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Effect of herbicides and their combination on weed dynamics in rice-based cropping system

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ABSTRACT

A field experiment was conducted at Zonal Agricultural Research Station, Mandya, Karnataka to study the shift in weed flora of different weed species due to application of pre-sowing, pre-emergence and post-emergence application of herbicides in comparisons with hand weeding and mechanical weeding. The effect of combination of herbicide bensulfuron-methyl + pretilachlor as well as mono-herbicide butachlor and their post-planting application were evaluated for their bio-efficacy either alone or combination with pre-planting application of non-selective glyphosate application. The treatment comprised of eight different weed management practices were laid out in randomised complete block design with three replications. The results revealed that application of glyphosate (15 days before transplanting of rice 0.75 kg/ha) in combination with bensulfuron methyl + pretilachlor applied at 5 DAT recorded higher grain yield of 7.02 t/ha and found significantly superior over other treatments due to reduced weed population and biomass of weeds (10.30 g/m^2) and higher weed control efficiency (64.97%) when compared with weedy check. There was more than 36% reduction in the grain yield of rice due to competition with weeds in weedy plots. The rice yield and weed control efficiency of herbicide combination was at par with recommended practice of hand weeding twice at 20 and 40 DAT. Sequential herbicide application is promising and effective in control of weeds as compared to single herbicide application in rice-based cropping system.

Key words: Chemical control, Cropping system, Herbicide combination, Rice, Weed dynamics

Rice is the most important staple food, accounting for 43% of the total food grain in the country. In Karnataka, rice is grown in an area of 15 lakhs ha with the total production of 55.72 lakh tons and average productivity 4.06 t/ha. Weed infestation in transplanted rice is a critical factor that reduced the yield to the extent of 15-45% (Chopra and Chopra 2003). In transplanted rice *Echinochloa* species, *Cyperus* species, *Commelina* spp, *Fimbristylis miliacea* are dominant weeds. Weeds not only compete with rice at nursery for growth factors but morphological similarities they got transplanted in the field along with rice seedlings. This crop-weed competition leads to significant yield losses to the tune of 35-55% in transplanted rice (Gautam and Mishra 1995, Purushamam 1996). Recent estimates showed that average reduction in yield due to weeds varied from 12 to 72% depending upon weed flora and the extent of competition offered by weeds to the crop. Manual removal of weeds is labour intensive, tedious, back-breaking and does not ensure weed removal at critical stage of crop-weed competition. Rice-rice is the major cropping system in Southern Karnataka wherein long duration varieties of rice adopted by the farmers give less time for field preparation between rice harvest during summer and sowing in rainy season resulting in more weed infestation. Existing pre-emergence herbicides are less effective against weeds like *Echinochloa* spp., *Panicumrepens* spp., *Cyperus* spp. *etc*. Hence, the present investigation was under taken to study the effect of combination of herbicide and their bio-efficacy either alone or combination with pre-planting application of non-selective glyphosate in rice rice based cropping system.

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MATERIALS AND METHODS

The field experiment was conducted at Zonal Agricultural Research Station, V.C. Farm, Mandya, University of Agricultural Sciences, Bengaluru, Karnataka, during rainy season of 2009 and 2010. The soil of the experimental field was red sandy loam in texture, acidic in reaction (pH: 6.68), medium in available N (273 kg/ha), P (20.5 kg/ha), and available K (178 kg/ha) and low in organic carbon content (0.45%). The experiment consisted of eight treatments was laid out in randomized complete block design with three replications. The treatments were as follows: glyphosate (0.75 kg/ha) applied at 15 days before transplanting of rice, butachlor (1.5 kg/ha) applied at 0-5 days after transplanting (DAT), bensulfuron-methyl + pretilachlor

