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Productivity of transplanted rice as influenced by herbicide combinations

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ABSTRACT

A field experiment was conducted during *Kharif*, 2013 and 2014, Collage of Agriculture, Rajendranagar, Hyderabad in Telangana state. Fourteen weed management practices were evaluated in a randomized complete block design, replicated thrice. Significantly higher grain yield (6.9 t/ha) was obtained with either hand weeding twice at 25 and 45 DAT or pyrazosulfuron-ethyl 20 g/ha at 3 DAT followed by manual weeding at 25 DAT (6.8 t/ha) or pretilachlor 750 g/ha as pre-emergence (PE) at 3 DAT followed by metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as post-emergence (PoE) at 25 DAT (6.6 t/ha) or bispyribac-sodium 20 g/ha + metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT (6.3 t/ha). However, significantly higher net returns (`/ha) and B:C ratio were recorded with pyrazosulfuron-ethyl 20 g/ha at 3 DAT followed by manual weeding at 25 DAT of (` 69788, B:C 2.79), pretilachlor 750 g/ha as PE at 3 DAT followed by metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT (` 67646, B:C 2.77), hand weeding twice at 25 and 45 DAT (` 68720, B:C 2.68), and bispyribac-sodium 20 g/ha + metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT (` 62299, B:C 2.58).

Key words: Grain yield, Herbicide combinations, Productivity, Transplanted rice, Weed dry matter

Rice (*Oryza sativa* L.) is one of the most important food grains produced and consumed worldwide. In India, rice is grown in an area of 44.1 million ha, with a production of 106.64 million tonnes, and productivity of 2416 kg/ha (Ministry of Agriculture 2016-17). In Telangana state, area under rice crop is 2.0 million ha with a production of 6.62 million tonnes and productivity of 3.30 t/ha (DES, Hyderabad, 2016-17). Rice crop suffers from various biotic and abiotic production constraints. Weed competition is one of the major yield limiting factors among biotic constraints in rice. The reduction in paddy yield due to weed competition ranged from 9-51 per cent (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 (Yaduraj and Mishra 2002). The direct and most important effect of weeds is the reduction in crop yields resulting from competition for water nutrients and sunlight, but also quality of grains is impaired besides causing some nuisance at the time of harvest (Rao *et al.* 2007).

Herbicide technology offers an alternative method of 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 have 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.

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MATERIALS AND METHODS

An investigation was carried out during *Kharif* 2013 and 2014 at College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. The soil of the experimental site was sandy clay loam in texture, neutral in reaction (7.9), low in available nitrogen (225.6 kg N/ha), high in available phosphorus (27.14 kg P/ha) and available potassium (169.7 Kg K/ha)

The experiment was laid out in a randomized block design with fourteen weed management practices, *viz.* pretilachlor 625 g/ha as pre-emergence (PE) or 6% + bensulfuron-methyl 0.6% 10 kg granules/ha as pre-emergence (PE) at 3 DAT, pyrazosulfuron-ethyl 20 g/ha at 3 DAT followed by manual weeding at 25 DAT, penoxsulam 22.5 g/ha as post-emergence (PoE) at 12 DAT, cyhalofop-p-butyl 100 g/ha as PoE 15 DAT, bispyribac-sodium 25 g/ha as PoE 25 DAT, azimsulfuron 35 g/ha as PoE at 25 DAT, bispyribac-sodium 25 g/ha + ethoxysulfuron 18.75 g/ha as PoE at 25 DAT, bispyribac-sodium 20 g/ha + metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT, pretilachlor 750 g/ha as PE at 3 DAT *fb* ethoxysulfuron 18.75 g/ha as PoE at 25 DAT, pretilachlor 750 g/ha as PE at 3 DAT *fb* metsulfuron-

methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT, hand weeding twice at 25 and 45 DAT and weedy check. The herbicides were applied using knap-sack sprayer fitted with flat fan nozzle by mixing in 500 L of water/ha as per treatments. Twenty five days old seedlings of rice variety '*MTU-1010*' were transplanted at a spacing of 15 x 15 cm. Recommended dose of 120: 60: 40 kg/ha of NPK was applied uniformly. Half of the nitrogen and whole of phosphate and potash were applied at the time of final puddling and the remaining quantity of nitrogen was applied at panicle initiation stage. Weed dry weight were sampled randomly at two places with the help of a 0.25 m^2 sized quadrate at 60 day growth stage. Weed control efficiency was also calculated on the basis of dry matter production by weeds.

