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Brief Articles

COTTON FLOWERING AND FRUITING RESPONSES TO APPLICATION TIMING OF CHEMICAL GROWTH RETARDANTS[1]

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ABSTRACT

The influence of several chemical growth modifiers on suppression of undesirable late fruiting and on yield of cotton (*Gossypium hirsutum*, L.) was studied in 1972 and 1973. Plant responses were critically dependent on timing of application. With application at first flower, two compounds had no effect on rate of flowering, but reduced boll retention from 3rd and 4th week flowers. A third compound reduced both flowering and boll retention during weeks 4 and 5. Yield was significantly reduced in each case. A fourth compound was evaluated at three dates of application: Jul. 23, Aug. 8 (peak of flowering), and Aug 23. Yield was reduced by treatment at the early and intermediate dates. Treatment Aug. 23 did not reduce yield significantly but effectively suppressed late boll set.

Comparisons of yield responses to growth retardants for both years revealed that the 1973 crop with generally higher yield, was the more sensitive to yield reduction. Application in early to mid-August at peak of flowering reduced yield significantly in 1973, whereas application 2 weeks later did not. Boll weight was reduced somewhat in late opening bolls from plots sprayed at peak of flowering. Thus chemical growth retardants that suppress late boll set may also impair full development of the last bolls that mature. Therefore, application timing is a compromise between the desired earlier termination of fruit set and the possible loss in yield and quality of late-opening bolls.

***Additional index words:* *Gossypium hirsutum* L., Growth retardant, Boll set, Cotton harvesting.**

COTTON (*Gossypium hirsutum* L.) is inherently a perennial which is cultured as an annual. Where high yields are produced, the continued late growth and fruiting that occurs must be suppressed in order to facilitate defoliation and expedite harvesting. To accomplish this, researchers are selecting lines with a more determinate fruiting habit and evaluating chemical retardants for earlier crop termination of established cultivars.

The earlier work with growth retardants for cotton was aimed at reducing plant height at maturity (1, 3, 5). However, recent investigations in the United States have dealt with earlier termination of growth and fruiting (2, 4). In this report, results from experiments in 1972 and 1973 show how growth retardants affected fruiting and yield. The objective was to search for a chemical treatment and application time to induce earlier termination of fruiting without adversely affecting yield. This response should contribute to more efficient harvesting.

MATERIALS AND METHODS

Several compounds were screened for effect on flower and boll production. The more active ones selected for this report were 2-chloroethyltrimethylammonium chloride (chlormequat, CCC); 4,4-dimethylmorpholinium chloride (Experimental BAS 0660, DMC); methyl-2-chloro-9-hydroxyfluorene-(9)-carboxylate (chlorflurenol-methylester, Experimental EMD-IT-3456, CFM); 3,3a-dihydro-2-(*p*-methoxyphenyl)-8*H*-pyrazolo-(5,1-*a*)isoindol-8-one (Experimental DPX 1840); and an analog of DPX 1840 designated DPX 2801.[3] Compounds were applied as foliar sprays at rates based on active ingredient.

In 1972 Experiment I was conducted to compare flowering and boll retention responses to CCC (7 and 14 g/ha), DMC (35 and 70 g/ha), and CFM (17 and 35 g/ha applied at flowering onset. 'Stoneville 213' seed was planted on May 5 in rows 1-m apart on Bosket sandy loam. Plants were thinned to one per 50 cm on Jun 2. With uniform development as a basis, selections were made on Jun 30 for the spray treatments. Compounds were compared, at two rates each plus an untreated control, in a split-plot design with compounds as main plots and rates as subplots, with six replications. Each main plot had three adjacent plants: one was a control and the others received the two rates of the compound. Applications were made on Jul 5 with a CO_2 regulated-pressure sprayer discharging about 224 liters/ha. Plastic shields confined the spray to the plant receiving treatment. Fruiting positions were tagged with dates of anthesis which were transcribed to fruiting diagrams in late September. Data for flowering, boll production, and yield were subdivided for analysis by weekly increments of flowering.

