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Sequential and Tank Mix Combinations of Selected Herbicides for Control of Prickly Sida and Seedling Johnsongrass in Cotton

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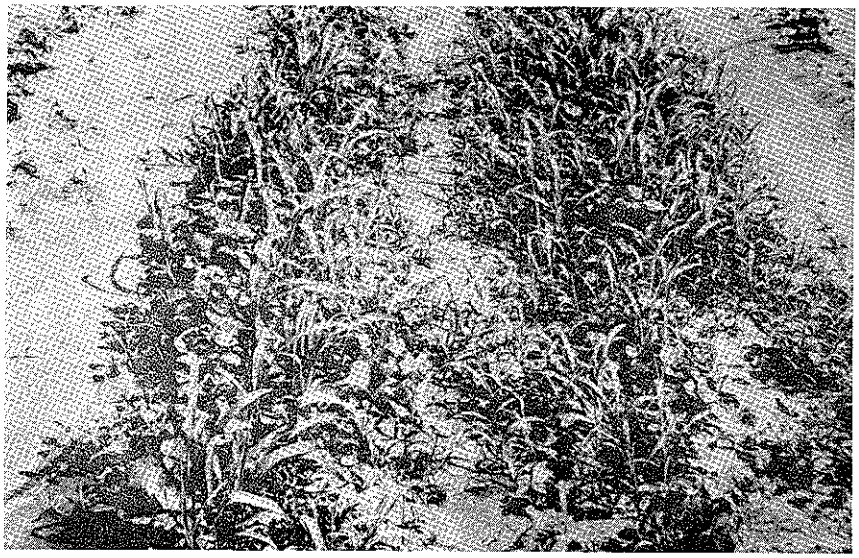
Sequential and Tank Mix Combinations of Selected Herbicides for Control of Prickly Sida and Seedling Johnsongrass in Cotton

Sequential applications of several herbicides (application preplant incorporated followed by preemergence application) are now registered for control of weeds in cotton. However, cotton producers often want to apply herbicides as tank mixes (two herbicides mixed in the same tank and applied preplant incorporated) to reduce expense and conserve time by eliminating a trip over their fields. Therefore, we investigated the feasibility of tank mixes of selected herbicides for control of annual broadleaf weeds and grasses in cotton.



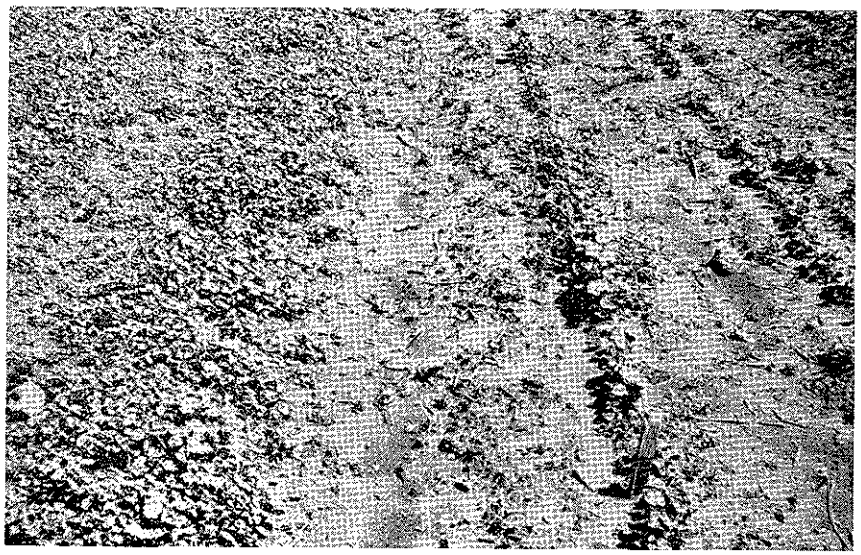
No herbicide (photographed 33 days after planting).

Materials and Methods

A 3-year experiment was conducted on a loam soil in Bolivar County, Mississippi. The soil used in 1974 and 1976 had a pH of 6.5 and was composed of sand (50%), silt (40%), clay (10%) and organic matter (0.84%). The soil used in 1975 had a pH of 6.75 and was composed of sand (41%), silt (44%), clay (15%) and organic matter (1.37%).

The experimental design was a randomized complete block with three replications. Each plot was two 40-inch rows 50 feet long.

