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ASSESSMENT OF PRE-EMPTIVE INSECTICIDE APPLICATIONS AT PINHEAD SQUARE SIZE FOR BOLL WEEVIL CONTROL

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Abstract

Automatic "pre-emptive" insecticide applications for boll weevil, *Anthonomus grandis grandis* Boheman (Coleoptera: Curculionidae), control initiated at pinhead square formation and followed by one or two more applications 3–7 d apart is widely practiced in the Lower Rio Grande Valley of Texas, but the tactic has been controversial for more than 20 years. Using 0.11-ha experimental field plots, this study demonstrated that three pre-emptive applications of cyfluthrin failed to significantly affect square production, boll weevil reproduction, and cotton lint yield. The reasons for the failure of pre-emptive spraying at pinhead square formation are discussed.

Introduction

Automatic "pre-emptive" insecticide applications for boll weevil, *Anthonomus grandis grandis* Boheman, control (Heilman et al. 1979, Gage et al. 1984) in the Lower Rio Grande Valley of Texas that begin at pinhead square formation, followed by one or two additional sprays 3–7 d apart, has been controversial for >20 yr, and it is still widely practiced. In some years when cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter), populations are great, insecticide applications occur to protect the vulnerable pinhead square stage from them (Heilman et al. 1979). Boll weevil populations at that time are presumed to be reduced by the fleahopper spray, or by using formulations that combine insecticides that are active against both fleahoppers and boll weevils. Pre-emptive sprays have been reported to delay late-season spraying by ≤11 d when 15% of randomly examined squares are oviposition-punctured, but significant ($P \leq 0.05$) lint yield differences were not detected (Heilman et al. 1979). Other studies have found that avoidance of boll weevil population build-ups during square production can be achieved by altering planting date (Slosser 1993, 1995, A.T. Showler and R.V. Cantú, unpublished data). The purpose of this study was to examine the sole effects of pre-emptive insecticide spraying on boll weevil oviposition and feeding damage to squares and bolls, and to populations of squares, blossoms, and bolls.

Materials and Methods

The study was conducted in 2003 using the variety DP 5415. A 1.6-ha field at the Kika de la Garza Subtropical Agricultural Research Center in Weslaco, Hidalgo County, Texas, was divided into fourteen 0.11-ha plots, each 24 m wide (row spacing = 1 m) by 47.5 m long. Seven randomly selected plots were treated with pre-emptive insecticide sprays, and the other seven plots were non-sprayed controls. The plots were planted on 10 March. Pendimethalin (Prowl 3.3 EC, Bayer, Kansas City, MO) at 924 g (AI)/ha was applied on 11 March, and weed control was again conducted 7 d later using a rolling cultivator, and by hand-roguing as needed. The plots were irrigated at the start of bloom.

The initial pre-emptive spray was conducted using cyfluthrin (Baythroid, Bayer, Kansas City, MO) at 140 g (AI)/ha on 24 April, when pinhead squares were observed, then two more times at 5-d intervals. The insecticide was applied through 16 Teejet 8003E nozzles, two angled toward each row, at a pressure of 3.5 kg/cm^3 (1.6 liters/min/nozzle) on a tractor boom. No other insecticides were applied to the treated and control plots for the rest of the season.

Numbers of total, non-damaged (clean), oviposition- or feeding-punctured, and damaged (oviposition- and feeding-punctured) non-abscised and fallen squares, and bolls were counted in 4-m sections of row in each plot at 2-wk intervals from 8 May to 2 July. Numbers of cotton plants per 4 m row were counted on 5 and 22 May, before and after pre-emptive spraying, respectively, and near harvest on 21 July. Fallen squares were collected from three randomly selected 1-m-long sections of furrow in each plot. No late-season sprays were used in either treatment. A week before harvest, plots were treated with defoliant, S,S,S,-tributylphosphorotrithioate (DEF, Bayer, Kansas City, MO) at 1.6 g (AI)/ha on 23 July. Cotton was hand-harvested a week later from three randomly selected sections of row in each plot, ginned, and weighed.

Treatment and time effects, and their interactions, for all measurements taken at intervals throughout the growing season were detected using repeated measures analysis (Analytical Software 1998). Treatment effect on yield was analyzed with the two-sample *t* test.

Results

Repeated measures analyses detected treatment effects at $P \leq 0.1$ for numbers of clean ($F = 3.27$, df = 1, 60, $P = 0.0756$) and feeding-punctured ($F = 4.65$, df = 1, 60, $P = 0.0350$) squares. Mean clean squares were most abundant during wk 10–12 (Fig. 1), but populations appeared to be lower in the control than in the pre-emptive treatment. Mean feeding-punctured squares appeared to be greater in the pre-emptive treatment than in the control on week 12 (Fig. 2).

No treatment differences at $P \leq 0.1$ were found for total, oviposition-punctured, and damaged squares; and for total, clean, oviposition- and feeding-punctured, and damaged bolls and fallen squares. Time effects, however, were observed in all categories of non-abscised and fallen squares, and bolls ($F \geq 2.88$, df = 4, 60, $P \leq 0.0300$), and treatment*time interactions were detected for total and clean non-abscised squares ($F \geq 3.10$, df = 4, 60, $P \leq 0.0218$). The control and pre-emptive plots yielded means of 272.5 ± 48.1 and 255.1 ± 44.6 kg cotton lint/ha, respectively, that were not significantly different (F = 0.27), df = 1, 12, $P = 0.7952$). There were no treatment or time effects, or a treatment*time interaction, for plant density.

