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Cotton & Annual Weed

Response from Normal and Reduced Herbicide Input Practices, 1989-98

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Introduction

Mississippi cotton producers are interested in controlling the weeds that infest their fields. Because weed control costs are one of the major expense items in producing cotton, producers are especially interested in lowering weed control inputs, provided that an acceptable yield can be maintained. This report details research results from a study comparing normal- (recommended) and reduced-herbicide input practices over 10 years. The objective was to evaluate systems of normal and reduced herbicide inputs on cotton stand and yield and on populations of naturally occurring annual broadleaf and grass weeds.

Materials and Methods

Conventional-till cotton ('DES 119' in 1989-95 and 'SG 125' in 1996-98) was planted in mid- to late April each year. Re-planting was necessary in early May 1994 and 1995 due to an inadequate stand with the first planting. This was done without additional seedbed tillage. The research was conducted at the Delta Research and Extension Center (DREC) in Stoneville, Mississippi, on a Bosket silt loam soil (Mollic Hapludalfs) with pH 6.1 and 0.7% organic matter.

Herbicide input systems consisted of selected preplant incorporated (PPI), preemergence (PRE), and directed postemergence (PODIR) herbicides (Tables 1-2). Herbicide treatments were applied to the same plots during 1989-1994 and during 1995-1998. After 1994, plots with input treatments were reversed; normal-input treatments were applied to plots that formerly had reduced-input treatments applied to them, and reduced-input treatments were applied to plots that formerly had normal-input treatments applied to them. These treatments continued through 1998. Individual plots consisted of four rows (40 inches wide, 40 feet long) arranged in a randomized complete block design with four replications. Treatment means were separated by DMRT at the 95% level of probability. All production practices, other than weed control, were those common to the production of dryland cotton in the Mississippi Delta. No supplemental irrigation was used.

Tables 1 and 2 list the PPI and PRE herbicide treatments, preplant tillage, planting, cultivations, and dates of each activity. The normal-input broadcast PPI treatments were applied as the work schedule and/or weather conditions permitted. Applications were made with tractor-mounted equipment at 20 gallons per acre. The application time varied from 0-50 days before initially hipping rows for planting, depending on the year. The initial soil incorporation was accomplished with a single pass of a four-row tandem disk harrow in 1989-1992 and 1995-1998 within 15-30 minutes after application of the herbicides. In 1993 and 1994, incorporation was with a single pass of a four-row rolling blade-type bed conditioner within 30 minutes after herbicide application (Table 1). The reduced-input PPI treatments were applied to a 20-inch band centered on the drill 2-33 days before planting. Initial soil incorporation was with a Lilliston cultivator in 1989 and with a bed conditioner in 1990-1998 operated one time over preformed beds after reducing the beds to approximately a 4-inch height before spraying. PRE herbicides were applied to a 16-inch-wide band centered on the

Table 1a. Preplant incorporated and preemergence herbicides, preplant tillage, dates of application, and planting and cultivation dates for an experiment on cotton weed control with normal- and reduced-herbicide input practices, DREC, Stoneville, MS, 1989-1994.

Year	Preplant treatments						Planting date	Preemergence treatments		Cultivation dates
	Normal input (treatments 6-10) [1]			Reduced input (treatments 1-5) [2]				Normal input [3] (treatments 6-10)	Reduced input [3] (treatments 1-5)	
	Date sprayed	Date tilled	Tillage method	Date sprayed	Date tilled	Tillage method				
1989	4/12	4/12	Disk harrow		4/12	Disk harrow	4/27	Cotoran 4L (fluometuron) 0.75 + Zorial 80DF 0.375	Cotoran 4L 0.5	5/11
		4/13	Hip		4/13	Hip				5/26
		4/24	Bed conditioner		4/24	Bed conditioner				
		4/25	Lilliston cultivator	4/25	4/25	Lilliston cultivator				6/19
		4/27	Bed conditioner, 2 times		4/27	Bed conditioner, 2 times				
1990	3/21	3/21	Disk harrow		3/21	Disk harrow	4/24	Cotoran 4L 0.75 + Zorial 80DF 0.375	Cotoran 4L 0.5	5/17
		4/19	Hip		4/19	Hip				6/8
		4/19	Bed conditioner, 2 times	4/19	4/19	Bed conditioner, 2 times				6/22
1991	3/11	3/11	Disk harrow		3/11	Disk harrow	4/26	Cotoran 4L 0.63 + Zorial 80DF 0.375	Cotoran 4L 0.5	5/17
		3/11, 4/25	Hip		3/11, 4/25	Hip				5/29
		4/3	Bed conditioner, 2 times	4/3	4/3	Bed conditioner, 2 times				6/11
		4/25	Bed conditioner		4/25	Bed conditioner				6/27
1992	3/16	3/16	Disk harrow		3/16	Disk harrow	4/27	Cotoran 4L 0.63 + Zorial 80DF 0.375	Cotoran 4L 0.5	5/1
		4/1	Hip		4/1	Hip				5/12
		4/23	Bed conditioner		4/23	Bed conditioner				
		4/24	Bed conditioner	4/24	4/24	Bed conditioner				5/18
										6/12
										6/29
1993	3/10	3/10	Bed conditioner		3/10	Bed conditioner	4/29	Cotoran 4L 0.063 + Zorial 80DF 0.375	Cotoran 4L 0.5	5/24
		3/29	Disk harrow		3/29	Disk harrow				5/31
		4/13	Hip		4/13	Hip				6/15
		4/14	Bed conditioner, 2 times	4/14	4/14	Bed conditioner, 2 times				
1994	3/15	3/15	Bed conditioner		3/15	Bed conditioner	4/27, 5/19 [4]	Cotoran 85DF 0.75 + Zorial 80DF 0.375	Cotoran 85DF 0.5	5/13
		3/16	Hip		3/16	Hip		Bueno 6E (MSMA) 2.0 [4]	Bueno 6E 2.0	6/13
		3/16	Bed conditioner		3/16	Bed conditioner				7/5
		3/25	Bed conditioner	3/25	3/25	Bed conditioner				

[1]The preplant-incorporated normal-input herbicide application consisted of 0.75 lb ai/A Treflan 4E (trifluralin) and 0.75 lb ai/A Zorial 80DF (norflurazon).
[2]The preplant-incorporated reduced-input herbicide application consisted of 0.5 lb ai/ATreflan 4E.
[3]These herbicides were applied on the day of planting in most years. In 1989, application was 1 day after planting. Application rates are measured in lb ai/A.
[4]On May 19, 1994, 0.94 lb ai/A Gramoxone Extra 2.5E (paraquat), plus Activate Plus 0.25%, was broadcast to destroy cotton plants from the first planting. On April 27, 1994, Bueno 6 was applied to control nutsedge.

