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USE OF SEVERAL SYSTEMS OF HERBICIDE APPLICATION IN COTTON (*Gossypium hirsutum*) CULTURE[1]

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1. INTRODUCTION

Cotton is one of the economically important crops most susceptible to competition with weeds, which affect it from planting to harvesting. In extreme cases, damage may reach a 90% rate. During the early phase of culture, weeds considerably reduce the growth and vigor of the plants, with consequent invasion by pests and disease. At the end of the cycle, they cause losses due to the reduction in fiber quality, impairing manual or mechanical harvesting and causing low work yields. The efficiency of harvesting machines is also reduced due to immature fibers and increased refuse (carimã) which impairs ginning. Weeds also increase the humidity of seeds, with consequent delayed harvesting and reduction of lint quality. Many weeds have a high silica content in their leaves, a fact that may damage the cotton fibers, leading to "hard fibers" that cause serious problems during spinning (*8*).

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The control methods for the full or partial elimination of weeds that grow together with cotton plants may be manual, mechanical (by animal transportation or by tractor) and chemical. The use of hoes has proved to be inadequate both because of the low availability of manpower and the low yield and efficiency in the control of weeds during the critical period of competition, which normally coincides with periods of high rainfall.

Mechanical weeding, although more economical than manual weeding, is also of low effectiveness due to the lack of control of weeds close to the planting row, possibly causing damage both to the stalk and the root system of the cotton plant, with consequent reduced productive capacity.

Many studied have been conducted in order to investigate the efficacy of herbicides, especially trifluralin, applied separately or mixed, or in combination with other methods of weed control in the different regions of Brazil where cotton is grown.

Since the pioneering studies by LEIDERMAN *et alii* (*9*) who investigated the efficacy of trifluralin and diuron and by ALVES e FORSTER (*1*) who investigated application methods, hundreds of other studies have been conducted with the most varied objectives, such as evaluating the efficacy of mixtures, the control of certain species, phytotoxicity, doses, type of application etc.

According to BELTRÃO *et al.* (*4*), diuron is one of the herbicides most often recommended and utilized in weed control for cotton crops, alone or mixed with other herbicides. CRUZ e TOLEDO (*6*) observed that diuron (1.0 kg/ha) + alachlor (3.0 L) efficiently control weeds in cotton crops. VICTORIA FILHO *et al.* (*13*) reported excellent control of monocotyledons and dicotyledons with a mixture of trifluralin and diuron incorporated into muddy soil during pre-planting. CRUZ e LEIDERMAN (*5*) reported excellent control of monocotyledons and dicotyledons with a tank mixture of M.S.M.A. and diuron applied at pre-emergence.

Cotton growers currently face the problem of how to use herbicides so as to obtain acceptable weed control without causing adverse effects on the crop. When correctly used, herbicides control many weed species that infest cotton fields. Culture practices such as crop rotation, cultivation and other techniques may also be necessary for adequate weed control. An appropriate combination of herbicides used at incorporated pre-planting (IPP) or applied to leaves, at pre-emergence, and post-emergence, or using other techniques can make the difference between good and poor weed control (*11*).

The objective of the present experiment was to evaluate the efficiency of different combinations of herbicides, especially pyrithiobac-sodium,

applied at IPP, at pre-emergence, post-emergence, by mechanical cultivation and by directed jet spray in order to harvest clean cotton.

2. MATERIAL AND METHODS

The trial was set up in the municipality of Bariri (SP) on the Bananal Farm, in soil classified as Dark Red Latossol, alic, moderate A, of clay texture, Limeira unit (10, 12), with 2.1% organic matter and pH 6.25.

The experimental area was set up in a cotton culture (*Gossypium hirsutum* L. cultivar IAC-10) planted on November 8, 1994. The soil was first prepared with a Romi harrow, a mold-board plow, a light harrow, a leveling harrow and planting. A Semeato PS-8 type machine was used to plant at a density of 12 to 14 seeds/linear meter and at a depth of 3 cm. Rows were spaced 90 cm apart. The basic fertilization at planting time was 210 kg/ha of 04.20.20 formula. The culture also received a cover of 100 kg/ha urea.

The experimental design consisted of plots subdivided into 40 treatments and 3 replications. Each plot covered an area of 40.0 x 7.2 m, for a total of 288.0 m2 treated area. The results were submitted to analysis of variance (F test) and the means were compared by the Tukey test, with the level of significance set at 5% (*3*).

The treatments were applied at different times, with the first consisting of incorporated preplanting (IPP), followed by pre-emergence (PRE) application, post-emergence (POST) application, mechanical cultivation (MC), and directed jet spray (DJ). The IPP application was performed one day before planting and the PRE application 2 days after planting. The first POST application was performed 23 days after planting and the second was performed with a DJ spray 20 days after mechanical cultivation, which was carried out 54 days after planting.

The IPP applications were performed with a tractor-type equipment fitted with a 19-nozzle plane jet bar XR 110.03, with an emptying rate of 350 L/ha. The PRE and POST treatments were applied to the entire plot area using a backpack equipment pressurized with carbonic dioxide and fitted with a TeeJet 110.03 compensated bar containing plane jet nozzles spaced 0.50 m apart and providing 2.0 m effective width. The equipment was operated at 2.78 kgf/cm2 (40 psi) using water as diluent and an application volume of 198 l/ha. The DJ treatment after emergence was applied along the interrow of the plot using the same equipment fitted with a TeeJet TK VS-2 lance containing 1 deflector nozzle with a protector of the Napoleon's hat type with an effective width of 1.0 m. The equipment was operated at 1.6 Kgf/cm2 (25 psi) with an application volume of 405 L/ha.

