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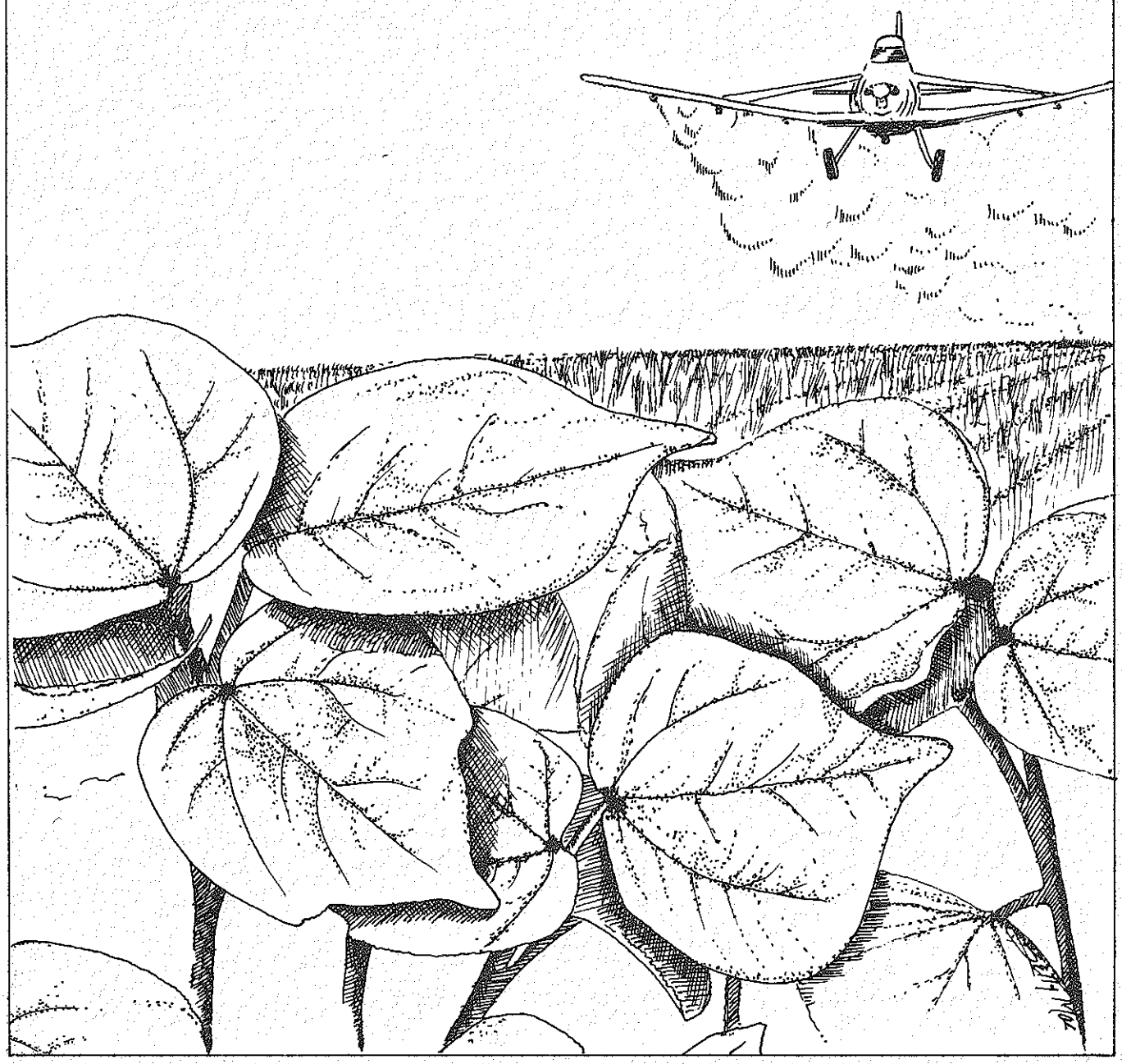
Response of Cotton to Selected Herbicides Applied to Simulate Drift



MAFES

MISSISSIPPI AGRICULTURAL & FORESTRY EXPERIMENT STATION R. Rodney Foil, Vice President and Director