Table 1b. Preplant incorporated and preemergence herbicides, preplant tillage, dates of application, and planting and cultivation dates for an experiment on cotton weed control with normal- and reduced-herbicide input practices, DREC, Stoneville, MS, 1995-1998.

Year	Preplant treatments						Planting date	Preemergence treatments		Cultivation dates
	Reduced input (treatments 1-5) [1]			Normal input (treatments 6-10) [2]				Reduced input [3] (treatments 1-5)	Normal input [3] (treatments 1-5)	
	Date sprayed	Date tilled	Tillage method	Date sprayed	Date tilled	Tillage method				
1995		3/20	Disk harrow	3/20	3/20	Disk harrow	4/19 [5], 5/3 [4]	Cotoran 4L (fluometuron) 1.25	Cotoran 4L 1.5 + Zorial 75DF 0.75	5/30
										6/5
		3/20	Hip		3/20	Hip				6/14
		3/20	Bed conditioner		3/20	Bed conditioner				
	4/7	4/7	Bed conditioner		4/7	Bed conditioner				
1996		3/11	Disk	3/11	3/11	Disk	4/26	Cotoran 4L 1.25	Cotoran 4L 1.5 + Zorial 75DF 0.75	5/5
										6/6
		3/11	Hip		3/11	Hip				6/18
		3/14	Bed conditioner		3/14	Bed conditioner				
	4/3	4/3	Bed conditioner		4/3	Bed conditioner				
1997		3/12	Disk	3/12	3/12	Disk	4/25	Cotoran 4L 1.25 + Gramoxone 0.95 + Latron AG-98 0.5%	Cotoran 7L 1.5 + Zorial 80DF 0.75	5/6
										6/4
										6/16
		3/12	Hip		3/12	Hip				7/8
		3/12	Bed conditioner		3/12	Bed conditioner				
	4/3	4/3	Bed conditioner		4/3	Bed conditioner				
1998		3/4	Disk	3/4	3/4	Disk		Roundup Ultra 0.5 [6]	Roundup Ultra 0.5 [6]	5/28
										6/8
		3/4	Hip		3/4	Hip				6/12
		3/4	Bed conditioner		3/4	Bed conditioner	4/23	Cotoran 4L 1.25	Cotoran 4L 1.5 + Zorial 80DF 0.75	6/12
										6/30
	3/24	3/24	Bed conditioner		3/24	Bed conditioner				

[1]The preplant-incorporated reduced-input herbicide application consisted of 0.5 lb ai/ATreflan 4E.
[2]The preplant-incorporated normal-input herbicide application consisted of 0.75 lb ai/A Treflan 4E (trifluralin) and 0.75 lb ai/A Zorial 80DF (norflurazon).
[3]These herbicides were applied on the day of planting in most years. In 1998, application was 1 day after planting. Application rates are measured in lb ai/A.
[4]On May 5, 1995, 0.94 lb ai/A Gramoxone Extra 2.5E, plus Activate Plus 0.25%, was broadcast to destroy cotton plants from the first planting.
[5]Bladex 90DF was added to treatments 1-10 at at a rate of 0.5 lb ai/A.
[6]On April 8, 1998, Roundup Ultra was applied at a rate of 0.5 lb ai/A.

Table 2. Sequence for preplant tillage, PPI application, incorporation, and planting for an experiment on cotton weed control with normal- and reduced-herbicide input practices, DREC, Stoneville, MS, 1989-1998.

Crop year	Stalks cut	Subsoil	Disk	Hip	Bed conditioner	Lilliston cultivator	Plant
1989	10/13/88	3/13/89	4/12/89[1]	4/13/89	4/24/89, 4/27/89 (2X)	4/25/89[2]	4/27/89
1990	11/2/89	12/6/89	3/21/90[1]	4/19/90	4/19/90, 4/19/90[2]	—	4/24/90
1991	11/1/90	11/21/89	3/11/91[1]	3/11/91, 4/25/91	4/3/91, 4/3/91[2], 4/25/91	—	4/26/91
1992	10/22/91	10/24/91	12/19/91[3], 3/16/92[1]	4/1/92	4/23/92, 4/24/92[2]	—	4/27/92
1993	10/30/92	2/2/93	11/13/92[3], 3/29/93	4/13/93	3/10/93[1], 4/14/93, 4/14/93[2]	—	4/29/93
1994	10/11/93	11/10/93	—	3/16/94	3/15/94[1], 3/16/94, 3/25/94[2]	—	4/27/94, 5/19/94
1995	11/4/94	2/3/95	3/20/95[1]	3/20/95	3/20/95, 4/7/95[2]	—	4/19/95, 5/3/95
1996	10/5/95	10/10/95	3/11/96[1]	3/11/96	3/14/96, 4/3/96[2]	—	4/26/96
1997	9/26/96	10/31/96	3/12/97[1]	3/12/97	3/12/97, 4/3/97[2]	—	4/25/97
1998	10/6/97	10/17/97	3/4/98[1]	3/4/98	3/4/98, 3/24/98[2]	—	4/23/98

[1]Applied to treatments 6-10 (1989-94) or treatments 1-5 (1995-98) normal-input PPI herbicide before operation.
[2]Applied to treatments 1-5 (1989-94) or treatments 6-10 (1995-98) reduced-input PPI herbicide before operation.
[3]Pink bollworm quarantine regulation requirement.

row with reduced input treatments and to a 20-inch-wide band with normal-input treatment.

Table 3 lists the PODIR treatments and dates of application. All herbicide applications were made with tractor-mounted equipment in a total broadcast spray volume of 20 gallons per acre. PODIR treatments were made with a four-row cultivator equipped with spray shields using two nozzle tips spraying a 16-inch band centered on each row. The over-the-top (OT) treatments with Staple in 1995-1998 were applied with a tractor-mounted spray boom with one tip over each row.

