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TIME OF APPLICATION OF PRE-EMERGENCE HERBICIDES IN DRY-SOWN RICE

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Abstract: A field experiment was conducted at the Agricultural Research Station, Mannuthy under the Kerala Agricultural University during the first crop season of 1988 to find out the optimum time of application of the pre-emergence herbicides, butachlor and thiobencarb and to assess the scope of second application of these herbicides for efficient weed control in dry-sown rice. Major part of the weed flora of the experimental field was constituted by grasses and sedges. Control of *Echinochloa colona* and other grasses was very effective in the treatments where thiobencarb was applied at 0, 3 or 6 days after sowing (DAS) and repeated at 25 DAS whereas almost all the butachlor treatments gave complete control of sedges. The population and drymatter production of weeds were appreciably reduced by the repeated application of thiobencarb and resulted in improvement of growth, yield attributes and yield of rice. These treatments also reduced the crop-weed competition for major nutrients N, P and K.

INTRODUCTION

Excessive weed growth is a major constraint for rice production in dry-sown rice, which is taken during the *Virippu* (May- September) season. Hand weeding is labour intensive and requires repeated operations for successful weed control. Chemical weed control methods offer scope for effective weed management at cheaper rates. Herbicides like butachlor and thiobencarb are found to be effective for pre-emergence application in dry-sown rice (Sankaran and De Datta, 1985 and KAU, 1986a). However, there are reports that these herbicides may cause toxicity to rice seedlings (Nako, 1977 and Sankaran and De Datta, 1985). By modifying the time of application of these herbicides, their toxicity to rice seedlings can be avoided to a great extent (Arceo and Mercado, 1981).

Weed-free condition up to 60 days is essential for getting good yields in dry-sown rice (Sankaran and De Datta, 1985). Since the effect of pre-emergence herbicides is short lived, the later emerging weeds can be controlled by application of post-emergence herbicides or by hand weeding which are costly. A second application of butachlor or thiobencarb 20 to 30 days after the first application can extend the effect of herbicides to cover the entire critical period of the crop. The present investigation was undertaken to find out the optimum time of application of pre-emergence herbicides, butachlor and thiobencarb and to assess the scope of second application of these herbicides.

MATERIALS AND METHODS

A field trial was conducted at the Agricultural Research Station, Mannuthy, under the Kerala Agricultural University, during the *Virippu* season of 1988. The soil of the experimental field was sandy clay loam in texture containing 0.6%. organic matter, 0.14% total N, 32.1 kg/ha available P and 172.1 kg/ha available K. Rice variety, Jyothi was used for the trial. The cultural practices recommended by the Kerala Agricultural University (KAU, 1986a) were followed during the course of the experiment, except the weed control operations, which varied as per the treatments. The treatments consisted of application of butachlor and thiobencarb, at zero, three, six or nine days after sowing only or repeated at 25 days after sowing. A weed-free check (hand weeded thrice) and an unweeded control were also included for comparison. In total there were 18 treatments (Table 1) which were laid out in a randomized block design with three replications. The gross and net plot sizes were, 5 m x 6 m and 4 m x 4 m, respectively.

Observations on the drymatter production of the crop and weeds were recorded at 30, 60 and 90 DAS and at harvest from two spots in the sampling strip using a quadrat of 0.5 x 0.5 m^2 size. Species-wise count of the weeds inside the quadrat was also recorded at 60 DAS. At the time of harvest, plant height, productive tillers per hill, panicle length, number of spikelets per panicle, thousand grain weight, grain yield and straw yield were recorded. The nutrient uptake (N, P and K) by the crop (at 60 DAS and harvest) and the weeds (at 60 DAS) were worked out by standard procedures. The data recorded for different characters were statistically analysed.