Donald W. Zacharias, President Mississippi State University, Mississippi State, MS 39762

Response of Cotton to Selected Herbicides Applied to Simulate Drift

Harold R. Hurst
Plant Physiologist
Delta Branch Experiment Station

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Introduction

In the Mississippi Delta, many rice and soybean fields are located adjacent to or near cotton fields. Thus, herbicides used for weed control in rice and soybeans may contact cotton plants by drift or by accidental direct application. Affected cotton plants may be injured or killed by such herbicides (used in rice and soybeans) as propanil (Stam® and other brands), metribuzin (Lexone® and Sencor®), and acifluorfen (Blazer®; Tackle®). Herbicides which are likely replacements for 2,4,5-T for broadleaf weed control in rice are bromoxynil (Brominal®, Buctril®), MCPA Amine (several brands), and 2,4-D (several brands). These are also potentially harmful to cotton plants.

Several studies have shown that cotton plants can be injured by early season applications of herbicides applied over-the-top (1, 3, 4, 5, 6, 7, 8). A Louisiana study (2) reported that yields were not reduced from applications of acifluorfen on six- to seven-leaf cotton (48 days after planting) at rates up to 0.08 pound active ingredient (ai) per acre. Applications of acifluorfen to cotton plants at early-bloom (early July) at rates up to 0.16 lb ai/A did not reduce cotton yields in the Louisiana study; applications of 0.16 lb ai/A to cotton at mid-bloom (late July) reduced yields, but rates of 0.08 lb ai/A and below had no effect.

The objectives of the studies reported here were to measure stands and yields of cotton when selected herbicides were applied over-the-top to cotton fields in the Mississippi Delta.

Materials and Methods

Experiments were conducted at the Mississippi Agricultural and Forestry Experiment Station Delta Branch during the 3-year period 1980-1982. A randomized complete block design with three (1980) or four (1981 and 1982) replications was used. Soil was a silt loam; 33.2% sand, 49.2% silt, 17.6% clay, 1.1% organic matter, 5.8 pH in 1980; 37.0% sand, 51.4% silt, 11.6% clay, 0.4% organic matter, 6.2 pH in 1981; and 32.3% sand, 49.4% silt, 18.3% clay, 1.0% organic matter, and 6.6 pH in 1982.

Individual plots were three (1980) or four (1981 and 1982) 40-inch rows of cotton 40 (1980) or 50 feet long (1981 and 1982).

The 'DES 56' cotton variety was planted April 25, 1980; April 23, 1981; and April 29, 1982. Standard management practices for optimum yields were used. The experimental area was kept weed-free, with standard herbicides applied preplant soil incorporated, surface preemergence, and directed postemergence; plus mechanical cultivation and hand hoeing.

All over-the-top herbicide treatments were applied with a tractor-mounted boom sprayer using a spray volume of 10 gallons per acre. The boom was positioned so that one flat-fan nozzle was located 10 inches above each cotton row. Applications were made at one of three cotton plant development stages: (a) cotyledonary, (b) three-node, or (c) six- or seven-node stage. The six-node stage was planned, but weather forced a delay in application until cotton plants reached the seven-node stage in 1980 and 1982.

Herbicide treatments are listed in Table 1. Application rate was often adjusted in successive years because of results from applications during previous years. Stands of cotton plants were counted 38 to 126 days after application to cotyledonary cotton, 46 to 105 days after application to cotton at the three-node stage, and 37 to 95 days after application to cotton at the six- or seven-node stage. Seed cotton yields were determined by mechanically harvesting one (1980) or two (1981 and 1982) rows in each plot one time.

In 1982, cotton at the three-node stage treated with 0.25 and 0.375 lb ai/A Blazer 2S or Tackle 2AS was injured to such an extent that replanting was required (a large number of plants were killed). Visually, the maturity of plants from these plots appeared delayed. However, this could not be confirmed as accidental harvest of the entire field occurred before an additional plot harvest could be made. Other treatments in 1982, and all treatments in 1980 and 1981, did not delay cotton maturity as determined by visual observation.