All plots were fertilized at the rate recommended for optimum production and seedbeds were prepared. We applied individual herbicides and tank mix combinations immediately after



No herbicide (left), 0.75 lb/A trifluralin plus 1.5 lb/A fluometuron tank mix, preplant incorporated (photographed 33 days after treatment).

preparing seedbeds and incorporated them on a 16-inch band---using one pass of a double-gang rolling cultivator. A weedy check and plots for evaluating the effectiveness of preemergence herbicides alone were not treated preplant.

'DPL-16' cottonseed (*Gossypium hirsutum* L.) were planted on all plots immediately after completing soil incorporation of the preplant herbicides. Seed at the rate of 30 lb/A were planted 1 inch deep in moist soil on April 30, 1974; May 23, 1975 and April 20, 1976. Preemergence herbicides were surface applied within one day after planting. Plots other than the weedy check and those treated preplant were treated preemergence. The 1975 and 1976 trials included preplant applications of single herbicides without follow-up preemergence treatment.

All herbicides were applied broadcast in a spray volume at the rate of 20 gallons per acre in 1974 and 1975, 28.5 gallons in 1976. Herbicides used are listed in Table 1. A tractor sprayer was used in 1974, a two-wheel bicycle push-type compressed air sprayer in 1975 and a backpack CO_2 sprayer in 1976.

A rain gauge about 1 mile from the test site recorded rainfall for 30 days after planting as follows:

1974	1975	1976
(inches)	(inches)	(inches)
May 1 - 0.6	May 26 - 0.75	April 21 - 0.4
May 5 - 0.2	May 28, 29 - 1.3	April 24 - 1.8
May 11 - 1.6	June 10-12 - 1.4	April 30 - 0.2
May 14 - 1.4	June 15 - 0.5	May 6 - 0.15
May 21, 22 - 1.5		May 14 - 0.25
May 26 - 0.75		May 15 - 0.6
		May 16 - 0.3

1 lb/A profluralin plus 1.5 lb/A fluometuron tank mix, preplant incorporated (photographed 33 days after treatment).

Table 1. Herbicides---trade name, common name and chemical formula, broadcast rate (lb/A ai) and years in the experiment, Bolivar county, Miss., 1974-1976.

Trade name[1]	Common name	Chemical formula	Broadcast rate	Years in Experiment
			lb/A ai	
Amex®	butralin[1]	4-(1,1-dimethylethyl)-**N**-(1-methylpropyl)-2,6-dinitrobenzenamine	2.0	1974, 1975, 1976
Basalin®	fluchloralin	**N**-(2-chloroethyl)-2,6-dinitro-**N**-propyl-4-(trifluoromethyl)aniline	0.75	1974, 1975, 1976
Cobex®	dinitramine	N_4,N_4-diethyl-*a,a,a*-trifluoro-3,5-dinitrotoluene-2,4-diamine	0.5	1974, 1975, 1976
Cotoran®	fluometuron	1,1-dimethyl-3-(*a,a,a*-trifluoro-**m**-tolyl)urea	1.5	1974, 1975, 1976
HOE 2991	tetrafluron	**N,N**-dimethyl-N_1-[3-(1,1,2 2-tetrafluoroethoxy)phenyl] urea	1.2	1976
Karmex®	diuron	3-(3,4-dichlorophenyl)-1,1-dimethylurea	1.0	1976
Planavin®	nitralin	4-(methylsulfonyl)-2,6-dinitro-**N,N**-dipropylaniline	0.75	1974
Prowl®	pendimethalin	N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine	0.75	1975, 1976
Tolban®	profluralin	**N**-(cyclopropylmethyl)-*a,a,a*-trifluoro-2,6-dinitro-**N**-propyl-**p**-toluidine	0.75	1974, 1975, 1976
Treflan®	trifluralin	*a,a,a*-trifluoro-2,6-dinitro-**N,N**-dipropyl-**p**-toluidine	0.75	1974, 1975, 1976
Zorial®	norflurazon	4-chloro-5-(methylamino)-2-(*a,a,a*-trifluoro-**m**-tolyl)-3(2**H**)-pyridazinone	1.5	1974, 1975, 1976

Trade names are given solely for purposes of identification. Mention or omission of any trade name implies neither endorsement nor criticism by the Mississippi Agricultural and Forestry Experiment Station.

[1]Applied 2.25 lb in 1974.

Cotton stands were determined by counting plants on 50 feet of one row in each plot. Weed counts were made on one preselected row in each plot. Three 1-square-foot quadrants per row were used in 1974, two 1-square-foot quadrants in 1975, and two 1-foot-by-3-feet quadrants (narrow axis centered over row) in 1976. Visual evaluations of crop injury and control of broadleaf and grass weeds (0 = no control, 100 = complete control) were made three or four weeks after crop emergence. Plots were not cultivated before plant counts and visual evaluations were made.

