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Efficacy of weed management practices in transplanted rice under southern dry zone of Karnataka

G.N. Dhanapal*, S. Kamala Bai, M.T. Sanjay, P. Nagarjun and A. Sandeep

University of Agricultural Sciences (B), MRS, Hebbal, Bengaluru, Karnataka 560 024

Email: dhanapalgn@yahoo.com

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ABSTRACT

A field experiment was conducted during *Kharif* 2016 and 2017 at Zonal Agriculture Research Station, V.C. Farm, Mandya (Southern dry Zone, Karnataka) to study the efficacy of various weed management practices on weeds in transplanted rice. The experiment consists of ten treatments replicated thrice in a randomized complete block design. Among the various treatments, significantly the lowest weed density (18.3-22.0 no./m^2) and weed biomass (5.4-6.3 g/m^2) was noticed with hand weeding at 25 and 45 DAS, which was at par with pre-emergence application (PE) of bensulfuron-methyl + pretilachlor *fb* triafamone + ethoxysulfuron applied at 30 days after transplanting (DAT). Weed management with bensulfuron-methyl + pretilachlor (60 + 600 g/ha) PE *fb* triafamone + ethoxysulfuron (60 g/ha) applied at 25 DAT recorded significantly higher paddy grain and straw yields and higher economic returns.

Rice (*Oryza sativa* L.) is one of the most important global food grain crop. In India rice is contributing 45% to the total food grain production and is grown in an area of 44.1 million ha with a production of 106.64 million tonnes and productivity of 2.42 t/ha (Bhatt *et al*. 2017). Rice suffers from various biotic and abiotic production constraints among which weed competition is one of the major yield limiting biotic constraint. The reduction in paddy yield due to weed competition ranges from 9-51% (Mani *et al*. 1986). With the advent of capital intensive technology like dwarf high yielding varieties tailored to respond to external inputs like fertilizers, irrigation and new intensive cropping systems also aggregated the problem of weeds (Yaduraju and Mishra 2002). The direct and most important effect of weeds is the reduction in crop yields due to competition for water nutrients and sunlight, with impaired quality of grains while causing some nuisance at the time of harvest (Rao *et al*. 2007).

The productivity of transplanted rice to a greater extent depends on adequate and efficient weed management. Transplanted rice faces diverse type of weed flora, consisting of grasses, broad-leaved weeds and sedges. They usually grow faster than rice and absorb available water, nutrient earlier than the rice and suppress rice growth. Effective control of weeds had increased the grain yield by 85.5% (Mukherjee and Singh 2005). Herbicide use offers best alternative method for selective and economical control of weeds right from the beginning, giving crop an advantage of good start and competitive superiority. However, no single herbicide is effective for broad-spectrum weed control in transplanted rice. Combination products consisting of two or more herbicides having greater activity on diverse weed flora due to differential mode of action and have become popular in recent years. With this background, the present investigation was undertaken to quantify the bio-efficacy of combination of herbicides against complex weed flora and yield of transplanted rice.

The field experiment was conducted during *Kharif* 2015 and 2016 at Zonal Agricultural Research Station, V.C. Farm, Mandya to quantify the bio-efficacy of combination of herbicides against complex weed flora, and yield of transplanted rice. The soil type was sandy loam soil. The treatment combinations tested were, bensulfuron methyl + pretilachlor (60 + 600 g/ha) pre-emergence application (PE) at 0-3 days after transplanting (DAT) *fb* passing of cono weeder at 25 DAT, oxadiargyl (100 g/ha) PE at 0-3 DAT *fb* passing of cono weeder at 25 DAT, bispyribac-Na (20 g/ha) post-emergence application (PoE) at 15-20 DAT followed by *(fb)* passing of cono weeder at 35-40 DAT, triafamone +

