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Chemical Plant Growth Suppressants for Reducing Late-Season Cotton Bollworm-Budworm Feeding Sites[1]

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ABSTRACT

Late-season vegetative and reproductive growth on cotton (*Gossypium hirsutum* L.) plants contributes little to yield, but provides feeding sites for diapausing insects. Increased numbers of damaging insects result the following season and require intensified control measures. The objective of this research was to evaluate the effect of plant growth suppressants on feeding sites and fall populations of *Heliothis* spp. Various combinations of chlorflurenol (methyl 2-chlor-9-hydroxyfluorene-9-carboxylate) and TD-1123 (potassium 3,4-dichloroisothiazole-5-carboxylate) were applied during late August and early September of 1977 and during early September of 1978. Evaluations were made of insect feeding sites (leaves, squares, and small bolls) in plant terminals, and of bollworm (*Heliothis zea Bobbie*) or tobacco budworm (*H. virescens* F.) larvae and eggs 15 to 25 days after treatment. The chemicals were more effective when applied either as a mixture or in sequence than when used alone. In 1977, feeding sites and bollworm eggs in sequentially treated plots were reduced 50% or more when compared with the control. In 1978 feeding sites were reduced an average of 85% and larval and egg populations reduced an average of 64% at five locations in plots treated with hoth chemicals. Lint yield in most chemically treated plots were reduced, but not significantly except at two locations where reductions occurred at the 10% level of probability; average reduction for all locations was 8.6%. This research indicates that plant growth suppressants can be used effectively to reduce late-season vegetative and reproductive growth and provide benefits in bollworm-budworm control.

Additional index words: **Gossypium hirsutum L., Cotton bollworm, *Heliothis zea* Bobbie, Tobacco budworm, *Heliothis virescens* F., Terminal growth, Chlorflurenol, Methyl 2-chlor-9-hydroxyfluorene-9-carboxylate, Potassium 3,4-dichloroisothiazole.**

COTTON (*Gossypium hirsutum* L.) cultured for maximum yield in the rainbelt area frequently continues to produce squares, flowers, and bolls in the fall. These parts contribute little but provide food for diapausing (overwintering generations) of insects, including boll weevil (*Anthonomus grandis* Boheman), bollworm (*Heliothis zea* Boddie), and tobacco budworm (*H. virescens* F.). New growth in terminals attracts weevil, and provides moth oviposition sites; and the abundance of food for adults and larvae causes increased damage to late-maturing bolls as well as increased overwintering populations which would otherwise remain at low levels (2, 6).

Chemical growth suppressants, or crop terminators, have been evaluated in the mid-South, chiefly for reducing vegetative growth and fruit set as an aid to more efficient harvesting (4, 7). However, chemical crop termination in the Southwest has proved beneficial for reducing overwintering populations of pink bollworm (*Pectinophora gossypiella* Saunders), where loss of squares and immature bolls deprived dispausing larvae of their main food source (1, 3, 4, 5). The objective of this study was to evaluate the effectiveness of chemical growth suppressants in reducing feeding sites and fall populations of the *Heliothis* spp. complex on cotton grown in the Yazoo-Mississippi Delta.

MATERIALS AND METHODS

The 1977 experiment was conducted in Bolivar County, Miss., on Commerce silt loam soil (fine silty mixed non-acid thermic Aeric Fluvaquents). Treatments were compared on the early-maturing cotton cultivar DES 24 and included: 1) an untreated control; 2) Chlorflurenol (methyl 2-chlor-9-hydroxyfluorene-9-carboxylate) (Maintain CF 125)[3] at 0.28 kg/ha applied 24 August, followed with TD 1123[3] (potassium 3,4-dichloroisothiazole-5-carboxylate) at 0.56 kg/ha applied 12 September; and 3) TD-1123 alone at 1.12 kg/ha applied 12 September. Plot size was 12 rows by 332 m (about 0.4 ha). Treatments were replicated three times in a randomized, complete-block design and chemical applications made with a high clearance ground sprayer adjusted to discharge 224 liters/ha. Plots were evaluated 22 September for differences in number of feeding sites in plant terminals, and for bollworm-budworm egg deposition. Data were obtained from 100 plant terminals per plot on the number of new leaves, worm-damaged leaves, squares, worm-damaged squares, and bollworm-budworm eggs.

In 1978, chemical crop termination was evaluated at five test sites in Bolivar and Washington Counties, Miss. Crop conditions at the various sites dictated the experimental designs. Experiments were replicated four times except at sites 1 and 2; plots at these sites were smallest and were replicated eight and five times respectively. Plots ranged from four to 12 rows in width, and length varied from 12 to 305 m. Treatments included: 1) an untreated control; 2) chlorflurenol at 0.28 kg/ha combined with TD 1123 at 0.56 kg/ha; and 3) chlorflurenol alone at 0.56 kg/ha. Treatment 3 was omitted at sites 1 and 2. Sites 1, 2, and 3 were located on Bosket sandy-to-sandy clay loam (fine loamy mixed thermic Mollic Hopludalf) with the early maturing cultivar DES 56. Site 4 was on Commerce silt loam with DES 56. Site 5 was on Bosket sandy loam with the Stoneville 213 cultivar.

Rows were 1 m apart at all sites except site 5, in which planting was in paired rows with 1 m between rows and 1.6 m between pairs. Stands were normal production populations of about 100,000 plants/ha. Treatments were applied on 4 September at sites 1, 2, and 3; on 18 September at site 4; and on 19 September at site 5. Applications were made with a ground sprayer adjusted to discharge 224 liters/ha at sites 1 through 4, and 187 liters/ha at site 5. Plots were evaluated 20 to 25 days after treatment for differences in number of feeding sites in plant terminals, and for bollworm-budworm populations. Data

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[3] TD-1123 supplied by Pennwalt Corp., and Maintain CF-125 supplied by EM Laboratories, Inc. Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products that may also be suitable. This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the USDA nor does it imply registration under FIFRA.