RESULTS AND DISCUSSION

Weed flora

A major part of the weed flora of the experimental field was constituted by grasses and sedges. Among the grasses, *Isachne miliacea* Roth, *Saccolcppis interrupta* L. and *Echinochloa colona* (L.) Link and among sedges, *Cyperus iria* L. were the prominent ones. The dicots were very few in number, *Sphaeranthus indicus* L., *Ludwigia parviflora* Roxb, *Ammannia baccifera* L., *Commelina benghalensis* L. and *Cyanotis* sp. being the main ones.

Weed population

The grass weeds were effectively controlled by thiobencarb application (Table 1). The observations on the major grass species, *Isachne miliacea*, *Saccolepis interrupta* and *Echinochloa colona* showed that thiobencarb applications at 0, 3 and 6 DAS and repeated at 25 DAS controlled these weeds more effectively and these treatments were statistically on par with hand weeding. The total grass weed population also was lower in these three treatments. Butachlor treatments were less efficient in controlling the grass weeds and only butachlor at 0+25 DAS could effect consistent control. The efficiency of thiobencarb in reducing grass weed population has been reported by Bhan *et al.* (1986) and Ali *et al.* (1986). All the butachlor treatments except its single application at 0 DAS gave total control of sedges. Among thiobencarb treatments, its application at 6+25 DAS only gave complete control of the sedges. The efficiency of butchlor in controlling the sedge population in rice is in accordance with the earlier reports of Cadang and Mercado (1980) and Patel *et al.* (1985). The total weed count was the lowest in hand weeded plot and the thiobencarb at 0+25, 3+25 and 6+25 DAS and butachlor at 0+25 DAS were on par with it.

Drymatter production by weeds

Comparison of the drymatter production of weeds (Table 2) showed that in general, thiobencarb treatments produced lower weed drymatter than the corresponding butachlor treatments. This effect was more pronounced at 60 and 90 DAS, wherein the thiobencarb 0+25, 3+25 and 6+25 DAS resulted in significantly lower weed drymatter production than the butachlor applications at these days. Butachlor at 0+25 DAS also reduced the weed drymatter production on par with these three treatments. All these treatments could give an effect equivalent to hand weeding during the critical stages of weed competition. The relative superiority of thiobencarb in reducing weed drymatter production may be due to the fact that it could more effectively control the grass weeds which accounted for the major part of the weed flora in the field. Earlier work by Palaikudy (1989) also showed the same trend.

Growth characters of the crop

The data on the growth characters (height and drymatter production) (Table 3) showed that high weed density and severe weed competition reduced the height and crop drymatter production. All the herbicide treatments were statistically superior to unweeded check and resulted in taller plants. The crop drymatter production was the least in unweeded control at all stages of observation. Except the treatments where the first application butachlor or thiobencarb was given at 9 DAS (whether or not repeated) all herbicide treatments resulted in higher crop drymatter production than unweeded control, at the harvest stage.

Yield attributes

The hand weeded plots produced the maximum number of productive tillers per hill and the repeated applications of thiobencarb at 0+25, 3+25 and 6+25 DAS and the butachlor application at 3+25 DAS were on par with it (Table 4). Hand weeding and the herbicide treatments where weed control was effective produced longer panicles and higher number of spikelets per panicle. There was no significant difference between the treatments with respect to thousand grain weight.

Yield

The highest grain yield was recorded by hand weeded plot followed by thiobencarb 0+25 DAS. The repeated application of thiobencarb at 3+25 DAS and 6+25 DAS also gave higher yields than the other treatments. Among the butachlor treatments, application at 0+25 DAS was the best. The maximum straw yield was produced by the hand weeded control which was on par with repeated applications of thiobencarb at 0+25 DAS.

The higher yields in the repeated application treatments have resulted from the cumulative contribution of yield attributes due to the relatively weed-free condition during the critical stages of the crop. The single herbicide applications, always yielded lower than their repeated applications probably due to the disintegration of the applied herbicide and its becoming ineffective to check the subsequent germination of weed seeds. Kulshrestha *et al.* (1981) have also reported that the half life of these herbicides is only 2 to 3 weeks under aerobic conditions in soil. Due to the effective control of grass weeds which dominated the weed flora, thiobencarb treatments yielded higher than the corresponding butachlor treatments.