In 1973 Experiment II was conducted to determine how application timing and rate of DPX 2801 suppressed late fruiting of Stoneville 213 in a typical production situation. Nitrogen was applied at the rate of 112 kg/ha. Planting was on May 1 on Bosket sandy loam. Plant population was approximately 120,000 plants/ha. Treatments included three rates, 0.28, 0.56, and 1.12 kg/ha; applied on each of three dates, Jul 26 and Aug 8 and 23; and an untreated control with three replications. The intermediate date coincided with peak rate of flowering. Plot size was four-rows wide (1 m between rows) and 39-m long. Chemicals were applied with a high-clearance ground sprayer discharging 224 liters/ha. The two center rows of each plot were machine-harvested for yield on Oct 11 and again on Nov 17. For determining treatment effect on late fruit set, the bolls remaining on plants after first harvest were counted in four 3-m row segments in each plot.

In 1972 and 1973, Experiment III was conducted to compare the effects of DPX 1840 and DPX 2801 at 1.12 kg/ha, and CFM at 0.125 and 0.25 kg/ha on machine-harvested yield. Treatment effects on maturation of late bolls in 1972 were also investigated. Application coincided with peak rate of flowering (Aug 2, 1972, and Aug 10, 1973) or 2 weeks after this stage. Treatments were randomized in complete blocks with four replications in 1972 and six replications in 1973. Plot size was four-rows wide (1-m apart) and 22.5-m long. Applications were made with a high-clearance ground sprayer discharging 224 liters/ha. For determinations of seed cotton weight and seed density in acid-delinted seed, 50-boll samples of late opening bolls were harvested on Oct 4, 1972 from plot border rows treated with DPX 1840 and CFM, and from adjacent untreated rows. Each seed sample was fractionated after acid delinting on the basis of sinking (mature seed) or floating (immature seed) in water. The two center rows of each plot were machine-harvested Oct 20, 1972, and Oct 10, 1973.

Data were analyzed statistically, and the significance among means was evaluated by Duncan's multiple range test.

RESULTS AND DISCUSSION

With application at first flower, CCC and DMC had no appreciable effect on rate of flowering (Fig. 1-A). However, CFM drastically reduced flowering in weeks 4, 5, and 6. Boll retention was significantly reduced by CCC and DMC in weeks 3 and 4 and by CFM in 4 and 5 (Fig. 1-B). At the most, yields were reduced

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[3] The mention of trade names or formulations is for identification only and does not imply any endorsement by the USDA.