All data were converted to percentages and transferred to arc sin for subjecting to analysis of variance. Means were separated by Duncan's New Multiple Range Test.

Results and Discussion

Cotton emerged to a good stand each year and symptoms of herbicide injury were not observed. Low temperatures reduced overall height of cotton plants in 1976 but all treatments were affected uniformly.

Natural populations of prickly sida were high in 1974 and 1976. Large infestations of seedling johnsongrass[1] occurred each year. Scattered annual morningglory (*Ipomoea* spp. L.), common cocklebur (*Xanthium pensylvanicum* Wallr.), spotted spurge (*Euphorbia maculata* L.), hophornbeam copperleaf (*Acalypha ostryaefolia* Riddell) and large crabgrass (*Digitaria sanguinalis* (L) Scop.) were observed.

Annual Broadleaf Weeds---Control with each combination of herbicides was slightly better when applied sequentially than when applied tank mixed; however, differences were significant ($P < .05$) only for fluchloralin and fluometuron in 1974, fluchloralin and norflurazon in 1976 (Table 2).

All herbicides applied preplant alone in 1975 provided poor control. Control with herbicides applied preplant alone in 1976 was generally poorer than control with these herbicides applied as sequential or tank mix combinations, but only a few differences were significant.

Prickly Sida---Sequential applications gave generally higher control values than tank mix combinations in 1974 but differences were not significant (Table 3). Control with all treatments was generally below acceptable levels. Sequential applications in 1976 also gave generally better control than did tank mix combinations; however differences were significant ($P < .05$) only for trifluralin and fluometuron.

Control with butralin, pendimethalin, profluralin and trifluralin applied preplant alone in 1976 did not differ significantly from control with these herbicides applied as sequential or tank mix combinations. Butralin and pendimethalin were more effective

Table 2. Control of annual broadleaf weeds with selected herbicides applied preplant incorporated alone, applied preplant incorporated as tank mix combinations (TM), applied as preplant incorporated and surface preemergence sequential combinations (S), and applied preemergence alone; Bolivar County, MS, 1974-1976[1].

Treatment		Year[2]											
		1974				1975				1976			
Preplant	Preemergence	Pre-plant	TM	S	Pre-emergence	Pre-plant	TM	S	Pre-emergence	Pre-plant	TM	S	Pre-emergence
		Percent Control											
Butralin	Fluometuron	---	95ab	98a	97a	0k	62a-g	93a	73a-d	73a-e	90a-c	94a	82a-d
Butralin	Norflurazon		97a	98a	98a		40c-i	58a-h	68a-f		91a-c	88a-c	90a-c
Butralin	Diuron		---	---	---		---	---	---		53d-g	77a-e	33fg
Dinitramine	Fluometuron	---	94ab	97a		32g-j	48b-h	90ab		75a-e	89a-c	93ab	
Dinitramine	Norflurazon		98a	97a			53b-h	52b-h			90a-c	92a-c	
Fluchloralin	Fluometuron	---	89b	98a		13i-k	72a-e	82a-c		65a-f	88a-c	87a-d	
Fluchloralin	Norflurazon		93ab	98a			30e-j	58a-h			50e-g	85a-d	
Nitralin	Fluometuron	---	97a	98a		---	---	---		---	---	---	
Nitralin	Norflurazon		91ab	97a			---	---			---	---	
Pendimethalin	Fluometuron	---	---	---		20h-k	70a-f	87ab		82a-d	90a-c	94a	
Pendimethalin	Norflurazon		---	---			27e-j	68a-f			85a-d	85a-d	
Profluralin	Fluometuron	---	93ab	98a		7jk	65a-f	88ab		62c-f	91a-c	92ab	
Profluralin	Norflurazon		96ab	92ab			33f-j	50b-h			90a-c	85a-d	
Trifluralin	Fluometuron	---	94ab	98a		0k	57a-h	82a-c		63b-f	78a-d	92a-c	
Trifluralin	Norflurazon		97a	98a			37d-i	53b-h			93a-c	72a-e	
---	Tetrafluron		---	---	---		---	---	---		---	---	85a-d
Weedy check			-------0c------				-------0k-------				-------0g-------		

[1]Control based on visual estimations.

[2]Values within years followed by a common letter are not different ($P = .05$) according to Duncan's New Multiple Range Test.

[1]*Seedling johnsongrass plants were differentiated from rhizome plants on the basis of plant height.*

Table 3. Control of prickly sida with selected herbicides applied preplant incorporated alone, applied preplant incorporated as tank mix combinations (TM), applied as preplant incorporated and surface preemergence sequential combinations (S), and applied preemergence alone; Bolivar County, MS, 1974 and 1976.