Nutrient uptake by crop and weeds

At 60 days, hand weeded plots recorded minimum removal of N, P and K by weeds (Table 5). The repeated application of thiobencarb, where the first application was done up to 6 DAS (0+25, 3+25 and 6+25) and butachlor application at 0+25 DAS, which controlled the weeds effectively reduced the nutrient removal considerably and were on par with hand weeding. The nutrient uptake by crop showed almost opposite trend. Towards harvest stage the Variations in nutrient uptake by crop between the different treatments got widened resulting in significantly higher uptake of all the nutrients for hand weeding and the above mentioned her-

Table 1. Effect of time of application of butachlor and thiobencarb on weed population (plants/m^2) at 60 DAS

Treatments	*Isachne miliacea* T	*Saccoleppis interrupta* T	*Echinochloa colona* T	Total grass T*	Sedges T	Total weeds T*
Butachlor 0 DAS	29.76	10.92	8.27	33.67	1.41	31.10
Butachlor 3 DAS	25.98	10.49	4.52	30.03	1.00	31.61
Butachlor 6 DAS	40.87	11.51	5.82	43.00	1.00	44.53
Butachlor 9 DAS	32.56	22.43	9.78	41.21	1.00	41.33
Butachlor 0+25 DAS	18.85	7.24	5.40	20.92	1.00	21.64
Butachlor 3+25 DAS	22.62	9.04	4.02	25.42	1.00	30.32
Butachlor 6+25 DAS	38.65	11.81	6.35	41.15	1.00	41.25
Butachlor 9+25 DAS	38.33	15.97	10.31	43.92	1.00	43.92
Thiobencarb 0 DAS	23.69	11.84	6.80	29.99	5.62	32.35
Thiobencarb 3 DAS	15.86	9.90	2.07	20.33	4.56	27.41
Thiobencarb 6 DAS	28.53	9.53	3.79	30.33	2.07	31.35
Thiobencarb 9 DAS	35.95	13.91	6.65	39.71	7.43	41.50
Thiobencarb 0+25 DAS	6.13	8.98	1.00	12.43	2.07	18.47
Thiobencarb 3+25 DAS	6.61	10.50	1.66	13.83	1.66	20.33
Thiobencarb 6+25 DAS	10.45	6.28	1.86	13.40	1.00	16.53
Thiobencarb 9+25 DAS	29.41	14.82	6.04	33.64	5.93	36.06
Hand weeded control	6.40	5.23	3.27	8.82	1.86	13.47
Unweeded control	39.02	24.48	12.42	47.86	5.42	48.18
SEm ±	4.56	2.24	1.39	3.84	1.12	4.44
CD (0.05)	13.12	6.46	4.02	11.12	3.23	12.77

T = transformed value ($\sqrt{x+1}$) T* = transformed value ($\sqrt{x}$)

Table 3. Height and drymatter production of rice as affected by time of application of butachlor and thiobencarb