RESULTS AND DISCUSSION

Weed flora

General weed flora of the experimental field during *Kharif* 2013 and 2014 were *Echinochloa crus-galli*, *Echinochloa colona*, *Paspalum distichum* among grasses, *Cyperus difformis*, *Cyperus rotundus* and *Fimbristylis dichotoma* among sedges and *Eclipta alba*, *Bacopa monnieri* and *Ammannia baccifera* among broad-leaved weeds, comprising 44% sedges, 30% grasses and 26% broad-leaved weeds.

Effect on weed dry matter

At 30 DAT, hand weeding twice at 25 and 45 DAT registered the lower total weed dry weight which was at par with pyrazosulfuron-ethyl 20 g/ha as PE at 3 DAT followed by manual weeding at 25 DAT, pretilachlor 750 g/ha as PE at 3 DAT followed by metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT, pretilachlor 750 g /ha as PE at 3 DAT followed by ethoxysulfuron 18.75 g/ha as PoE at 25 DAT, which were significantly superior over other treatments. These were followed by pretilachlor 6% + bensulfuron methyl 0.6% 10 kg granules/ha as PE at 3 DAT and was statistically comparable with pyrazosulfuron-ethyl 20 g /ha 3 DAT, pretilachlor 625 g/ha as PE at 3 DAT and penoxsulam 22.5 g/ha as PoE at 12 DAT. Maximum total weed dry weight was registered in weedy check during both the years.

At 60 DAT, pre-emergence application of pyrazosulfuron-ethyl 20 g/ha at 3 DAT followed by manual weeding at 25 DAT registered the lower total weed dry weight (13.0 and 14.5 g/m^2), whereas at 90 DAT and at harvest, significantly the lower total weed dry weight (32.69 and 39.85 g/m^2) was recorded with hand weeding twice at 25 and 45 DAT and was statistically comparable with pyrazosulfuron-ethyl 20 g/ha followed by manual weeding at 25 DAT, pretilachlor 750 g/ha as PE at 3 DAT followed by metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT and bispyribac-sodium 20 g /ha + metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT. In turn, all these treatments were followed by pretilachlor 750 g/ha as PE at 3 DAT followed by ethoxysulfuron 18.75 g/ha as PoE at 25 DAT and was statistically on par with azimsulfuron 35 g/ha as PoE at 25 DAT, bispyribac-sodium 25 g/ha + ethoxysulfuron 18.75 g/ha as PoE at 25 DAT and pretilachlor 6% + bensulfuron-methyl 0.6% 10 kg granules/ha as PE at 3 DAT. The higher total weed dry weight was recorded under weedy check however, it was at par with penoxsulam 22.5 g/ha as PoE at 12 DAT, pyrazosulfuron-ethyl 20 g/ha 3 DAT, bispyribac-sodium 25 g/ha as PoE 25 DAT, pretilachlor 625 g/ha as pre-emergence (PE) or 6% + bensulfuron-methyl 0.6% 10 kg granules/ha as PE at 3 DAT and cyhalofop-p-butyl 100 g /ha as PoE 15 DAT under the study. Among the herbicide treated plots, pyrazosulfuron-ethyl 20 g/ha as PE at 3 DAT followed by manual weeding at 25 DAT was statistically comparable with hand weeding twice at 25 and 45 DAT. This was mainly due to killing of germinating weed seeds as well as removal of established weeds. Sulfonylurea herbicides inhibit the aceto lactate synthase enzyme which involved in the synthesis of the branched chain amino acids (leucine, isoleucine, and valine) which are required for DNA synthesis and cell growth. During the critical period of crop weed competition, weed dry weight continuously remained increasing and crop growth affected due to competition from weeds for the natural resources (Parthipan and Ravi 2014).

Weed control efficiency (WCE) ranged from 73.3-76.8% and 75.2-80.6% in respective years with various herbicide combinations. Weed control efficiency was high between 0-30 DAT then decreased sharply between 30 - 60 DAT, thereafter, it decreased linearly toward harvest in both years owing to increase in weed density. High weed control efficiency in the initial growth stages appeared to be mainly due to higher herbicide efficacy.