The following products were used for the treatments: Treflan (trifluralin), a commercial product containing 445 g/l of α,α-trifluoro-2,6-dinitro-N-N-dipropyl-p-toluidine; Staple 280 (KJH 2031 - pyrithiobac-sodium), a commercial product containing 280 g/l sodium-2-chloro-6-(4,6-dimethoxy-pyrimidine-2-ylthio)-benzoate; Daconate (M.S.M.A.), a commercial product containing 480 g/l methane arsonate monosodium ; Laco C.E. (alachlor), a commercial product containing 480 g/l 2-chloro-2,6'-diethyl-N-(methoxymethyl)-acetanilide; Karmex 500 S.C. (diuron), a commercial product containing 500 g/l 3-(3,4-dichlorophenyl)1,1-dimethylurea; Cobra (lactofen), a commercial product containing 240 g/l 1-(carboethoxy) -ethyl-5-[2-chloro-4-(trifluoromethyl)-phenoxy]-2-nitrobenzoate; Iharaguen (polyoxyethylene alkyl phenol ether), a commercial product containing 200 g/l of non-ionic alkyphenol-ethoxylate. The treatments employed are presented in Table 1.

The herbicide trifluralin was applied at IPP to all treatments, including the unhoed check, at 0.89 kg a.i./ha. Pyrithiobac was applied at 30 g a.i./ha along the row together with mechanical cultivation, at 70 g a.i./ha in two applications (PRE and POST) at 140 g a.i./ha, at PRE + mechanical cultivation, at 70 g ia.i + diuron at 1.40 kg/ a.i./ha at PRE + mechanical cultivation and at POST, at 70 g a.i./ha + M.S.M.A. at 1.44 g a.i./ha, at 70 g a.i./ha + alachlor at 1.0 kg a.i./ha + mechanical cultivation at POST, at 70 and 140 g a.i./ha both at POST and was also applied to a check. At 60 days after treatment (D.A.T.) all treatments were submitted to mechanical cultivation. At 75 D.A.T. a DJ was applied using the following treatments: diuron + M.S.M.A., 1.5 + 1.44 kg a.i./ha, respectively, diuron + pyrithiobac-sodium, 1.5 + 0.07 kg a.i./ha, respectively, M.S.M.A. + pyrithiobac-sodium, 1.44 + 0.07 kg a.i./ha, and lactofen + pyrithiobac-sodium, 0.15 + 0.07 kg a.i./ha, respectively. The effects of the treatments employed were evaluated on the basis of apparent phytotoxicity, agronomic efficiency and yield.

a. *Apparent Phytotoxicity*

Phytotoxicity was evaluated visually at 15 and 45 D.A.T. using a visual scale from 1 to 9, where 1 represents "no symptoms of apparent phytotoxicity" and 9 "total plant death", according to the EWRC scale (7).

b. *Agronomic Efficiency*

Agronomic efficiency as a function of type of culture and period of competition was evaluated visually at 15 and 45 D.A.T. and at 20 D.A.T.

with the DJ. A percent scale was used in which 0% represents no control and 100% total control compared to the "unhoed" check (*2*).

c. ***Yield***

Yield was evaluated by manual harvested on March 28 and 29 and on April 19 and 20, 1995. Four central rows of each plot were harvest, with the initial and final 0.50 m being discarded as edges. Thus, the harvested area represented 36.0 m^2 of each subplot. The cotton bolls were cleaned of impurities and weighed and the values were transformed into kg/ha cotton bolls.

TABLE 1 - Herbicides used in the experiment, with their respective common names and application methods (PRE, POST, MC and DJ) and applied doses in terms of active ingredient (a.i.) and commercial product per hectare, as well as the number of plots in the statistical design.

Treatments	Treatments in Kg a.i./ha		
Number	IPP	PRE	POST
1 - 11 - 21 - 31	Trifluralin 0,89	Pyrithiobac-sodium 0,03	MC
2 - 12 - 22 - 32	Trifluralin 0,89	pyrithiobac-sodium 0,07	pyrithiobac-sodium 0,07
3 - 13 - 23 - 33	Trifluralin 0,89	pyrithiobac-sodium 0,14	MC
4 - 14 - 24 - 34	Trifluralin 0,89	pyrithiobac-sodium 0,07 + diuron 1,40	MC
5 - 15 - 25 - 35	Trifluralin 0,89	-	pyrithiobac-sodium 0,07 + M.S.M.A. 1,44
6 - 16 - 26 - 36	Trifluralin 0,89	pyrithiobac-sodium 0,07 + alachlor 1,00	MC
7 - 17 - 27 - 37	Trifluralin 0,89	-	pyrithiobac-sodium 0,07
8 - 18 - 28 - 38	Trifluralin 0,89	-	pyrithiobac-sodium 0,14
9 - 19 - 29 - 39	Trifluralin 0,89	alachlor 1,00 (line)	MC
10 - 20 - 30 - 40	Trifluralin 0,89	-	-

Treatments number	DIRECTED JET SPRAY (kg a.i./ha)
DJ1 – 1 to 9	diuron 1,5 + M.S.M.A. 1,44
DJ2 – 11 to 19	Diuron 1,5 + pyrithiobac-sodium 0,07
DJ3 – 21 to 29	M.S.M.A. 1,44 + pyrithiobac-sodium 0,07
DJ4 – 31 to 39	Lactofen 0,18 + pyrithiobac-sodium 0,07

PRE (Kg a.i./ha) 11/10/94 — POST (Kg a.i/ha)