(0.06 + 0.6 kg/ha) applied at 5 DAT, glyphosate (0.75 kg/ha) applied at 15 days before transplanting of rice + butachlor (1.5 kg/ha) applied at 0-5 DAT, glyphosate (0.75 kg/ha) applied at 15 days before crop establishment + bensulfuron-methyl + pretilachlor (0.06 + 0.6 kg/ha) applied at 5 DAT, hand weeded twice (20 and 40 DAT), use of cono-weeder and, non-weeded control. Agronomic practices were followed for raising crop. The rice variety '*BR-2655*' was used in the study. Treatment herbicide combination was applied using knapsack sprayer with a spray volume of 500 l/ha. Hand weeding was done manually, hand and mechanical weeding was done by cono-weeder. Hand weeding with hoe and mechanical weeding with cono-weeder was used in the respective treatments. Recommended dose of 100 kg N, 50 kg P_2O_5, 50 kg K_2O and 20 kg $ZnSo_4$ was given in the form of urea, SSP, MOP and $ZnSo_4$. At the time of transplanting, 50% N and K, full dose of P was applied as basal dose and remaining 50% N was supplemented as top dressing at 30 and 60 DAT and 50% K was applied at the time of panicle initiation. Weed counts were recorded at 30, 60 and 90 DAT with the help of quadrate of $1m^2$ in each plot. Weed biomass (g/m^2) and weed control efficiency (%) were calculated as per the standard formulae given by Patel *et al.*(1987) and Gill and Vijay Kumar 1969. The data of yield, yield attributes were statistically analyzed at 5% level of significance.

RESULTS AND DISCUSSION

Weed flora

The dominating weed flora observed in the experimental field were *Cyperus difformis, Cyperus iria, Fimbristylis woodrowii, Echinochloa crusgalli, Cynodon dactylon, Rotala densiflora* and *Eclipta alba* among the broad-leaved weeds and *Cyperus* spp. among sedges.

Effect on weed biomass

The results indicated that among the different weed management practices, the application of glyphosate (15 days before transplanting of rice 0.75 kg/ha) in combination with bensulfuron-methyl (0.6% G) + pretilachlor (6.0% G) (0.06 + 0.6 kg/ha) applied at 5 DAT recorded lower biomass of weed (29.43 g), followed by the use of cono-weeding at 20 and 40 DAT (32.93 g) and found significantly superior over other treatments. The non-weeded control plot recorded maximum biomass of weed (85.46 g/m^2).

Weed control efficiency

The efficacy of herbicides on the basis of weed biomass indicated that application of glyphosate (15 days before transplanting of rice 0.75 kg/ha) in combination with bensulfuron methyl (0.6% G) + pretilachlor (6.0% G) applied at 5 DAT was most effective with a weed control efficiency of 65.0% followed by use of cono weeding at 20 and 40 DAT (60.5%) and rice field treated with butachlor 50 EC 1.5 kg/ha applied at 5 DAT was least effective 40.4%.

Yield and yield attributes

Among the different weed management practices, the pooled data of two years indicated that the application of glyphosate (15 days before transplanting of rice 0.75 kg/ha) in combination with bensulfuron-methyl + pretilachlor applied at 5 DAT recorded significantly higher grain yield of 7.02 t/ha, *fb* bensulfuron-methyl + pretilachlor applied at 5 DAT (6.73 t/ha)

Table1. Weed biomass and weed control efficiency as influenced by different weed management practices in transplanted rice

