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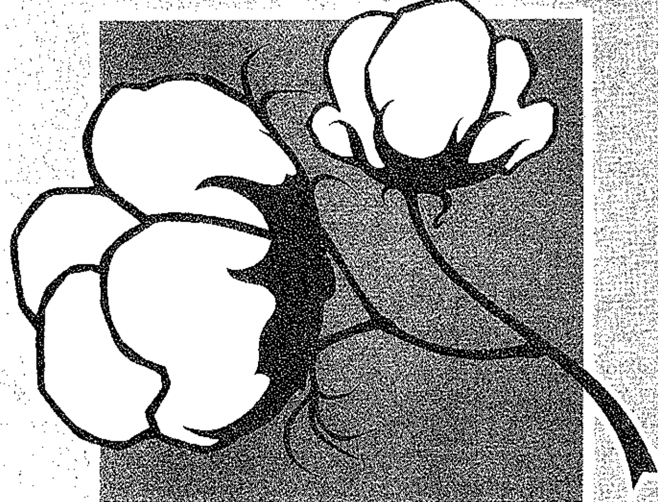

Chemical, Mechanical, and Economic Relationships of Weed Control Methods in Mississippi Cotton

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Abstract

Response of cotton (*Gossypium hirsutum* L.) was evaluated in 1987, 1988, and 1989 when weed density was changed by the addition of preemergence applications of fluometuron (0, 50, or 100% surface coverage), cultivation (0, 1, 2, or 3 times), and post-directed fluometuron + MSMA. Weed densities varied widely among years and were directly related to early-season soil moisture. A post-directed herbicide treatment or cultivation(s) had little effect on weed density, but cultivation(s) or post-directed herbicides reduced weed biomass. The use of a banded (50% surface coverage) fluometuron application reduced weed biomass 28% to 47%. A further decrease occurred when preemergence fluometuron was increased from banded to broadcast (100% surface coverage). Seed cotton yields were low in those plots that received no preemergence fluometuron. Plots that had banded fluometuron applications and at least one cultivation had yields similar to those plots treated with broadcast fluometuron only. A broadcast application of fluometuron followed by one cultivation and a broadcast application of fluometuron + MSMA applied post-directed resulted in the highest average net returns.

In a weed-free study initiated in 1987, when cultivations were begun at 1 or 2 weeks after emergence and cultivated on a once-weekly basis at a total frequency of 0, 1, 2, 4, or 6 times, seed cotton yields were not increased on a consistent basis.

Introduction

Weed control in cotton differs from that in other common row crops, with cotton producers facing challenges that other row-crop farmers do not face. Weed problems are often greater in the southern United States. This is at least partially because warm, humid growing conditions cause more rapid herbicide breakdown and rapid weed germination and growth. Fewer herbicides are available to cotton growers than to soybean or corn producers, so available products must be used extensively. Because of the increased presence of weeds and lack of persistent soil-applied herbicides or crop-tolerant postemergence herbicides, producers routinely rely on cultivation and post-directed herbicide applications to control late-emerging weeds in their cotton fields.

Fluometuron (Cotoran®, Meturon®) is a substituted urea herbicide commonly used for weed control in cotton (1). It controls many annual grass and broadleaf weeds preemergence when sufficient moisture is available, and is effective for post-directed control of several problem weeds in cotton. It can be absorbed through both plant roots and shoots, but is more efficacious via root uptake. Postemergence activity is possible by the addition of suitable adjuvants to facilitate plant uptake by emerged weeds.

Fluometuron's primary mechanism of action is disruption of electron transport in the photosynthetic process, with the resultant free-radical formation causing most of the visible herbicidal effects (1). Fluometuron may persist longer than one cropping season, so carryover damage to small grains is a concern (14).