Treatments	Plant height (cm)	Drymatter production by crop (g/m^2)			
		30 DAS	60 DAS	90 DAS	Harvest
Butachlor 0 DAS	77.53	47.33	189.33	432.00	495.00
Butachlor 3 DAS	83.01	106.66	336.66	430.66	512.66
Butachlor 6 DAS	81.20	64.00	299.33	408.66	502.00
Butachlor 9 DAS	68.30	67.33	212.00	293.33	332.33
Butachlor 0+25 DAS	78.93	66.00	279.33	560.66	686.00
Butachlor 3+25 DAS	84.50	68.00	197.33	370.66	493.66
Butachlor 6+25 DAS	74.12	66.00	276.66	380.66	458.66
Butachlor 9+25 DAS	59.98	56.00	134.00	233.33	261.66
Thiobencarb 0 DAS	77.76	45.33	328.66	412.00	456.00
Thiobencarb 3 DAS	81.99	65.33	372.00	532.00	603.00
Thiobencarb 6 DAS	80.89	74.66	250.66	310.00	408.00
Thiobencarb 9 DAS	72.05	48.00	217.33	289.33	347.00
Thiobencarb 0+25 DAS	82.72	73.33	350.66	585.33	695.00
Thiobencarb 3+25 DAS	76.34	106.66	313.33	466.66	651.00
Thiobencarb 6+25 DAS	74.77	80.00	326.66	493.33	713.00
Thiobencarb 9+25 DAS	74.77	51.33	235.33	327.33	379.00
Hand weeded control	74.81	53.33	289.33	714.66	996.33
Unweeded control	50.24	26.67	182.66	211.33	229.33
SEm±	3.17	14.24	64.94	60.06	59.07
CD (0.05)	9.12	40.92	NS	172.43	169.75

Table 4. Yield attributes of rice as influenced by time of application of butachlor and thiobencarb

Treatments	Productive tillers (No./hill)	Length of panicle (cm)	Total No. of spikelets/ panicle	Thousand grain weight (g)
Butachlor 0 DAS	5.20	17.76	56.26	24.96
Butachlor 3 DAS	5.08	17.35	54.20	27.73
Butachlor 6 DAS	6.43	17.08	50.41	27.33
Butachlor 9 DAS	3.13	15.17	29.37	24.26
Butachlor 0+25 DAS	5.00	18.21	60.33	25.83
Butachlor 3+25 DAS	5.83	18.13	55.20	27.86
Butachlor 6+25 DAS	3.36	15.87	41.73	27.33
Butachlor 9+25 DAS	4.13	14.41	39.66	22.90
Thiobencarb 0 DAS	3.60	16.44	42.63	25.86
Thiobencarb 3 DAS	5.96	16.37	46.53	27.06
Thiobencarb 6 DAS	5.16	17.70	57.80	25.86
Thiobencarb 9 DAS	4.40	16.76	37.79	23.96
Thiobencarb 0+25 DAS	5.90	17.42	50.00	24.60
Thiobencarb 3+25 DAS	7.00	17.66	56.00	25.50
Thiobencarb 6+25 DAS	5.83	17.67	56.73	27.06
Thiobencarb 9+25 DAS	4.63	16.55	49.24	26.50
Hand weeded control	7.76	17.76	59.80	27.56
Unweeded control	4.26	13.86	31.20	25.90
SEm±	0.70	0.67	5.28	1.31
CD (0.05)	2.03	1.93	15.20	NS

Table 5. Effect of time of application of butachlor and thiobencarb on nutrient uptake by crop and weeds (kg/ha)