During both years, higher WCE at all the stages was noticed in pyrazosulfuron-ethyl 20 g/ha as PE at 3 DAT followed by manual weeding at 25 DAT, hand weeding twice at 25 and 45 DAT and pretilachlor 750 g /ha as PE at 3 DAT followed by metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT due to higher suppression of weeds with sequential application of PE herbicide/PoE herbicides or manual weeding and broad spectrum weed control. The

treatment bispyribac-sodium 20 g/ha + metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT showed less WCE at 30 DAT and then from 60 DAT, it showed comparatively higher WCE owing to PoE application of herbicide. It was clearly evident that combination of two chemicals gave higher weed control efficacy than sole application. The treatment pretilachlor 625 g/ha as pre-emergence (PE) or 6% + bensulfuron-methyl 0.6% 10 kg granules/ha as PE at 3 DAT, pyrazosulfuron-ethyl 20 g/ha 3 DAT, pretilachlor 6% + bensulfuron-methyl 0.6% 10 kg granules/ha as PE at 3 DAT, penoxsulam 22.5 g/ha as PoE at 12 DAT, cyhalofop-p-butyl 100 g /ha as PoE 15 DAT, bispyribac-sodium 25 g/ha as PoE 25 DAT, azimsulfuron 35 g/ha as PoE at 25 DAT, bispyribac-sodium 25 g/ha + ethoxysulfuron 18.75 g/ha as PoE at 25 DAT, and pretilachlor 750 g/ha as PE at 3 DAT *fb* ethoxysulfuron 18.75 g/ha as PoE at 25 DAT showed good WCE up to 30 DAT due to single application of PE herbicide alone as the herbicide controlled a portion of weed population. Poor weed control efficiency was noticed in azimsulfuron because it controlled only sedges, bispyribac-sodium controlled only grasses and cyhalofop-p-butyl controlled only barnyard grass at all crop growth stages in 2013 and 2014 (Parthipan and Ravi 2014).

Effect on crop

Rice grain yield was significantly higher with hand weeding twice at 25 and 45 DAT treatment to the tune of 6.4 t/ha and 6.9 t/ha during 2013 and 2014, respectively. However, comparable grain yields were recorded with pyrazosulfuron-ethyl 20 g/ha as PE at 3 DAT followed by manual weeding at 25 DAT, pretilachlor 750 g/ha as PE at 3 DAT followed by metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT and bispyribac-sodium 20 g/ha + metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT. There was no significant difference in grain yield among the treatments pretilachlor 750 g/ha as PE at 3 DAT *fb* ethoxysulfuron 18.75 g/ha as PoE at 25 DAT, azimsulfuron 35 g/ha as PoE at 25 DAT, bispyribac-sodium 25 g/ha + ethoxysulfuron 18.75 g/ha as PoE at 25 DAT and pretilachlor 6% + bensulfuron-methyl 0.6% 10 kg granules/ha as PE at 3 DAT. On an average 28.96, 33.19, 36.24 and 36.80%

Table 1. Effect of different pre- and post-emergence herbicides on weed dry matter (WDM) in transplanted rice