The initial weed infestation was very low in 1989, and it was determined with early-season visual evaluations that the PPI and PRE herbicides (even at the reduced rates) could control the population adequately, thus no postemergence herbicides were applied.

The populations of all winter weeds were determined for each plot during the winter months of 1990-1991 through 1997-1998 (Table 4). Predominate winter weeds were annual bluegrass (*Poa annua* L.), bittercress (*Cardamine* sp.), henbit (*Lamium amplexicaule* L.), horseweed [*Conyza canadensis* (L.) Crong.], and common chickweed [*Stellaria media* (L.) Vill.]. Other weeds present in few numbers were mousetail (*Myosurus minimus* L.), Carolina foxtail (*Alopecurus carolinianus* Walt.), swinecress [*Coronopus didymus* (L.) Sm.], cutleaf eveningprimrose (*Oenothera laciniata* Hill), Carolina geranium (*Geranium carolinianum* L.), and cheat (*Bromus secalinus* L.).

Visual field evaluation of the winter weed infestation during the winter of 1989-1990 did not indicate a population difference between treatments. During the winter of 1990-1991, it appeared that the population of winter weeds was different between treatments, so counts were made on February 12, 1991, and were continued each winter afterwards. Plants were counted from three, 1- by 3-foot areas per plot in 1991; from a 40-inch by 10-foot area in 1991, 1994, 1995, and 1997; and from a 40-inch by 40-foot area of in 1992, 1996, and 1998. Counts are presented in Table 4 as plants per square foot for broadleaf weeds in 1989-91 or total weeds in 1992-1998. Annual grasses were at very low infestation levels before 1992. In 1992-1998, counts of Southern crabgrass [*Digitaria ciliaris* (Retz.) Koel.], browntop millet [*Brachiaria ramosa* (L.) Stapf], and broadleaf signalgrass [*Brachiaria platyphylla* (Griseb.) Nash] were included with the annual broadleaf count each June. Predominant annual broadleaf weeds were pitted morningglory (*Ipomoea lacunosa* L.), ivyleaf morningglory [*Ipomoea hederacea* (L.) Jacq.], nodding spurge (*Euphorbia nutans* Lag.), prostrate spurge (*Euphorbia humistrata* Engelma, ex Gray), smooth pigweed (*Amaranthus hybridus* L.), and prickly sida (*Sida spinosa* L.). There were also a few scattered plants of spurred anoda [*Anoda cristata* (L.) Schlecht.] and slender amaranth (*Amaranthus viridus* L.). Summer weed counts were made in 1989-1998 from a 12-inch by 40-foot area centered on an inside row of each plot (Table 5). All weed counts were converted to plants per square foot and are presented in Tables 4 and 5.

Weed control was also visually evaluated in mid- to late-season in 1990 and 1992-1998 after all PODIR her-

Table 3a. Directed postemergence herbicides (PODIR) and dates of application for an experiment on cotton weed control with normal- and reduced-input practices, DREC, Stoneville, MS, 1989-1994.

Trt. no.	Herbicide/rate (lb ai/A)[1]	Application date(s) 1990[2]	1991	1992	1993	1994
Reduced inputs						
1.	Cotoran 4L 0.8 + Latron AG-98 0.25%	6/11, 6/27	5/29, 6/11	5/18, 6/29	5/31, 6/15	6/13
	Cobra 2E (lactofen) 0.2 + Agri-Dex 1%	—	—	—	—	7/5
2.	Probe 75DF (methazole) 0.6 + Latron AG-98 0.25%	6/11, 6/27	5/29, 6/11	5/18, 6/29	—	—
	Cotoran 4L 0.8 + Latron AG-98 0.25%	—	—	—	5/31	6/13
	Buctril 4E (bromoxynil) 0.25	—	—	—	6/15	7/5
3.	Caparol 4L (prometryn) 0.4 + Latron AG-98 0.25%	6/11, 6/27	5/29, 6/11	5/18, 6/29	5/31, 6/15	6/13, 7/5
4.	Cotoran 4L 0.8 + Latron AG-98 0.25%	6/11	5/29	5/18	5/31	6/13
	Goal 1.6E (oxyfluorfen) 0.25 + Latron AG-98 0.25%	6/27	6/11	6/29	6/15	7/5
5.	No herbicide, hand hoe[3]	6/27, 7/12	6/21, 7/15	5/18, 6/12	6/7, 7/1	6/15, 7/5
Normal inputs						
6.	Cotoran 4L 1.0 + Latron AG-98 0.25%	6/11, 6/27	—	—	—	—
	Cotoran 4L 1.0 + Bueno 6 1.5	—	5/29, 6/11	6/29	5/31, 6/15	6/13
	Cobra 2E 0.2 + Agri-Dex 1%	—	—	—	—	7/5
7.	Probe 75DF 0.75 + Latron AG-98 0.25%	6/11, 6/27	—	—	—	—
	Probe 75DF 0.75 + Bueno 6 1.5	—	5/29, 6/11	6/29	—	—
	Cotoran 4L 1.0 + Bueno 6 1.5	—	—	—	5/31	6/13
	Buctril 4E 0.38	—	—	—	6/15	7/5
8.	Caparol 4L 0.5 + Latron AG-98 0.25%	6/11, 6/27	—	—	—	—
	Caparol 4L 0.5 + Bueno 6 1.5	—	5/29, 6/11	6/29	5/31, 6/15	6/13, 7/5
9.	Cotoran 4L 1.0 + Latron AG-98 0.25%	6/11	—	—	—	—
	Goal 1.6E 0.38 + Latron AG-98 0.25%	6/27	6/11	—	—	—
	Cotoran 4L 1.0 + Bueno 6 1.5	—	5/29	—	5/31	6/13
	Goal 1.6E 0.38 + Bueno 6 1.5	—	—	6/29	6/15	7/5
10.	No herbicide, hand hoe[3]	6/27, 7/12	6/21, 7/15	5/18, 6/12, 8/3	6/7, 7/1	6/15, 7/5

[1]Herbicides were applied to a 16-inch-wide band centered on the row. No herbicides were applied in 1989. Probe was not available after 1992.
[2]Cobra 2E (lactofen) at 0.2 lb ai/A, plus Agri-Dex 1%, was applied layby to the entire area on July 6.
[3]Hoed July 6, 1989.