ethoxysulfuron (60 g/ha) PoE at 15-20 DAT *fb* passing of cono weeder at 35-40 DAT, bensulfuron-methyl + pretilachlor (60+600 g/ha) PE *fb* bispyribac-Na (20 g/ha) PoE at 25-30 DAT, oxadiargyl (100 g/ha) PE *fb* bispyribac-Na (20 g/ha) PoE at 25-30 DAT, bensulfuron-methyl + pretilachlor (60 + 600 g/ha) PE DAT *fb* triafamone + ethoxysulfuron (60 g/ha) at 25-30 DAT, oxadiargyl (100 g/ha) at 0-3 DAT *fb* triafamone + ethoxysulfuron (60 g/ha) at 25-30 DAT, hand weeding 25 and 25 DAT and weedy check. These treatment combinations were replicated thrice in randomized complete block design (RCBD).

Rice variety '*Rasi*' was transplanted at a spacing of 30 × 10 cm and fertilizer level of 125 kg N, 62.5 kg P_2O_5 and 62.5 kg K_2O/ha. The gross and net plot sizes were 4.0 × 3.0 m and 3.2 × 3.5 m, respectively. The species wise weed density data was collected using a quadrate (50 × 50 cm) on 60 DAT (days after transplanting). Data averaged over three replications and two spots per replication. From this, density of major weed species/m^2 (sedges, grass and broad-leaf weeds) was worked out (**Table 1**). The density of weeds' category - sedge, grass and broad-leaf weeds on 60 DAT were worked out (**Table 2**). In addition, biomass of weeds' category–sedges, grass and broad-leaf weeds (g/m^2) were also collected at 60 DAT (**Table 1**). The data on weeds' density and biomass were analyzed using transformation of square root of $(\sqrt{x+1})$ and log $(\sqrt{x+2})$, depending on the variability. The data on rice grain and straw yield was collected after the rice harvest. The economics of weed management practices was worked out. The data collected on different traits was statistically analyzed using the standard procedure and the results were tested at five per cent level of significance as given by Gomez and Gomez (1984).

Weed flora

The extent of growth and yield loss caused by weeds depends on weed species and their density in a crop community. Major weed flora observed in the experimental plots were; *Cyperus difformis, Cyperus iria* (among sedges), *Panicum repens, Paspalum distichum* and *Echinochloa colona* (among grasses), *Alternenthera sessilis, Monochoria vaginallis, Marselia quadrifoliata, Ludwigia parviflora* (among broad-leaf weeds).

Weed density and biomass

Among different category of weeds, density and biomass of broad-leaf weeds (40.02%) was higher followed by sedges (37.45%) and grasses (22.39%) at 60 DAT in both 2016 and 2017 (**Table 1**). Among the various treatments significantly the lowest weed density (22.0 and 18.3 in 2016 and 2017, respectively) and biomass (6.3 g/m^2 in 2016 and 5.4 g/m^2 in 2017, respectively) was noticed with hand weeding at 25 and 45 DAT similar results are observed by Singh *et al.* (2006). However, it was at par with application of bensulfuron-methyl + pretilachlor (60 + 600 g/ha) PE *fb* triafamone + ethoxysulfuron (60 g/ha) PoE and oxadiargyl (100 g/ha) PE *fb* triafamone + ethoxysulfuron (60/ha) PoE at 30 DAT. Other herbicidal combinations like bensulfuron-methyl + pretilachlor (60 + 600 g/ha) PE *fb* bispyribac-Na (20 g/ha) PoE at 30 DAT and oxadiargyl (100 g/ha) PE *fb* bispyribac-Na (20 g/ha) PoE at 30 DAT were also found effective in suppressing the weeds effectively in both the years, indicating the necessity of combination of herbicides to manage complex weed flora in transplanted rice. The higher broad spectrum weed control was observed with sequential application of PE herbicide and PoE herbicides or manual weeding which is in conformity with Parthipan and Ravi (2014) and Bhatt *et al.* (2017).

