

Feasibility of Reducing Herbicide Dose in Combination with Sorgaab for Weed Control in Transplanted Fine Rice (*Oryza sativa* L.)

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ABSTRACT

A field trial was conducted to investigate the possibilities of reducing herbicide dose in combination with sorgaab for weed control in transplanted fine rice. Pre-emergence herbicides as ethoxysulfuron (Sunstar, 15 WG) and butachlor (Machete, 60 EC) at reduced rates viz 15, 10 g a.i.ha⁻¹ and viz 600, 400 g a.i.ha⁻¹ were tank mixed with sorgaab @ 12 L ha⁻¹. The recommended rate of these herbicides i.e. 25 and 30 g a.i.ha⁻¹ and 1150 and 1200 g a.i.ha⁻¹ respectively were included as standard treatments and a weedy check was maintained as a control treatment. Results of the study reveal that combination of sorgaab @ 12 L ha⁻¹ with reduced doses (1/3-1/2) of recommended doses of pre-emergence herbicides i.e. ethoxysulfuron (Sunstar, 15 WG) and butachlor (Machete, 60 EC) @ 10, 15 g a.i.ha⁻¹ and 400, 600 g a.i.ha⁻¹, respectively showed maximum reduction in total weed dry weight (76.1-77%) at 45 DAT. The increase in paddy yield with treatment combination of sorgaab @ 12 L ha⁻¹ and butachlor (Machete, 60 EC) @ 600 g a.i.ha⁻¹ was maximum (12.57%) and it was only the economical treatment.

Key Words: Allelopathy; Sorgaab; Reduced herbicide dose; Weed control; *Oryza sativa*

INTRODUCTION

Uncontrolled weeds reduce the paddy yield by 11% (Majeed & Afzal, 1985). Following a scientific rotation and maintaining 3-4 cm thick continuous layer of water in the field for early 40 days after transplanting may be affectively manipulated for controlling most rice weeds. But unfortunately majority of the farmers do not properly utilize these cultural approaches. Recently they have started the use of herbicides in rice. Although herbicides provide effective weed control, yet the herbicides pose serious health and environment threats (Dhaliwal *et al.*, 1996). This situation demands efforts for minimizing the herbicide usage by developing new techniques. Allelopathic substances combined with lower rates of herbicides may be a step ahead in this direction. Recent studies by Cheema and his associates on wheat, cotton, maize and mungbean (Cheema *et al.*, 2002; Cheema *et al.*, 2003a,b,c) reveal that the dose of respective herbicides for these crops can be reduced by (50-70%) in combination with sorgaab (Sorghum water extract). As no such study has been conducted in rice previously, therefore present studies were carried out to determine a suitable dose of two pre-emergence herbicides in combination with sorgaab for weed control in transplanted fine rice under Faisalabad conditions.

MATERIALS AND METHODS

The possibilities of combining sorgaab with lower doses of two rice pre-emergence herbicides were

investigated in a field trial during kharif (summer) 2003. The experiment was laid out in randomized complete block design (RCBD) with four replications in 5X1.8 m plots. Fine rice variety Basmati-385 was used as test crop. Sorgaab was prepared by following the procedure devised by Cheema and Khaliq (2000). Reduced rates of pre-emergence herbicides as ethoxysulfuron (Sunstar, 15 WG) at 10 and 15 g a.i.ha⁻¹ and butachlor (Machete, 60 EC) at 400 and 600 g a.i.ha⁻¹ were combined with concentrated sorgaab @ 12 L ha⁻¹. Recommended doses of both pre-emergence herbicides were also sprayed as standard treatments and a weedy check was maintained as control plot. Volume of the spray was 350 L ha⁻¹ and spraying was done with knapsack hand sprayer fitted with flat fan nozzle. Data on weed density; fresh and dry weights were recorded at 45 DAT from randomly selected two quadrates (0.5m²) from each experimental plot. Weeds were cut from ground surface, dried at room temperature in the lab and then dried in an oven at 80°C for 48 h. Weed flora of experimental site consisted of purple nutsedge (*Cyperus rotundus*), wild rice (*Echinochloa colonum*) and barnyard grass (*Echinochloa crus-galli*). Data on rice growth and yield parameters were recorded from randomly selected samples. Data collected were subjected to Fisher's analysis of variance technique and treatment means were compared using least significant difference test (LSD) at 0.05 probability level (Steel & Torrie, 1984). Economic analysis was performed by using the method devised by Byerlee (1988) to determine the comparative net benefits and marginal rate of return.

RESULTS AND DISCUSSION

In the experimental area, main weeds were purple nutsedge, wild rice and few plants of barnyard grass were also present. All the treatments significantly inhibited the density and dry weight of weeds (Table I). Combination of sorgaab @ 12L ha⁻¹ with (1/3-1/2) doses of ethoxysulfuron (Sunstar, 15 WG) @ 10, 15 g a.i ha⁻¹ sprayed as pre-emergence suppressed total weed density by 73.18 - 74.32% and dry weight by 76.94 to 77%. Ethoxysulfuron (Sunstar, 15 WG) alone @ 25 and 30 g a.i ha⁻¹ reduced total weed density and dry weight in the range of 66.29 to 73.95% and 69.23 to 85.71%.