Treatment	30 DAT		60 DAT		90 DAT		Harvest	
	2013	2014	2013	2014	2013	2014	2013	2014
Pretilachlor 625 g/ha as PE at 3 DAT	4.76 (21.7)	4.44 (18.8)	10.93 (119.0)	10.68 (113.6)	12.37 (151.9)	12.99 (167.9)	12.99 (172.6)	13.32 (183.7)
Pyrazosulfuron-ethyl 20 g/ha 3 DAT	4.40 (18.4)	4.30 (17.5)	10.73 (114.3)	10.53 (110.0)	12.11 (145.6)	12.65 (159.1)	12.72 (163.8)	13.17 (176.1)
Pretilachlor 6% + bensulfuron-methyl 0.6% 10 kg granules/ha as PE at 3 DAT	4.29 (17.5)	4.22 (16.8)	9.21 (85.5)	8.51 (71.9)	10.07 (100.4)	10.81 (115.8)	10.88 (117.3)	11.42 (129.5)
Pyrazosulfuron-ethyl 20 g/ha at 3 DAT followed by manual weeding at 25 DAT	2.02 (3.1)	2.06 (3.3)	3.36 (13.0)	3.93 (14.5)	5.91 (30.8)	5.52 (29.6)	6.76 (44.7)	6.42 (40.3)
Penoxsulam 22.5 g/ha as PoE at 12 DAT	4.31 (18.2)	4.35 (18.4)	10.45 (108.2)	10.77 (115.0)	12.43 (154.0)	12.47 (154.7)	12.70 (169.3)	12.98 (175.0)
Cyhalofop-p-butyl 100 g/ha as PoE 12 DAT	5.86 (32.5)	5.52 (29.6)	11.02 (120.7)	10.91 (118.0)	12.58 (157.2)	13.00 (168.1)	13.10 (176.5)	13.41 (187.7)
bispyribac-sodium 25 g/ha as PoE 25 DAT	5.54 (30.7)	5.49 (29.2)	10.54 (110.0)	10.39 (107.0)	12.20 (147.9)	12.66 (159.6)	12.87 (167.5)	13.19 (174.8)
Azimsulfuron 35 g/ha as PoE at 25 DAT	5.62 (30.6)	5.33 (27.9)	8.61 (73.2)	8.12 (65.0)	10.69 (113.2)	11.11 (122.0)	11.40 (129.0)	11.72 (136.5)
Bispyribac-sodium 25 g/ha + ethoxysulfuron 18.75 g/ha as PoE at 25 DAT	5.62 (30.5)	5.46 (28.5)	8.65 (73.9)	8.43 (70.2)	10.38 (106.8)	11.12 (122.4)	11.07 (121.5)	11.66 (134.9)
Bispyribac-sodium 20 g/ha + metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT	5.62 (30.6)	5.41 (28.3)	4.50 (19.76)	4.66 (21.1)	6.25 (38.37)	6.30 (39.0)	7.10 (49.4)	7.17 (50.6)
Pretilachlor 750 g/ha as PE at 3 DAT followed by ethoxysulfuron 18.75 g/ha as PoE at 25 DAT	2.50 (5.6)	2.38 (4.7)	8.07 (66.1)	8.08 (64.3)	9.88 (96.6)	10.35 (106.2)	10.59 (111.1)	10.91 (118.4)
Pretilachlor 750 g/ha as PE at 3 DAT followed by metsulfuron-methyl + chlorimuron-ethyl 4 g /ha as PoE at 25 DAT	2.43 (4.4)	2.28 (3.7)	4.47 (19.1)	4.61 (20.4)	6.20 (37.8)	6.15 (37.0)	7.07 (49.1)	6.84 (46.4)
Hand weeding twice at 25 and 45 DAT	1.93 (2.9)	2.05 (3.2)	3.61 (14.6)	4.26 (17.2)	5.52 (32.7)	5.49 (29.1)	6.39 (39.8)	6.34 (39.4)
Weedy check	5.96 (34.2)	5.62 (30.8)	11.13 (127.4)	11.07 (122.0)	12.74 (161.4)	13.15 (175.4)	13.50 (181.3)	13.87 (193.0)
LSD (p=0.05)	0.58	0.37	1.15	0.79	0.87	0.85	0.89	0.91

Original data in parentheses was subjected to squar root transformation; PE: Pre-emrgence; PoE: Post-emegence

Table 2. Yield and economics as influenced by different weed control treatments in transplanted rice