In 1987, preemergence surface applications were applied to essentially 100% of Mississippi's cotton acreage, with 99% applied as banded applications (19). In Mississippi, fluometuron was applied preemergence to 85% of the cotton acreage in 1989 (6). Postemergence applications of fluometuron or fluometuron + MSMA were on 60%, 67%, 52%, 55%, 83%, and 25% of the cotton acreage in Alabama, Arkansas, Georgia, Louisiana, Missouri, and Mississippi, respectively (6). In each of these states, fluometuron was typically applied more than once, since total treated acreage exceeded 100%. For example, 75% and 83% of Missouri's acreage was treated with preemergence and postemergence fluometuron, respectively. This suggested that more than 50% of the acreage received at least two fluometuron applications.

Partly because of the lack of suitable herbicides for topical application to cotton, 81% of the cotton acreage in Mississippi received post-directed applications, of which 99% were banded applications (19). The high percentage of banded applications in Mississippi necessitates cultivation to remove weeds from the untreated row middles. This in turn may require a post-directed herbicide application to control late-emerging weeds in the row not controlled by cultivation. Band applications create a two-step weed control approach that is dependent upon subsequent inputs of labor and fuel.

Applying herbicides as banded treatments necessitates subsequent inter-row cultivation and/or postemergence herbicide treatments. Cultivation improved weed control in cotton, especially where band applications were used (10, 20). Historically, cultivation has been used specifically for weed control. The introduction of herbicides for use in cotton in the early 1950's has diminished the need for cultivation. Cultivation requirements vary with herbicide(s) used and the weed spectrum present (8, 9, 15, 21). In some cases, cultivation is not necessary to achieve optimum yields (10, 21). Without herbicides, five cultivations plus an average of 75 hr/acre of hand-labor were needed annually to reduce weed competition for 7 to 8 weeks (8).

Cultivation is often imperative for effective weed control. The frequency of cultivations depends upon the individual situations encountered in the field. Very little information is available on the effects of cultivation on crop yield in the absence of yield-reducing weed populations. In 1973, Hauser et al. (12) reported yield increases in peanut (*Arachis hypogaea* L.) with one well-timed cultivation. Detrimental effects of cultivation on soybeans were reported in 1971 (16). Evaluation of several cultivation practices conducted in Alabama on two soil types did not result in improved cotton yields (4).

Cultivation effects on soil properties are also an important consideration. Cultivation increases water infiltration (22). Also, cultivation, in the form of two rotary hoeings, improved soil physical conditions in nonirrigated sorghum [*Sorghum bicolor* (L.) Moench.] (5). In some cases, cultivation destroys soil structure by physically disrupting soil aggregates (3). Soil organic matter may decline as a result of cultivation, where organic matter that was inaccessible prior to cultivation is exposed to bio-oxidation. Loss of organic matter contributes to instability of soil aggregates and decreased water infiltration (3).

Increased environmental concerns and fluctuations in fuel costs have aroused interest in reducing herbicide and cultivation inputs. It is becoming increasingly evident that optimization of these inputs is necessary to remain productive and environmentally safe. From a weed control standpoint, the benefits of cultivation are self-evident. However, any direct benefits to certain crops have varied. For cotton, Buchanan and Hiltbold (4) indicated little benefit of cultivation on cotton yield beyond that of weed control, but varying cultivation frequency and initiation timing was not addressed.

The objectives of the research summarized in this bulletin were: **(1)** to determine the optimum combination of three weed control strategies: preemergence fluometuron use, cultivation, and post-directed fluometuron use; and **(2)** to determine if cultivation enhances cotton productivity in the absence of yield-restricting weed populations. The goals were to optimize cotton yield while minimizing herbicide use and cultivations. Minimum herbicide use would be beneficial from an economic and environmental perspective. Minimizing cultivations would decrease fuel costs, save time, and reduce environmental pollution.

Materials and Methods

Chemical/Mechanical Relationships

Experiments were conducted at the Delta Branch Experiment Station near Stoneville, MS in 1987, 1988, and 1989. The soil type was a Dundee silty clay loam (fine-silty, mixed, thermic Aeric Ochraqualf). Soil organic matter was 1.3%, and pH was 6.3. Plot size was four 40-inch rows, 20 feet long. 'DES 119' cotton was planted on April 22, 1987, May 16, 1988, and May 2 in 1989, respectively. Trifluralin (Treflan®, Trilin®) at 0.75 lb/A was applied preplant incorporated to all plots.