Table 3b. Directed postemergence herbicides (PODIR) and dates of application for an experiment on cotton weed control with normal- and reduced-input practices, DREC, Stoneville, MS, 1995-1998.

Trt. no.	Herbicide/rate (lb ai/A)[1]	Application date(s) 1995	1996	1997	1998
Reduced inputs					
1.	Staple 85SP (pyrithiobac) 0.05 + Latron AG-98 0.25%	6/4 (OT)	6/6 (OT), 6/18 (OT)	6/16 (OT), 7/8 (OT)	5/28 (OT)[2]
2.	Cotoran 4L 0.8 + Latron AG-98 0.25%	6/14	6/6	6/16	5/28
	Bladex 4L 0.6 + Latron AG-98 0.25%	6/29	6/18	7/8	6/11
3.	Caparol 4L 0.4 + Latron AG-98 0.25%	6/14, 6/29	6/6, 6/18	6/16, 7/8	5/28, 6/11
4.	Cotoran 4L 0.8 + Latron AG-98 0.25%	6/14	6/6	6/16	5/28
	Goal 2XL 0.25 + Latron AG-98 0.25%	6/29	6/18	7/8	6/11
5.	No herbicide, hand hoe	7/3	6/17	7/9	6/3, 7/24
Normal inputs					
6.	Staple 85SP 0.063 + Bueno 6 1.5 (OT)	6/14 (OT)	6/6 (OT), 6/18 (OT)	6/10(OT)[3],7/8(OT)[3]	5/29 (OT)
7.	Cotoran 4L 1.0 + Bueno 6 1.5	6/14	6/6	6/16	5/28
	Bladex 4L 0.8 + Bueno 6 1.5	6/29	6/18	7/8	6/11
8.	Caparol 4L 0.5 + Bueno 6 1.5	6/14, 6/29	6/6, 6/18	6/16, 7/8	5/28, 6/11
9.	Cotoran 4L 1.0 + Bueno 6 1.5	6/14	6/6	6/16	5/28
	Goal 2XL 0.38 + Bueno 6 1.5	6/29	6/18	7/8	6/11
10.	No herbicide, hand hoe	7/3	6/17	7/9	6/3, 7/24

[1]Herbicides were applied to a 16-inch-wide band centered on the row.
[2]Added Assure II 0.8E (quizalofop) at 0.063 lb ai/A.
[3]Activate Plus 0.5% for Bueno 6 (cotton too large for OT).

bicide applications had been made (Table 6). Control was rated on a scale of 0-100 (0 = no control, 100 = complete kill).

The time for hoeing weeds from the two center rows of each plot was determined from treatments 5 and 10 (where no PODIR herbicides were used). A 12-inch by 40-foot area centered on each row was hoed on each date. The average time required for hoeing these treatments are presented as hours per acre in Table 7.

Weeds between rows on all plots were controlled with timely cultivations using a four-row cultivator. The unit left an undisturbed 12-inch-wide band of soil centered on each row.

Cotton stand was determined in 1990-1998 by counting the number of cotton plants on one or both inside rows of each plot. Counts were converted to plants per acre, and averages are presented in Table 8.

Cotton was harvested with a mechanical plot picker from the two center rows of each plot once each year to determine yield. Plot cotton weights were converted to pounds per acre, and the average seed cotton yields are presented in Table 9.

Table 4. Winter weed population with an experiment on cotton weed control with reduced- and normal-input practices, DREC, Stoneville, MS, 1989-1998.

Trt. No.	PPI	PRE	PODIR [1]	All winter weeds (plants/square foot) [2]								
				2/12/91	12/17/91	3/26/93	2/25/94	1/31/95	2/15/96	2/17/97	1/20/98	2/10/98
Reduced Inputs												
1.	Treflan	Cotoran	Cotoran fb Cotoran (fb Cobra, 1994) Staple (OT)(1995-1998)	4.3 ab	3.3 ab	1.0 a	4.1 a	4.4 ab	0.2 a	1.2 a	0.4 abc	3.2 cd
2.	Treflan	Cotoran	Probe fb Probe (1990-92) Cotoran fb Buctril (1993-94) fb Bladex (1995-1998)	4.1 ab	4.0 a	0.7 a	3.9 a	4.9 ab	0.1 a	1.2 a	0.3 bc	2.5 d
3.	Treflan	Cotoran	Caparol fb Caparol	4.4 ab	3.6 a	1.0 a	5.3 a	4.8 ab	0.3 a	1.9 a	0.4 abc	4.1 bcd
4.	Treflan	Cotoran	Cotoran fb Goal	3.7 ab	3.7 a	0.8 a	5.3 a	3.6 abc	0.2 a	1.0 a	0.7 a	3.1 cd
5.	Treflan	Cotoran	Hand hoe	5.4 a	4.7 a	0.8 a	3.9 a	5.5 a	0.2 a	1.3 a	0.5 abc	3.8 bcd
Normal Inputs												
6.	Treflan + Zorial	Cotoran + Zorial	Cotoran fb Cotoran (1990) Cotoran + MSMA fb Cotoran + MSMA (1991-1994) fb Cobra, 1994 Staple + Bueno 6 (OT) (1995-1998)	2.2 ab	0.8 c	0.1 b	0.8 b	3.0 bc	0.1 a	1.7 a	0.3 abc	4.5 abc
7.	Treflan	Cotoran	Probe fb Probe (1990) Probe + MSMA fb Probe + MSMA (1991-1992) Cotoran + MSMA fb Buctril (1993-1994) Bladex + Bueno 6 (1995-1998)	2.5 ab	1.2 bc	0.2 b	1.2 b	3.2 bc	0.2 a	1.9 a	0.2 c	5.5 ab
8.	Treflan + Zorial	Cotoran + Zorial	Caparol fb Caparol (1990) Caparol + MSMA fb Caparol + MSMA (1991-1998)	2.1 ab	0.9 c	0.2 b	1.0 b	2.4 c	0.2 a	1.6 a	0.6 abc	5.0 ab
9.	Treflan + Zorial	Cotoran + Zorial	Cotoran fb Goal (1990) Cotoran + MSMA fb Goal + MSMA (1991-1998)	1.5 b	1.0 c	0.1 b	0.3 b	1.9 c	0.0 a	1.2 a	0.4 abc	4.7 abc
10.	Treflan + Zorial	Cotoran + Zorial	Hand hoe	3.6 abc	2.6 abc	0.2 b	1.3 b	3.2 bc	0.4 a	2.1 a	0.6 abc	5.9 a

