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Timing Late-season Fruiting Termination of Cotton with Potassium 3,4-Dichloroisothiazole-5-Carboxylate[1]

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ABSTRACT

A plant growth regulator, Pennwalt TD-1123[3] (3,4-dichloroisothiazole-5-carboxylic acid) was evaluated as a chemical termination agent for reducing fruit set on cotton (*Gossypium* spp.) in 32 tests in Arizona and California from 1974 through 1977. A reduction in immature bolls through chemical termination causes a similar reduction in diapausing pink bollworms [*Pectinophora gossypiella* (Saunders)]. In most tests, TD-1123 was applied in mixture with a persistent plant growth regulator, which was used to prevent plants from recovering from TD-1123 effects and renewing fruiting. The timing of TD-1123 application was found critical for obtaining maximum reduction of immature bolls at harvest and minimum reduction of yield and quality. The formula "harvest date, less average number of days from flowering to boll maturity for that date, plus seven" gave a near-optimum time for treatment. The ratio of the actual number of days from treatment to harvest to the suggested number of days was used to evaluate treatments used in previous tests. Early application (ratio greater than 1) of TD-1123 moderately reduced the yield of southeastern Upland (Delta type) cotton (*G. hirsutum* L.) cultivars, but greatly reduced yields of Acala (*G. hirsutum* L.) and American Pima (*G. barbadense* L.) cottons. With the suggested application date (ratio 1.0), immature bolls were reduced about 95% on southeastern Upland cotton, 75 to 80% on Acala cotton, and 60% on Pima cotton.

Additional index words: Gossypium hirsutum L., *Gossypium barbadense* L., Pink bollworm, *Pectinophora gossypiella* (Saunders), Plant growth regulator, Chemical termination.

CONTROL of pink bollworm [*Pectinophora gossypiella* (Saunders)] by elimination of late-season cotton (*Gossypium* spp.) fruit has been successfully demonstrated with an early plow down of cotton in the lower Rio Grande Valley of Texas (4). However, with current varieties and management practices, a plow down by 31 August as practiced in south Texas would seriously reduce yields in Arizona and California as well as in most of the remainder of the Cotton Belt. Elimination of late-season fruit from cotton plants with a single application of plant growth regulators (chemical termination) has been proposed as an alternate technique (10). Properly timed applications of plant growth regulators have given 90 to 95% reduction in the number of immature bolls at first harvest with little or no yield loss (2, 8). Reduction of immature bolls at first harvest has given a similar reduction in the number of pink bollworm larvae that overwinter (diapause) (9). Excellent termination of fruiting has been obtained with the experimental growth regulator TD-1123[3] (3,4-dichloroisothiazole-5-carboxylic acid) obtained from Pennwalt Corp. It is superior to certain other plant growth regulators for chemical termination primarily because it has the additional advantage of enhancing defoliation (1, 3, 5, 6, 7). This report is concerned with determination of the optimum time of application of TD-1123 for chemical termination under diverse cultivar, climatic, and farm-management conditions in Arizona and California.

MATERIALS AND METHODS

Data on the effects of TD-1123 on cotton were obtained from 1974 through 1977 in 30 small-plot tests on experiment stations and two large-plot tests on farms. Details of 25 small-plot tests (1974 through 1976) are presented elsewhere (8). Twenty-seven of the small-plot tests were on University of Arizona experiment stations located at Phoenix, Mesa, Marana, Safford and Yuma. The remaining three tests were conducted at Brawley and Thermal, California. The two tests in which TD-1123 was applied to large plots on commercial farms, one each in 1976 and 1977, involved 14 farms with test plots; each farm was a replicate. Ten of the farms were located in central and western Arizona, one each in the Imperial and Palo Verde Valleys of the desert southeast California, and two in the San Joaquin Valley of California. For the purposes of this report, data from each farm are presented as if from a separate experiment.

Most small-plot tests were in a randomized block design with four replications. Plot size was four rows wide and 12 m long. The center two rows were used for yield determination and immature boll count. Large farm plots were the length of the field, which varied from 242 to 732 m, with most about 380 m long. Farm plots varied from 6 to 32 rows wide, with all rows harvested for yield determination in most cases.