A randomized complete block design with four replications and a factorial arrangement of preemergence fluometuron at 1.5 lb/A (none, 50%, and 100% surface application), cultivation (0, 1, 2, or 3 times) and broadcast post-directed fluometuron + MSMA (monosodium salt of MAA) at 0.8 + 2.0 lb/A (with or without) was used. Preemergence fluometuron was applied with a tractor-mounted sprayer in 15 gallons/acre of water carrier.

Initial cultivation treatments were begun on May 5, 1987, June 6, 1988, and May 22, 1989, with additional cultivations implemented as needed or biweekly. Post-directed applications were made June 2, 1987, June 21, 1988, and June 22, 1989, when cotton was 6 to 8 inches tall. Standard production practices for cotton were used to prepare seedbeds, apply fertilizer, and augment disease and insect management. Cotton was appropriately defoliated prior to a once-over mechanical harvest.

Weed density and biomass were measured in late August prior to mechanical harvest. The predominant weeds were morningglory species (*Ipomoea* spp.), prickly sida (*Sida spinosa* L.), and hemp sesbania (*Sesbania exaltata* (Raf.) Rydb. ex. A. W. Hill.). There was a significant year-by-treatment interaction, so data are presented for each year. The post-directed herbicide application had little effect on weed density or seed cotton yield. Therefore, the data presented for those two parameters are from plots not receiving a post-directed herbicide application. However, differences for weed biomass were not the same for each level of post-directed application (Table 3). Thus, data are presented for both methods. Means were separated by the Least Significant Difference (LSD) test at the 0.05 probability level.

Returns above weed control costs per acre were estimated for each of the 24 treatments in each year of the study. An average of these net returns over the 3 years was computed for each treatment. The variability of net returns over time was measured by the standard deviation of net returns. Treatments having high average net returns and low standard deviations would be preferred to treatments having low average net returns and high standard deviations.

Lint and cottonseed yields were derived from seed cotton yields assuming lint weight was 36% of seed cotton weight. Since most cotton farmers participate in the Acreage Reduction Program, cotton lint prices for each year were calculated by adding the deficiency payment per pound received by Mississippi farmers to the statewide seasonal average price received (Mississippi Agricultural Statistics). This procedure resulted in lint prices of \$0.81, \$0.71, and \$0.75 per pound in 1987, 1988, and 1989, respectively. Cottonseed prices used in these analyses were \$0.037, \$0.05, and \$0.049 per pound in the 3 years. Gross returns per acre included revenue from lint and cottonseed.

Weed control costs were based on the use of a four-row cultivator and a tractor-mounted sprayer. The per-acre cost of a chemical treatment was calculated by multiplying application rate per acre by statewide average price. In addition to the cost of chemicals used for each treatment, other weed control costs included labor, fuel, and machinery repairs required to perform the spraying and cultivation operations. Interest expense on each cost item was based on the time period between use and the harvest date. The total weed control cost per acre was subtracted from gross return per acre to obtain net return per acre for each weed control treatment.

Weed-free Cultivation Relationships

Experiments were conducted in 1988 and 1989 at the Delta Branch Experiment Station, Stoneville, MS, on two soil types. The first soil type was a Dundee silty clay loam (fine-silty, mixed, thermic, Aeric ochraqualf) with 1.3% organic matter and a pH of 6.3. Row spacing for this soil type was 40 inches and plot length was 20 feet. There was no irrigation applied either year on the Dundee soil.

The second soil type was a Bosket very fine sandy loam (fine-loamy, mixed, thermic, Mollic hapludalf) with a pH of 6.8 and organic matter of 0.9%. Duplicate trials were established on this soil type both years to determine the influence of cultivation on cotton growth under irrigated and nonirrigated conditions. In 1989, because of excessively wet conditions, no irrigation was necessary; therefore, results were combined to provide eight replications for 1989 data. In 1988, one of the duplicate trials was furrow-irrigated once each in late June and early August. Irrigation required a furrow plow in order to facilitate drainage through the whole study. This practice was conducted over the whole test and was in lieu of the sixth cultivation for the 2 weeks after emergence treatments.