Butachlor (Machete, 60 EC) @ 400 and 600 g a.i ha⁻¹ combined with sorgaab @ 12 L ha⁻¹ reduced total weed density by 58.99 to 62.83% and dry weight by 67.93 to 76.71%, respectively while higher doses of butachlor (Machete, 60 EC) @ 1150 and 1200 g a.i ha⁻¹ (recommended dose) reduced total weed density by 46.77 to 59.20% and dry weight by 63.91 to 66.18% as compared with control, recorded at 45 days after transplanting (DAT).

Paddy yield was significantly increased in all the weed control treatments as compared to control (Table II). Highest paddy yield (12.57%) was obtained in case of

combination of sorgaab @ 12 L ha⁻¹ + ½ dose of butachlor (Machete, 60 EC) @ 600 g a.i ha⁻¹, followed by ethoxysulfuron (Sunstar, 15 WG) alone @ 25 g a.i ha⁻¹ with 12.19% over control. Results of study strongly supported the hypothesis of reducing the herbicide dose in combination with natural allelopathic water extracts as sorgaab.

The increase in paddy yield may be attributed to regulation of plant height at maturity, number of fertile tillers m⁻², number of grains per panicle, 1000-kernels weight (g) (Table II).

The effectiveness of any production practice is ultimately evaluated on the basis of its economics. Economic and marginal analysis (Table III & IV) showed that treatment combination i.e Sorgaab @ 12 L ha⁻¹ combined with ½ butachlor (Machete, 60 EC), dose @ 600 g a.i ha⁻¹ was the most economical with highest net returns of Rs. 52712.5 and 1882.47% marginal rate of return.

The treatment combination of sorgaab @ 12 L ha⁻¹ with 1/3 butachlor (Machete, 60 EC) dose @ 400g a.i. ha⁻¹ also appeared economical treatment giving 921.29% marginal rate of return, while all other treatments were dominated due to higher cost that vary and hence were uneconomical. The findings of this study suggest that

Table I. Effect of Sorgaab in combination with pre-emergence herbicides on density and dry weight of weeds

Treatments	Purple nutsedge		Wild rice		Total weeds	
	Density	Dry weight (g)	Density	Dry weight (g)	Density	Dry weight (g)
T ₁ = Weedy check (control)	23.38a	23.18a	9.25a	10.65a	32.63a (—)	33.83a(—)
T ₂ = Ethoxysulfuron (Sunstar 15 WG) @ 25 g a.i ha ⁻¹	5f	4.96g	3.50bc	5.45b	8.50d (73.95%)	10.41e (69.23%)
T ₃ = Ethoxysulfuron (Sunstar 15 WG) @ 30 g a.i ha ⁻¹	9cd	8.17c	2.00cd	3.44e	11.00cd (66.29%)	11.60c (65.71%)
T ₄ = Butachlor (Machete 60 EC) @ 1150 g a.i ha ⁻¹	10.13c	7.89c	3.06bc	3.55d	13.31c (59.20%)	11.44c (66.18%)
T ₅ = Butachlor (Machete 60 EC) @ 1200 g a.i ha ⁻¹	14b	9.59b	3.37bc	2.62f	17.37b (46.77%)	12.21b (63.91%)
T ₆ = Sorgaab conc. @ 12 L ha ⁻¹ + Ethoxysulfuron (Sunstar 15 WG) @ 10 g a.i ha ⁻¹	7.50de	5.24fg	0.87d	2.54g	8.38d (74.32%)	7.78f (77.00%)
T ₇ = Sorgaab conc. @ 12 L ha ⁻¹ + Ethoxysulfuron (Sunstar 15 WG) @ 15 g a.i ha ⁻¹	6.75ef	5.59ef	2.00cd	2.21h	8.75d (73.18%)	7.80f (76.94%)
T ₈ = Sorgaab conc. @ 12 L ha ⁻¹ + Butachlor (Machete 60 EC) @ 400 g a.i ha ⁻¹	9.30cd	5.92e	4.00b	1.96i	13.38c (58.99%)	7.88f (76.71%)
T ₉ = Sorgaab conc. @ 12 L ha ⁻¹ + Butachlor (Machete 60 EC) @ 600 g a.i ha ⁻¹	8.88cd	7.06d	3.25dc	3.79c	12.13c (62.83%)	10.85d (67.93%)
LSD value	2.025	0.3575	1.61	0.07993	2.685	0.3484

1 Any two means not sharing a letter in common differ significantly at 5% level of probability

2 figures given in parenthesis show % decrease over control

Table II. Effect of Sorgaab in combination with pre-emergence herbicides on yield and yield components of rice