Treatment	Dosage	Time of application (DAT)	Weed biomass (g/m^2) at 60 DAT	Weed control efficiency (%) at 60 DAT	Panicle number/m^2			Panicle weight (g)		
					2009	2010	Mean	2009	2010	Mean
Glyphosate	0.75 kg/ha	15 days before crop establishment	16.97	36.03	371	293	332	2.62	2.77	2.70
Butachlor	1.5 kg/ha	5 DAT	19.43	26.76	378	315	347	2.57	2.60	2.59
Bensulfuron-methyl + pretilachlor	0.06 + 0.60 kg/ha	5 DAT	13.2	50.25	395	326	361	3.00	2.90	2.95
Glyphosate + butachlor	0.75 kg/ha + 1.5 kg/ha	15 days before crop establishment + 5 DAT	13.53	49.00	388	380	384	2.84	2.77	2.81
Glyphosate + bensulfuron-methyl + pretilachlor	0.75 kg/ha + 0.06 + 0.60 kg/ha	5 DAT	10.3	61.18	415	396	406	2.89	3.33	3.11
Hand weeded twice		20 & 40 DAT	11.97	54.88	395	313	354	2.78	2.67	2.73
Use of cono weeder		20 & 40 DAT	11.67	56.01	380	384	382	2.60	3.00	2.80
Non weeded control	-	-	26.53		310	265	288	2.32	2.37	2.35
LSD (P=0.05)			5.96		15.27	21.19	18.23	0.22	0.27	0.25

Table 2. Effect of weed management practices on the yield and yield attributing characters in transplanted rice

Treatment	Dosage	Time of application (DAT)	Grain yield (t/ha)			Total cost of cultivation (x10^3 `/ha)	Gross returns (x10^3 `/ha)	Net returns (x10^3 `/ha)	B:C
			2009	2010	Mean				
Glyphosate	0.75 kg/ha	15 days before crop establishment	6.04	5.95	5.99	32.65	85.93	53.28	1.63
Butachlor	1.5 kg/ha	5 DAT	6.26	6.32	6.29	33.64	89.73	56.08	1.60
Bensulfuron-methyl + pretilachlor	0.06 + 0.60 kg/ha	5 DAT	6.66	6.80	6.73	34.60	96.33	61.72	1.78
Glyphosate + butachlor	0.75 kg/ha + 1.5 kg/ha	15 days before crop establishment+5 DAT	6.51	6.60	6.55	33.86	93.60	59.74	1.76
Glyphosate + bensulfuron-methyl + pretilachlor	0.75 kg/ha + 0.06 + 0.60 kg/ha	5 DAT	6.88	7.15	7.02	34.90	100.110	65.21	1.87
Hand weeded twice		20 & 40 DAT	6.64	6.40	6.52	35.60	93.17	57.57	1.67
Use of cono weeder		20 & 40 DAT	6.24	6.94	6.59	34.40	93.84	59.44	1.73
Non weeded control	-	-	4.48	4.51	4.50	32.50	63.66	31.16	0.95
LSD (P=0.05)			0.29	0.33	0.31				

(Table 2). The lowest rice yield was observed with non-weeded control (4.50 t/ha). Higher yield might be due to more number of panicle/m^2 (406) and higher panicle weight (3.11g) compared to non-weedy control (panicle number–288/m^2 and panicle weight - 2.35 g, respectively). All the herbicides treatment showed significantly higher grain yield over the un weeded check. This was due to the fact that the less competition for moisture, light and nutrient uptake by the crop plants. The higher assimilation of photosynthesis in weedicides treated plots may be the reason for higher yield. The result was in close conformity with those of Singh *et al.* (2003), Singh *et al.* (2006), Singh *et al.* (2007).

Economics

Weed management practices in the study showed variation in gross returns, net returns and B: C ratio. Among the different weed management practices, the pooled data of two years indicated that the application of glyphosate (15 days before transplanting of rice 0.75 kg/ha) in combination with bensulfuron-methyl + pretilachlor applied at 5 DAT recorded higher net returns (` 65,210/ha) and B: C ratio (1.87 ), followed by bensulfuron-methyl + pretilachlor applied at 5 DAT (` 61,729/ha and 1.78, respectively). The lower net returns and B: C ratio (` 31,161 and 0.95, respectively) were recorded with non-weeded control. Thus it is inferred that sequential herbicide application is promising and effective to control weeds as comparision to single herbicide application in rice-based cropping system.

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