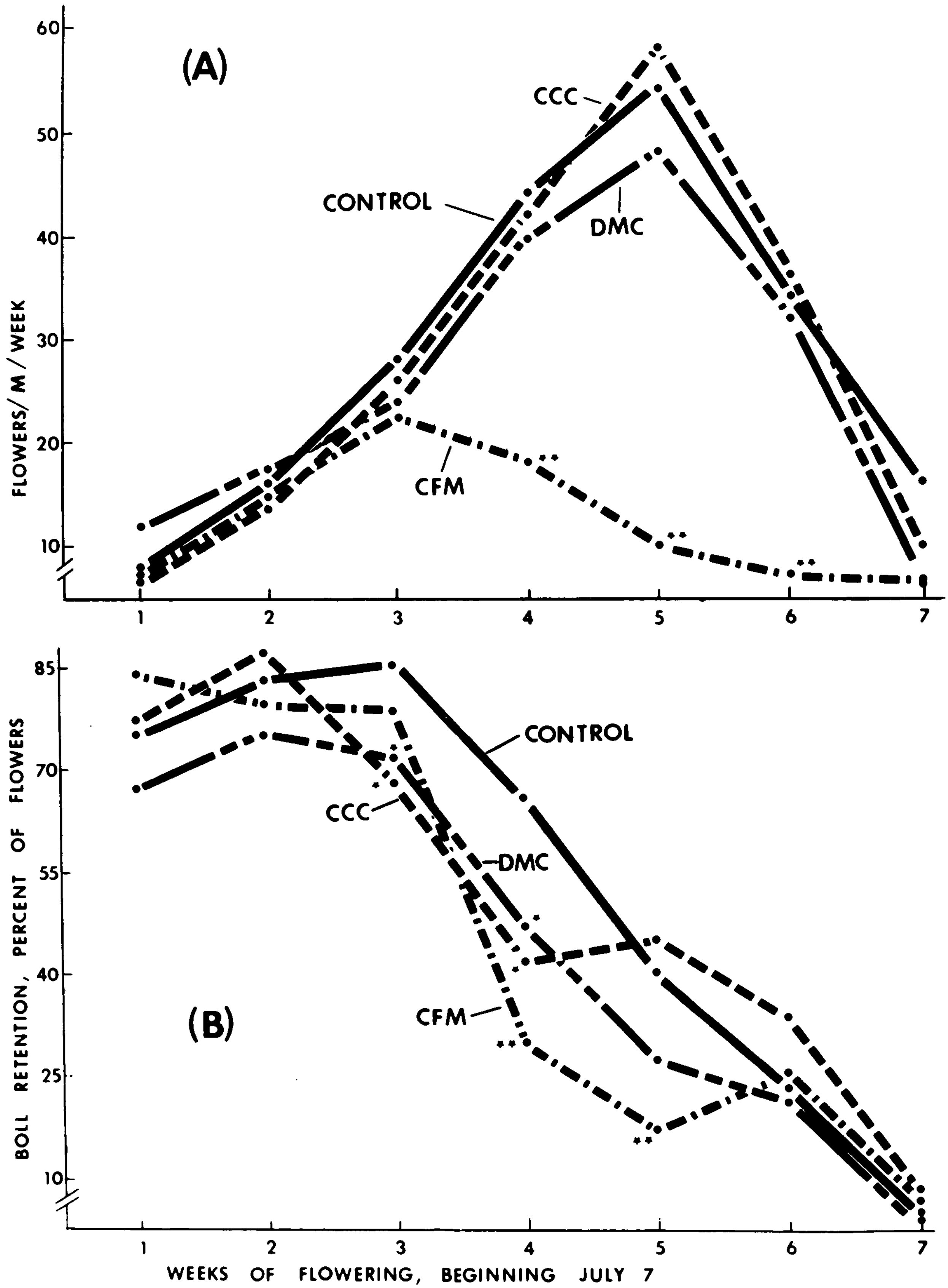

Fig. 1. Influence of CCC at 14 g/ha, DMC at 70 g/ha, and CFM at 35 g/ha, applied Jul. 5 at first flower, on rates of (A) flowering and (B) boll retention. *,** Differences from control significant at P = 0.05 and 0.01, respectively.

Table 1. Influence of application timing and rate of DPX 2801 on late boll set and yield, 1973.

Applied	Rate	Late bolls/† 12 m	Machine-picked seed cotton Oct 11	Nov 17	Total
	kg/ha		kg/ha		
Untreated		165 a*	3,181 a*	665 a**	3,846 a*
Jul 26	0.28	‡	3,033 a	461 c	3,494 ab
	0.56	‡	2,943 a	452 c	3,395 b
	1.12	‡	2,903 a	399 c	3,302 b
Aug 8	0.28	142 ab	3,100 a	570 bc	3,670 a
	0.56	139 ab	2,755 a	559 bc	3,314 b
	1.12	124 b	2,823 a	512 bc	3,335 b
Aug 23	0.28	140 ab	3,298 a	582 ab	3,880 a
	0.56	132 b	3,078 a	573 ab	3,651 a
	1.12	97 c	3,305 a	476 c	3,781 a
CV, %		12	9	9	8

*, ** Means, within a column, followed by the same letter are not significantly different at P = 0.05 or 0.01, respectively. † Opened after Oct 11 (developed from mid and late-August flowers). ‡ Counts not made.

from 15 to 27% by CCC and DMC and 52% by CFM (Fig. 2). CCC and DMC did not suppress flowering under these conditions. CFM suppressed both flowering and boll retention after a delay of 3 weeks following application.

In Experiment II, yields were reduced severely by the Jul 26 applications of DPX 2801 (Table 1). The Aug 8 applications coincided with peak of flowering. Reduction of late boll set was significant with the high rate applied Aug 8, and with both intermediate and high rates applied Aug 23. As the most effective treatment, late application at the high rate reduced bolls 41% compared to the untreated control. Total yield was significantly reduced by intermediate and high rates applied Aug 8, but not by the Aug 23 applications. Earliness was increased by the late application at the high rate, as shown by the higher yield at first harvest and significantly less late crop at second harvest. Both early and intermediate applications were detrimental to yield, whereas late application was both more safe and effective in suppressing late boll set.

Table 2. Summary: application timing effect on yield.

	Rate	Machine-picked seed cotton 1972 PkRF†	1973 PkRF†	1973 + 2 weeks‡
		kg/ha		
Untreated	--	2,860 a*	3,464 a*	3,317 a*
DPX 1840	1.12	2,922 a	3,278 ab	2,996 a
DPX 2801	1.12		2,966 b	3,142 a
CFM	0.125	2,465 ab	3,133 b	3,083 a
CFM	0.25	2,336 b		

* Means, within a column, followed by the same letter are not significantly different at P = 0.05. † At or near peak rate of flowering. ‡ Two weeks after PkRF.

