACT and prompted to walk onto the treated surface. This procedure likely allowed a more natural response and may have minimized weevil contact with the toxicant. In contrast, present observations of mortality resulting from natural response were consistent with the only other report of similar assays evaluating the currently produced BWACT (Spurgeon et al. 1998). The combined results of these studies suggest that assessment of mortality supplied by BWACTs is most consistently and accurately achieved by assay of feral weevils responding naturally.

Study results indicate a relatively small proportion of weevils responding to the BWACT ultimately land on the device, and few of the weevils landing are killed. Thus, considerable improvements in current attract-and-kill technology and methods of assay are needed before meaningful evaluation of population suppression by these devices can be accomplished.

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Table 1. Times of exposure of boll weevils naturally responding to BWACTs of different ages

BWACT age (wk)	Mean Exposure Time (min)	SE	*n*	% of Weevils Exposed for <5 min
0	1.73	0.390	47	91.49
1	4.61	1.576	40	80.00
3	8.46	3.028	25	56.00
5	4.90	0.851	29	62.07
7	7.94	2.409	40	57.50

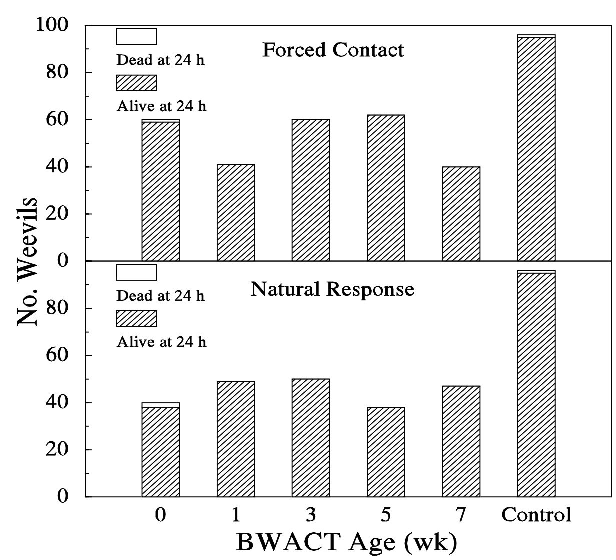

Figure 1. Mortality of boll weevils 24 h after exposure due to field-aged BWACTs by forced contact or natural response.

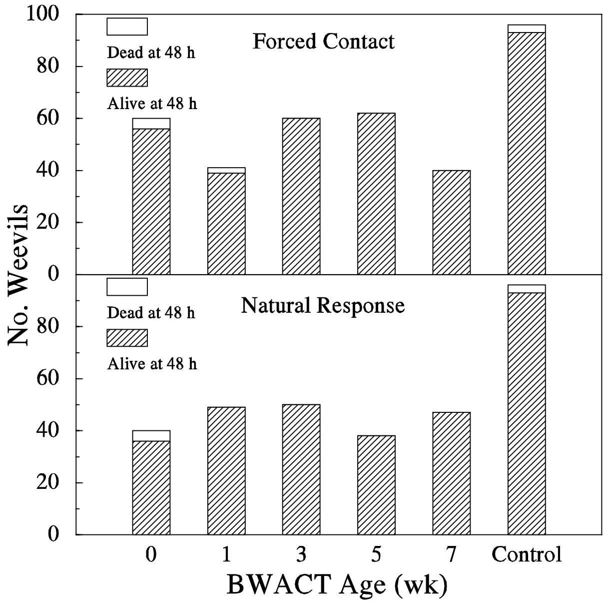

Figure 2. Mortality of boll weevils 48 h after exposure to field-aged BWACTs by forced contact or natural response.