A randomized complete block with four replications was used. Treatments were factorially arranged to establish the interaction of initiation timing and frequency of cultivation on cotton yield response.

'DES 119' was planted in four-row plots. Cultivation was initiated at 1- or 2-weeks after emergence (herein referred to as timing) and cultivated 0, 1, 2, 4, or 6 times (herein referred to as frequency) on weekly intervals or as environmental conditions dictated. Weeds were eliminated from all test areas with timely applications of trifluralin, fluometuron, or MSMA at appropriate timings and rates for each individual situation. Escapes were controlled by hand hoeing as necessary with minimal soil disturbance. Cultivation depth did not exceed 4 inches at any location and was conducted with standard four-row equipment. Care was taken not to travel through or disturb plots unnecessarily so as to impede water infiltration.

Total seed cotton yield was determined by mechanically harvesting the two center rows of each plot once. Crop height was determined 2, 4, and 8 weeks past the final cultivation. Main stem heights of 5 to 10 randomly selected plants were measured from each plot. Measurements were from the soil surface to the tip of the terminal bud.

Data for total seed cotton yield were subjected to linear regression over cultivation frequency for each initiation timing period. Also, a factorial analysis of seed cotton yield response to cultivation timing and frequency was conducted. Where appropriate, mean yields were averaged over timing initiation or frequency, and means were separated using Fisher's Protected Least Significant Difference at the 0.05 level of probability.

Results and Discussion

Chemical/Mechanical Relationships

Soil moisture during the growing season was higher in 1987 and 1989 than in 1988 (Table 1). The distribution of rainfall in each year affected the aggregate weed density and biomass and the effect of cultivation and post-directed herbicide application. When soil moisture was ample, as in 1987 and 1989, weed seed

Table 1. Monthly rainfall during the growing season in field experiments.

	Rainfall Amount		
Month	1987	1988	1989
April	2.8	2.8	4.7
May	7.5	0.8[a]	5.9
June	4.7	0.4	9.4
July	3.9	2.4	10.6
August	1.2	3.5	3.5
September	1.6	4.7	7.1
October	0.4	6.3	0.8

[a]All plots were furrow-irrigated prior to planting to facilitate cotton germination.

germination early in the growing season provided those weeds with a comparative advantage, since early emergence and subsequent preemption of space is critical to successful plant growth in a competitive environment (7). In years with abundant soil moisture early in the growing season, early cultivations would be effective in shifting space allocation toward the cotton. In dry seasons, cultivations would not have a major effect because of lower weed germination and emergence rate.

Weed densities varied widely between the 3 years of the study, with the highest average densities in 1987 and the lowest in 1988 (Table 2). The use of a post-directed herbicide treatment had little effect on weed density (data not shown). In 1987, the order of weed density based on preemergence fluometuron use was none > band > broadcast. In 1987, within each application method, use of one or two cultivations to plots receiving no fluometuron, or one cultivation following banded fluometuron applications, decreased weed density when compared to no cultivation. Three cultivations did not further reduce weed densities in 1987.

Table 2. Weed density in 1987, 1988, and 1989 as affected by the level of preemergence fluometuron application and cultivation.

Area treated with/fluometuron[a]	Cultivation frequency	Weed density x 1,000		
		1987	1988	1989
	no.		No/A	
0%	0	59	8	28
	1	36	5	28
	2	24	11	20
	3	30	4	26
50%	0	24	6	11
	1	8	6	2
	2	4	5	4
	3	5	2	6
100%	0	6	3	3
	1	4	1	8
	2	2	2	4
	3	2	1	2
LSD (0.05)		12	3	10

[a]Preemergence fluometuron applied at 1.5 lb/A to cover 0% (none), 50% (band), or 100% (broadcast) of the soil surface.

In 1988, weed densities were lower but three cultivations were necessary for 0 and 50% fluometuron applications to reduce weed density.

In 1989, cultivation did not reduce weed density. Weed density reductions were dependent upon fluometuron application only. In 1989, above-average soil moisture prevented cultivation at the proper time, but also enhanced fluometuron activity. This combination of events resulted in a favorable response to fluometuron application while at the same time negated the effects of cultivation.