Table 1. Effect of chemical growth suppressants on bollworm feeding sites and egg deposition in cotton plant terminals; 1977.

Response (10 days after treatment)	Untreated control	TD-1123 applied: after chlorflurenol†	TD-1123 applied: alone‡
	No./ha($\times 10^{-3}$)§	Reduction from control, %	
New leaves	425	51**	12
Damaged leaves	250	38***	3
Squares	12	60	36
Damaged squares	5	69	0
Bollworm eggs	8	77	4

,* Reductions significant at 0.01 and 0.10 levels, respectively.
† Chlorflurenol at 0.28 kg/ha August 24, followed by TD 1123 at 0.56 kg/ha; 12 September. ‡ TD 1123 at 1.12 kg/ha; 12 September.
§ Counts projected to hectare basis from average stand of 107,500 plant/ha.

were obtained from 50 terminals per plot on number of squares and small bolls, and on larvae and egg populations. Yields were obtained at sites 1, 2, and 3 by hand harvest of 4 m from each of the two center rows, and at sites 4 and 5 by machine spindle harvest of the full length of the two center rows. Standard methods were used for data analysis, and treatment effects discussed are significant at 0.01, 0.05, or 0.10 level of probability.

RESULTS AND DISCUSSION

Treatment effects for the 1977 experiment are summarized in Table 1. Counts per 100 terminals for the untreated control are projected to per hectare levels and data for the growth suppressant treatments are expressed as percent reduction from the comparable control value. The sequential treatment with chlorflurenol and TD 1123 gave reductions of more than 50% in all except worm-damaged leaves, and was the more effective of the two treatments. The lack of statistical significance in the reduced square and egg counts is attributed to field variability.

In 1978 the chlorflurenol-TD 1123 combination effectively reduced the numbers of squares and young bolls in plant terminals by more than 70% at all test sites, with an average reduction of 85% (Table 2). Chlorflurenol used alone was less effective, but gave an average reduction of 70% at sites 3, 4, and 5. The combination treatment significantly (0.10 probability level or less) reduced larvae and egg populations at four of the five test sites, with an average reduction of 64% which was significant at the 0.10 level. Chlorflurenol used alone was less effective and resulted in no significant reduction in larvae and egg numbers. Yields were reduced significantly (0.10 level) at one of the sites by each chemical treatment; average reduction was 8% in the combination treated plots and 9% in the chlorflurenol-alone plots. Neither of these average values were significantly different from the control at the 0.10 level.

These results demonstrate that chemical growth suppressants, applied toward the end of the fruiting period, can effectively reduce fall bollworm-budworm egg and small larvae populations by suppressing development of preferred oviposition sites and depriving larvae of their prime food source. This treatment can be important in the mid-South, where late-season rain may cause a resumption of growth which supports increased insect populations. Of course, dispausing populations do not correlate directly with the populations emerging in the spring because of other factors such as stalk destruction and burial of pupae by fall land preparation. Bariola et al. (1) reported that chemical termination of cotton fruiting reduced dispausing pink bollworm populations by 97% in the fall, and the emerging populations by 40% the following spring. However, additional benefits from chemical growth suppression may include elimination of one or two insecticide applications and, if weather permits, earlier harvesting. These benefits are probably additive in that reduced populations of diapausing larvae, when followed with earlier stalk destruction and plowing made possible by earlier harvesting, should combine to minimize the overwintering populations emerging next season. We therefore suggest that chemical suppression of late fruiting will provide long-term benefits in cotton production through earlier harvest and crop residue disposal, and reduced populations of diapausing bollworm-budworm larvae and emerging adults the following year. In addition, the removal or suppression of vegetative growth in plant terminals may serve as protection from *Heliothis* damage to green bolls located immediately below the terminals. Larvae that hatch from eggs in terminals with a sparse food supply will likely fail to develop sufficiently to damage these bolls, or even to move to areas where these bolls are located.

Reduction of feeding sites through the use of these chemicals can also be expected to reduce overwintering boll weevil populations (6). These insects require a 1 to 3 weeks feeding period in order to accumulate

Table 2. Effect of chemical growth suppressants on fruiting forms and bollworm-budworm populations in cotton plant terminals, and on yield at five test sites; 1978.

Test site†	Untreated control	Chlorflurenol with TD 1123‡	Chlorflurenol alone§
	No./ha($\times 10^{-4}$)	Reduction from control, %	
	Squares and young bolls		
1	15	96**	0
2	37	87**	0
3	9	78*	82*
4	10	71*	54**
5	8	85**	78**
Avg	16	85*	70**
	Larvae and eggs¶		
1	15	87**	0
2	15	67*	0
3	10	32*	23
4	4	44***	21
5	7	39	28
Avg	10	64***	24
	Lint yield		
	kg/ha		
1	1,042	0.5	0
2	1,052	14	0
3	922	10***	0
4	939	11	14
5	1,112	6	13***
Avg	1,013	8	9

,*,* Reductions significant at 0.01, 0.05, and 0.10 levels, respectively.
† Nos. 1, 2, 3 at Stoneville, No. 4 at Merigold, No. 5 at Leland.
‡ Chlorflurenol @0.28 kg/ha, TD 112 @0.56 kg/ha. § Chlorflurenol @0.56 kg/ha. ¶ Counts/50 terminals projected to hectare, basis 10^5 plants/ha. Counts made 20 to 25 days following applications.

enough fat reserves to attain firm diapause, so the elimination of feeding sites should be detrimental to winter survival of large populations.

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