Plots were harvested October 15, 1980, October 20, 1981, and September 20, 1982. Plants from one outside row in each plot were removed 3 days after treatment to obtain plant material for propanil (Stam M4) residue analyses in 1980 and 1981 (data not reported). This was repeated at 10 days after treatment on the other outside row in each plot. Plants for residue determinations were also removed from the same rows in non-propanil treated plots so seed cotton yield could be compared.

Field data on cotton stand are presented as percent

of the original stand in each plot; yield data are presented as percent of the untreated controls. Data were subjected to analysis of variance and means were separated by Duncan's Multiple Range Test at the 5% level.

Results and Discussion

Cotton Stand

All treatments applied to cotyledonary cotton plants reduced the stand in 1980 (Table 1). This was an unusually dry growing season which probably allowed less opportunity for treated plants to recover. Treatments applied to cotyledonary cotton in 1981, which did not reduce stand, were: Blazer 2S at 0.125 lb ai/A, Blazer 2S and Tackle 2AS at 0.25 lb ai/A, and Stam M4 at 0.03125 and 0.0625 lb ai/A. Natural mortality of plants in 1981 was high, resulting in a 27% stand reduction in the untreated control. In 1982, no herbicide treatment reduced the stand below that of the untreated control when applied to cotyledon-stage cotton plants.

The application of propanil (Stam M4, Stam 4F) to three-node cotton plants did not reduce stand in any year when compared with the untreated controls. When propanil was applied to six- or seven-node cotton plants, Stam M4 at 0.125 lb ai/A in 1980 reduced the stand when compared to the untreated controls. However, an increase in stand resulted in plots with this treatment in 1981.

Concurrent with cultivation of the plot area on June 2, 1982, a 16-inch band application of fluometuron (Cotoran® 80W) plus MSMA was made directed to the base of cotton plants at a broadcast rate of 0.8 + 1.6 lb ai/A. This was 9 days after the three-node simulated drift treatments were applied. From field observation on June 4, it was very apparent that plants previously treated at the three-node stage with propanil (Stam M4) had considerably greater injury symptoms than plants which had not been treated. Pronounced injury symptoms did not occur with plants surviving the cotyledonary stage treatments or with plants treated at the seven-node stage. Treatments to seven-node cotton were made 40

Table 1. The effect of simulated drift from selected herbicides on the stand of cotton when applied at three plant growth stages. MAFES, Delta Branch, Stoneville, MS, 1980-1982.

		Cotton growth stage at treatment[1], [2]								
	Rate	Cotyledon			3-Node			6- or 7-Node		
Herbicide	(lb ai/A)	1980	1981	1982	1980	1981	1982[3]	1980	1981	1982
		Stand counts (%)[4]			Stand counts (%)[4]			Stand counts (%)[4]		
PROPANIL (Common name)										
Stam M4®	0.03125	----------	73.8 a	134.9 a	---------	62.0 a	----------	----------	----------	----------
Stam M4	0.0625	41.7 bc	60.2 abc	86.7 ab	89.0 a	65.6 a	79.6 ab	----------	112.9 ab	105.7 ab
Stam M4	0.125	55.7 b	51.3 cde	73.0 b	87.3 a	67.9 a	82.3 ab	70.0 b	123.3 a	90.0 b
Stam M4	0.25	----------	34.5 e	----------	---------	59.5 a	101.8 ab	84.3 ab	106.6 abc	100.2 ab
Stam M4	----------	---------	----------	----------	---------	---------	----------	----------	98.4 bc	----------
Stam 4F	0.125	55.7 b	44.9 cde	----------	90.0 a	69.2 a	----------	----------	----------	----------
Stam 4F	0.25	----------	38.4 de	----------	---------	70.1 a	----------	93.3 a	112.2 ab	----------
Stam 4F	0.375	----------	----------	----------	---------	---------	----------	----------	114.2 ab	----------
ACIFLUORFEN (Common name)										
Blazer 2S®	0.0625	----------	----------	131.1 a	---------	----------	----------	----------	----------	----------
Blazer 2S	0.125	39.7 bc	57.4 a-d	64.1 b	---------	----------	114.0 a	----------	----------	118.4 a
Blazer 2S	0.25	35.0 bc	52.6 b-e	64.8 b	77.0 a	56.7 ab	84.8 ab	----------	----------	107.4 ab
Blazer 2S	0.375	----------	----------	----------	82.0 a	36.4 b	92.2 ab	86.0 ab	100.6 bc	103.2 ab
Blazer 2S	0.50	----------	----------	----------	---------	----------	----------	88.7 ab	95.1 c	----------
Tackle 2AS®	0.0625	----------	----------	115.3 ab	---------	----------	----------	----------	----------	----------
Tackle 2AS	0.125	----------	----------	94.5 ab	---------	----------	69.7 b	----------	----------	105.4 ab
Tackle 2AS	0.25	----------	53.7 a-e	----------	---------	----------	92.1 ab	----------	----------	88.6 b
Tackle 2AS	0.375	----------	----------	----------	---------	48.1 ab	85.3 ab	----------	----------	111.6 ab
Tackle 2AS	0.50	----------	----------	----------	---------	---------	----------	----------	103.2 bc	----------
UNTREATED	----------	86.0 a	73.3 ab	98.5 ab	82.7 a	69.6 a	83.8 ab	99.0 a	101.2 bc	102.1 ab
ORIGINAL PLANTS/A (in thousands)		(50.0)	(58.9)	(43.8)	(44.4)	(60.4)	(38.6)	(47.6)	(56.6)	(40.6)