Compared to no fluometuron application, broadcast preemergence fluometuron application reduced weed density in all years. Cultivation frequency had no significant effect on these applications (Table 2). For banded applications and no fluometuron, three cultivations were necessary in 1988 to reduce weed density when compared to 0, 1, or 2 cultivations. In 1987, one cultivation following a band application reduced weed density.

Weed biomass per acre was determined at the same time as weed density. In each year, the addition of a banded fluometuron application reduced weed biomass 28% to 47% when compared to the untreated (Table 3). Broadcast preemergence fluometuron application reduced weed biomass when compared to no cultivation and band application. Weed biomass was reduced 58% to 92% when fluometuron was applied broadcast. Cultivation following a broadcast application did not further reduce weed biomass 2 of 3 years. This supports earlier research that showed a similar response in a 4-year study (21).

In 1988, weed biomass was reduced by one cultivation or by a post-directed application when following broadcast application of fluometuron. However, both practices combined did not reduce biomass further. The need for additional control measures was because of poor activation of preemergence fluometuron. However, even under poor activation conditions, broadcast application reduced weed biomass better than band application.

Use of a post-directed fluometuron + MSMA application reduced weed biomass in plots that received 0 or 50% preemergence fluometuron applications and zero or one cultivation. The post-directed applications were made 4 to 5 weeks after emergence, so it affected weed biomass more than weed density because weeds that emerged late in the season were smaller. These late-emerging, smaller weeds apparently had little effect on cotton yield. The use of post-directed fluometuron + MSMA did not affect weed biomass when following a broadcast application.

Post-directed fluometuron + MSMA had no effect on seed cotton yield, so the data presented are from those plots not receiving a post-directed application (Table 4). This agrees with similar research reported in Arkansas where various post-directed treatments did not improve lint yield (13). The absence of preemergence fluometuron was coincident with the lowest cotton yields, with virtually no harvestable yield in 1989. Yield in plots receiving no preemergence fluometuron was increased by three cultivations only in 1988, a dry year. Three cultivations increased yield beyond that of the 0 and 50% fluometuron application when fluometuron was applied broadcast.

When compared to no preemergence fluometuron, yields were higher with fluometuron applied to 50% of the soil surface (Table 4). Maximum seed cotton yields were produced on plots treated with banded fluometuron and cultivated once in 1987 and 1988, and twice in 1989. At least one cultivation was needed for optimum yields when band applications were used. However, this approach (leaving middles untreated) is not always possible due to field conditions that do not allow timely field equipment operation.

Comparing plots that received broadcast versus banded preemergence fluometuron applications, the addition of a broadcast application increased seed cotton yield more than comparable band applications when plots were cultivated zero or one time in 1987, when cultivated three times in 1988, and when cultivated 0, 1, or 2 times in 1989 (Table 4).

Within the broadcast preemergence fluometuron treatments, the use of one cultivation in the weed control system increased seed cotton yield in all years. This is in contrast to previous work that reported no improvement in seed cotton yield when cultivation followed broadcast application of fluometuron (21). However, seed cotton yield was not increased by more than one cultivation in plots receiving broadcast fluometuron applications. Also, in 1989, a wet year, three cultivations were needed following a band application to equal a broadcast application with one cultivation. In 1987, a band application plus one cultivation was necessary to equal a single broadcast application with no cultivation.

Increasing the area treated with fluometuron from 50% to 100% of the soil surface with no cultivation resulted in yield increases of 213%, 74%, and 325% in 1987, 1988, and 1989, respectively. These were significant differences in 1987 and 1989. In 1988, dry growing conditions after weed control measures were implemented reduced the need for additional measures. Therefore, very few additional inputs were needed, whether fluometuron was band-applied or broadcast-applied.

Table 3. Weed biomass in 1987, 1988, and 1989 as effected by the level of preemergence fluometuron application, cultivation, and post-directed herbicide use.