Chemical termination treatments were applied with a two-row hand sprayer adjusted to deliver 209 liters of water solution/ha to small plots and applied with a high clearance ground applicator at 160 to 320 liters/ha to large plots. The rate of application of TD-1123 was 840 to 1,680 g/ha, with most treatments being 1,120 g/ha. All but three treatments in one small-plot test and two large-plot farm tests in the San Joaquin Valley also included either chlorflurenol (methyl 2-chloro-9-hydroxyfluorene-9-carboxylate) or chlormequat [(2-chloroethyl)-trimethylammonium chloride] at 560 g/ha in mixture with TD-1123 to prevent resumption of fruiting after TD-1123 became ineffective.

Immature bolls were counted on the entire length of yield rows in small-plot tests and on four 15-m row segments per plot in large-plot tests. These counts were made just before or just after first pick. Additional immature boll counts were made

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[3] 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. Agricultural chemicals mentioned herein are not registered or recommended for use on cotton by the USDA. All uses of these chemicals must be registered by the appropriate state and federal agencies before they can be recommended.

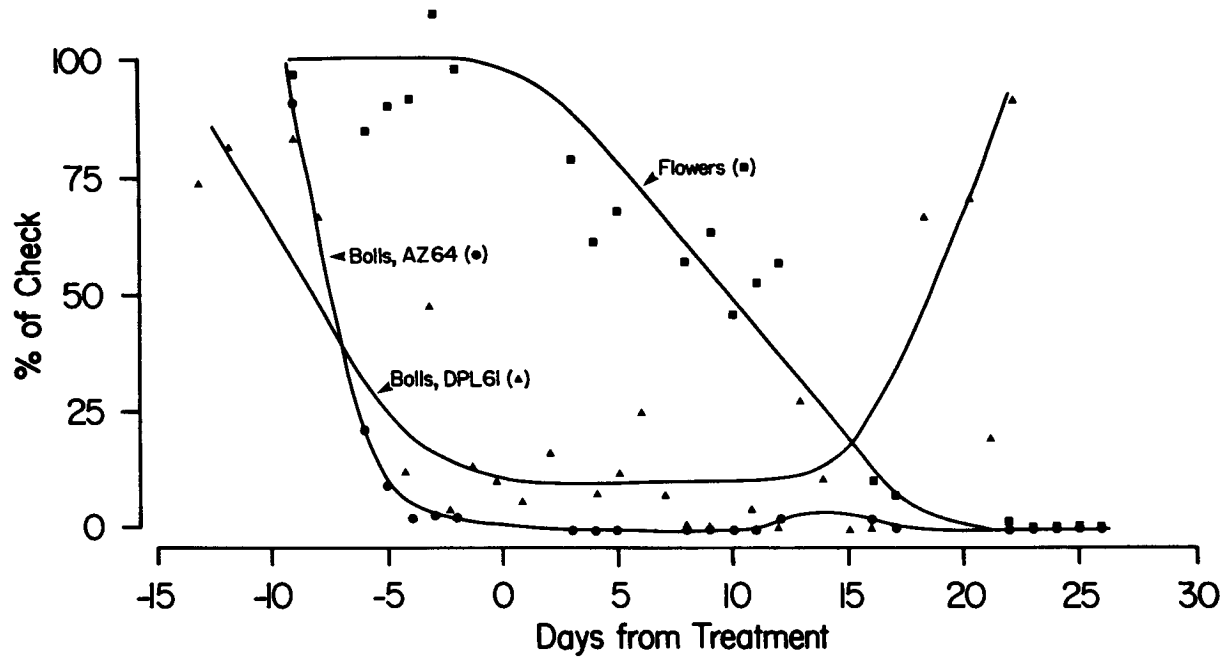

Fig. 1. Boll and flower production on AZ 64 cotton plants treated with TD-1123 at 1,120 g (a.i.)/ha plus chlorflurenol at 560 g (a.i.)/ha on 17 August and boll production on DPL 61 cotton treated with TD-1123 alone at 1,120 g (a.i.)/ha on several dates.

on four 4-m segments of row of selected farm plots at weekly intervals before harvest.

Cultivars in these tests included three southeastern types of Upland cotton, *G. hirsutum* L. 'Deltapine (DPL) 16,' 'DPL 61,' and 'Stoneville 213'; four Acala cottons, *G. hirsutum* L. 'Hopicala,' 'AZ 64,' 'SJ-2,' and 'SJ-4'; and two Pima cottons, *G. barbadense* L. 'Pima S-4' and 'Pima S-5.'

