Effect of Reduced Rates of Ethephon on Late-Season Insect Oviposition and Feeding Sites in Cotton[1, 2]

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ABSTRACT Studies to evaluate the effectiveness of low rates of ethephon in removing late-season squares and small bolls from cotton was conducted at Little Rock and Florence, SC in 1988. Ethephon at 0, 0.14, 0.28, 0.56, and 0.84 kg/ha was applied to cotton with terminal regrowth following cutout. Rates of 0.56 and 0.84 kg/ha caused significant abscission of fruiting forms within three days of application. Yield was not affected.

KEY WORDS *Gossypium hirsutum,* 2-chlorophosphonic acid, cotton regrowth, insect control, diapause, boll weevil, ethephon.

Insect management via control of late-season fruiting in cotton (*Gossypium hirsutum* L.) has been studied for several years. Kittock and Arle (1977) used plant growth regulators to terminate fruiting in an effort to eliminate young fruiting structures as a food source for pre-diapausing pink bollworm, *Pectinophora gossypiella* (Saunders) larvae. Hopkins and Moore (1980) terminated late-season cotton growth with thidiazuron (*N*-phenyl-*N'* -1, 2, 3-thiadiazol-5-ylurea) and found significantly reduced boll weevil, *Anthonomus grandis grandis* Boheman, and bollworm, *Heliothis zea* (Boddie) populations.

Ethephon (2-chlorophosphonic acid) is registered to accelerate boll opening in cotton. Cathey and Thomas (1986), in a review of the literature on plant growth regulators, reported that ethephon at 1.12 and 2.24 kg/ha also caused crop termination and induced abscission of young fruiting structures. Henneberry et al. (1988) showed that ethephon application at rates of 1.12, 1.68, and 2.24 kg/ha caused increased abscission of late-season squares and bolls which resulted in smaller boll weevil populations. Rate of boll weevil population growth was also decreased in that study due to ethephon treatment.

Although ethephon applications at levels of 1.12 to 2.24 kg/ha have reduced insect populations, economic considerations warrant investigation of its efficacy at lower levels as a management tool in a diapause control program. Therefore, this study was conducted to determine the effect of reduced levels of ethephon on late-season fruiting structure abscission.

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Materials and Methods

The study was conducted at the Clemson University's Pee Dee Research and Education Center near Florence, SC, and at the USDA-APHIS Witchweed Methods Farm near Little Rock, SC, in 1988. The soil type was a Norfolk loamy sand (fine-loamy, siliceous, thermic, Typic Paleudult) at Florence and a Fuquay sand (loamy, siliceous, thermic, Arenic Plinthic Paleudult) at Little Rock.

'Coker 315' was planted on 3 May at Florence and 22 April at Little Rock. Plant density at both locations was approximately 86,500 plants/ha. Standard fertility recommendations for cotton production based on soil test results were followed at both locations. At Florence, 392 kg/ha of 3-9-18 (N-P_2O_5-K_2O) fertilizer was band applied at planting and 84 kg N/ha (as NH_4NO_3) was sidedressed on 20 June. At Little Rock, 336 kg/ha of 20-0-25 fertilizer was banded at planting and 67 kg N/ha was sidedress applied on 1 June. Additionally at Little Rock, a foliar application of 2.24 kg B/ha was made on 29 June.

Plot size was eight 23 m long rows at Florence and four 12 m long rows at Little Rock. Row width at both locations was 1 m. Treatments in the experiment were ethephon application rates of 0, 0.14, 0.28, 0.56, or 0.84 kg/ha. The applications were made after plant cutout on 13 and 12 September at Florence and Little Rock, respectively. Treatments were applied with a self-propelled ground sprayer at both locations. Ethephon was applied in 59.8 L water/ha with a nozzle pressure of 345 kPa at Florence and 58 L water/ha with a nozzle pressure of 241.5 kPa at Little Rock. Sprayers at both locations were equipped with TX-6 hollow cone nozzles.

No boll weevils were present at either location because the USDA-APHIS Boll Weevil Eradication Program has nearly eliminated this pest from South Carolina. Therefore, the confounding effect of boll and square shedding due to boll weevil damage was not present. Bollworms were below economic levels at both locations and the effect of other insect pests on fruit loss was minimal.