[1] Expressed as % of original stand; calculated from counts made before and after treatment.

[2] Values in the same column followed by the same letter are not significantly different (P = .05) according to Duncan's Multiple Range Test.

[3] Treatments with Blazer 2S and Tackle 2AS at 0.25 and 0.375 lb/A were replanted June 4, 1982 because of excessive stand reduction brought about by a very light rain shower (just enough to wet leaves) 40 minutes after application and again at 19 hours after application. Treatments with Blazer 2S and Tackle 2AS at 0.125 lb/A were injured severely but plants recovered.

[4] Percent of the original plants.

minutes after the directed postemergence application of fluometuron + MSMA. In 1982, fluometuron was also applied preemergence to a 16-inch band over the row at planting at a broadcast rate of 1.0 lb ai/A. The greater injury symptoms with propanil treatments applied to three-node cotton plants in 1982 did not adversely affect subsequent cotton yield (Table 2).

Blazer 2S applied at 0.375 lb ai/A to three-node cotton plants was the only acifluorfen treatment which reduced stand in 1981 (Table 1). However, treatments of Blazer 2S and Tackle 2AS at all rates applied to three-node plants in 1982 injured cotton severely. The severe injury occurred because of light rains (just enough to wet plant leaves) 40 minutes after application and again about 19 hours after application. The rates of 0.25 and 0.375 lb ai/A resulted in plant injury and death (96 to 99% stand reduction) sufficient to require replanting June 4. Cotton stand with the second planting was not affected. The treatments with 0.125 lb ai/A produced severe injury and delayed plant growth, but surviving plants produced an adequate stand. The values in Table 1 represent the final stand. No acifluorfen treatment reduced stand when applied to six- or seven-node cotton plants.

Cotton Yields

Seed cotton yields were greater overall in 1980 and 1981 because of the final plot row configuration in these studies. After plants were removed for propanil analysis, the field had an alternating pattern of one row of cotton and two skip rows in 1980 and a two cotton-two skip row pattern in 1981. This allowed the cotton plants to have access to greater amounts of soil moisture and nutrients and greater sunlight penetration. Therefore, to allow better comparisons between treated and untreated plots through all years, yields are expressed as a percent of the untreated control.

In 1980, all propanil treatments reduced yield when

Table 2. The effect of simulated drift from selected herbicides on seed cotton yield when applied to cotton plants at three growth stages. MAFES Delta Branch, Stoneville, MS, 1980-1982.