RESULTS AND DISCUSSION

Treatment Date

Severe reductions in yield were observed when TD-1123 was applied too early (8). Late treatment corrected those deficiencies but, if too late, was less effective for reducing late-season immature bolls. Date-of-treatment tests indicated that 15 September was about the optimum date for applying TD-1123 to cotton to obtain a minimum reduction in yield and a maximum reduction of immature bolls at harvest at the University of Arizona Cotton Research Center at Phoenix, where first harvest usually occurs about 10 November (8).

Application of TD-1123 on 15 September on other experiment stations and farms frequently was not satisfactory because of the varied crop-management and harvest dates. Therefore, we developed a method of determining when to apply TD-1123 most effectively with varied crop-management conditions.

Since the purpose of chemical termination is to retain the bolls that will mature before harvest and to eliminate the bolls that will not, the optimum treatment date depends on harvest date and number of days from flowering to boll maturity. The average number of days required for a boll to mature increases as temperatures decrease in late season. For determining days from flowering to boll maturity, we have adapted a seasonal days-to-boll-maturity curve for 'Deltapine 61' grown at Phoenix, Arizona (data not shown). For use in other cotton growing areas the data may need modification to fit local boll maturity data.

Flowering and Boll Set

The effect of TD-1123 on squares, flowers, and young bolls should be considered also in determining when to treat. Boll set from tagged flowers of Acala cotton (AZ 64) treated with TD-1123 plus chlorflurenol was near 100% of the check for flowers occurring 9 days or more before treatment and about 50% of the check for flowers occurring 7 days before treatment (Fig. 1). Boll set was near zero on the date of treatment and remained near zero for over 60 days after treatment (some data not shown). TD-1123 applied alone to 'DPL 61' cotton at 1,120 g (a.i.)/ha caused about 50% of the bolls set 7 days before treatment to abscise. From 5 days before treatment to 15 days after treatment, boll set on treated plants was about 10% of untreated plants. Fifteen to 20 days after treatment, plants recovered from effects of TD-1123 when used alone and began setting bolls. In another test, plants treated with TD-1123 alone produced more bolls than the check following recovery from TD-1123 effects (8). Chlorflurenol or chlormequat were used with TD-1123 to prevent such recovery as well as to enhance the treatment. TD-1123 causes fruiting forms to abscise for a period of 20 to 25 days and then the plants recover. The effects of chlorflurenol and chlormequat on fruiting develop more gradually than TD-1123, making them undesirable to use alone, but their effects persist much longer. Chlorflurenol prevents growth and bud development and is effective for 60 to 90 days. Chlormequat, which