Treatment	Grain yield (t/ha)		Gross returns (x10^3 `ha)		Net returns (x10^3 `ha)		BC ratio	
	2013	2014	2013	2014	2013	2014	2013	2014
Pretilachlor 625 g/ha as PE at 3 DAT	2.96	2.84	47.81	46.35	11.21	8.75	1.31	1.23
Pyrazosulfuron-ethyl 20 g/ha 3 DAT	3.20	3.05	51.39	49.73	14.59	11.93	1.40	1.32
Pretilachlor 6% + bensulfuron methyl 0.6% 10 kg granules /ha as PE at 3 DAT	4.25	4.23	68.65	67.64	30.33	28.32	1.79	1.72
Pyrazosulfuron-ethyl 20 g/ha at 3 DAT followed by manual weeding at 25 DAT	6.39	6.87	101.54	108.79	63.54	69.79	2.67	2.79
Penoxsulam 22.5 g/ha as early PoE at 12 DAT	3.24	3.37	52.20	54.44	13.91	15.15	1.36	1.39
Cyhalofop-p-butyl 100 g/ha as early PoE 12 DAT	2.77	2.89	45.27	47.06	8.29	7.76	1.22	1.20
bispyribac-sodium 25 g/ha as PoE 25 DAT	3.03	3.16	49.04	50.90	11.01	11.87	1.29	1.30
Azimsulfuron 35 g/ha as PoE at 25 DAT	4.54	4.39	73.06	70.44	34.73	31.12	1.91	1.79
bispyribac-sodium 25 g/ha + ethoxysulfuron 18.75 g/ha as PoE at 25 DAT	4.32	4.20	69.90	67.65	31.16	27.91	1.80	1.70
bispyribac-sodium 20 g/ha + metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT	5.97	6.38	95.60	101.80	57.10	62.30	2.48	2.58
Pretilachlor 750 g/ha as PE at 3 DAT followed by ethoxysulfuron 18.75 g/ha as PoE at 25 DAT	4.66	4.84	75.31	77.34	37.88	38.91	2.01	2.01
Pretilachlor 750 g/ha as PE at 3 DAT followed by metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT	6.17	6.68	98.32	105.83	60.83	67.65	2.62	2.77
Hand weeding twice at 25 and 45 DAT	6.44	6.93	102.27	109.72	62.27	68.72	2.56	2.68
Weedy check	2.77	2.78	45.00	45.17	9.00	8.17	1.25	1.22
LSD (p=0.05)	0.48	0.61	6.68	9.70	6.68	9.70	-	-

increase in grain yield was noticed in hand weeding twice at 25 and 45 DAT over pretilachlor 750 g/ha as PE at 3 DAT *fb* ethoxysulfuron 18.75 g/ha as PoE at 25 DAT, azimsulfuron 35 g/ha as PoE at 25 DAT, bispyribac-sodium 25 g/ha + ethoxysulfuron 18.75 g/ha as PoE at 25 DAT and pretilachlor 6% + bensulfuron-methyl 0.6% 10 kg granules/ha as PE at 3 DAT, respectively. The lower grain yield was registered with weedy check and was statistically comparable with penoxsulam 22.5 g/ha as early PoE at 12 DAT, pyrazosulfuron-ethyl 20 g/ha 3 DAT, bispyribac-sodium 25 g/ha as PoE 25 DAT, pretilachlor 625 g/ha as PE at 3 DAT and cyhalofop-p-butyl 100 g/ha as PoE 12 DAT during both the years.

Economics

Significantly the higher gross returns during 2013 and 2014 were achieved in hand weeding twice at 25 and 45 DAT (` 102273 and 109720), which was at par with pyrazosulfuron-ethyl 20 g/ha at 3 DAT followed by manual weeding at 25 DAT (` 101541 and 108788), pretilachlor 750 g/ha as PE at 3 DAT followed by metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT (` 98319 and 105833) and bispyribac-sodium 20 g/ha + metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as post-emergence at 25 DAT (` 95598 and 101798). However, significantly higher net returns was noticed in pyrazosulfuron-ethyl 20 g/ha at 3 DAT followed by manual weeding at 25 DAT (` 63541 and 69788) and it was at par with hand weeding twice at 25 and 45 DAT (` 62273 and 68720), pretilachlor 750 g/ha as PE at 3 DAT followed by metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as PoE at 25 DAT (` 60832 and 67646) and bispyribac-sodium 20 g/ha + metsulfuron-methyl + chlorimuron-ethyl 4 g/ha as post emergence at 25 DAT (` 57099 and 62299). The higher benefit: cost ratio was recorded in pyrazosulfuron-ethyl 20 g/ha at 3 DAT followed by manual weeding at 25 DAT.

It was concluded that pre-emergence application of pyrazosulfuron-ethyl 20 g/ha at 3 DAT followed by manual weeding at 25 DAT was better options for efficient weed control, higher grain yield and profit in transplanted rice.

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