There was a considerable reduction in weed emergence at the initial crop growth stage with adopted weed management treatments. Rice established vigorously in these treatments due to effective control of weeds with either manually or chemically. The initially vigorous crop stand provided spatial advantage to crop in suppressing the weeds below threshold level even at later stages.

Rice grain yield

Among the various weed management treatments, bensulfuron-methyl 60 g/ha + pretilachlor 600 g/ha PE *fb* triafamone + ethoxysulfuron 60 g/ha PoE 25 DAT recorded significantly higher rice grain yield (5.35 t/ha) and straw yield (7.66 t/ha) followed by hand weeding at 25 and 45 DAT (4.80 and 6.96 t/ha, respectively) in 2016 (**Table 2**). Whereas in 2017 hand weeding at 25 and 45 DAT recorded the highest grain and straw yields (5.95 and 6.95 t/ha, respectively) and statistically found at par with bensulfuron-methyl 60 g/ha + pretilachlor 600 g/ha PE *fb* triafamone + ethoxysulfuron 60 g/ha post-emergence (PoE) at 25 DAT (5.84 and 6.56 t/ha, respectively). Reduced competition for moisture, space, light and nutrients between crop and weeds along with effective suppression of weeds by combination of herbicides as helped in obtaining higher yield in both the years as reported by Upasani

Table 1. Weed density and weed biomass as influenced by weed management practices in transplanted rice at 60 DAT during 2016 and 2017