		Cotton growth stage at treatment[1], [2]								
	Rate	Cotyledon			3-Node			6- or 7-Node		
Herbicide	(lb ai/A)	1980	1981	1982	1980	1981	1982[3]	1980	1981	1982
		Yield (%)[4]			Yield (%)[4]			Yield (%)[4]		
PROPANIL (Common name)										
Stam M4®	0.03125	----------	105 ab	93 a	----------	107 a	----------	----------	----------	----------
Stam M4	0.0625	43 bcd	102 ab	102 a	98 a	103 ab	92 b	----------	93 abc	100 ab
Stam M4	0.125	65 bc	92 bc	102 a	93 a	92 bcd	108 a	113 a	89 bc	101 ab
Stam M4	0.25	----------	85 c	----------	----------	95 abc	102 ab	96 abc	94 abc	92 c
Stam M4	0.375	----------	----------	----------	----------	----------	----------	----------	78 d	----------
Stam 4F	0.125	56 bcd	107 ab	----------	93 a	94 abc	----------	----------	----------	----------
Stam 4F	0.25	----------	93 abc	----------	----------	99 ab	----------	103 ab	97 ab	----------
Stam 4F	0.375	----------	----------	----------	----------	----------	----------	----------	89 bc	----------
ACIFLUORFEN (Common name)										
Blazer 2S®	0.0625	----------	----------	97 a	----------	----------	----------	----------	----------	----------
Blazer 2S	0.125	74 ab	108 a	100 a	----------	----------	59 c	----------	----------	102 a
Blazer 2S	0.25	55 bcd	97 abc	102 a	99 a	82 cde	14 d	----------	----------	96 bc
Blazer 2S	0.375	----------	----------	----------	89 a	80 de	10 d	79 c	89 bc	93 c
Blazer 2S	0.50	----------	----------	----------	----------	----------	----------	101 ab	86 cd	----------
Tackle 2AS®	0.0625	----------	----------	101 a	----------	----------	----------	----------	----------	----------
Tackle 2AS	0.125	----------	----------	101 a	----------	----------	92 b	----------	----------	97 abc
Tackle 2AS	0.25	----------	94 abc	----------	----------	----------	12 d	----------	----------	101 ab
Tackle 2AS	0.375	----------	----------	----------	----------	78 e	13 d	----------	----------	100 ab
Tackle 2AS	0.50	----------	----------	----------	----------	----------	----------	----------	93 abc	----------
UNTREATED	----------	100 a	100 abc	100 a	100 a	100 ab	100 ab	100 ab	100 a	100 ab
(lb/A seed cotton)		(4,552)	(2,879)	(2,987)	(4,182)	(3,215)	(2,463)	(3,714)	(3,702)	(2,919)

[1] Yield is expressed as % of untreated controls; the yield is greater than normal in 1980 and 1981 because one row on each side of the harvest rows was removed in early season for herbicide residue determinations. The field was accidentally harvested in 1982 before a second plot harvest could be obtained.

[2] Values within the same column followed by the same letter are not significantly different (P = .05) according to Duncan's Multiple Range Test.

[3] Treatments with Blazer 2S and Tackle 2AS at 0.25 and 0.375 lb/A were replanted June 4, 1982 because of excessive stand reduction brought about by a very light rain shower (just enough to wet leaves) 40 minutes after application and again at 19 hours after application. Treatments with Blazer 2S and Tackle 2AS at 0.125 lb/A were injured severely but plants recovered.

[4] Percent of untreated plot yields.