	DJ1 ↓	DJ2 ↓	DJ3 ↓	DJ4 ↓		
Pyrithiobac-sodium 0,03 →	1	11	21	31		← MC
Pyrithiobac-sodium 0,07 →	2	12	22	32	← pyrithiobac-sodium 0,07	← MC
Pyrithiobac-sodium 0,14 →	3	13	23	33		← MC
pyrithiobac-sodium 0,07+diuron 1,40 →	4	14	24	34		← MC
	5	15	25	35	← pyrithiobac-sodium 0,07 +diuron 1,40	← MC
pyrithiobac-sodium 0,07+alachlor 1,0 →	6	16	26	36		← MC
	7	17	27	37	← pyrithiobac-sodium 0,07	← MC
	8	18	28	38	← pyrithiobac-sodium 0,14	← MC
Alachlor 1,00 (line) →	9	19	29	39		← MC
	10	20	30	40		

3. **RESULTS AND DISCUSSION**

The data summarized in Table 2 represent the mean values for apparent phytotoxicity obtained 15 and 34 D.A.T. It can be seen that at 15 D.A.T. apparent phytotoxicity was absent or mild. At 45 D.A.T., no symptoms of phytotoxicity were observed.

TABLE 2 – Results obtained for the apparent phytotociity at 15 and 45 days after spraying (D.A.T.) of herbicides applied to cotton crops at IPP, PRE and POST

	Treatments (Kg a.i./ha)			Apparent phytotoxicity	
	IPP	PRE	POST	15	45
1	trifluralin 0,89	pyrithiobac-sodium 0,03	MC	2,6 a	0,0
2	trifluralin 0,89	pyrithiobac-sodium 0,07	pyrithiobac-sodium 0,07	2,0 ab	0,0
3	trifluralin 0,89	pyrithiobac-sodium 0,14	MC	2,3 ab	0,0
4	trifluralin 0,89	pyrithiobac-sodium 0,07 + diuron 1,40	MC	2,6 a	0,0
5	trifluralin 0,89	-	pyrithiobac-sodium 0,07 + M.S.M.A. 1,44	0,0 c	0,0
6	trifluralin 0,89	pyrithiobac-sodium 0,07 + alachlor 1,00	MC	2,0 ab	0,0
7	trifluralin 0,89	-	pyrithiobac-sodium 0,07	1,7 ab	0,0
8	trifluralin 0,89	-	pyrithiobac-sodium 0,14	2,0 ab	
9	trifluralin 0,89	alachlor 1,00 (line)	MC	2,6 a	
10	trifluralin 0,89	-	-	1,0 bc	
F treatments					

MC = mechanical cultivation
**Significant at the 1% level of probability.
Means followed by the same letter in the columns did not differ significantly.

Tables 3 to 9 contain the mean data concerning the level of weed control detected at 15 and 45 D.A.T. and at 20 D.A.T. with DJ. The results are presented below for each weed species.

a) *Brachiaria plantaginea*

Table 3 shows that all treatments used led to an excellent level of weed control.

TABLE 3 - Results obtained for percent control of *Brachiaria plantaginea* at 15 and 45 days after treatment (D.A.T.) with herbicides applied to cotton crops at IPP, PRE and POST and 20 D.A.T. using a directed jet spray (DJ) (Bariri, SP, 1994/95).

	Treatments (Kg a.i./ha)			% control		20 D.A.T. in DJ			
	IPP	PRE	POST	15	45	DJ - 1	DJ - 2	DJ - 3	DJ - 4
1	trifluralin 0,89	Pyrithiobac-sodium 0,03	MC	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
2	trifluralin 0,89	Pyrithiobac-sodium 0,07	pyrithiobac-sodium 0,07	99,3 a	98,3 ab	100,0 a	100,0 a	100,0 a	100,0 a
3	trifluralin 0,89	Pyrithiobac-sodium 0,14	MC	100,0 a	99,3 ab	100,0 a	100,0 a	100,0 a	100,0 a
4	trifluralin 0,89	Pyrithiobac-sodium 0,07 + diuron 1,40	MC	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
5	trifluralin 0,89	-	pyrithiobac-sodium 0,07 + M.S.M.A. 1,44	100,0 a	100,0 a	100,0 a	99,7 a	100,0 a	100,0 a
6	trifluralin 0,89	Pyrithiobac-sodium 0,07 + alachlor 1,00	MC	100,0 a	98,3 ab	100,0 a	100,0 a	100,0 a	100,0 a
7	trifluralin 0,89	-	pyrithiobac-sodium 0,07	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
8	trifluralin 0,89	-	pyrithiobac-sodium 0,14	100,0 a	98,3 ab	100,0 a	100,0 a	100,0 a	100,0 a
9	trifluralin 0,89	alachlor 1,00 (line)	MC	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
10	trifluralin 0,89	-	-	99,7 a	85,0 b	91,6 b	95,7 b	96,0 b	95,0 b
	F treatments			2,17 ns	2,84*	25,0**	33,4**	16,0**	3,0**

MC = mechanical cultivation

ns = non significant

* Significant at the 5% level of probablity

**Significant at the 1% level of probability

Means followed by the same letter in the columns did not differ significantly.