Treatment	Dose (g/ha)	Time (DAT)	Weed density (no./m^2)				Weed biomass (g/m^2)			
			Sedges #	Grasses +	Broad-leaf#	Total #	Sedges +	Grasses +	Broad-leaf#	Total #
2016										
Bensulfuron-methyl + pretilachlor *fb* passing of conoweeder	60+600	0-3/25	1.26 (16.6)	2.76 (7.0)	1.15 (12.7)	1.58 (36.3)	2.90 (7.5)	2.07 (3.3)	1.00 (8.2)	1.32 (19.1)
Oxadiargyl *fb* passing of conoweeder	100	0-3/25	1.20 (17.6)	2.92 (8.0)	1.23 (15.7)	1.60 (41.3)	2.95 (8.6)	2.24 (4.4)	1.09 (10.5)	1.38 (23.9)
Bispyribac-Na *fb* passing of conoweeder	20	15-20/35-40	1.35 (20.3)	3.06 (8.7)	1.29 (17.7)	1.69 (46.7)	3.76 (13.2)	2.59 (5.9)	1.17 (12.9)	1.53 (32.1)
Triafamone+ ethoxysulfuron *fb* passing of conoweeder	60	15-20/35-40	1.26 (18.3)	2.94 (8.3)	1.21 (16.0)	1.64 (42.7)	3.32 (10.6)	2.41 (5.5)	1.09 (11.5)	1.46 (27.4)
Bensulfuron-methyl + pretilachlor *fb* bispyribac-Na	60 + 600 *fb* 20	0-3/25-30	1.09 (11.3)	2.43 (5.0)	1.13 (11.7)	1.47 (28.0)	2.17 (3.8)	1.61 (1.6)	0.89 (5.8)	1.12 (11.9)
Oxadiargyl *fb* bispyribac-Na	100 *fb* 20	0-3/25-30	1.18 (13.6)	2.52 (5.7)	1.09 (11.0)	1.51 (30.3)	2.41 (4.9)	1.67 (1.8)	0.87 (5.6)	1.16 (12.4)
Bensulfuron-methyl + pretilachlor *fb* triafamone+ ethoxysulfuron	60 + 600 *fb* 60	0-3/25-30	1.06 (9.6)	2.60 (6.3)	1.08 (10.0)	1.44 (26.0)	2.02 (3.0)	1.80 (2.4)	0.83 (4.8)	1.08 (10.3)
Oxadiargyl *fb* triafamone + ethoxysulfuron	100 *fb* 60	0-3/25-30	1.04 (9.3)	2.69 (6.7)	1.08 (10.7)	1.46 (26.7)	2.01 (3.0)	1.88 (2.6)	0.84 (5.1)	1.11 (10.8)
Hand weeding at 25 and 45 DAT	-	25, 45 DAT	0.96 (7.6)	2.51 (5.7)	1.02 (8.7)	1.37 (22.0)	1.69 (1.9)	1.59 (1.5)	0.67 (2.7)	0.91 (6.2)
Weedy check	-	-	1.51 (30.6)	4.34 (18.3)	1.54 (32.7)	1.92 (81.7)	5.11 (25.5)	4.15 (16.6)	1.51 (30.7)	1.87 (72.4)
LSD (p=0.05)			0.31	1.39	0.23	0.17	0.91	0.95	0.21	0.15
2017										
Bensulfuron-methyl + pretilachlor *fb* passing of conoweeder	60+600	0-3/25	1.01 (10.6)	1.10 (11.6)	1.17 (13.0)	1.55 (35.3)	1.99 (3.3)	2.38 (4.9)	0.92 (6.3)	1.21 (14.5)
Oxadiargyl *fb* passing of cono weeder	100	0-3/25	1.08 (12.0)	1.14 (12.3)	1.11 (11.0)	1.56 (35.3)	2.28 (4.5)	2.71 (6.4)	0.94 (6.7)	1.29 (17.6)
Bispyribac-Na *fb* passing of cono weeder	20	15-20/35-40	1.26 (18.6)	1.33 (22.0)	1.33 (20.3)	1.77 (61.0)	2.98 (8.4)	3.63 (12.9)	1.19 (14.4)	1.55 (35.8)
Triafamone + ethoxysulfuron *fb* passing of cono weeder	60	15-20/35-40	1.11 (11.0)	1.09 (12.3)	1.23 (16.3)	1.59 (39.6)	2.15 (3.6)	2.49 (5.6)	1.04 (9.4)	1.29 (18.7)
Bensulfuron-methyl + pretilachlor *fb* bispyribac-Na	60 + 600 *fb* 20	0-3/25-30	1.01 (9.3)	1.02 (9.3)	1.07 (9.6)	1.46 (28.3)	1.86 (2.6)	2.05 (3.3)	0.79 (4.1)	1.07 (10.1)
Oxadiargyl *fb* bispyribac-Na	100 *fb* 20	0-3/25-30	1.08 (13.0)	1.23 (17.3)	1.12 (13.0)	1.59 (43.3)	2.43 (5.4)	3.21 (10.0)	0.99 (8.8)	1.36 (24.3)
Bensulfuron-methyl + pretilachlor *fb* triafamone+ ethoxysulfuron	60 + 600 *fb* 60	0-3/25-30	0.94 (8.0)	0.97 (8.3)	0.91 (6.6)	1.35 (23.0)	1.69 (2.0)	1.90 (2.7)	0.66 (2.7)	0.95 (7.4)
Oxadiargyl *fb* triafamone + ethoxysulfuron	100 *fb* 60	0-3/25-30	1.15 (12.6)	1.23 (16.3)	1.09 (11.6)	1.60 (40.6)	2.41 (4.9)	3.13 (9.1)	0.93 (7.3)	1.34 (21.4)
Hand weeding at 25 and 45 DAT	-	25, 45 DAT	0.94 (7.0)	0.84 (5.3)	0.89 (6.0)	1.30 (18.3)	1.63 (1.6)	1.61 (1.6)	0.61 (2.1)	0.87 (5.4)
Weedy check	-	-	1.37 (21.6)	1.50 (30.0)	1.48 (28.3)	1.91 (80.0)	3.50 (11.2)	4.71 (21.3)	1.41 (23.5)	1.76 (56.0)
LSD (p=0.05)			0.35	0.28	0.25	0.21	0.81	0.97	0.23	0.20

Data within the parentheses are original values; Transformed values, # : log $\sqrt{x+2}$, +: square root of ($\sqrt{x+1}$); DAT: Days after transplanting

et al. (2012). Unweeded control gave the lowest paddy grain yield due to severe competition from all types of weeds. Similar trend was noticed with respect to weed index.