Area treated with fluometuron[a]	Cultivation frequency	Post[b]	Weed Biomass x 1,000 1987	1988	1989
	(no.)		(lb/A)		
0%	0	No	27	19	22
	1	No	20	11	16
	2	No	16	7	16
	3	No	16	6	15
	0	Yes	19	10	14
	1	Yes	12	5	12
	2	Yes	13	4	9
	3	Yes	12	5	12
50%	0	No	14	13	16
	1	No	6	7	6
	2	No	1	4	4
	3	No	15	3	2
	0	Yes	4	4	4
	1	Yes	3	1	1
	2	Yes	2	1	1
	3	Yes	1	1	1
100%	0	No	4	8	2
	1	No	2	2	2
	2	No	1	4	1
	3	No	4	2	1
	0	Yes	2	3	1
	1	Yes	1	1	1
	2	Yes	2	2	1
	3	Yes	1	2	1
LSD (0.05)			5	5	5

[a] Preemergence fluometuron applied at 1.5 lb/A to cover 0% (none), 50% (band), or 100% (broadcast) of the soil surface.

[b] Fluometuron + MSMA applied at 0.8 + 2.0 lb/A post-directed.

Table 4. Seed cotton yield per hectare in 1987, 1988, and 1989 as effected by the level of fluometuron application and cultivation.

Area treated with/fluometurona	Cultivation frequency	Seed cotton yield 1987	1988	1989
	no.	lb/A		
0%	0	90	285	10
	1	160	560	10
	2	430	790	125
	3	420	970	30
50%	0	470	470	180
	1	1,520	1,120	380
	2	1,820	1,330	800
	3	1,860	1,160	1080
100%	0	1,480	820	760
	1	2,100	1,520	1,210
	2	2,100	1,230	1,300
	3	1,800	1,870	1,400
LSD (0.05)		520	625	410

[a]Preemergence fluometuron applied at 1.5 lb/A to cover 0% (none), 50% (band), or 100% (broadcast) of the soil surface.

In this and previous research (13, 21), it can be concluded that acceptable weed control in cotton with cultivation alone cannot be achieved under the conditions defined in these studies. These studies confirm the need for herbicide use to optimize cotton yield. To minimize the total weed control input, adjustments in the total area covered by an herbicide or in the number of sequential cultivations are possible. However, both these factors are interrelated and dependent upon factors such as environment, weed spectrum present, and weed infestation level.

Earlier research (21) indicated that a broadcast preemergence application of fluometuron can achieve maximum seed cotton yield without additional inputs. In the present study, this was not true. However, no more than one cultivation was needed to achieve maximum seed cotton yield. Additionally, a post-directed spray was not needed for optimum yield. Reduction of initial herbicide input by 50% necessitated the need for additional inputs. With respect to seed cotton yield, only one (1987, 1988) or two (1989) cultivations were necessary for optimum performance. However, implementing the same number of cultivations after increasing initial herbicide input to 100% increased yields further in 2 of 3 years.

Although these minimal inputs provide optimum crop yield, they do not optimize weed control. For example, weed biomass was reduced further by the addition of a post-directed application following a 50% application of fluometuron (Table 3). However, this did not increase seed cotton yield. Also, for all application methods, a certain level of weed biomass remained. Weed-free seed cotton yields were 1,920, 2,040, and 1,050 lb/A in 1987, 1988, and 1989, respectively, and were not significantly higher than those treatments involving maximum inputs (data not shown). This indicated that maximum weed control response was achieved with selected treatments, but did not eliminate weed biomass altogether.

Maximizing weed control inputs in an effort to sanitize fields for future crops is an aspect that warrants consideration. However, earlier long-term studies with continuous corn have shown that row cultivation (2) or tillage (2, 11) did not influence total seed production in any year and that intensive herbicide inputs were not necessary to alter existing numbers of weed seeds in soil (2, 17,18). However, shifts in weed populations were apparent in one study(2) and lack of herbicide use after 3 years allowed weed populations to recover (18). More importantly, judicious use of her-

Table 5. Economic results of the mechanical/chemical weed control systems, 1987-89.

