Short communication

Comparative efficacy of new herbicides in direct seeded rice

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Abstract

A field experiment was conducted during *rabi* season in a farmer's field in the *Kole* lands at Pullu in Thrissur district during the period November 2012 to March 2013. The treatments included application of both pre emergence and post emergence herbicides. The pre emergence herbicides selected were oxyfluorfen sprayed at 3 days after sowing (DAS) and butachlor and pretilachlor sprayed at 6 DAS. Pyrazosulfuron-ethyl, an early post emergence herbicide, was sprayed at 8 DAS. The herbicides cyhalofop butyl, fenoxaprop-p-ethyl, metamifop, penoxsulam, bispyribac sodium and azimsulfuron, are post emergence in action and were sprayed at 20 DAS. Hand weeded (handweeding at 20 and 40 DAS) and unweeded controls were also included for comparison with the herbicide treatments. The best herbicide for control of grass weeds was either fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} or cyhalofop butyl @ 80 g a.i. ha^{-1}, both applied at 20 DAS. Broad spectrum weed control can be made possible by spraying herbicide combinations that could give higher yield and B:C ratio.

Key words: Herbicide, Direct seeded rice

Rice (*Oryza sativa* L.) is a major food crop in Asia and many other tropical and sub-tropical countries of the world. Weed management is a major factor contributing a considerable share to the cost of production and deciding the final yield, especially in direct seeded rice (DSR), as the crop and weeds emerge simultaneously due to which the crop suffers competition even from early stages of growth which in turn reduces the grain yield (Choubey et al., 2001). Success of direct seeded rice depends largely on effective weed management techniques (Pandey and Velasco, 2002). This change in method of rice establishment from traditional manual transplanting to direct seeding has occurred in many Asian countries in the last two decades (Benvenuti et al., 2004). Weed competition is the major limitation for success of DSR (Rao et al., 2007). Uncontrolled weeds decreased yield by 96% in dry DSR and 61% in wet DSR (Maity and Mukherjee, 2008).

A field experiment was conducted during the *rabi* season of the year 2012 to 2013 at Alappad-Pullu *Kole* lands located in Chazhur panchayath of Thrissur district, Kerala ($75^0$58' latitude and $76^0$11' longitude and 1m below MSL). The soil of the experimental field was clay loam in texture, with pH 5.2, organic C 1.4%, available N 890 kg ha^{-1}, available P 24 kg/ha and K 281 kg ha^{-1}. The crop received rainfall of 165.5 mm during the crop period. The mean monthly minimum and maximum temperatures were 33.9^{o}C and 23.2^{o}C respectively during the crop period. The experiment comprised of twelve treatments. The pre emergence herbicide oxyfluorfen 23.5 EC was sprayed 3 days after sowing (DAS), while butachlor 50 EC and pretilachlor 50 EC were sprayed 6 DAS. The early post emergence treatment pyrazosulfuron ethyl 10 WP was sprayed 8 DAS. The post emergence herbicides cyhalofop butyl 10 EC, fenoxaprop-p-ethyl 6.9 EC, bispyribac sodium 10 SC, metamifop 10 EC, azimsulfuron 50 DF and penoxsulam 24 SC were sprayed 20 DAS. The control treatments were hand weeded control (hand weeding at 20 and 40 DAS) and weedy check. The trial was laid out in

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randomized block design with three replications in plots of size of 20 m^2. The rice variety used was Jyothi (PTB 39), a red kernelled, short duration variety of 115-120 days duration. The seed rate for sowing was 100 kg ha^{-1}. The crop was fertilized with N, P_2O_5, and K_2O at 90, 35, and 45 kg ha^{-1} respectively.

Observations on weed density, relative density and weed dry weight were recorded with a quadrate (0.25x0.25 m) placed randomly in each plot at 30 DAS, 60 DAS and harvest and data presented as per m^2. The data on weed density were subjected to square root transformation ($\sqrt{x+0.5}$). Weed control efficiency (WCE) was computed by using weed dry weight. The data were analyzed using ANOVA and the least significant difference (LSD) values at 5% level of significance were calculated.

The grass weeds were predominant and accounted for 45% of the population, sedges for 36%, and broad leaf weeds for 19%. The higher proportion of grasses compared to sedges and broad leaved weeds in rice in *Kole* lands was also reported by Joy et al. (1993) and Sindhu (2008). Among grasses, *Echinochloa crusgalli* and *Echinochloa stagnina* (17%) and *Leptochloa chinensis* (28%) dominated. Among dicots only *Ludwigia parviflora* was the serious weed (12%), and among sedges, *Fimbristylis miliacea* (14%), *Cyperus iria* and *Cyperus difformis* (21%) were the important ones.