All squares and small green bolls (<2.5 cm diameter) were counted on 10 randomly chosen plants in two center rows after ethephon application at both locations. To ensure uniformity in plant regrowth across treatments, all plants chosen had similar numbers of new leaves at the terminals. Counts were made to determine the initial response of the chemical at 3 days after application. Subsequent counts at 10 and 21 days after application were also made. Seedcotton yield was determined by machine picking two interior rows at Florence on 24 October and hand-picking 3.1 m of row at Little Rock on 20 October.

The experimental design at both locations was a randomized complete block with four replicates at Florence and three replicates at Little Rock. Number of squares, small bolls, total fruiting forms (squares plus small bolls), and yield data were analyzed using analysis of variance. Means were separated using least significant difference (LSD) at the 5% probability level.

Results and Discussion

Daily maximum and minimum temperatures for the two locations during the time ethephon applications and fruiting counts were made are given in Table 1. Although weather conditions were quite similar, Little Rock had slightly greater temperature extremes than Florence. Precipitation was less at Little Rock (31.5 mm) during this three-week period than at Florence (69.3 mm).

Table 1. Daily minimum and maximum air temperatures at Florence and Little Rock, SC during ethephon application and observation period.*

Month	Date	Florence		Little Rock	
		Minimum	Maximum	Minimum	Maximum
		°C			
Sept.	12	17.8	26.1	16.1	29.4
	13	16.1	25.5	15.6	31.1
	14	17.8	27.2	20.6	33.3
	15	22.2	30.0	18.3	27.2
	16	17.8	22.2	17.2	25.0
	17	17.2	22.2	16.7	20.0
	18	18.3	19.4	17.8	22.2
	19	18.9	19.4	20.0	25.0
	20	21.1	23.3	20.0	29.4
	21	22.8	27.2	17.2	30.0
	22	15.0	26.7	13.9	29.4
	23	16.1	26.7	15.0	30.0
	24	18.9	27.8	20.0	32.2
	25	20.0	29.4	18.3	24.4
	26	17.8	26.1	15.6	19.4
	27	13.9	16.7	12.8	25.5
	28	14.4	22.2	15.0	27.8
	29	16.1	24.4	15.0	27.8
	30	17.2	24.4	17.2	26.7
Oct.	1	15.6	23.9	--†	--†
	2	17.2	25.0	--†	--†
	3	21.1	26.1	17.8	24.4
	4	16.1	22.8	14.4	19.4
	Mean	17.8	24.6	16.9	26.6

* Ethephon applications were made on 13 and 12 September at Florence and Little Rock, respectively.
† No temperature data collected due to instrument malfunction.

Because of the earlier planting date, cotton plants at Little Rock had more regrowth at the time of ethephon application than plants at Florence. Fewer bolls and somewhat fewer squares (although not significantly fewer) were on the plants at Florence compared with plants at Little Rock (Table 2, Figs. 1, 2, and 3).

The 0.56 and 0.84 kg/ha levels of ethephon substantially reduced the total number of squares and bolls by three days after application (Fig. 3). Significantly fewer squares were found on plots treated with 0.28 kg/ha at Florence than in the control plots at 3 days after treatment (Fig. 1); however, more than one-third of the squares remained on the plants three days after treatment with that application level. At Little Rock, average square number was not significantly reduced with the 0.28 kg/ha level by 3 days after application (Fig. 1). This low level had no effect on the number of small bolls at either location at the first sampling time (Fig. 2).

No substantial increase in number of squares occurred between days 3 and 10 at either location for the 0, 0.14, 0.56, or 0.84 kg/ha levels (Fig. 1). Square number increased between these dates at the 0.28 kg/ha level only at Florence. This increase, along with a major increase in squares at that level in Florence between

Table 2. Mean squares from analysis of variance for number of squares, bolls, and total fruiting structures per plant measured at 3, 10, and 21 days after ethephon application and seedcotton yield.

Source	Squares	Bolls	Total	Seedcotton Yield
				- X10³ -
Location (L)	2.0	100.7**	75.9	536
Error A	19.3	0.8	20.9	197
Ethephon Rate (E)	197.0**	24.1**	357.5**	22
Day (D)	166.4**	3.7**	219.3**	--
L X E	11.0*	10.4**	8.2	64
L X D	26.5**	0.3	28.3**	--
E X D	3.9	1.2*	3.7	--
L X E X D	9.1*	0.4	10.5	--
Error B	4.4	0.3	4.9	61

*, ** Significant F at $P \leq 0.05$ and 0.01, respectively.