	DIRECTED JET SPRAY (kg a.i./ha)
DJ - 1	Diuron 1,5 + M.S.M.A. 1,44
DJ - 2	Diuron 1,5 + pyrithiobac-sodium 0,07
DJ - 3	M.S.M.A. 1,44 + pyrithiobac-sodium 0,07
DJ - 4	Lactofen 0,18 + pyrithiobac-sodium 0,07

b) *Digitaria horizontalis*

Table 4 shows that all the treatments and doses tested were efficient in controlling this weed species at 15 and 45 D.A.T. and after application of the herbicides with a DJ. This response was probably due to the efficiency of trifluralin at IPP.

c) *Commelina benghalensis*

Table 5 shows that all products and doses were efficient in controlling this species at 15 D.A.T., except for the check. At 45 D.A.T., efficiency was usually good, except for treatment 1 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.03 kg a.i./ha, applied to the row at PRE) and 7 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.07 kg a.i./ha at POST) and the check. The most efficient treatments were no. 2 (pyrithiobac-sodium applied at PRE and POST, two doses of 0.07 kg a.i./ha) and no. 3 (pyrithiobac-sodium applied at PRE and POST, 0.14 kg a.i./ha) and no. 9 (alachlor applied to the row).

d) *Ipomoea grandifolia*

Table 6 presents the results obtained for the control of *I. grandifolia*. It can be seen that this species was susceptible to all treatments used when evaluated at 15 D.A.T. At 45 D.A.T., there was a good level of control, except for the treatment with alachlor, 1.00 kg a.i./ha, applied to the row.

e) *Acanthospermum hispidum*

Table 7 shows that the response of the weed ranged from susceptible to highly susceptible for all treatments at 15 D.A.T., except for the check. At 45 D.A.T., treatments 2 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.07 kg a.i./ha at PRE + pyrithiobac-sodium, 0.07 kg a.i./ha + diuron, 1.40 kg a.i./ha at PRE + MC at POST), 5 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.07 kg a.i./ha + M.S.M.A., 1.44 kg a.i./ha at POST), 7 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.07 kg a.i./ha at POST), and 8 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.14 kg a.i./ha at POST) presented good control of *A. hispidum*.

f) *Sida cordifolia*

As can be seen in Table 8, all treatments were highly effective in the control of this weed at 15 and 45 D.A.T., except for the check.

TABLE 4 - Results obtained for percent control of *Digitaria horizontalis* at 15 and 45 days after treatment (D.A.T.) with herbicides applied to cotton crops at IPP, PRE and POST and 20 D.A.T. using a directed jet spray (DJ) (Bariri, SP, 1994/95).

	Treatments (Kg a.i./ha)			% control		20 D.A.T. in DJ			
	IPP	PRE	POST	15	45	DJ - 1	DJ - 2	DJ - 3	DJ - 4
1	trifluralin 0,89	pyrithiobac-sodium 0,03	MC	96,7 a	95,0 a	100,0 a	100,0 a	100,0 a	100,0 a
2	trifluralin 0,89	pyrithiobac-sodium 0,07	pyrithiobac-sodium 0,07	100,0 a	96,7 a	100,0 a	100,0 a	100,0 a	100,0 a
3	trifluralin 0,89	pyrithiobac-sodium 0,14	MC	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
4	trifluralin 0,89	pyrithiobac-sodium 0,07 + diuron 1,40	MC	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
5	trifluralin 0,89	-	pyrithiobac-sodium 0,07 + M.S.M.A. 1,44	100,0 a	98,3 a	100,0 a	99,7 a	99,7 a	100,0 a
6	trifluralin 0,89	pyrithiobac-sodium 0,07 + alachlor 1,00	MC	100,0 a	100,0 a	100,0 a	100,0 a	96,3 a	100,0 a
7	trifluralin 0,89	-	pyrithiobac-sodium 0,07	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
8	trifluralin 0,89	-	pyrithiobac-sodium 0,14	100,0 a	95,0 a	100,0 a	100,0 a	100,0 a	100,0 a
9	trifluralin 0,89	alachlor 1,00 (line)	MC	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
10	trifluralin 0,89	-	-	94,7 a	92,7 a	96,0 b	96,0 b	95,0 a	95,0 b
	F treatments			1,56 ns	1,20 ns	16,0**	16,0**	1,31ns	3,0**

MC = mechanical cultivation

ns = non significant

**Significant at the 1% level of probability

Means followed by the same letter in the columns did not differ significantly.

	DIRECTED JET SPRAY (kg i.a./ha)
DJ - 1	diuron 1,5 + M.S.M.A. 1,44
DJ - 2	diuron 1,5 + pyrithiobac-sodium 0,07
DJ - 3	M.S.M.A. 1,44 + pyrithiobac-sodium 0,07
DJ - 4	lactofen 0,18 + pyrithiobac-sodium 0,07

TABLE 5 - Results obtained for percent control of *Commelina bengalensis* at 15 and 45 days after treatment (D.A.T.) with herbicides applied to cotton crops at IPP, PRE and POST and 20 D.A.T. using a directed jet spray (DJ) (Bariri, SP, 1994/95).

	Treatments (Kg a.I./ha)			% control		20 D.A.T. in JD			
	IPP	PRE	POST	15	45	DJ - 1	DJ - 2	DJ - 3	DJ - 4
1	trifluralin 0,89	pyrithiobac-sodium 0,03	MC	83,3 ab	66,7 bc	98,3 a	99,3 a	97,0 a	97,7 a
2	trifluralin 0,89	pyrithiobac-sodium 0,07	pyrithiobac-sodium 0,07	96,0 a	95,0 a	100,0 a	99,3 a	99,0 a	99,0 a
3	trifluralin 0,89	pyrithiobac-sodium 0,14	MC	96,0 a	95,0 a	100,0 a	91,7 c	90,0 b	98,3 a
4	trifluralin 0,89	pyrithiobac-sodium 0,07 + diuron 1,40	MC	95,0 a	83,3 ab	97,6 a	93,3 bc	96,0 a	95,0 a
5	trifluralin 0,89	-	pyrithiobac-sodium 0,07 + M.S.M.A. 1,44	96,0 a	80,0 ab	100,0 a	97,6 ab	98,3 a	99,0 a
6	trifluralin 0,89	pyrithiobac-sodium 0,07 + alachlor 1,00	MC	95,0 a	81,7 ab	99,3 a	99,3 a	100,0 a	95,7 a
7	trifluralin 0,89	-	pyrithiobac-sodium 0,07	88,3 ab	46,7 c	98,0 a	100,0 a	99,0 a	100,0 a
8	trifluralin 0,89	-	pyrithiobac-sodium 0,14	97,0 a	81,7 ab	98,3 a	100,0 a	100,0 a	100,0 a
9	trifluralin 0,89	alachlor 1,00 (line)	MC	96,6 a	95,0 a	96,0 a	99,7 a	97,7 a	98,3 a
10	trifluralin 0,89	-	-	51,6 c	0,0 d	88,3 b	83,3 d	83,3 c	83,3 b
	F treatments			45,16**	41,53**	10,57**	24,91**	27,49**	12,79**