Weeds (Table 1), especially the sedges and broad leaf weeds, were present in all treatments except in pretilachlor, where sedges were not recorded, and in bispyribac sodium, where broad leaf weeds were absent. Azimsulfuron and penoxsulam, though

Table 1. Effect of herbicides on weed density (no. m^{-2}) at 30 DAS, 60 DAS and harvest

Treatments	Dose (g *a.i.* ha^{-1})	Weed density (no. m^{-2})								
		30 DAS			60 DAS			Harvest		
		G	S	B	G	S	B	G	S	B
Butachlor-50 EC	1250	*3.80^{f} (14)	4.06^{h} (16)	3.81^{e} (14)	9.62^{e} (92)	3.14^{h} (9.4)	2.92^{f} (8)	7.31^{e} (53)	2.92^{e} (8)	2.12^{i} (4)
Oxyfluorfen-23.5 EC	150	2.55^{g} (6)	3.39^{i} (11)	5.34^{b} (28)	7.52^{h} (56)	4.53^{e} (20)	2.92^{f} (8)	5.70^{g} (32)	2.34^{f} (5)	4.06^{f} (16)
Pretilachlor-50 EC	500	0.71^{i} (0)	0.71^{k} (0)	4.95^{c} (24)	5.34^{i} (28)	3.54^{g} (12)	6.67^{c} (44)	4.18^{h} (17)	1.60^{g} (2)	6.04^{d} (36)
Pyrazosulfuron-ethyl-10 WP	30	0.71^{i} (0)	4.52^{g} (20)	2.92^{f} (8)	10.22^{c} (104)	3.81^{f} (14)	2.12^{g} (4)	7.78^{c} (60)	1.22^{gh} (1)	2.92^{h} (8)
Azimsulfuron-50 DF	35	4.53^{d} (20)	5.70^{f} (32)	4.53^{d} (20)	10.79^{b} (116)	3.54^{g} (12)	2.92^{f} (8)	7.78^{c} (60)	0.71^{i} (0)	4.53^{e} (20)
Bispyribac sodium-10 SC	30	5.61^{b} (31)	6.07^{e} (36)	0.71^{h} (0)	10.12^{d} (102)	4.53^{e} (20)	2.12^{g} (4)	8.09^{b} (65)	2.92^{e} (8)	2.12^{i} (4)
Cyhalofop-butyl-10 EC	80	2.55^{g} (6)	8.03^{d} (64)	5.34^{b} (28)	4.95^{j} (24)	8.28^{c} (68)	5.96^{d} (36)	3.54^{i} (12)	6.67^{c} (44)	8.03^{b} (64)
Fenoxaprop-p-ethyl-6.9 EC	60	0.71^{i} (0)	8.27^{c} (68)	4.95^{c} (24)	0.71^{k} (0)	7.52^{d} (56)	7.97^{b} (63)	2.12^{h} (4)	7.45^{b} (55)	6.67^{c} (44)
Metamifop-10 EC	100	4.06^{e} (16)	9.08^{b} (82)	5.34^{b} (28)	9.41^{f} (88)	9.41^{b} (88)	6.04^{d} (36)	7.52^{d} (56)	5.79^{d} (33)	4.53^{e} (20)
Penoxsulam-24 SC	25	5.28^{c} (24)	3.99^{h} (15)	3.81^{e} (14)	8.51^{g} (72)	3.54^{g} (12)	3.80^{e} (14)	7.11^{f} (50)	0.71^{i} (0)	3.54^{g} (12)
Handweeded control	-	1.58^{h} (2)	2.74^{j} (7)	1.87^{g} (3)	0.71^{k} (0)	1.22^{i} (1)	0.71^{h} (0)	0.71^{j} (0)	0.71^{i} (0)	1.87^{j} (3)
Unweeded control	-	6.04^{a} (36)	10.7^{a} (115)	6.36^{a} (40)	12.66^{a} (161)	11.44^{a} (130)	8.75^{a} (76)	9.61^{a} (92)	9.87^{a} (97)	9.19^{a} (84)
SEm+_		2.67	3.03	2.29	2.39	1.73	1.71	1.94	1.77	1.83
LSD (P=0.05)		5.67	6.33	4.78	5.02	3.63	3.57	4.07	3.87	3.82

G – Grasses, S – Sedges, B – Broad leaf weeds, DAS – Days after sowing
*”x+0.5 transformed values. Original values are given in the parentheses

Table 2. Effect of herbicides on weed dry weight (g m^{-2}), weed control efficiency (WCE %) and yield (Mg ha^{-1})