Trt. no.	Area treated with fluometuron[a]	Cultivation frequency	PDS trt.	Net Returns 1987	1988	1989	Avg.	S.D.[b]
		(No.)		($/A)				
1	0	0	No	26.80	81.39	0.30	36.16	3.76
2	0	1	No	49.10	157.82	-2.67	68.08	66.88
3	0	2	No	130.68	220.44	31.12	127.41	77.32
4	0	3	No	123.64	272.17	-1.67	131.38	111.93
5	0	0	Yes	73.82	245.96	-14.60	101.73	108.19
6	0	1	Yes	130.43	318.94	37.88	195.75	117.33
7	0	2	Yes	216.17	231.14	-21.45	141.95	115.70
8	0	3	Yes	270.60	253.25	-23.80	166.68	134.88
9	50	0	No	139.08	124.56	42.12	101.92	42.70
10	50	1	No	465.32	307.11	103.04	291.82	148.29
11	50	2	No	559.19	365.71	223.62	382.84	137.53
12	50	3	No	567.28	315.05	306.85	396.39	120.88
13	50	0	Yes	445.58	232.18	124.57	267.44	133.40
14	50	1	Yes	559.00	438.32	337.67	444.99	90.48
15	50	2	Yes	641.52	434.79	275.63	450.65	149.80
16	50	3	Yes	559.13	470.13	209.08	412.78	148.55
17	100	0	No	449.80	217.76	208.03	291.86	111.75
18	100	1	No	644.25	413.54	344.58	367.46	128.14
19	100	2	No	636.60	328.91	366.62	444.05	137.02
20	100	3	No	543.80	508.33	394.40	482.18	63.73
21	100	0	Yes	582.26	468.90	385.70	478.95	80.56
22	100	1	Yes	597.94	515.12	412.86	508.64	75.70
23	100	2	Yes	634.12	409.79	398.44	480.78	108.52
24	100	3	Yes	549.83	506.67	410.55	489.02	58.22

[a] Preemergence fluometuron applied at 1.5 lb/A to cover 0% (none), 50% (band), or 100% (broadcast) of the soil surface.
[b] Standard deviation.

bicides in these systems negated any weed response to tillage (2) and minimized the impact of subsequent weed populations.

Even though post-directed herbicide application did not impact yields significantly, average net returns increased with the addition of the post-directed herbicide treatment (Table 5). Jordan et al. (13) reported a similar response in work conducted in Arkansas. Also, average net returns increased as the preemergence treatment of fluometuron was changed from 0 to 50% to 100% of surface coverage.

Comparing the cultivation treatments, average net returns were lowest when no cultivation was made, regardless of the herbicide treatment. The impacts on net returns from one, two or three cultivations varied somewhat. Without a post-directed herbicide, three cultivations resulted in the highest average net returns within the three levels of preemergence surface coverage. However, with a post-directed herbicide, one cultivation resulted in the highest average net returns when the preemergence herbicide covered 0 or 100% of the surface. With 50% coverage plus post-directed herbicide, average net returns were highest with two cultivations.

Comparing all treatments, 100% surface coverage with fluometuron, one cultivation, and post-directed fluometuron + MSMA resulted in the highest average net return, and also had a low standard deviation. Other treatments with high returns and low variability were treatments 20, 21, and 24. In addition to the above-mentioned treatments, several other treatments (14, 15, 18, 19, and 23) warrant further study and consideration.

Weed-free Cultivation Relationships

On the Dundee soil in 1988, there were no differences in yields within frequency, timing, or timing by frequency (Table 6). In 1989 on the Dundee soil, there was a significant interaction of timing by frequency indicating that differences within each timing were not the same. When cultivations were begun at one week after emergence, yields were significantly higher for only one cultivation as compared to two or six cultivations. When cultivation was begun at 2 weeks after emergence, yield of treatments receiving two cultivations per year was significantly higher than one. However, these yields did not exceed that of the 0 cultivation frequency. When averaged over frequency, seed cotton yields did not differ in 1988 on the Dundee soil for the 1 or 2 weeks after emergence initiation timings (Table 7).