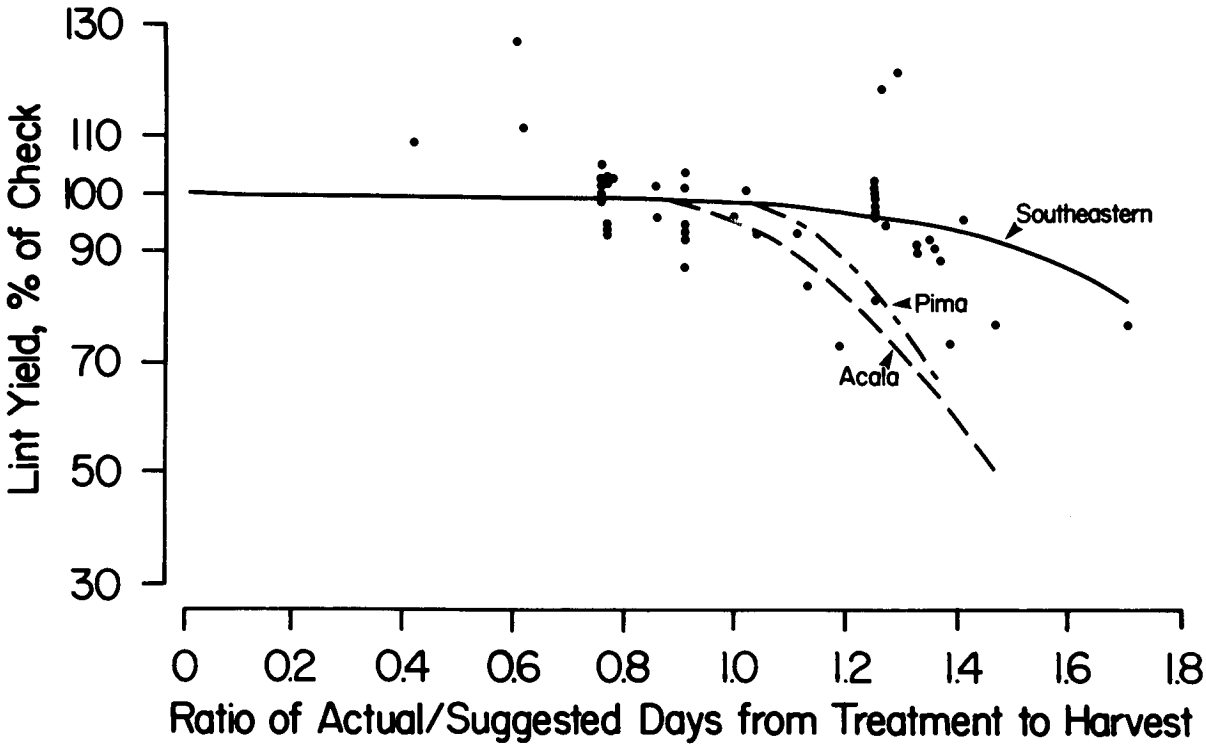

Fig. 2. Effect of TD-1123 applied at different days from harvest at 840 to 1,680 g (a.i.)/ha with most at 1,120 g (a.i.)/ha on lint yield of southeastern cotton (52 means, data points shown), Acala cotton (42 means, data points not shown), and Pima cotton (12 means, data points not shown) in Arizona and California from 1974 through 1977.