Table 3. Influence of two growth retardants, applied at peak rate of flowering on degree of maturation in late bolls.*

	Rate	Seed cotton Mean	Seed cotton SE	Seed Mean	Seed SE
	kg/ha	g/boll		% sinkers†	
DPX 1840	1.12	3.80	0.23	83.8	5.0
Untreated		4.36	0.17	90.4	3.5
CFM	0.125	3.64	0.20	80.1	4.4
Untreated		4.12	0.17	92.5	3.6
CFM	0.25	3.94	0.17	82.0	3.6
Untreated		4.55	0.27	89.6	4.0

* Terminal or subterminal positions, opened just before harvest Oct 4. † Acid-delinted, dried to 12% moisture, immature seed removed by water flotation, and mature seed (sinkers) redried to 12% moisture and reweighed.

Results of Experiment III are given in Tables 2 and 3. Yield comparisons for treatments at peak rate of flowering show significant reductions only by the higher rate of CFM in 1972, but by both DPX 2801 and a lower rate of CFM in 1973. On the other hand, losses from treatment 2 weeks later (1973) were not significant. Comparisons of seed cotton and seed weights from late bolls in treated and untreated rows (Table 3) show some impaired maturation by DPX and CFM applied at peak of flowering.

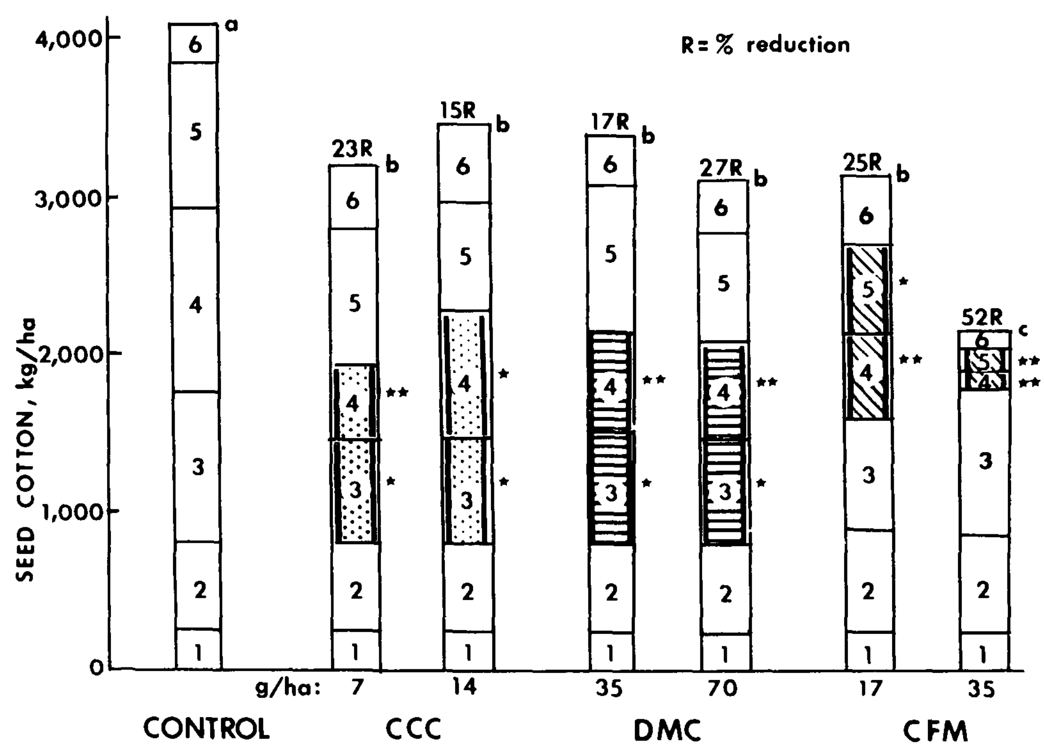

Fig. 2. Effects of CCC, DMC, and CFM, applied at first flower, on yield stratified by contribution from each week of flowering. Shading denotes production significantly less than the control at (*,**) P = 0.05 and 0.01, respectively. Total yields followed by the same letter do not differ significantly at P = 0.05.