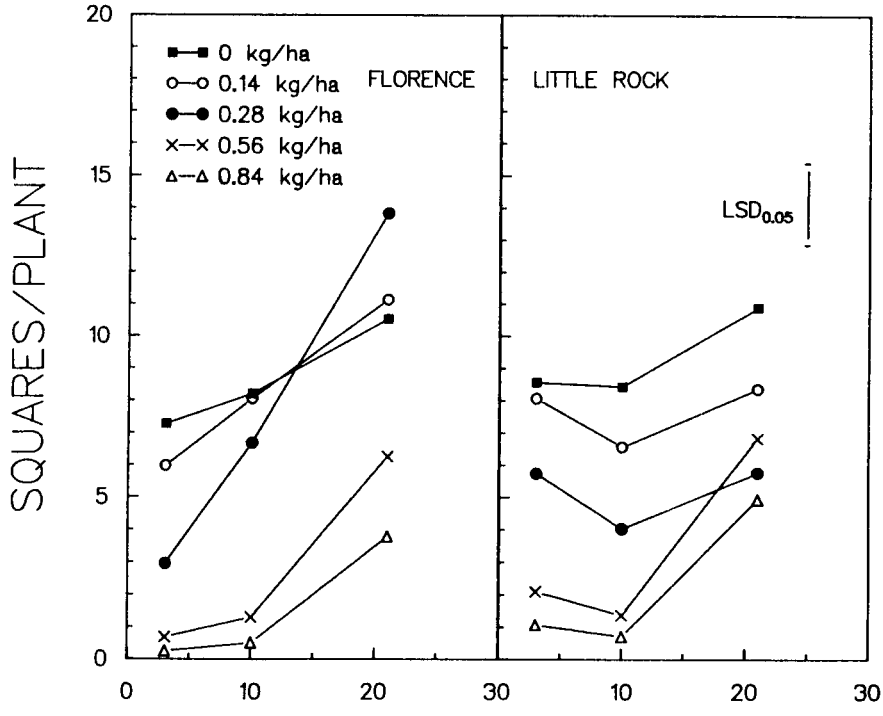

Fig. 1. Cotton squares per plant as influenced by varying levels of ethephon at Florence and Little Rock, SC.

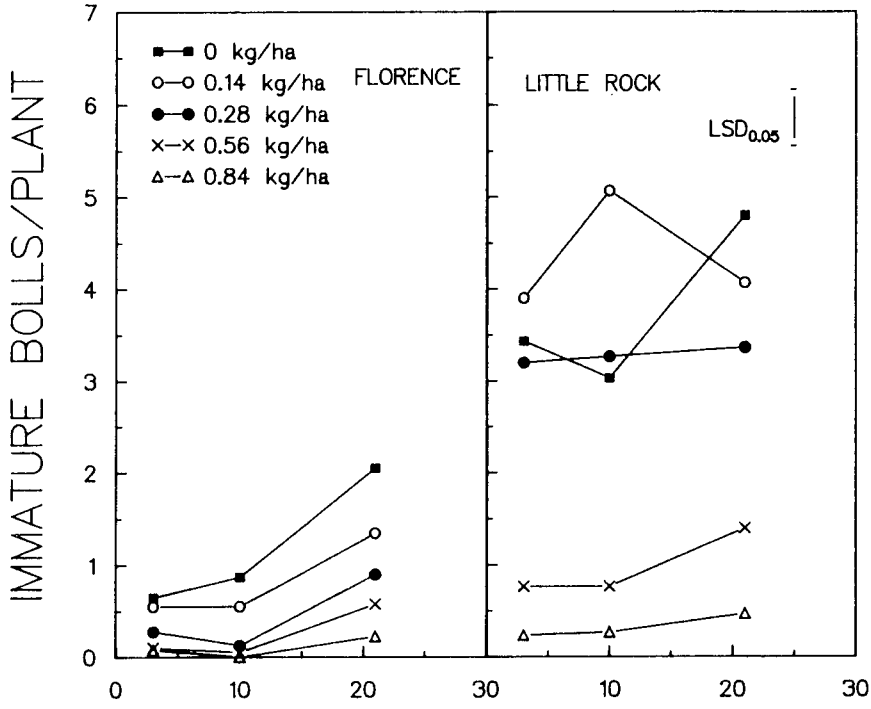

Fig. 2. Unopened cotton bolls (<2.5 cm diameter) per plant as influenced by varying levels of ethephon at Florence and Little Rock, SC.

days 10 and 21 (Fig. 1), appears to be mainly responsible for the Location x Ethephon Level x Day interaction that occurred for both squares and total number of squares and small bolls (Table 2). No increase in squares or total immature fruit with 0.28 kg/ha was found at Little Rock (Fig. 3).