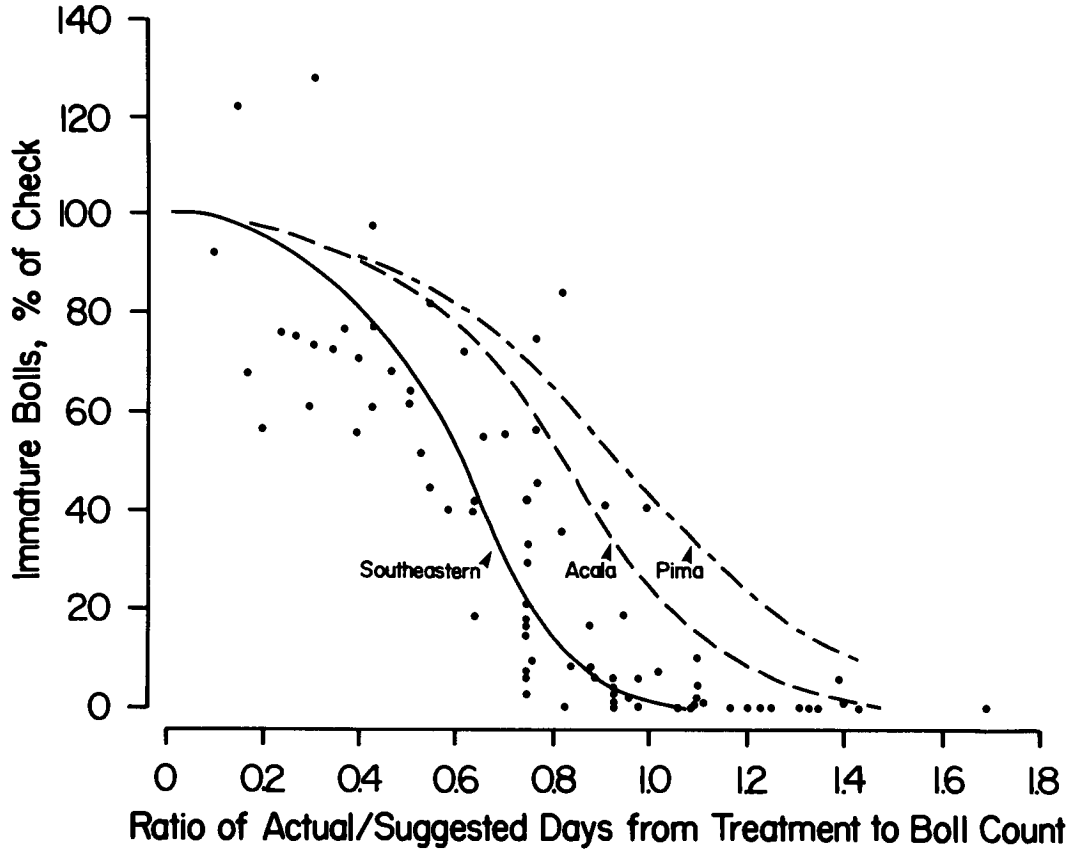

Fig. 3. Effect of TD-1123 applied at different days from harvest at 840 to 1,680 g (a.i.)/ha with most at 1,120 g (a.i.)/ha on immature bolls at harvest of southeastern cotton (85 means, data points shown), Acala cotton (33 means, data points not shown), and Pima cotton (15 means, data points not shown) in Arizona and California from 1974 through 1977.

Table 1. Estimated optimum time to apply TD-1123 for chemical termination of fruiting in cotton, according to planned harvest date.

Planned harvest date	Optimum treatment time†
	Days before harvest
1-15 September	43
16-30 September	46
1-15 October	49
16-31 October	53
1-15 November	57
16-30 November	61
1-15 December	67
16-31 December	77

† Average number of days from flowering to boll maturity minus 7.

is effective for 45 to 60 days, causes abnormal flower development and fruit abscission.

Flowering in plots treated with TD-1123 plus chlorflurenol, in contrast to boll set, decreased gradually from near 100% of check on the date of treatment to near zero 21 days after treatment and remained near zero for over 60 days (some data not shown).

The formula for timing application of TD-1123 involves determining the planned harvest date, subtracting the average number of days it takes a boll to mature at that harvest date and then adding 7 days (50% boll abscission from TD-1123 and thus an equal effect on yield and immature bolls). Data suitable for determining the proper TD-1123 application date for central and western Arizona and adjacent areas of California are given in Table 1. We tested this formula with data from completed tests with different treatment and harvest dates, converting the time span to the ratio of actual days/suggested days (from Table 1).

Lint Yield

Application of TD-1123 had no effect on lint yield of southeastern cotton cultivars (52 means) until the actual days/suggested days ratio exceeded 1.0 (Fig. 2). When the ratio was over 1.0, lint yield decreased gradually. Acala (42 means) and Pima (12 means) cotton cultivars, in contrast, had greater decrease in yield when the time from treatment to harvest exceeded the suggested time. This difference was expected since Acala and Pima cotton cultivars usually produce a larger proportion of their lint later in the season than southeastern cotton cultivars.

Immature Bolls

The number of immature bolls of southeastern cotton (85 means) treated with TD-1123 decreased to less than 5% of the check for southeastern cotton when the actual/suggested time ratio reached 1.0. When the ratio reached 1.2, essentially all immature bolls had been eliminated (Fig. 3). Treatments with TD-1123 were less effective in reducing immature bolls on Acala (33 means) and Pima (15 means) cottons. TD-1123 was applied at 1,680 g (i.a.)/ha with chlormequat at 560 g (a.i.)/ha to determine if the higher application rate would increase its effectiveness. The higher rate effectively eliminated immature bolls on Hopicala (Acala), but eliminated only about 75% of the immature bolls on Pima S-5 (data not shown). Chlormequat alone could be responsible for the 75% reduction of immature bolls (8, 10). TD-1123 plus chlorflurenol or chlormequat has consistently been less effective in several tests for chemical termination of Pima cotton than other less promising fast-acting plant growth regulators in mixture with chlorflurenol or chlormequat (8). In contrast, the TD-1123 treatment on all Upland cottons in immediately adjacent tests was generally the most effective treatment. Thus, the reduction in immature bolls shown for Pima cotton in Fig. 3 probably is mainly due to the effects of chlorflurenol or chlormequat.

The formula for timing application of TD-1123 for chemical termination of Upland cotton appears to be adequate. If zero yield loss is desired, application 7 to 10 days later than indicated may be needed. Conversely, earlier application will give slightly better insect control, but will decrease lint yield.

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