Treatment		Year							
		1974[1]				1976[2]			
Preplant	Preemergence	Preplant	TM	S	Preemergence	Preplant	TM	S	Preemergence
		----------Percent Control----------							
Butralin	Fluometuron	---	39	47	30	86a-c	87a-e	99a	87a-e
Butralin	Norflurazon		46	68	44		84a-e	95a-c	80a-e
Butralin	Diuron		---	---	---		70a-e	85a-e	23fg
Dinitramine	Fluometuron	---	20	35		54d-f	81a-e	92a-c	
Dinitramine	Norflurazon		50	67			91a-e	96a-c	
Fluchloralin	Fluometuron	---	40	66		52ef	90a-e	94a-c	
Fluchloralin	Norflurazon		46	81			64b-f	84a-e	
Nitralin	Fluometuron	---	49	52		---	---	---	
Nitralin	Norflurazon		37	62			---	---	
Pendimethalin	Fluometuron	---	---	---		82a-e	78a-e	94a-c	
Pendimethalin	Norflurazon		---	---			91a-e	95a-c	
Profluralin	Fluometuron	---	45	58		65a-e	95a-c	90a-c	
Profluralin	Norflurazon		81	64			85a-e	92a-c	
Trifluralin	Fluometuron	---	32	50		67a-e	62c-f	98ab	
Trifluralin	Norflurazon		41	70			83a-e	86a-e	
---	Tetrafluron		---	---	---		---	---	95a-c
Weedy check[3]									

[1]No differences (P = .05).

[2]Values within years followed by a common letter are not different (P = .05) according to Duncan's New Multiple Range Test.

[3]Plants per square foot were 15.7 in 1974, 17.7 in 1976. Data for 1975 is not presented because weeds were not sufficient to be meaningful. (Control in all plots based on actual counts.)

than other herbicides applied preplant alone.

Fluometuron and norflurazon applied preemergence alone in 1974 provided poor control. Control with fluometuron, norflurazon and tetrafluron applied preemergence alone in 1976 compared favorably with that provided by sequential and tank mix combinations. Diuron applied preemergence alone in 1976 gave very poor control.

Annual Grass Weeds---All combinations other than profluralin and norflurazon in 1975, dinitramine and fluometuron in 1976 and pendimethalin and fluometuron in 1976 gave better control when applied sequentially than when applied as tank mixes (Table 4). However, differences were significant only for butralin and norflurazon in 1974, nitralin and norflurazon in 1974.

Control with butralin, dinitramine, fluchloralin and trifluralin applied preplant alone in 1975 compared favorably with that provided by all sequential combinations. Results with pendimethalin and profluralin did not differ ($P < .05$) from those obtained with any sequential or tank mix combination. All herbicides applied preplant incorporated in 1976 were as effective as any sequential or tank mix combination.

Fluometuron and norflurazon applied preemergence alone were as effective as any combination used in 1974, were generally less effective than sequential combinations in 1975, and were equally or more effective than tank mix combinations in 1976. Control with all herbicides applied preemergence alone in 1976 did not differ ($P < .05$) from control with sequential or tank mix combinations.

Seedling Johnsongrass---Differences in control attained with sequential and tank mix combinations in 1974 and 1975 were not significant ($P < .05$).

Table 4. Control of annual grass weeds with selected herbicides applied preplant incorporated alone, applied preplant incorporated as tank mix combinations (TM), applied as preplant incorporated and surface preemergence sequential combinations (S), and applied preemergence alone; Bolivar County, MS, 1974-1976[1].