Since the two lower levels of ethephon (0.14 and 0.28 kg/ha) had only a minor effect on square and boll removal, the three-way interaction appears to be of little consequence when considering this product as a management option in an insect control program. Although the two higher ethephon levels (0.56 and 0.84 kg/ha) caused significant abscission of immature fruiting forms, they did not affect the rate of regrowth between days 10 and 21 at either location (Fig. 3). Averaged over both locations for the control treatment (0 kg/ha) between these days, an increase of approximately 3.5 fruiting forms/plant occurred. Between these same dates, the increase with the 0.56 kg/ha level was 5.6 fruiting form/plant and with the 0.84 kg/ha level, the increase averaged 3.2 fruiting forms/plant. Thus, these two levels of ethephon did not appear to cause lasting damage to growing points on the plants nor cause an enhanced regrowth due to elimination of carbon sinks (the abscised squares and bolls) on the upper parts of the plants.

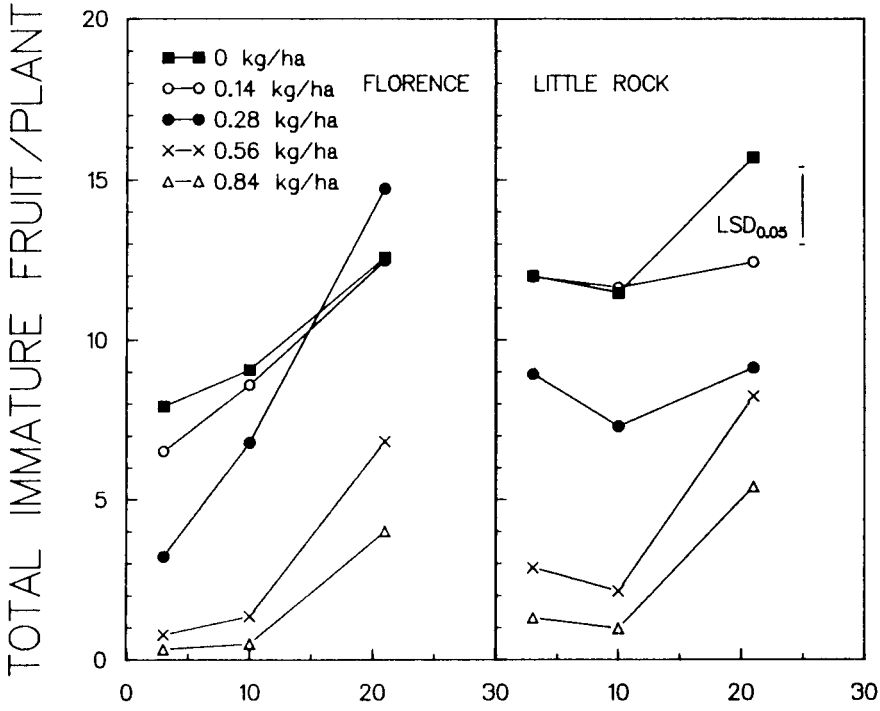

Fig. 3. Total fruiting forms (squares plus unopened bolls, <2.5 cm diameter) per plant available as feeding and oviposition sites as influenced by varying levels of ethephon at Florence and Little Rock, SC.

Treatment of cotton with low levels of ethephon did not significantly alter yield at either location (Table 2). Average seedcotton yields were 973 and 1222 kg/ha at Florence and Little Rock, respectively.

Application of ethephon at levels of 1.12 kg/ha or greater to cotton late in the season has been shown to reduce boll weevil populations in the southwest USA (Henneberry et al. 1988). Our results suggest that levels as low as 0.56 kg/ha can be effective in removing the late season small bolls and squares that would serve as oviposition and feeding sites for these insects in the southeastern USA. However, weather conditions, especially night time temperatures, have a considerable influence on the activity of defoliating chemicals (Cathey, 1986). Since temperatures were high at both locations immediately following ethephon application in our study, the efficacy of low levels of ethephon needs to be determined for less optimal conditions.

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