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ARTHROPOD MANAGEMENT

Longevity of Overwintered Boll Weevils (Coleoptera: Curculionidae) On Pre-fruiting Cotton

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ABSTRACT

Field-cage studies have indicated that pre-fruiting cotton (*Gossypium hirsutum* L.) is not nutritionally adequate to support extended longevity of overwintered boll weevils (*Anthonomus grandis* Boheman), but these studies did not separate the respective effects of environment and nutrition on survival. The longevity of trap-captured overwintered weevils fed pre-fruiting cotton under controlled conditions was examined. Weevils held at 24 ± 1°C under a 12:12 [L:D] h photoperiod were supplied water, water plus cotyledon stage plants, or water plus four-leaf stage plants. The longevity of both sexes was similar, and averaged 81.7, 61.8, and 6.8 d for cotyledon stage plants, four-leaf stage plants, and water alone, respectively. Temporal patterns of mortality also differed among the feeding treatments. Longevities were substantially greater than those previously reported, indicating pre-fruiting cotton has greater nutritional value than is generally recognized. These results indicate that factors other than the nutritional status of cotton seedlings likely play important roles in the effectiveness of cultural practices, such as uniform delayed planting. Continued study of the ecology of overwintered weevils should provide additional insights that will permit more effective implementation of early-season cultural practices.

Boll weevils (*Anthonomus grandis* Boheman) typically begin to emerge from their overwintering habitat before cotton (*Gossypium hirsutum* L.) is fruiting (Rummel and Carroll, 1983), and their longevity on these plants is considered limited. For example, average longevity was 8.12 d for overwintered weevils fed pre-fruiting plants (Fenton and Dunnam, 1927). Rummel and Carroll (1985) do not provide estimates of mean longevity, but 60% of weevils fed pre-fruiting cotton died within 10 d. Additionally, 17% of overwintered weevils caged on pre-fruiting cotton survived until the plants fruited, and 3% survived longer than 90 d. These authors concluded the limited longevity was evidence of the importance of cotton pollen for extended survival. The asynchrony between fruiting of the cotton crop and weevil emergence from overwintering, and the limited longevity of weevils on pre-fruiting plants form the basis for the practice of uniform delayed planting, which has been used effectively to reduce early-season populations of weevils in some production areas (Masud et al., 1985; Fuchs et al., 1998).

Despite almost universal acceptance that pre-fruiting plants do not support extended longevity of boll weevils, careful examination of the literature reveals more variation among reports of longevity than is generally acknowledged. In addition to the reports by Fenton and Dunnam (1927) and Rummel and Carroll (1985), overwintered weevils lived an average of 18.8 d when fed cotton seedlings (Smith, 1921). Fye et al. (1959) reported average longevities of 20.2 and 23.6 d in a 2-yr study of weevils fed cotton seedlings, and concluded that the factors limiting longevity were mainly climatic. Overwintered weevils fed cotton terminals without fruit had an average longevity of 23.1 d (Bariola, 1984). All of these studies were conducted under ambient environmental conditions, either in field cages or in outdoor insectaries. Although Fye et al. (1959), Bariola (1984), and Rummel and Carroll (1985) periodically replaced plants, none of these reports clearly indicate the frequency of food replacement or the degree of food deterioration before plants were replaced. In contrast to reports of limited longevity on pre-fruiting plants, breeding colonies of boll weevils were maintained on bundles of cotton seedlings wrapped in parafilm (Sterling et al., 1965; Sterling and Adkisson, 1966), and the mortality of weevils fed cotton cotyledons was reported to be about the same as for those fed squares (Vanderzant and Davich, 1958).

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The variation in environmental conditions and experimental techniques makes comparing studies difficult. Furthermore, the reports of field-cage studies may not accurately indicate the potential longevity of overwintered weevils because caging in the field may restrict weevils to unfavorable micro-climatic or host conditions. The objective of this research was to reassess the potential longevity of trap-captured overwintered boll weevils on both cotyledon and four-leaf stage plants under environmental conditions that were controlled to avoid confounding mortality produced by adverse conditions.

MATERIALS AND METHODS

Between 9 April and 7 May 2001, before fruiting cotton was available, overwintered boll weevils were collected daily from Southeastern Foundation boll weevil pheromone traps (Technical Precision Plastics, Mebane, NC) placed adjacent to overwintering habitat in Burleson Co., TX. Weevils were sexed using the method of Sappington and Spurgeon (2000), and partitioned among three treatments; 1) unfed, 2) one cotton plant with expanded cotyledons per weevil, or 3) one cotton plant with four unrolled leaves per two weevils. Cotton plants (DP 436 RR, Delta and Pine Land Company, Scott, MS) were grown in a greenhouse in 1-L deli trays (PACTIV Corp., Lake Forest, IL). Weevils and plants were held in screened plexiglass cages (20.3 x 30.5 x 35.6 cm) maintained at 24 ± 1°C with a 12:12 (L:D) h photoperiod. Each cage also contained a 22.2-ml plastic water vial with a cotton wick extending through the lid. Three times weekly, dead weevils were removed and sexed, and plants were replaced, maintaining the designated ratio of plants to weevils for each treatment. A thin layer of sand spread on the surface of the soil facilitated the recovery of live and dead weevils.

The experiment was replicated seven times. Within each replicate, 10 weevils of each sex captured on a single day were assigned to each feeding treatment (cage) except in the first replicate. The first replicate contained weevils captured over three consecutive days, with 9 ♂♂ and 10 ♀♀ assigned to the unfed control, and 9 ♂♂ and 11 ♀♀ assigned to each of the fed treatments. Because some weevils were not recovered or were accidentally killed during the experiment, final sample sizes ranged from 7 to 10 weevils of each sex per cage. Sample size was less than 10 for eight of the cages, and less than 9 for two of the 21 cages.