MC = mechanical cultivation

**Significant at the 1% level of probability

Means followed by the same letter in the columns did not differ significantly.

	DIRECTED JET SPRAY (kg i.a./ha)
DJ - 1	diuron 1,5 + M.S.M.A. 1,44
DJ - 2	diuron 1,5 + pyrithiobac-sodium 0,07
DJ - 3	M.S.M.A. 1,44 + pyrithiobac-sodium 0,07
DJ - 4	lactofen 0,18 + pyrithiobac-sodium 0,07

TABLE 6 - Results obtained for percent control of *Ipomoea grandifolia* at 15 and 45 days after treatment (D.A.T.) with herbicides applied to cotton crops at IPP, PRE and POST and 20 D.A.T. using a directed jet spray (DJ) (Bariri, SP, 1994/95).

	Treatments (Kg a.i./ha)			% control		20 D.A.T. in DJ			
	IPP	PRE	POST	15	45	DJ - 1	DJ - 2	DJ - 3	DJ - 4
1	Trifluralin 0,89	pyrithiobac-sodium 0,03	MC	96,7 a	90,0 ab	100,0 a	100,0 a	100,0 a	100,0 a
2	Trifluralin 0,89	pyrithiobac-sodium 0,07	pyrithiobac-sodium 0,07	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
3	Trifluralin 0,89	pyrithiobac-sodium 0,14	MC	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
4	Trifluralin 0,89	pyrithiobac-sodium 0,07 + diuron 1,40	MC	100,0 a	93,3 ab	100,0 a	100,0 a	100,0 a	100,0 a
5	Trifluralin 0,89	-	pyrithiobac-sodium 0,07 + M.S.M.A. 1,44	100,0 a	96,7 a	100,0 a	100,0 a	100,0 a	100,0 a
6	trifluralin 0,89	pyrithiobac-sodium 0,07 + alachlor 1,00	MC	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
7	trifluralin 0,89	-	pyrithiobac-sodium 0,07	99,3 a	94,3 a	100,0 a	100,0 a	99,6 a	100,0 a
8	trifluralin 0,89	-	pyrithiobac-sodium 0,14	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
9	trifluralin 0,89	alachlor 1,00 (line)	MC	98,3 a	66,7 b	100,0 a	100,0 a	100,0 a	100,0 a
10	trifluralin 0,89	-	-	0,0 b	0,0 c	96,0 b	93,3 b	86,7 b	96,7 a
	F treatments			689,7**	121,1**	16,0**	16,0**	61,24**	0,77ns

MC = mechanical cultivation

ns = non significant

**Significant at the 1% level of probability

Means followed by the same letter in the columns did not differ significantly.

	DIRECTED JET SPRAY (kg a.I./ha)
DJ - 1	diuron 1,5 + M.S.M.A. 1,44
DJ - 2	diuron 1,5 + pyrithiobac-sodium 0,07
DJ - 3	M.S.M.A. 1,44 + pyrithiobac-sodium 0,07
DJ - 4	lactofen 0,18 + pyrithiobac-sodium 0,07

TABLE 7 - Results obtained for percent control of *Sida cordifolia* at 15 and 45 days after treatment (D.A.T.) with herbicides applied to cotton crops at IPP, PRE and POST and 20 D.A.T. using a directed jet spray (DJ) (Bariri, SP, 1994/95)

	Treatments (Kg a.i./ha)			% control		20 D.A.T. in DJ			
	IPP	PRE	POST	15	45	DJ - 1	DJ - 2	DJ - 3	DJ - 4
1	trifluralin 0,89	pyrithiobac-sodium 0,03	MC	98,3 a	93,3 a	100,0 a	100,0 a	100,0 a	99,7 a
2	trifluralin 0,89	pyrithiobac-sodium 0,07	pyrithiobac-sodium 0,07	99,3 a	99,3 a	100,0 a	100,0 a	100,0 a	100,0 a
3	trifluralin 0,89	pyrithiobac-sodium 0,14	MC	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
4	trifluralin 0,89	pyrithiobac-sodium 0,07 + diuron 1,40	MC	100,0 a	98,3 a	100,0 a	100,0 a	100,0 a	100,0 a
5	trifluralin 0,89	-	pyrithiobac-sodium 0,07 + M.S.M.A. 1,44	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
6	trifluralin 0,89	pyrithiobac-sodium 0,07 + alachlor 1,00	MC	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
7	trifluralin 0,89	-	pyrithiobac-sodium 0,07	99,3 a	99,3 a	100,0 a	100,0 a	100,0 a	100,0 a
8	trifluralin 0,89	-	pyrithiobac-sodium 0,14	97,7 a	100,0 a	100,0 a	100,0 a	100,0 a	100,0 a
9	trifluralin 0,89	alachlor 1,00 (line)	MC	100,0 a	97,6 a	100,0 a	100,0 a	100,0 a	100,0 a
10	trifluralin 0,89	-	-	0,0 b	0,0 b	93,3 b	95,0 b	96,0 b	75,0 b
	F treatments			171,1**	194,7**	16,0**	3,0*	16,0**	75,8**

MC = mechanical cultivation

* Significant at the 5% level of probablity

**Significant at the 1% level of probability

Means followed by the same letter in the columns did not differ significantly.