These results show that compounds that suppress late growth and boll set may also impair full boll development in the last part of the crop. Therefore, application timing represents a compromise between the desired shorter fruiting period and the possible reduced yield. The best time to apply compounds to a potentially long-season crop with good early fruiting appears to be 10 to 14 days after peak rate of flowering. This allows for the lag between treatment and the desired suppression of flowering by Aug 31. Also, it allows more time for bolls in significant portions of the crop to develop unimpaired. Future studies should measure the impact of earlier crop termination on harvest schedules and quality preservation, evaluate the effects of reduced feeding sites on late insect populations, and determine where growth suppressant compounds localize within the plant.

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HERBIVORE FEEDING ON CYANOGENIC AND ACYANOGENIC WHITE CLOVER SEEDLINGS[1]

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ABSTRACT

Populations of white clover (*Trifolium repens* L.) seedlings consisting of 11% cyanogenic and 89% acyanogenic phenotypes were exposed in the field at four locations to test for selective elimination of phenotypes by herbivores (mainly insects and other small pests). No significant relationship was found between phenotypes and elimination of seedlings by the herbivores.

Additional index words: **Cyanogenesis, Plant adaptation, Phytochemistry, *Trifolium repens* L.**

WHITE clover, *Trifolium repens* L., is polymorphic for the cyanophoric character. Plants that evolve hydrocyanic acid (HCN) after mechanical damage to the leaves are cyanogenic; those without this property are acyanogenic. Evolvement of HCN depends on the presence of cyanoglucosides and the associated enzymes (2). Apparently, the amount of HCN evolved by white clover leaves is below the level dangerous to grazing cattle (3).

Daday found the frequency of cyanogenic plants in wild white clover populations to be near zero in areas near the colder limits of the species and near 100% in frost free areas (5). He proposed adaptative advantages as an explanation for the distribution of the phenotypes (6). Others have reported selective feeding on acyanogenic plants by herbivores, a collective term for slugs, snails, insects, and other pests that feed on white clover (8). However, Bishop and Korn (1) could show no such selective feeding by one species each of snail and slug.

White clover seedlings are especially vulnerable to elimination by herbivore feeding (4). The seedlings are small and the growing point located at the point of attachment of the cotyledons is likely to be destroyed if the cotyledons are eaten. The objective of this test was to determine if herbivore feeding selectively eliminates acyanogenic white clover seedlings from a mixed population.

MATERIALS AND METHODS

The modified Guignard test was used to identify plants that evolved HCN (7). The frequency of cyanogenic seed in a seed lot of 'Tillman' white clover was estimated by classifying 100 seedlings selected at random from plants raised in the greenhouse. Seedlings from the same seed lot were exposed in the late Summer and Fall of 1973 to herbivores in a total of 12 tests located at Blacksburg, Va.; Raleigh, N.C.; Clemson, S.C.; and Mississippi State, Miss. In each test, seedlings from 1-g of seed were exposed to herbivores for a month or longer. The tests at Clemson and Mississippi State included an early and a late planting date.

Two procedures were used to expose seedlings to herbivores. In one procedure, seed were drilled in a row 10-m long in the field. After germination and exposure to herbivores, surviving seedlings were selected at random and classified for evolvement of HCN. In the other procedure, the seed were planted in a wooden flat in a greenhouse. Soon after germination, the flat was moved to the field and positioned so that the surface of the soil in the flat was level with the surrounding soil. After exposure to herbivores, seedlings were classified for evolvement of HCN. The agreement among the authors at the beginning of the experiment was to classify a minimum of 50 plants, preferably more. Therefore, the number of seedlings classified varied from test to test.

Plans for the tests did not include identification of herbivores. The intent was first to determine if selective elimination occurred by exposing seedlings to the array of herbivores at different locations; then, if selective elimination occurred, to proceed with identification of the herbivores involved. To insure the presence of an array of herbivores, sites for all tests were in or adjacent to existing stands of grass or grass-clover.

RESULTS AND DISCUSSION

The results from the 12 tests included in this experiment provide little if any evidence that herbivores feed selectively on acyanogenic white clover seedlings (Table 1). The heterogeneity chi-square value among locations was not significant and the ratio of acyanogenic to cyanogenic plants in the 12 tests differed from that of the unexposed sample only in Clemson test D.

At Blacksburg, herbivore damage was light. At Raleigh, stand losses varied from 30 to 50%. Common

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