[1]fb = followed by.
[2]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

RESULTS

Winter Weeds

After 2 years (1989 and 1990), the normal-input treatment with PODIR Cotoran followed by (fb) Goal had fewer winter weeds than the reduced-input treatment without PODIR herbicides but hoed once (Table 4). The other treatments were not different from either of the above. After 2 years of herbicide applications, the winter weed population was reduced December 17, 1991, with normal-input treatments of PODIR Cotoran + MSMA fb Cotoran + MSMA, Caparol + MSMA fb Caparol + MSMA, and Cotoran + MSMA fb Goal + MSMA when compared with all reduced-input treatments. However, these three effective treatments were not different from the normal-input treatments of PODIR Probe + MSMA fb Probe + MSMA or hoeing twice. Counts made on March 26, 1993, and February 25, 1994, resulted in fewer winter weed plants with all the normal-input treatments compared with all the reduced-input treatments. Treatments within the reduced- or normal-input treatment groups were not different from each other. Counts of winter weeds on January 31, 1995, reflected winter weed plant numbers similar to counts made on February 12, 1991. Normal-input treatments with PODIR Cotoran + MSMA fb Goal + MSMA and Caparol + MSMA fb Caparol + MSMA were lower in winter weeds than all the reduced-input treatments except PODIR Cotoran fb Goal but were not different from the other normal-input treatments. The reduced-input treatment that was hoed twice in 1994 was higher than all the normal-input treatments in number of winter weeds in January 1995 but was not different from the other reduced-input treatments.

In 1996 and 1997, no differences among treatments occurred with winter weed counts. Remember that the plot areas for reduced- and normal-input practices were reversed after 1995. Plot areas for Treatments 1 and 6, 2 and 7, etc., were reversed, which permitted normal-input treatments to be applied to plot areas that had formerly (1989-1995) received reduced-input treatments. Over the first 6 years (1989-1995), weed populations had increased. We determined that reversing plot areas could answer the question of how much time would be required to reduce this increase in weed infestation. Such a reduction apparently occurred after the first year of reversed treatment areas. Winter weed counts continued to be very low in 1997. In 1998, winter weed counts were much greater but were inconsistent among reduced- and normal-input treatments.

Summer Weeds

The numbers of broadleaf and total weeds per square foot on the drill row are presented in Table 5. Broadleaf weed counts on June 22, 1989, did not result in any treatment being different from the normal-input fb hoeing treatment. The normal-input PODIR Probe fb Probe treatment was lower in broadleaf weeds than the reduced-input hoe and the normal-input Cotoran fb Goal treatments. As no PODIR herbicides were applied in 1989 and plots were not hoed until June 27, these differences are probably due to weed population variability. With counts on June 11, 1990, the average broadleaf weed population with the normal-input practices was 79 percent less than the average of the reduced-input practice treatments (Table 4). In 1991, the average broadleaf weed population for the normal-input practice treatments in June was 84 percent less than the average of the reduced-input treatments. There were no differences in the number of broadleaf weeds between the normal-input treatments in 1990 and 1991. In 1990 the reduced-input hoe treatment had fewer weeds than the Caparol fb Caparol and the Cotoran fb Goal treatments. In 1991, there were no differences among reduced-input treatments.

With June counts of all weeds (Table 4), the normal-input practices reduced the average counts 95 percent in 1992, 71 percent in 1993, 91 percent in 1994, 93 percent in 1995, 86 percent in 1996, 100 percent in 1997, and 90 percent in 1998, when compared with the average weed counts for the reduced-input treatments. There were no differences in weed counts among the normal-input treatments for 1992 and 1994-1998. In 1993, the hoe treatment had lower counts than other normal-input treatments, except Cotoran fb Goal. The reduced-input hoe treatment weed count was higher than all the normal-input treatments in 1992 and 1994 and was higher than the count with the normal-input

Table 5. Annual broadleaf or total summer weed population with an experiment on cotton weed control with reduced- and normal-input practices, DREC, Stoneville, MS, 1989-1998.

Trt. No.	PPI	PRE	PODIR [1]	Broadleaf weeds [2]			All weeds [2]						
				8/22/89	6/1/90	6/10/91	6/12/92	6/30/93	6/13/94	6/5/95	6/17/96	6/6/97	6/4/98
Reduced Inputs													
1.	Treflan	Cotoran	Cotoran fb Cotoran (fb Cobra, 1994) Staple (OT) (1995-1998)	1.3 ab	2.0 ab	0.5 ab	1.4 ab	2.5 b	1.3 a	0.2 abc	0.3 b	0.1 bc	1.1 b
2.	Treflan	Cotoran	Probe fb Probe (1990-92) Cotoran fb Buctril (1993-94) fb Bladex (1995-1998)	2.1 ab	1.5 abc	0.5 ab	1.6 a	2.7 ab	1.3 a	0.3 ab	0.2 b	0.2 ab	1.3 ab
3.	Treflan	Cotoran	Caparol fb Caparol	1.9 ab	2.2 a	0.6 ab	2.7 a	3.6 a	1.3 a	0.3 ab	0.2 b	0.2 ab	1.6 a
4.	Treflan	Cotoran	Cotoran fb Goal	1.9 ab	2.4 a	0.9 a	1.6 a	0.6 cd	0.6 ab	0.4 a	0.1 b	0.3 a	1.2 b
5.	Treflan	Cotoran	Hand hoe	2.2 a	0.8 bc	0.7 ab	2.7 a	1.2 c	1.3 a	0.1 c	0.6 a	0.2 ab	0.0 c
Normal Inputs													
6.	Treflan + Zorial	Cotoran + Zorial	Cotoran fb Cotoran (1990) Cotoran + MSMA fb Cotoran + MSMA (1991-1994) fb Cobra, 1994 Staple + Bueno 6 (OT) (1995-1998)	1.2 ab	0.3 c	0.1 b	0.1 b	0.6 cd	0.1 b	0.0 c	0.1 b	0.0 c	0.1 c
7.	Treflan	Cotoran	Probe fb Probe (1990) Probe + MSMA fb Probe + MSMA (1991-1992) Cotoran + MSMA fb Buctril (1993-1994) Bladex + Bueno 6 (1995-1998)	0.7 b	0.5 c	0.1 b	0.1 b	1.0 cd	0.1 b	0.1 c	0.0 b	0.0 c	0.1 c
8.	Treflan + Zorial	Cotoran + Zorial	Caparol fb Caparol (1990) Caparol + MSMA fb Caparol + MSMA (1991-1994)	2.1 ab	0.5 c	0.1 b	0.1 b	0.6 cd	0.1 b	0.0 c	0.0 b	0.0 c	0.2 c
9.	Treflan + Zorial	Cotoran + Zorial	Cotoran fb Goal (1990) Cotoran + MSMA fb Goal + MSMA (1991-1994)	2.3 a	0.2 c	0.1 b	0.1 b	0.1 d	0.1 b	0.0 c	0.0 b	0.0 c	0.1 c
10.	Treflan + Zorial	Cotoran + Zorial	Hand hoe	1.3 ab	0.3 c	0.1 b	0.1 b	0.8 cd	0.1 b	0.0 c	0.1 b	0.0 c	0.0 c