Economics

Economics is the ultimate criteria for acceptance or rejection and wider adoption of any technology. Among the various treatments, herbicide combination of bensulfuron-methyl + pretilachlor *fb* triafamone + ethoxysulfuron recorded higher net returns of ` 62,530/ha in 2016 and ` 65,600/ha in 2017 with higher benefit: cost ratio in both the years (3.08 and 3.19 in 2016 and 2017, respectively) compared to other treatments. This may be attributed to effective weed management at critical stages by integration of effective pre- and post-emergence herbicides which resulted in higher grain with

Table 2. Ricegrain and straw yields weed index and economics as influenced by weed management practices during 2016 and 2017

Treatment	Dose (g/ha)	Time (DAT)	Rice grain yield (t/ha)		Straw yield (t/ha)		Weed index (%)		Net returns (×10^3`/ha)		B:C
			2016	2017	2016	2017	2016	2017	2016	2017	2016
Bensulfuron-methyl + pretilachlor *fb* passing of conoweeder	60+600	0-3 / 25	4.63	4.93	6.51	5.57	3.54	17.1	48.22	49.30	2.53
Oxadiargyl *fb* passing of conoweeder	100	0-3 / 25	4.37	3.70	6.41	5.05	8.96	37.7	47.04	34.25	2.62
Bispyribac-Na *fb* passing of conoweeder	20	15-20 / 35-40	3.56	3.98	5.38	4.72	25.83	33.0	32.42	35.90	2.08
Triafamone+ ethoxysulfuron *fb* passing of conoweeder	60	15-20 / 35-40	4.46	3.87	6.37	5.37	7.08	34.9	47.36	36.69	2.59
Bensulfuron-methyl + pretilachlor *fb* bispyribac-Na	60 + 600 *fb* 20	0-3 / 25-30	4.69	5.48	6.66	6.53	2.29	7.9	49.45	59.33	2.77
Oxadiargyl *fb* bispyribac-Na	100 *fb* 20	0-3 / 25-30	3.64	3.86	5.30	4.93	24.17	35.1	20.72	22.47	1.49
Bensulfuron-methyl + pretilachlor *fb* triafamone+ ethoxysulfuron	60 + 600 *fb* 60	0-3 / 25-30	5.35	5.84	7.66	6.56	-11.46	1.8	62.53	65.60	3.08
Oxadiargyl *fb* triafamone + ethoxysulfuron	100 *fb* 60	0-3 / 25-30	4.24	3.78	6.01	4.68	11.67	36.5	46.15	36.18	2.71
Hand weeding at 25 and 45 DAT	---	25, 45 DAT	4.80	5.95	6.96	6.95	0.00	0.0	50.78	65.70	2.56
Weedy check	--	--	1.70	3.47	2.22	3.73	64.58	41.6	4.26	31.80	1.17
LSD (p=0.05)			1.00	1.17	1.39	1.18	NA	NA	NA	NA	NA

NA: not analysed; DAT: days after transplanting

reduced cost of cultivation as reported by Bhatt *et al.* 2017. The lowest B:C ratio (1.17 and 1.30 in 2016 and 2017, respectively) was obtained in the weedy check plot in both the years.

The herbicide combination of bensulfuron-methyl + pretilachlor 660 g/ha as pre-emergence *fb* triafamone + ethoxysulfuron 60 g/ha post-emergence were very effective in controlling weeds in transplanted rice and resulted in higher grain and straw yield with better economic returns due to reduced cost of cultivation.

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