Discussion

Avoidance of large boll weevil population build-ups by planting early is characterized by greater abundance of bolls in the bottom half of the plant canopy (A.T. Showler, unpublished data). If pre-emptive insecticide applications fail to have a positive effect on the "bottom crop," then they have not protected square production from boll weevil damage. This study demonstrates that pre-emptive sprays had no impact on boll weevil reproduction because differences in mean numbers of oviposition-punctured squares were not detected. Mated female boll weevils fed on match-head squares (2–3-mm-diameter), are 73% less gravid and 79% less fecund than weevils fed on large (5–7-mm-diameter) squares (A.T. Showler and R.V. Cantú, unpublished data). Therefore, feeding on pinhead and match-head squares does not contribute toward the rapid boll weevil population build-ups observed when squares become large (A.T. Showler, unpublished data). Also, boll weevil feeding and oviposition on pinhead squares is negligible compared with damage to squares > 3 mm in diameter (A.T. Showler, unpublished data). Furthermore, boll weevils leave overwintering habitats and enter cotton fields throughout the spring and early summer (Parajulee et al. 1996), so early insecticide application does not protect against overwintered boll weevils after toxic residual effects have been substantially reduced. In the Lower Rio Grande Valley, the effective residual period of the commonly used insecticides for boll weevil control was ≤4 d (A.T. Showler and A.W. Scott, unpublished data).

In terms of square-loss because of boll weevil damage, the numbers of fallen squares, and the numbers that had been punctured by oviposition or feeding, were not statistically different. The number of potentially yielding, or clean, squares was lower in the control plots on two sampling dates, but by the last two sampling dates, clean square populations were similar. Also, the treatment effect was not statistically significant ($0.1 > P > 0.05$). From similar mean populations of clean squares developed comparable numbers of blossoms and bolls, which resulted in similar yields.

Because the significant treatment effect for feeding-punctured squares occurred on a single sampling date, the variability associated with that data was relatively great, and boll weevil damage in cotton fields was generally patchy (Hixson 1936, Guerra 1986), this difference is best explained as a result of sampling error. If the increase in feeding punctured squares was actually widespread, it should have been accompanied by a surge in boll weevil reproduction.

Although pre-emptive insecticide applications have possibly delayed spraying at later-season thresholds based on percentages of randomly sampled squares that were oviposition-punctured, the delays were not statistically analyzed, and in some replications there were no delays (Gage et al. 1984, Walker et al. 1984). Reduction of late-season sprays can likely be better and more reliably achieved by boll weevils populations build-up avoidance through short-season cultivars (Heilman et al. 1979) or early planting (A.T. Showler, unpublished data). Other research suggests that automatic insecticide applications when squares are larger might be more effective at protecting yield (A.T. Showler and R.V. Cantú, unpublished data).

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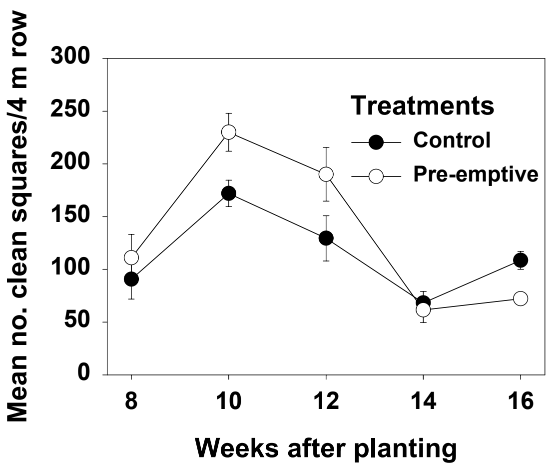

Figure 1. Mean numbers (±SE) of clean (not damaged by boll weevil oviposition or feeding) cotton squares per 4 m row in plots that received pre-emptive insecticide application at pinhead square formation and two more times at 5-d intervals, and control plots, Hidalgo County, TX, 2003.

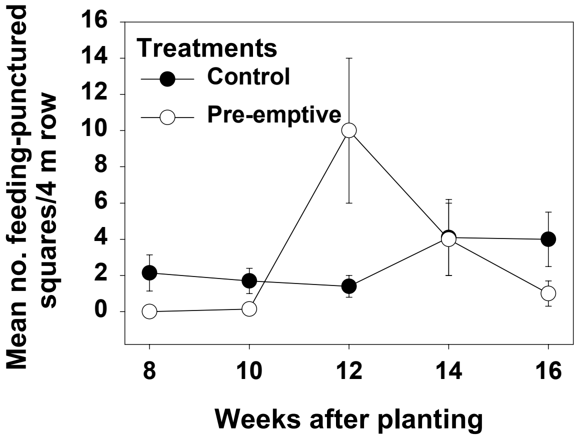

Figure 2. Mean numbers (±SE) of feeding-punctured cotton squares per 4 m row in plots that received pre-emptive insecticide application at pinhead square formation and two more times at 5-d intervals, and control plots, Hidalgo County, TX, 2003.