[1]fb = followed by.
[2]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

Cotoran + MSMA fb Goal + MSMA treatment in 1993. In 1992 and 1994, there were no differences among any reduced-input treatments. In 1993, the lowest population for all weeds was obtained from the Cotoran fb Goal treatment. This treatment was not different from the reduced-input hoe treatment. The broadleaf plus grass weed count from the reduced-input Cotoran fb Cotoran treatment in 1993 was intermediate, while the Caparol fb Caparol was highest. In 1995, with reduced-input treatment, the hoe treatment count was less than other treatments except with Staple + Bueno 6. However, in 1996, the reduced-input hoe treatment was greatest. Reduced-input weed counts in 1996 were not different among chemical PODIR treatments. In 1997, Cotoran fb Goal had greater counts than Staple OT. In 1998, lowest counts were obtained with the hoe treatment. Highest weed counts were obtained with Caparol fb Caparol, and weed counts for the other reduced-input treatments were intermediate.

In mid-season 1990, the visual evaluation showed that all normal-input treatments controlled weeds 81 to 95 percent with no difference among treatments or the minimum-input hoe treatment (89 percent) (Table 6). The minimum-input PODIR treatments provided very

Table 6. Visual control of weeds in late-season with an experiment on cotton weed control with reduced- and normal-input practices, DREC, Stoneville, MS, 1990-1998.

Trt. No.	PPI	PRE	PODIR [1]	Visual control estimates (0-100%) [2]							
				7/5/90	7/1/92	7/12/93	7/19/94	7/10/95	9/4/96	7/24/97	6/22/98
Reduced Inputs											
1.	Treflan	Cotoran	Cotoran fb Cotoran (fb Cobra, 1994) Staple (OT) (1995-1998)	50 b	55 d	61 b	18 c	81 ab	88 bc	59 c	74 bc
2.	Treflan	Cotoran	Probe fb Probe (1990-92) Cotoran fb Buctril (1993-94) fb Bladex (1995-1998)	46 b	50 de	61 b	0 c	92 ab	86 bc	38 d	10 d
3.	Treflan	Cotoran	Caparol fb Caparol	45 b	39 e	38 c	53 b	88 ab	80 c	30 d	10 d
4.	Treflan	Cotoran	Cotoran fb Goal	34 b	74 c	65 b	23 c	86 ab	88 bc	44 cd	10 d
5.	Treflan	Cotoran	Hand hoe	89 a	73 c	93 a	97 a	97 a	85 bc	86 b	58 c
Normal Inputs											
6.	Treflan + Zorial	Cotoran + Zorial	Cotoran fb Cotoran (1990) Cotoran + MSMA fb Cotoran + MSMA (1991-1994) fb Cobra, 1994 Staple + Bueno 6 (OT) (1995-1998)	81 a	90 a	97 a	87 a	83 ab	97 a	99 a	99 a
7.	Treflan	Cotoran	Probe fb Probe (1990) Probe + MSMA fb Probe + MSMA (1991-1992) Cotoran + MSMA fb Buctril (1993-1994) Bladex + Bueno 6 (1995-1998)	88 a	86 ab	97 a	83 a	74 b	97 a	100 a	96 a
8.	Treflan + Zorial	Cotoran + Zorial	Caparol fb Caparol (1990) Caparol + MSMA fb Caparol + MSMA (1991-1998)	83 a	80 bc	94 a	91 a	88 ab	95 ab	100 a	90 ab
9.	Treflan + Zorial	Cotoran + Zorial	Cotoran fb Goal (1990) Cotoran + MSMA fb Goal + MSMA (1991-1998)	86 a	93 a	100 a	86 a	91 ab	98 a	100 a	87 ab
10.	Treflan + Zorial	Cotoran + Zorial	Hand hoe	95 a	93 a	97 a	98 a	97 a	90 abc	97 ab	99 a

[1]fb = followed by.
[2]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

poor control but were not different from one another, ranging from 34 to 50 percent. In 1992, the normal-input PODIR treatment Caparol + Bueno 6 fb Caparol + Bueno 6 gave less control (80 percent) than the other normal-input treatments except the Cotoran + Bueno 6 fb Bladex + Bueno 6 treatment (86 percent). The normal-input Caparol + Bueno 6 fb Caparol + Bueno treatment was not different from the minimum-input Cotoran fb Goal (74 percent) and hoe (73 percent) treatments. Other minimum-input PODIR treatments gave very poor control. In 1993, all normal-input treatments and the minimum input hoe treatment gave excellent control (93 to 100 percent). The minimum-input PODIR treatments gave poor to very poor control (38 to 65 percent). In 1994, a similar result was obtained but actual values were lower except with normal- and minimum-input hoe treatments. In 1995, the first year after the field plot treatments were reversed, weed control on minimum-input treatments was much higher. This was probably due to excellent prior control on these plots, which maintained a low weed infestation. Likewise, generally less control was obtained with the normal-input treatments, which was probably due to less prior control with reduced-input treatments. Count data (Table 5) indicate a larger weed population in 1995 (reduced input) than in 1994 (normal input). Control in 1996-1998 generally returned to a similar pattern as in 1993 and 1994. The normal-input treatments continued to give excellent control, while the reduced-input treatments gave less. The reduced-input PODIR treatments degraded in control from fair to good in 1996 (80 to 88 percent) to very poor in 1997 (30 to 59 percent) and 1998 (10 percent). The exception to this trend was the fair control of 74 percent in 1998 with the minimum-input Staple OT.