On the Bosket soil type in 1988, cultivation frequency did not influence seed cotton yields within either initiation timing (Table 8). However, when yields were averaged over frequency, seed cotton yield was higher when cultivations were begun 2 weeks after emergence as compared to those begun one week after

Table 6. Analysis of variance for seed cotton yield response to cultivation timing, frequency, and timing x frequency.

		Posterior significance		
Location and Description	**Year**	**Timing**	**Frequency**	**Timing x Frequency**
Dundee scl	1988	0.6794	0.5699	0.6551
Dundee scl	1989	0.6493	0.9031	0.0004
Bosket vfsl-irrigated	1988	0.7460	0.8668	0.5835
Bosket vfsl-nonirrigated	1988	0.0199	0.4771	0.5985
Bosket vfsl-nonirrigated	1989	0.2170	0.2897	0.2200

Table 7. Seed cotton yield when cultivation was initiated at one or two weeks after emergence and averaged over frequency.

		Total seed cotton yield	
Location and description	**Year**	**1 wk mean**	**2 wk mean**
		(lb/A)	
Dundee scl	1988	2,700	2,770
Bosket vfsl			
irrigated	1988	3,950	3,920
nonirrigated	1988	2,370**	2,603**
	1989	3,240	3,310

**indicates a significant difference between these two means within the same row at the 5% level.

Table 8. Seed cotton yield following two cultivation timings and five frequencies.

Treatment timing after emergence	Frequency	Total seed cotton yield				
		1988			1989	
		Dundee	Bosket-N-I[a]	Bosket-I	Dundee	Bosket
(week)	(no/year)	(lb/A)				
1	0	2,860	2,410	3,830	2,680	3,180
1	1	2,400	2,520	3,910	3,200	3,230
1	2	2,380	2,360	4,030	2,540	3,370
1	4	2,790	2,320	3,980	2,820	3,240
1	6	3,040	2,230	3,990	2,360	3,200
2	0	2,500	2,480	4,080	2,880	3,350
2	1	2,860	2,620	3,770	2,310	3,490
2	2	2,680	2,630	3,900	3,090	3,270
2	4	2,930	2,840	3,960	2,570	3,260
2	6	2,910	2,440	3,890	2,990	3,180
LSD (0.05)[b]		NS	NS	NS	580	NS

[a]NI = nonirrgated; I = irrigated.
[b]For comparison of any two means within a column except for frequency means.

emergence under nonirrigated conditions. Although seed cotton yields did not respond to cultivation frequency, yields were higher when cultivation began 2 weeks after emergence as compared to one week when averaged over cultivation frequency (Table 7).

In 1988, which was an abnormally dry year, seed cotton yield increased by delaying cultivation until 2 weeks after emergence. In 1988, when plots were irrigated on the Bosket very fine sandy loam, or in 1989 when moisture was adequate, there were no differences in seed cotton yield for any timing or frequency (Table 8). This suggested that in a year when moisture was deficient, cultivation may have improved cotton yield by promoting more efficient use of available water because of changes in water infiltration. This response was further enhanced by delaying the initiation of cultivation by approximately 2 weeks. When soil moisture was adequate, cotton response to cultivation was not apparent.

In 1988 under nonirrigated conditions, first harvest seed cotton yields were higher for four cultivations started 2 weeks after emergence than for two, four, or six cultivations begun at one week after emergence and six cultivations begun at 2 weeks (data not shown). However, no differences within frequency were noted for total seed cotton yield. When averaged over frequency, first harvest yields were higher for 2 weeks after emergence treatments, as was the case for total seed cotton yield. This indicated a delay in maturity when cultivation was begun one week after emergence.

Results indicate very little yield response to cultivation on several soil types evaluated. Seed cotton yields were sometimes higher when cultivations were begun 2 weeks after emergence than when cultivations were begun at one week after emergence. When averaged over initiation timing in two locations, it was shown that four or six cultivations were not any better than two cultivations.

Under weed-free conditions, it appeared that cultivation was of little direct benefit to cotton growth or yield when considering frequencies greater than two. There was evidence, however, that cultivation was more beneficial if begun at 2 weeks after emergence instead of one.

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