Effects of the treatments on longevity were analyzed using PROC MIXED of SAS (release 8.02; SAS Institute, Cary, NC). The ANOVA model included fixed effects of feeding treatment, sex, and their interaction, and random effects of replication, replication by feeding treatment, and replication by sex interaction. Means were separated using the ADJUST=TUKEY option of the LSMEANS statement. In addition, a two-parameter Weibull function ($P = 1 - \exp[-(\text{days}/b)^c]$) was fitted to mortality data from each feeding treatment using the SAS procedure PROC NLIN, where P is the cumulative proportion of mortality. The estimated parameters b and c define the scale and shape of the Weibull curve, respectively, and are generated using the METHOD=DUD option in PROC NLIN (Popham and Garris, 1991).

RESULTS AND DISCUSSION

The effect of feeding treatment on longevity ($F = 62.74$; df = 2, 12; $P < 0.01$) was significant, but the effects of sex ($F = 1.68$; df = 1, 384; $P = 0.20$) and the feeding treatment by sex interaction ($F = 1.00$; d = 2, 384; $P = 0.37$) were not significant. Additionally, the estimates of replication effects were not different from zero ($P = 0.87$ to 0.97). Mean longevity (±SE) of weevils in the unfed control (6.8 ± 5.01 d; n = 139) was less ($P < 0.01$) than that of weevils fed cotyledon (81.7 ± 5.03 d; n = 133) or four-leaf stage plants (61.8 ± 5.02 d; n = 136). Also, longevity on cotyledon stage plants was significantly greater ($P = 0.04$) than on four-leaf stage plants. The Weibull functions adequately fit the mortality data from each treatment ($R^2 = 0.80$ to 0.95) indicating a high mortality rate in the first week for the unfed weevils compared with fed weevils, and higher mortality of weevils fed plants at the four-leaf stage than weevils fed plants at the cotyledon stage between days 30 and 100 of the survival period (Fig. 1).

Longevities of unfed weevils were similar to those previously reported (Smith, 1921; Wade and Rummel, 1978; Bariola, 1984), but the longevities for fed weevils were much greater than in previous reports. Additionally, although reproductive development of the weevils in this study was not monitored, one egg was recovered from the sand in a cage containing cotyledon stage plants. These results indicate the plant stages examined in this study provide greater nutrition for overwintered boll weevils than is generally recognized, and is consistent with observations by Vanderzant and Davich (1958), Sterling et al. (1965), and Sterling and Adkisson (1966) regarding laboratory cultures of weevils.

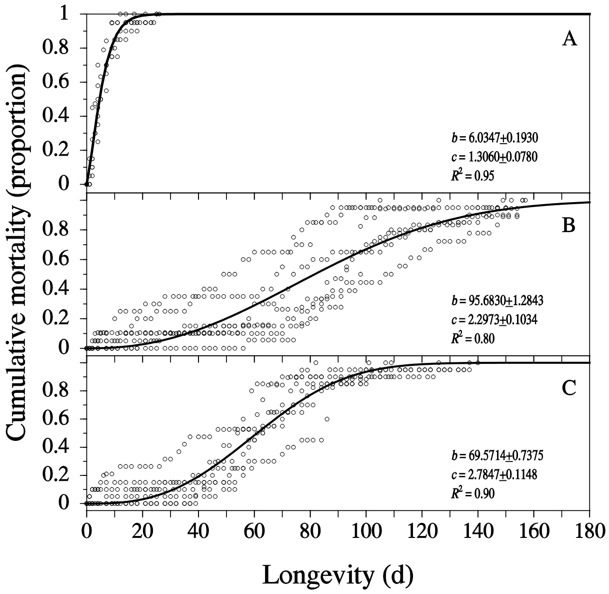

Figure 1. Weibull functions ($P = 1 - \exp[-(\text{days}/b)^c]$) fit to the observed cumulative mortalities of seven cohorts of overwintered boll weevils fed A) water only, B) cotyledon stage seedlings, and C) four-leaf stage cotton seedlings; where *P* = cumulative proportion of mortality, and *b* and *c* ± standard errors are estimated.

The sources of differences between our estimates of longevity and those of earlier reports are uncertain, but likely lie in the differences in environmental conditions among studies, and possibly are related to the degree of damage inflicted on the plants in the respective studies. During the 2- to 3-d feeding intervals, weevils in our study destroyed most of the leaves by severing the petioles. Fenton and Dunnam (1929) reported similar damage in field cages. Such damage likely reduces the acceptability and nutritional value of the host plants, and in a field-cage setting would produce a more hostile environment than intact plants. The extent to which weevils use pre-fruiting plants in the field is not well documented. A small percentage of overwintered weevils have been reported to enter cotton before squaring (White and Rummel, 1978). Reardon and Spurgeon (2003) found substantial numbers of weevils in pre-fruiting cotton, but did not determine if those weevils were resident or transient.

We are not suggesting our results represent the longevity realized by weevils in the field because longevity may depend on prevailing environmental conditions and on the ability or inclination of the weevil to locate and feed on seedling cotton. The demonstration of the longevity of weevils on pre-fruiting cotton implies success of the delayed planting tactic is not entirely explained by the nutritional inadequacy of pre-fruiting cotton. Additional effects of delayed planting, such as decreased survival of boll weevil larvae (Fuchs et al., 1998), may play more prominent roles than are generally recognized. This information, combined with the results of continued study of factors influencing early-season boll weevil population dynamics and survival, could result in extension of the uniform delayed planting tactic to additional production regions.

DISCLAIMER

This article reports the results of research only. Mention of a proprietary product does not constitute an endorsement for its use by USDA.

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