Hoe time ranged from a low of 7.1 hours per acre in 1989 to a high of 95.2 hours per acre in 1994 for the reduced-input hoe treatment (Table 7). The respective low and high hoe time values for the normal-input hoe treatment ranged from 0.9 hours per acre in 1998 (only one hoeing) to 19.7 hours per acre in 1992. Hoe time for the normal-input hoe treatment remained fairly steady after the first year until it was very low at year 10. The hoe time for the reduced-input hoe treatment increased each year until it reached 13.4 times the 1989 value by the sixth year, after which it was inconsistent.

Table 7. Time to hoe plots treated PPI and PRE only with reduced inputs (Treflan, Cotoran) and normal inputs (Treflan + Zorial, Cotoran + Zorial) for cotton weed control, DREC, Stoneville, MS, 1989-1998.

Year	Month	Day	Hoe time (hours/acre)	
			Reduced input	Normal input
1989	July	6	7.1	3.4
1990	June	27	16.7	5.9
	July	12	10.8	5.3
	Total		27.5	11.2
1991	June	21	13.2	4.2
	July	15	11.4	5.8
	Total		24.6	10.0
1992	May	18	10.9	4.7
	June	12	17.3	3.1
	August	3	26.5	11.9
	Total		54.7	19.7
1993	June	7	30.6	2.8
	July	1	25.4	9.3
	Total		56.0	12.1
1994	June	15	27.5	2.0
	July	5	67.7	11.3
	Total		95.2	13.3
1995	July	3	10.2	9.7
1996	June	17	7.6	5.7
1997	July	9	21.9	2.3
1998	June	3	11.8	0.9

Cotton stand was adequate for optimum yield in 1989 (data not shown). In 1990, cotton stand with all treatments was less than optimum (Table 8). The reduced-input hoe treatment was especially low in stand but produced yield comparable to other treatments (Table 9). The normal-input PODIR treatment with Cotoran fb Cotoran in 1990 and fb Cotoran + MSMA in 1992 had a greater stand than the reduced-input hoe treatment. Also in 1992, the normal-input PODIR Cotoran + MSMA fb Cotoran + MSMA treatment had greater stand than reduced-input treatments with Caparol fb Caparol and Cotoran fb Goal. The cotton stand in 1991 and 1993 was adequate with no differences between treatments. In 1994, the cotton stand was adequate for optimum yield with all treatments (Table 8). The greatest numerical stand was obtained with the normal-input PODIR Caparol + MSMA fb Caparol + MSMA treatment. This treatment was greater than the

Table 8. Cotton stand with an experiment on cotton weed control with reduced- and normal-input practices, DREC, Stoneville, MS, 1990-1998.

Trt. No.	PPI	PRE	PODIR [1]	Cotton plants/acre (thousands) [2]								
				1990	1991	1992	1993	1994	1995	1996	1997	1998
Reduced Inputs												
1.	Treflan	Cotoran	Cotoran fb Cotoran (fb Cobra, 1994) Staple (OT) (1995-1998)	25.7 ab	45.7 a	32.9 ab	36.5 a	32.0 c	56.3 a	56.0 a	30.8 b	36.9 a
2.	Treflan	Cotoran	Probe fb Probe (1990-92) Cotoran fb Buctril (1993-94) fb Bladex (1995-1998)	26.6 ab	42.1 a	33.3 ab	40.2 a	41.7 ab	52.0 a	56.9 a	42.2 ab	41.8 a
3.	Treflan	Cotoran	Caparol fb Caparol	23.8 ab	45.8 a	27.4 b	43.0 a	40.7 abc	53.9 a	49.7 a	31.2 b	39.0 a
4.	Treflan	Cotoran	Cotoran fb Goal	26.3 ab	48.0 a	27.5 b	41.8 a	36.5 abc	53.9 a	57.3 a	37.0 ab	35.0 a
5.	Treflan	Cotoran	Hand hoe	21.3 b	36.8 a	27.4 b	37.4 a	35.0 bc	56.7 a	59.5 a	41.6 ab	42.1 a
Normal Inputs												
6.	Treflan + Zorial	Cotoran + Zorial	Cotoran fb Cotoran (1990) Cotoran + MSMA fb Cotoran + MSMA (1991-1994) fb Cobra, 1994 Staple + Bueno 6 (OT) (1995-1998)	29.7 a	37.8 a	35.0 a	41.4 a	42.8 ab	51.2 a	57.7 a	46.8 ab	44.8 a
7.	Treflan	Cotoran	Probe fb Probe (1990) Probe + MSMA fb Probe + MSMA (1991-1992) Cotoran + MSMA fb Buctril (1993-1994) Bladex + Bueno 6 (1995-1998)	27.0 ab	38.7 a	31.0 ab	35.2 a	36.8 abc	55.2 a	54.4 a	45.0 ab	45.2 a
8.	Treflan + Zorial	Cotoran + Zorial	Caparol fb Caparol (1990) Caparol + MSMA fb Caparol + MSMA (1991-1998)	27.6 ab	37.3 a	27.9 ab	41.3 a	45.2 a	52.8 a	62.0 a	54.8 a	44.9 a
9.	Treflan + Zorial	Cotoran + Zorial	Cotoran fb Goal (1990) Cotoran + MSMA fb Goal + MSMA (1991-1998)	24.9 ab	40.8 a	32.1 ab	42.7 a	41.7 ab	50.6 a	56.2 a	54.6 a	46.7 a
10.	Treflan + Zorial	Cotoran + Zorial	Hand hoe	26.5 ab	40.8 a	32.3 ab	42.8 a	44.0 ab	48.2 a	54.7 a	39.6 ab	37.6 a

[1]fb = followed by.
[2]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

Table 9. Seed cotton yield from an experiment on cotton weed control with reduced- and normal-input practices, DREC, Stoneville, MS, 1989-1998.