Treatments	Weeds 60 DAS			Crop 60 DAS			Crop Harvest		
	N	P	K	N	P	K	N	P	K
Butachlor 0 DAS	48.13	6.58	73.46	37.86	5.86	60.58	72.47	10.24	105.08
Butachlor 3 DAS	35.88	4.42	57.72	67.33	8.75	79.78	77.56	10.87	106.13
Butachlor 6 DAS	76.30	7.83	106.53	59.86	7.77	89.62	77.48	10.56	100.10
Butachlor 9 DAS	96.60	10.92	123.90	38.16	5.51	60.42	50.48	6.86	70.92
Butachlor 0+25 DAS	16.08	2.79	24.97	78.21	8.65	83.80	93.91	15.90	140.82
Butachlor 3+25 DAS	31.36	6.26	69.44	43.41	6.11	59.20	69.50	12.14	96.78
Butachlor 6+25 DAS	51.89	10.37	127.88	44.26	7.19	71.93	65.24	9.17	95.49
Butachlor 9+25 DAS	128.66	11.82	154.41	26.80	3.48	46.90	32.92	5.71	56.35
Thiobencarb 0 DAS	40.40	5.65	75.75	65.73	8.54	108.46	66.90	10.58	99.78
Thiobencarb 3 DAS	26.47	3.62	43.89	59.52	9.66	92.02	70.74	14.05	123.90
Thiobencarb 6 DAS	47.97	5.31	59.96	35.09	7.76	75.20	54.48	8.16	77.06
Thiobencarb 9 DAS	58.14	9.48	97.92	36.94	5.64	65.20	43.77	7.55	68.55
Thiobencarb 0+25 DAS	13.33	1.06	20.26	70.13	9.81	119.22	108.26	15.68	139.14
Thiobencarb 3+25 DAS	15.49	1.45	25.45	50.13	8.76	106.53	88.76	14.43	118.74
Thiobencarb 6+25 DAS	12.50	1.25	12.06	71.86	10.12	98.01	103.32	14.24	132.72
Thiobencarb 9+25 DAS	36.40	5.71	52.00	37.65	5.40	65.89	42.15	7.86	80.21
Hand weed control	3.06	0.30	3.53	66.54	6.65	95.48	160.42	26.42	198.03
Unweeded control	69.28	5.77	60.62	32.88	4.74	47.49	24.20	4.86	49.98
SEm±	10.63	1.40	16.01	13.43	1.84	22.37	7.89	1.32	13.40
CD (0.05)	30.56	4.03	46.00	NS	NS	NS	22.67	3.80	38.53

Table 2. Effect of treatments on the drymatter production by weeds (g/m^2)

Treatments	30 days		60 days		90 days		Harvest	
	T	O	T	O	T	O	T	O
Butachlor 0 DAS	5.74	29.95	14.85	220.73	27.85	775.95	21.50	462.38
Butachlor 3 DAS	3.87	14.87	12.17	148.14	23.18	537.72	21.66	469.14
Butachlor 6 DAS	7.47	55.80	17.56	308.44	22.84	522.05	22.55	508.71
Butachlor 9 DAS	5.95	35.40	20.13	405.30	24.06	579.11	24.52	601.59
Butachlor 0+25 DAS	4.16	17.35	9.15	83.85	17.09	292.39	21.75	473.12
Butachlor 3+25 DAS	4.15	17.28	14.14	199.97	21.67	469.70	22.21	493.63
Butachlor 6+25 DAS	7.61	57.99	18.28	354.48	26.37	695.42	17.72	314.07
Butachlor 9+25 DAS	7.52	56.55	22.54	508.14	26.39	696.46	18.61	346.55
Thiobencarb 0 DAS	4.33	18.82	13.64	186.04	25.72	661.53	21.43	459.58
Thiobencarb 3 DAS	3.34	11.18	11.32	128.17	22.28	496.68	26.65	710.44
Thiobencarb 6 DAS	5.17	26.82	12.65	160.23	24.27	589.25	22.47	505.06
Thiobencarb 9 DAS	7.22	52.24	17.40	302.95	26.60	707.96	18.64	347.77
Thiobencarb 0+25 DAS	2.08	4.33	7.19	51.77	12.62	159.36	16.35	267.38
Thiobencarb 3+25 DAS	2.76	7.64	6.80	46.29	13.36	178.57	20.10	404.01
Thiobencarb 6+25 DAS	3.87	15.02	6.41	41.16	10.96	120.16	23.44	549.54
Thiobencarb 9+25 DAS	5.73	32.90	12.91	166.71	22.64	512.91	20.31	412.64
Hand weeded control	2.42	5.88	3.50	12.27	2.74	7.54	9.10	82.90
Unweeded	10.00	100.18	16.84	283.88	28.14	792.24	22.86	522.68
SEm ±	1.03		1.62		1.79		2.52	
CD (0.05)	2.98		4.68		5.16		7.26	

T = $\sqrt{x}$ transformed value   0 = original value bicides treatments. This might be because of the better growth and drymatter production of crop due to the absence of competition from weeds during the critical stages of crop-weed competition for the major nutrients.

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