	DIRECTED JET SPRAY (kg i.a./ha)
DJ - 1	diuron 1,5 + M.S.M.A. 1,44
DJ - 2	diuron 1,5 + pyrithiobac-sodium 0,07
DJ - 3	M.S.M.A. 1,44 + pyrithiobac-sodium 0,07
DJ - 4	lactofen 0,18 + pyrithiobac-sodium 0,07

Table 8 - Results obtained for percent control of *Acanthospermum hispidum* at 15 and 45 days after treatment (D.A.T.) with herbicides applied to cotton crops at IPP, PRE and POST and 20 D.A.T. using a directed jet spray (DJ) (Bariri, SP, 1994/95).

	Treatments (Kg a.i./ha)			% control		20 D.A.T. in DJ			
	IPP	PRE	POST	15	45	DJ - 1	DJ - 2	DJ - 3	DJ - 4
1	trifluralin 0,89	pyrithiobac-sodium 0,03	MC	83,3 b	26,7 d	99,3 a	98,3 ab	100,0 a	100,0 a
2	trifluralin 0,89	pyrithiobac-sodium 0,07	pyrithiobac-sodium 0,07	97,7 a	80,0 b	100,0 a	100,0 a	100,0 a	100,0 a
3	trifluralin 0,89	pyrithiobac-sodium 0,14	MC	83,3 b	32,3 d	99,0 a	97,7 ab	91,6 ab	92,7 ab
4	trifluralin 0,89	pyrithiobac-sodium 0,07 + diuron 1,40	MC	98,3 a	81,7 b	98,3 a	100,0 a	98,3 ab	100,0 a
5	trifluralin 0,89	-	pyrithiobac-sodium 0,07 + M.S.M.A. 1,44	100,0 a	95,0 a	100,0 a	99,3 ab	99,3 a	100,0 a
6	trifluralin 0,89	pyrithiobac-sodium 0,07 + alachlor 1,00	MC	81,7 b	53,3 c	100,0 a	99,3 ab	96,3 ab	100,0 a
7	trifluralin 0,89	-	pyrithiobac-sodium 0,07	100,0 a	86,7 ab	100,0 a	100,0 a	100,0 a	100,0 a
8	trifluralin 0,89	-	pyrithiobac-sodium 0,14	100,0 a	93,3 a	100,0 a	100,0 a	100,0 a	100,0 a
9	trifluralin 0,89	alachlor 1,00 (line)	MC	86,7 b	23,3 d	98,3 a	100,0 a	100,0 a	100,0 a
10	trifluralin 0,89	-	-	0,0 c	0,0 e	96,7 a	91,7 b	88,3 b	91,0 b
	F treatments			376,5**	236,3**	0,77 ns	2,64*	3,91**	4,03**

MC = mechanical cultivation

ns = non significant

* Significant at the 5% level of probablity

**Significant at the 1% level of probability

Means followed by the same letter in the columns did not differ significantly.

	DIRECTED JET SPRAY (kg a.i./ha)
DJ - 1	diuron 1,5 + M.S.M.A. 1,44
DJ - 2	diuron 1,5 + pyrithiobac-sodium 0,07
DJ - 3	M.S.M.A. 1,44 + pyrithiobac-sodium 0,07
DJ - 4	lactofen 0,18 + pyrithiobac-sodium 0,07

g) *Bidens pilosa*

This species was controlled by all treatments studied at 15 D.A.T. (Table 9). At 45 D.A.T., treatments no. 3 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.14 kg a.i./ha at PRE + MC at POST), no. 6 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.07 kg a.i./ha + alachlor, 1.00 kg a.i./ha at PRE + MC at POST) and the check showed a control below the desired level.

Tables 3 to 9 show that all treatments with DJ efficiently controlled the weeds present in the study area, permitting a clean cotton harvest.

Crop yields, expressed as kg/ha cotton bolls, are summarized in Table 10. Analysis of these data shows that all treatments (1 to 10) led to equally significant productivity. Treatments no. 11 to no. 20 (DJ2) showed the best results for the check, which was submitted to hoeing several times, and MC in addition to DJ, followed in absolute values by treatments no. 6 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.07 kg a.i./ha + alachlor, 1.00 kg a.i./ha at PRE + MC at POST), no. 8 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.14 kg a.i./ha at POST) and no. 9 (trifluralin, 0.89 kg a.i./ha at IPP + alachlor, 1.00 kg a.i./ha at PRE + MC at POST). For treatments 21 to 30 (DJ3), the best treatments after the check were no. 6, no. 7 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.07 kg a.i./ha at POST) and no. 9, followed by no. 3 (trifluralin, 0.90 kg ia.i at IPP + pyrithiobac-sodium, 0.14 kg a.i./ha at PRE + MC at POST), and no. 8. In the set of treatments from 31 to 40 (DJ4), those leading to the highest yields for the experiment as a whole were trifluralin, pyrithiobac-sodium (0.07 kg a.i./ha at POST) + (lactofen + pyrithiobac-sodium) applied as a directed jet, with 3,146.3 kg cotton bolls/ha. Treatments 2 (trifluralin, 0.89 kg a.i./ha at IPP + pyrithiobac-sodium, 0.07 kg a.i./ha et PRE + pyrithiobac-sodium, 0.07 kg a.i./ha at POST), 3, 6, 9 and 10 (trifluralin, 0.89 kg a.i./ha at IPP) were equivalent.