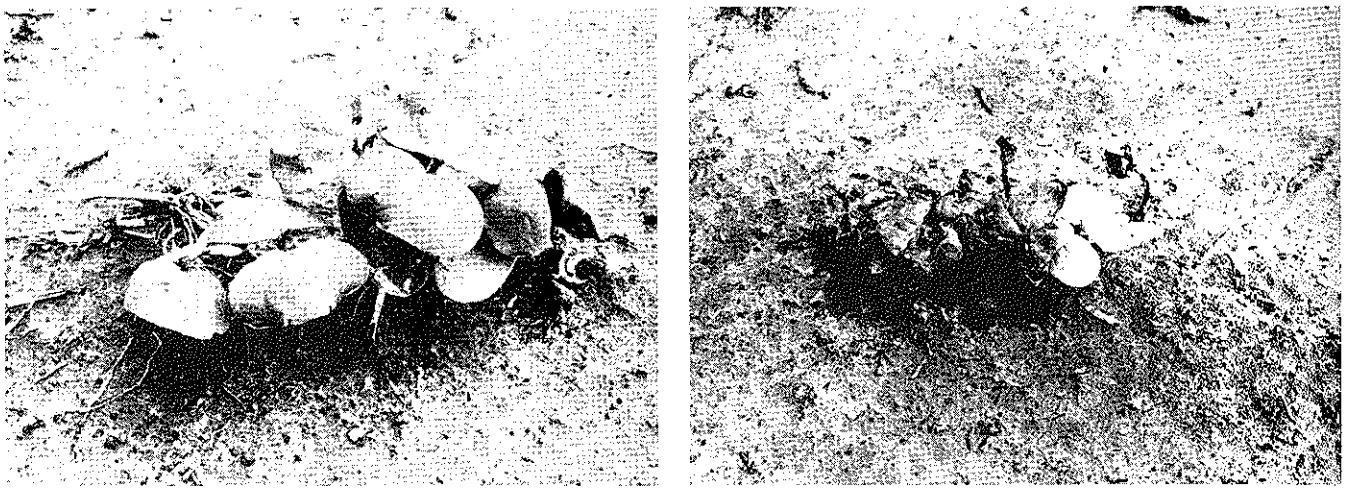

Figure 1. Cotton plant at left is the untreated control. The plant at right is shown 10 days after treatment with 0.25 lb/A of Blazer 2S at the cotyledon stage of growth.

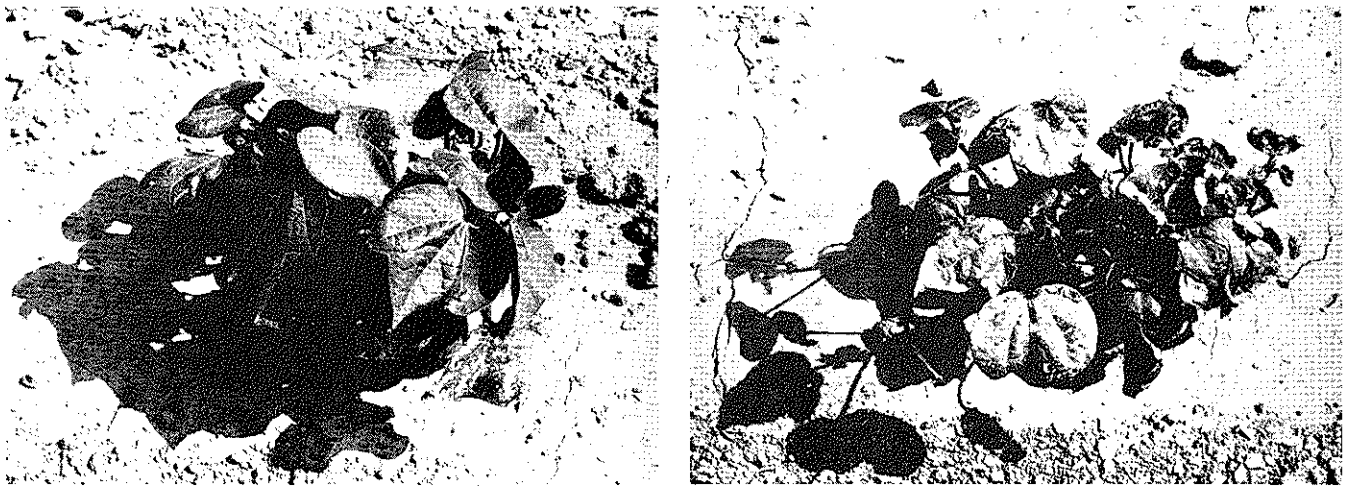

Figure 2. Cotton plant at left is the untreated control. The plant at the right is shown 3 days after treatment with 0.25 lb/A of Blazer 2S at the three-node stage of growth.

Figure 3. Cotton plant at left is the untreated control. The plant at the right is shown 10 days after treatment with 0.0625 lb/A of Stam M4 at the cotyledon stage of growth.

Figure 4. Cotton plant at left is the untreated control. The plant at right is shown 10 days after treatment with 0.0625 lb/A of Stam 4S at the three-node stage of growth.

Figure 5. Cotton plant at left is the untreated control. The plant at the right is shown 10 days after treatment with 0.25 lb/A of Stam M4 at the three-node stage of growth.