Treatment		Year[2]											
		1974				1975				1976			
Preplant	Preemergence	Pre-plant	TM	S	Pre-emergence	Pre-plant	TM	S	Pre-emergence	Pre-plant	TM	S	Pre-emergence
		Percent Control											
Butralin	Fluometuron	---	95ab	98a	97a	68a-d	73a-d	88a	52c-e	82a	80a	84a	93a
Butralin	Norflurazon		90bc	98a	97a		43de	68a-d	70a-d		82a	90a	87a
Butralin	Diuron		---	---	---		---	---	---		66ab	91a	73ab
Dinitramine	Fluometuron	---	97a	98a		67a-d	64a-d	88a		90a	91a	91a	
Dinitramine	Norflurazon		93a-c	97a			66a-d	78a-c			87a	90a	
Fluchloralin	Fluometuron	---	95ab	98a		72a-d	63a-d	80a-c		88a	86a	89a	
Fluchloralin	Norflurazon		90bc	98a			72a-d	80a-c			57b	90a	
Nitralin	Fluometuron	---	94ab	98a		---	---	---		---	---	---	
Nitralin	Norflurazon		88c	97a			---	---			---	---	
Pendimethalin	Fluometuron	---	---	---		40de	67a-d	82a-c		77ab	90a	90a	
Pendimethalin	Norflurazon		---	---			72a-d	88a			87a	87a	
Profluralin	Fluometuron	---	95ab	98a		30de	60a-d	78a-c		87a	91a	93a	
Profluralin	Norflurazon		93a-c	97a			62a-d	60a-d			83a	93a	
Trifluralin	Fluometuron	---	94ab	98a		60a-d	60a-d	87ab		68ab	92a	93a	
Trifluralin	Norflurazon		94ab	98a			57b-d	72a-d			88a	87a	
---	Tetrafluron		---	---	---		---	---	---		---	---	83a
Weedy check			-------0d-------				-------0f-------				-------6c-------		

[1]Control based on visual estimates.

[2]Values within years followed by a common letter are not different (P = .05) according to Duncan's New Multiple Range Test.

1.5 lb/A norflurazon (left) and 1.5 lb/A fluometuron (right), both applied preemergence (photographed 33 days after treatment).

Butralin and diuron provided excellent control when applied sequentially in 1976, poor control when applied as a tank mix. Control with other sequential and tank mix combinations used in 1976 did not differ.

All herbicides applied preplant alone gave poor control in 1975. Results with herbicides applied preplant alone in 1976 did not differ significantly from results with sequential and tank mix combinations.

Norflurazon applied preemergence alone in 1974 gave good to excellent control. Fluometuron and norflurazon applied preemergence in 1975 and tetrafluron applied preemergence in 1976 gave poor control. Control with flurometuron, norflurazon and diuron applied preemergence in 1976 did not differ significantly from that with sequential and tank mix combinations.

Table 5. Control of seedling johnsongrass with selected herbicides applied preplant incorporated alone, applied preplant incorporated as tank mix combinations (TM), applied as preplant incorporated and surface preemergence sequential combinations (S), and applied preemergence alone; Bolivar County, MS, 1974-1976.

Treatment		Year[1]											
		1974				1975				1976			
Preplant	Preemergence	Pre-plant	TM	S	Pre-emergence	Pre-plant	TM	S	Pre-emergence	Pre-plant	TM	S	Pre-emergence
		Percent Control											
Butralin	Fluometuron	---	89a	87a	76ab	13d-f	70a-e	91a	15c-f	84a-c	72a-d	54b-d	92a-c
Butralin	Norflurazon		71ab	95a	86a		31a-f	52a-f	50a-f		62a-d	94a-c	80a-d
Butralin	Diuron		---	---	---		---	---	---		33de	96ab	81a-d
Dinitramine	Fluometuron	---	77ab	83ab		61a-e	81a-d	88ab		58a-d	88a-c	96ab	
Dinitramine	Norflurazon		82ab	90a			80a-d	87a-c			66a-d	89a-c	
Fluchloralin	Fluometuron	---	91a	85a		56a-f	49a-f	33a-f		79a-d	86a-c	78a-c	
Fluchloralin	Norflurazon		80ab	93a			64a-e	62a-e			73a-d	99a	
Nitralin	Fluometuron	---	84a	60ab		---	---	---		---	---	---	
Nitralin	Norflurazon		54b	74ab			---	---			---	---	
Pendimethalin	Fluometuron	---	---	---		38a-f	13d-f	65a-e		67a-d	77a-d	88a-c	
Pendimethalin	Norflurazon		---	---			44a-f	67a-e			86a-c	73a-d	
Profluralin	Fluometuron	---	90a	89a		37a-f	29b-f	54a-f		76a-d	81a-d	88a-c	
Profluralin	Norflurazon		84a	89a			71a-e	60a-e			83a-d	94ab	
Trifluralin	Fluometuron	---	85a	89a		31a-f	19c-f	63a-e		58a-d	79a-d	90a-c	
Trifluralin	Norflurazon		89a	85a			49a-f	68a-e			83a-d	93a-c	
---	Tetrafluron		---	---	---		---	---	---		---	---	47cd
Weedy check[2]													

[1]Values within years followed by a common letter are not different (P = .05) according to Duncan's New Multiple Range Test.

[2]Plants per square foot were 20.8 in 1974; 6.7 in 1975; 6.9 in 1976. (Control in all plots based on actual counts.)

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