In general, the best results were obtained with treatment no. 9 (trifluralin, 0.89 kg a.i./ha at IPP + alachlor, 1.00 kg a.i./ha (row) at PRE + MC at POST) for almost all combinations with a DJ.

On the basis of the conditions of the experiment, we may conclude that regardless of the system used, herbicides had caused mild or no phytotoxicity to the culture at 14 D.A.T., with the effects disappearing at 45 D.A.T. In general the combination of IPP, PRE, POST and MC treatments produced a good level of weed control during the critical period of competition. Evaluation at 20 D.A.T. showed that the four different treatments involving application of a DJ were effective in controlling the species still present, permitting a clean harvest. The best results in terms of

TABLE 9 - Results obtained for percent control of *Bidens pilosa* at 15 and 45 days after treatment (D.A.T.) with herbicides applied to cotton crops at IPP, PRE and POST and 20 D.A.T. using a directed jet spray (DJ) (Bariri, SP, 1994/95).

	Treatments (Kg a.i./ha)			% control			20 D.A.T. in DJ		
	IPP	PRE	POST	15	45	DJ - 1	DJ - 2	DJ - 3	DJ - 4
1	trifluralin 0,89	pyrithiobac-sodium 0,03	MC	83,3 c	90,0 ab	98,3 a	99,3 a	100,0 a	99,3 a
2	trifluralin 0,89	pyrithiobac-sodium 0,07	pyrithiobac-sodium 0,07	100,0 a	90,0 ab	100,0 a	100,0 a	100,0 a	100,0 a
3	trifluralin 0,89	pyrithiobac-sodium 0,14	MC	86,7 bc	76,7 b	99,3 a	100,0 a	90,0 c	93,3 b
4	trifluralin 0,89	pyrithiobac-sodium 0,07 + diuron 1,40	MC	93,3 ab	96,7 a	100,0 a	100,0 a	100,0 a	98,7 ab
5	trifluralin 0,89	-	pyrithiobac-sodium 0,07 + M.S.M.A. 1,44	100,0 a	93,3 a	100,0 a	100,0 a	100,0 a	99,7 a
6	trifluralin 0,89	pyrithiobac-sodium 0,07 + alachlor 1,00	MC	85,0 bc	75,0 b	99,7 a	99,3 a	96,7 ab	99,7 a
7	trifluralin 0,89	-	pyrithiobac-sodium 0,07	100,0 a	81,7 ab	99,6 a	100,0 a	99,7 a	100,0 a
8	trifluralin 0,89	-	pyrithiobac-sodium 0,14	100,0 a	88,3 ab	100,0 a	100,0 a	100,0 a	100,0 a
9	trifluralin 0,89	alachlor 1,00 (line)	MC	86,7 bc	88,3 ab	95,0 a	100,0 a	100,0 a	100,0 a
10	trifluralin 0,89	-	-	0,0 d	0,0 c	93,3 a	90,0 b	93,3 bc	80,0 c
	F treatments			251,7**	86,2**	1,83 ns	110,0**	9,07**	32,8**

MC = mechanical cultivation

ns = non significant

**Significant at the 1% level of probability

Means followed by the same letter in the columns did not differ significantly.

	DIRECTED JET SPRAY (kg a.I./ha)
JD - 1	diuron 1,5 + M.S.M.A. 1,44
JD - 2	diuron 1,5 + pyrithiobac-sodium 0,07
JD - 3	M.S.M.A. 1,44 + pyrithiobac-sodium 0,07
JD - 4	lactofen 0,18 + pyrithiobac-sodium 0,07

TABLE 10 - Cotton production (kg cotton bolls/ha) after spraying with herbicides applied to cotton crops at IPP, PRE and POST and using a DJ (Bariri, SP, 1994/95).

	Treatments (Kg a.i./ha)			Yield (Kg cotton/ha)			
	IPP	PRE	POST	DJ - 1	DJ - 2	DJ - 3	DJ - 4
1	trifluralin 0,89	pyrithiobac-sodium 0,03	MC	2027,9 a	2000,8 bc	1777,6 cd	2387,0 b
2	trifluralin 0,89	pyrithiobac-sodium 0,07	pyrithiobac-sodium 0,07	2213,2 a	1999,8 bc	2036,8 bc	2643,1 ab
3	trifluralin 0,89	pyrithiobac-sodium 0,14	MC	2139,1 a	1990,6 bc	203,5 abc	2683,3 ab
4	trifluralin 0,89	pyrithiobac-sodium 0,07 + diuron 1,40	MC	2055,7 a	1814,7 c	1833,2 cd	2368,5 b
5	trifluralin 0,89	-	pyrithiobac-sodium 0,07 + M.S.M.A. 1,44	2100,2 a	1647,9 c	1333,1 d	2350,0 b
6	trifluralin 0,89	pyrithiobac-sodium 0,07 + alachlor 1,00	MC	2315,0 a	2222,0 ab	2444,2 ab	2738,9 ab
7	trifluralin 0,89	-	pyrithiobac-sodium 0,07	2574,3 a	2018,3 bc	2444,3 ab	3146,3 a
8	trifluralin 0,89	-	pyrithiobac-sodium 0,14	2352,1 a	2240,6 ab	2240,2 abc	2424,1 b
9	trifluralin 0,89	alachlor 1,00 (line)	MC	2611,3 a	2314,6 ab	2444,2 ab	2794,4 ab
10	trifluralin 0,89	-	-	2540,2 a	2607,9 a	2672,8 a	2730,8 ab
	F treatments			2,64 ns	12,31**	11,10**	3,24*

MC = mechanical cultivation

ns = non significant

* Significant at the 5% level of probablity

**Significant at the 1% level of probability

Means followed by the same letter in the columns did not differ significantly.