Trt. No.	PPI	PRE	PODIR [1]	Seed cotton yield (pounds/acre) [2]									
				1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Reduced Inputs													
1.	Treflan	Cotoran	Cotoran fb Cotoran (fb Cobra, 1994) Staple (OT) (1995-1998)	2,199 ab	3,229 a	4,100 a	2,675 bc	2,384 a	667 b	2,640 a	3,236 a	2,565 ab	2,618 a
2.	Treflan	Cotoran	Probe fb Probe (1990-92) Cotoran fb Buctril (1993-94) fb Bladex (1995-1998)	2,176 ab	2,970 a	3,757 ab	2,435 cd	2,344 a	825 ab	2,631 a	3,047 a	2,707 ab	2,732 a
3.	Treflan	Cotoran	Caparol fb Caparol	1,905 b	3,077 a	4,076 a	2,073 d	2,141 a	884 ab	2,668 a	3,153 a	2,265 b	2,557 a
4.	Treflan	Cotoran	Cotoran fb Goal	2,038 b	2,781 a	3,377 b	3,074 ab	2,454 a	658 b	2,728 a	3,133 a	2,739 ab	2,561 a
5.	Treflan	Cotoran	Hand hoe	2,305 ab	2,984 a	3,916 ab	3,013 abc	2,521 a	939 a	2,698 a	2,839 a	2,896 ab	2,664 a
Normal Inputs													
6.	Treflan + Zorial	Cotoran + Zorial	Cotoran fb Cotoran (1990) Cotoran + MSMA fb Cotoran + MSMA (1991-1994) fb Cobra, 1994 Staple + Bueno 6 (OT) (1995-1998)	2,364 ab	3,162 a	3,692 ab	3,368 a	2,579 a	934 a	2,729 a	2,984 a	3,001 ab	2,749 a
7.	Treflan	Cotoran	Probe fb Probe (1990) Probe + MSMA fb Probe + MSMA (1991-1992) Cotoran + MSMA fb Buctril (1993-1994) Bladex + Bueno 6 (1995-1998)	2,256 ab	2,966 a	3,933 ab	3,357 a	2,555 a	957 a	2,633 a	3,037 a	2,951 ab	2,867 a
8.	Treflan + Zorial	Cotoran + Zorial	Caparol fb Caparol (1990) Caparol + MSMA fb Caparol + MSMA (1991-1998)	2,328 ab	2,981 a	3,822 ab	3,101 ab	2,608 a	1,006 a	2,832 a	3,127 a	3,183 a	3,030 a
9.	Treflan + Zorial	Cotoran + Zorial	Cotoran fb Goal (1990) Cotoran + MSMA fb Goal + MSMA (1991-1998)	2,507 a	2,840 a	3,504 ab	3,101 ab	2,395 a	1,024 a	2,741 a	3,034 a	2,962 ab	3,001 a
10.	Treflan + Zorial	Cotoran + Zorial	Hand hoe	2,194 ab	3,207 a	3,794 ab	3,528 a	2,611 a	1,064 a	2,690 a	3,159 a	2,995 ab	2,652 a

[1]fb = followed by.
[2]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

reduced-input treatment PODIR Cotoran fb Cobra and the reduced-input hoe treatment. The reduced-input PODIR Cotoran fb Cobra treatment had less stand than all the normal-input treatments except the PODIR Cotoran + MSMA fb Buctril treatment. There were no treatment differences in cotton stand in 1995, 1996, and 1998. A good stand was obtained in 1997 with all treatments, except the reduced-input Staple and Caparol fb Caparol treatments.

Seed cotton yields were not different with any treatment in 1990, 1993, 1995, 1996, and 1998 (Table 9). In 1989 and 1991, no treatment was different from either the reduced- or the normal-input hoe treatments, and they were not different from each other. In 1989, the highest numerical seed cotton yield was from the normal-input PODIR Cotoran fb Goal treatment. No PODIR herbicides were applied in 1989 so treatment differences in yield probably resulted from experimental error and/or from subtle influences from the low and poorly distributed weed population. In 1991, the greatest yield was with the reduced-input PODIR Cotoran fb Cotoran treatment. This and the Caparol fb Caparol treatments were greater in seed cotton yield than the reduced-input PODIR Cotoran fb Goal treatment. In 1992, the least seed cotton yield was harvested from the reduced-input PODIR Caparol fb Caparol treatment, which was lower than all other treatments except the reduced-input treatment with PODIR Probe fb Probe. Greatest seed cotton yield was obtained with three of the normal-input treatments: hoeing; PODIR Cotoran + MSMA fb Cotoran + MSMA; and PODIR Probe + MSMA fb Probe + MSMA treatments. Yields from these treatments were greater than yields from the reduced-input treatments: PODIR Cotoran fb Cotoran; PODIR Probe fb Probe; and PODIR Caparol fb Caparol. Seed cotton yield in 1994 was very low due to the May 19 replanting and excessive rainfall in July (11.6 inches), causing plants to abort fruit and extend their vegetative growth period. Greatest seed cotton yield was obtained with the normal-input hoe treatment, which was greater than the reduced-input PODIR Cotoran fb Cobra treatment and the reduced-input PODIR Cotoran fb Goal treatment. These treatments were lower in seed cotton yield than all other treatments, except the reduced-input PODIR Caparol fb Caparol and the reduced-input PODIR Cotoran fb Buctril treatments. In 1997, seed cotton yield was greatest with the normal-input PODIR Caparol + Bueno fb Caparol + Bueno treatment. This treatment yield was greater than the reduced-input PODIR Caparol fb Caparol treatment. The other treatments were intermediate. There were no differences in seed cotton yield in 1998.

SUMMARY

Over a 10-year period (1989-1998), an experiment was conducted on silt loam soil without irrigation to compare normal- (recommended) input practices with reduced-input practices for weed control in conventional-till cotton. Winter weed populations with normal-input treatments were lower in 7 of 8 years (1991-1996, 1998). The annual summer broadleaf weed population was lower with normal-input treatments in all years when only broadleaf weeds were counted (1989-1991), as well as in all years (1992-1998) when both broadleaf and grass weeds were counted. Cotton stand was not affected by input treatments. Replanting was necessary in 1994 and 1995. Seed cotton yields averaged over the normal-input practice treatments resulted in numerical increases in 8 of the 10 years of the study (average increase of 248 pounds per acre, range of 23 to 637 pounds), when compared with the average yield from reduced-input practices. The average yields from the reduced-input practice treatments were greater in 1991 (96 pounds per acre) and 1996 (14 pounds per acre).

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