Treatments	Plant Height (cm)	Productive tillers (m ⁻²)	Number grains/panicle	of 1000-Kernel wt (g)	Paddy (Mg/ha)	yield % increase over control
T1	146.9d	229.60h	161.32f	18.92e	5.25d	(—)
T2	146.9d	228.80c	183.67b	21.12b	5.89ab	12.19
T3	150.1b	332.40a	178.60c	21.67a	5.76c	9.71
T4	146.5d	242.85g	167.43e	20.96bc	5.76c	9.71
T5	152.4a	264.00e	172.08d	20.58c	5.77c	9.90
T6	151.7a	268.40d	181.65bc	20.69bc	5.31d	1.14
T7	150.6b	260.80f	173.52d	18.94e	5.79bc	10.29
T8	146.6d	268.80d	185.09ab	20.10d	5.70c	8.57
T9	149c	293.20b	187.50a	20.66c	5.91a	12.57
LSD (5%)	0.7179	2.777	3.765	0.4354	0.1032	

Any two means not sharing a letter in common differ significantly at 5% level of probability.

Table III. Economic analysis of different weed control methods in Rice

	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	Remarks
Paddy yield	5.25	5.89	5.76	5.76	5.77	5.31	5.79	5.70	5.91	t ha ⁻¹
Adjusted yield	4.73	5.30	5.18	5.18	5.19	4.78	5.21	5.13	5.32	To bring at farmers level (10 % less)
Gross income	47300	53000	51800	51800	51900	47800	52100	51300	53200	Rs. 400/40 kg
Cost of herbicide		681.22	817.5	551.03	575	272.5	408.75	191.66	287.5	Rs. 230/800 mL Machete and Rs. 327/80 g Sunstar
Cost of sorgaab	-	-	-	-	-	50	50	50	50	Expenditure on preparation of 12 L sorgaab Rs. 50
Spray appl. cost	-	100	100	100	100	100	100	100	100	Rs. 100/man (1 man/day/ha)
Sprayer rent	-	50	50	50	50	50	50	50	50	Rs. 50/spray
Cost that vary		831.22	867.5	721.03	725	472.5	680.75	391.66	487.5	Rs./ha
Net benefit	47300	52168.7	50932.5	51078.	51175	47327.5	51491.2	50908.34	52712.5	Rs./ha

T₁ = Weedy check (control), T₂ = Ethoxysulfuron (Sunstar 15 WG) @ 25 g a.i ha⁻¹, T₃ = Ethoxysulfuron (Sunstar 15 WG) @ 30 g a.i ha⁻¹

T₄ = Butachlor (Machete 60 EC) @ 1150 g a.i ha⁻¹, T₅ = Butachlor (Machete 60 EC) @ 1200 g a.i ha⁻¹

T₆ = Sorgaab conc. @12 L ha⁻¹ + Ethoxysulfuron (Sunstar 15 WG) @ 10 g a.i ha⁻¹ T₇ = Sorgaab conc. @12 L ha⁻¹ + Ethoxysulfuron (Sunstar 15 WG) @ 15 g a.i ha⁻¹, T₈ = Sorgaab conc. @12 L ha⁻¹ + Butachlor (Machete 60 EC) @ 400 g a.i ha⁻¹, T₉ = Sorgaab conc. @12 L ha⁻¹ + Butachlor (Machete 60 EC) @ 600 g a.i ha⁻¹

Table IV. Dominance and marginal analysis of different weed control methods in Rice

Treatments	Cost that vary Rs/ ha	Net benefit Rs/ ha	Marginal rate of return %
T ₁ = Weedy check (control)	0	47300	0
T ₉ = Sorgaab conc. @12 L ha ⁻¹ + Butachlor (Machete 60 EC) @ 400 g a.i ha ⁻¹	391.66	50908.34	921.29
T ₆ = Sorgaab conc. @12 L ha ⁻¹ + Ethoxysulfuron (Sunstar 15 WG) @ 10 g a.i ha ⁻¹	472.5	47327.5	D
T ₉ = Sorgaab conc. @12 L ha ⁻¹ + Butachlor (Machete 60 EC) @ 600 g a.i ha ⁻¹	487.5	52712.5	1882.47
T ₇ = Sorgaab conc. @12 L ha ⁻¹ + Ethoxysulfuron (Sunstar 15 WG) @ 15 g a.i ha ⁻¹	608.75	51491.25	D
T ₄ = Butachlor (Machete 60 EC) @ 1150 g a.i ha ⁻¹	721.03	51078.97	D
T ₅ = Butachlor (Machete 60 EC) @ 1200 g a.i ha ⁻¹	725	51175	D
T ₂ = Ethoxysulfuron (Sunstar 15 WG) @ 25 g a.i ha ⁻¹	831.22	52168.78	D
T ₃ = Ethoxysulfuron (Sunstar 15 WG) @ 30 g a.i ha ⁻¹	867.5	50932.5	D
LSD value			

$$\text{MRR\%} = \frac{\text{Change in net benefit}}{\text{Change in cost}} \times 100$$

herbicide dose may be reduced by 50-67% in combination with allelopathic water extract (sorgaab, @ 12 L ha⁻¹). Further, it may be worthwhile to continue investigation with different crop water extract.

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