	DIRECTED JET SPRAY (kg a.I./ha)
JD - 1	diuron 1,5 + M.S.M.A. 1,44
JD - 2	diuron 1,5 + pyrithiobac-sodium 0,07
JD - 3	M.S.M.A. 1,44 + pyrithiobac-sodium 0,07
JD - 4	lactofen 0,18 + pyrithiobac-sodium 0,07

crop yield, expressed as kg cotton bolls, were obtained for the plots treated with a DJ with lactofen + pyrithiobac-sodium. The highest yields were obtained for the treatment with trifluralin at 0.89 kg/ a.i./ha at IPP, pyrithiobac-sodium at 0.07 at POST and DJ application of lactofen (0.18 kg a.i./ha + pyrithiobac-sodium (0.07 kg a.i./ha) with a yield of 3,143.3 kg cotton bolls/ha. The data obtained with pyrithiobac-sodium in the Staple 280 C.S. formulation, especially when applied in combination with trifluralin, showed a good potential for use in cotton crops. The data obtained here permit us to recommend the herbicides, which gave positive results in an application system (IPP, PRE, POST, MC and DJ) to cotton crops, in view of their high efficiency in weed control and their safety for the crop.

5. SUMMARY

The objective of this work was to evaluate the efficacy of different combinations of herbicide treatments, applied at incorporated preplanting (IPP), pre-emergence (PRE), post-emergence (POST), mechanical cultivation and direct spray on cotton crop (*Gossypium hirsutum* L.) cultivar IAC-20. The treatments were tested with the following products: trifluralin applied at IPP in all treatments, including the non hoed control, at 0.89 Kg a.i./ha, pyrithiobac-sodium applied at 30 g a.i./ha in the row, plus mechanical cultivation; at 70 g a.i./ha in two applications at pre and post-emergence and 140 g a.i./ha at pre + mechanical cultivation, at 70 g a.i./ha + diuron at 1.40 Kg a.i./ha at pre-emergence + mechanical cultivation and post-emergence, at 70 g a.i./ha + M.S.M.A. at 1.44 g a.i./ha, at 70 g a.i./ha + alachlor at 1.0 Kg a.i./ha + mechanical cultivation at post-emergence, at 70 and 140 g a.i./ha, both at post-emergence and a control. At 60 D.A.T. all treatments were subjected to mechanical cultivation. At 75 D.A.T., a directed spray was applied with treatments of diuron + M.S.M.A. at 1.5 + 1.44 Kg a.i./ha, respectively; diuron + pyrithiobac- sodium at 1.5 + 0.07 Kg a.i./ha; M.S.M.A. + pyrithiobac-sodium at 1.44 + 0.07 Kg a.i./ha and lactofen + pyrithiobac-sodium at 0.15 + 0.07 Kg a.i./ha. Irrespective of the system, the herbicides presented the effect of evident phytotoxicity from none to light at 15 D.A.T. , which disappeared at 45 D.A.T. The data obtained for pyrithiobac-sodium, formulation Staple 280 CS, mainly with the application associated with trifluralin, showed an efficient control of weeds. which permits the recommendation of its use on cotton crop.

6. **RESUMO**

(EMPREGO DE VÁRIOS SISTEMAS DE APLICAÇÃO DE HERBICIDAS NA CULTURA DO ALGODÃO (*Gossypium hirsutum* L.))

O presente trabalho teve como objetivo avaliar a eficiência de diferentes combinações de tratamentos herbicidas aplicados em pré-plantio incorporado (PPI), pré e pós-emergência, cultivo mecânico e jato dirigido na cultura de algodão (*Gossypium hirsutum* L.). O experimento foi conduzido em campo, sendo a área experimental instalada com o cultivar IAC-20. Foram testados tratamentos com os seguintes produtos: trifluralina aplicado em PPI em todos os tratamentos, inclusive na testemunha não capinada, a 0,89 kg i.a./ha; pyrithiobac-sodium aplicado a 30 g i.a./ha na linha mais cultivo mecânico, a 70 g i.a./ha em duas aplicações: em pré e pós-emergência a 140 g i.a./ha em pré + cultivo mecânico, a 70 g i.a./ha + diuron a 1,40 kg i.a./ha em pré-emergência + cultivo mecânico e pós-emergência, a 70 g i.a./ha + M.S.M.A. a 1,44 g i.a./ha, a 70 g i.a./ha + alachlor a 1,0 kg i.a./ha + cultivo mecânico em pós-emergência, a 70 e 140 g i.a./ha, ambos em pós-emergência e uma testemunha. Aos 60 dias após o tratamento (D.A.T.) todos os tratamentos receberam cultivo mecânico. Aos 75 D.A.T. foi aplicado jato dirigido com os tratamentos constituídos de diuron + M.S.M.A. a 1,5 + 1,44 Kg i.a./ha, respectivamente, diuron + pyrithiobac-sodium a 1,5 + 0,07 kg i.a./ha, M.S.M.A. + pyrithiobac-sodium a 1,44 + 0,07 kg i.a./ha e lactofen + pyrithiobac-sodium a 0,15 + 0,07 kg i.a./ha. Os herbicidas, independentemente do sistema utilizado, provocaram toxicidade aparente entre nula e leve na cultura aos 15 D.A.T.; desaparecendo aos 45 D.A.T. Pyrithiobac-sodium, na formulação Staple 280 C.S., principalmente na aplicação associada com trifluralina, controlou eficientemente as plantas daninhas, permitindo recomendar seu uso na cultura algodoeira.

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