Figure 6. Cotton plant at left is the untreated control. The plant at the right is show 7 days after treatment with 0.25 lb/A of Stam M4 at the three-node stage of growth.

Table 3. A comparison of herbicide rates normally used for weed control and seed cotton yield reductions in simulated drift studies at the MAFES Delta Branch, Stoneville, MS, 1980-1982.

Herbicide	Rate for weed control		Rate required to reduce seed cotton yield		
	Rice	Soybeans	Cotyledon	3-Node	6- or 7-Node
	(lb ai/A)		(lb ai/A)		
Propanil	3-6	NR[1]	0.0625	N[2]	0.375
Acifluorfen	0.125	0.375-0.5	0.25	0.125[3]	0.375

[1] NR = Not registered for use.
[2] N = No effect at the rates applied.
[3] Only occurred with unusual rainfall conditions; otherwise, 0.25 lb ai/A was required.

compared to the untreated control. This was probably due to the extreme dry weather in the 1980 growing season. Cotton plants never fully recovered from the early propanil injury and stand reduction. Propanil (Stam M4, Stam 4F) applied to cotyledonary cotton plants did not affect seed cotton yield in 1981 or 1982 (Table 2). There was a trend for lower yield as rate increased in 1981.

Acifluorfen (Blazer 2S, Tackle 2AS) applied to cotyledonary cotton plants did not reduce yield in 1981 and 1982. In 1980, yield was reduced only by Blazer 2S at 0.25 lb ai/A.

When applied to three-node cotton plants, propanil (Stam M4, Stam 4F) treatments did not reduce yield in any year when compared with the untreated control (Table 2). Acifluorfen (Blazer 2S) applied to three-node cotton plants in 1980 did not reduce yields from those of the untreated control (Table 2). However, these same treatments, and Tackle 2AS at the higher rate applied in 1981, reduced seed cotton yields by 18 to 22%. In 1982, acifluorfen applied to three-node cotton plants produced severe injury under the conditions previously described. Very low yields resulted from the replanted plots (Table 2). The entire field was accidentally harvested before a second plot harvest was made. Plots treated with Blazer 2S and Tackle 2AS at 0.125 lb ai/A were not replanted. With these treatments, Blazer 2S yielded 33% less than Tackle 2AS.

When propanil (Stam M4, Stam 4F) was applied to six- or seven-node cotton plants, yield was reduced by Stam M4 and Stam 4F at 0.375 lb ai/A in 1981, and by Stam M4 at 0.125 lb ai/A in 1981 and at 0.25 lb ai/A in 1982 (Table 2). Acifluorfen applied to six- or seven-node cotton plants as Tackle 2AS at 0.5 lb ai/A in 1981, or at 0.125 to 0.375 lb ai/A in 1982, did not affect yield. When applied as Blazer 2S, yield was reduced from the application of 0.375 lb ai/A in 1980, 1981, and 1982 and 0.5 lb ai/A in 1981.

Summary

Selected rice and soybean herbicides were applied to cotton plants at three growth stages in a manner designed to simulate drift or accidental direct application. Cotton stand was reduced when applications of herbicides were made during years of poor growing conditions. Injury was greatest from applications to cotton plants in the cotyledon stage of development. Cotton stand was not reduced when applications of herbicides were made to three-node (except in 1982 with acifluorfen) or to six- or seven-node plants, except when the rates were excessively high.

Seed cotton yields were reduced during 1980, a year of extremely low rainfall. Yields were reduced when herbicides were applied to cotyledonary cotton plants. Table 3 summarizes the rate required to reduce seed cotton yields. From these results, the order of toxicity to cotyledonary cotton is propanil greater than acifluorfen. When applied to three-node plants, the acifluorfen is more toxic than propanil. The toxicity of chemicals applied to six- or seven-node cotton plants the same (propanil is equal to acifluorfen).

Table 3 also includes the herbicide application rates normally used to control weeds. It is apparent that with herbicides in these studies, seed cotton yields can be reduced with propanil at 1 to 12% of the normal use rate and 33 to 133% the normal rate of acifluorfen applied to soybeans or 100 to 300% the normal rate for rice. From these comparisons, it appears that the overall toxicity to cotton of herbicides used in these studies is that propanil is more toxic than acifluorfen.

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