Treatments	Dose (g *a.i.* ha^{-1})	Total weed dry weight (g m^{-2}) 30 DAS	60 DAS	Harvest	WCE % 30 DAS	60 DAS	Harvest	Grain yield (Mg ha^{-1})	Straw yield (Mg ha^{-1})	B:C ratio
Butachlor-50 EC	1250	6.01^{i}	99.34^{b}	76.45^{d}	64.54^{d}	6.83^{k}	30.75^{i}	4.74^{h}	5.19^{de}	1.6
Oxyfluorfen-23.5 EC	150	13.70^{c}	80.96^{d}	70.40^{e}	19.20^{j}	24.66^{i}	36.23^{h}	4.76^{g}	4.99^{e}	1.6
Pretilachlor-50 EC	500	8.80^{g}	57.87^{h}	52.71^{h}	48.10^{f}	46.14^{e}	52.25^{e}	4.53^{j}	5.20^{de}	1.5
Pyrazosulfuron-ethyl-10 WP	30	2.53^{k}	59.55^{g}	47.80^{i}	85.06^{b}	44.59^{f}	56.70^{d}	4.67^{i}	5.63^{bc}	1.5
Azimsulfuron-50 DF	35	7.84^{h}	63.78^{f}	79.25^{c}	53.76^{e}	40.65^{g}	28.21^{j}	4.83^{f}	4.92^{f}	1.6
Bispyribac sodium-10 SC	30	1.10^{e}	65.28^{e}	61.40^{g}	35.11^{h}	39.25^{h}	44.38^{f}	5.02^{d}	5.25^{d}	1.7
Cyhalofop-butyl-10 EC	80	9.43^{f}	43.65^{j}	40.60^{j}	44.41^{g}	59.38^{c}	63.23^{c}	5.46^{c}	5.74^{b}	1.9
Fenoxaprop-p-ethyl-6.9 EC	60	2.93^{j}	36.23^{k}	34.01^{k}	82.72^{c}	60.70^{b}	69.19^{b}	5.88^{b}	5.74^{b}	2.1
Metamifop-10 EC	100	14.40^{b}	90.33^{c}	88.07^{b}	15.05^{k}	7.56^{j}	11.17^{k}	4.48^{k}	5.37^{c}	1.4
Penoxsulam-24 SC	25	11.58^{d}	44.85^{i}	68.54^{f}	31.70^{i}	58.26^{d}	37.92^{g}	4.93^{e}	5.64^{bc}	1.6
Handweeded control	-	2.02^{l}	0.48^{l}	1.62^{l}	88.11^{a}	100.0^{a}	97.0^{a}	6.46^{a}	5.87^{a}	1.9
Unweeded control	-	16.95^{a}	107.46^{a}	110.40^{a}	-	-	-	4.07^{l}	5.37^{c}	1.3
SEm+_		1.14	2.73	1.7	0.68	0.25	0.15	0.13	0.34	
LSD (P=0.05)		2.37	5.87	3.72	1.43	0.53	0.31	0.26	0.70	

In a column, means followed by same superscript do not differ significantly at 5% level of significance in DMRT.

broad spectrum herbicides, were found less effective than bispyribac sodium in controlling broad leaf weeds. Unweeded control recorded the highest count of sedges and broad leaf weeds. Among the herbicides, metamifop was least effective against sedges, while broad leaf weeds were highest in the treatment cyhalofop butyl. Fenoxaprop-p-ethyl was seen to be the most effective herbicide to control grasses, and was on par with the hand weeding treatment.

Grasses, sedges and broad leaf weeds persisted till harvest, and dry weight (Table 2) was highest in the unweeded plot. It was observed that weed dry weight was generally lower at 30 DAS compared to 60 DAS and harvest. Hand weeding resulted in lowest weed dry matter production. At 30 DAS the treatments cyhalofop, pretilachlor, azimsulfuron, butachlor, fenoxaprop-p-ethyl, and pyrazosulfuron showed less weed dry weight production (Table 2). At 60 DAS, the weed dry weight increased by six times in unweeded control and the lowest dry weight was noticed in fenoxaprop-p-ethyl treated plots followed by cyhalofop butyl. The hand weeded plots showed very low accumulation of weed dry matter. At the time of harvest also, weed dry weight production was the lowest in hand weeded plots followed by fenoxaprop-p-ethyl. The treatments cyhalofop butyl and pyrazosulfuron ethyl were the next best treatments with lower weed dry weights. In most of the treatments, weed dry weight was less at harvest stage than at 60 DAS.

The weed control efficiency (WCE) of treatments at 30 DAS, 60 DAS and harvest was highest in fenoxaprop-p-ethyl, followed by cyhalofop butyl (Table 2). Lowest WCE at 30 DAS and harvest was in metamifop whereas at 60 DAS, it was in butachlor treated plot. The highest grain yield of 6.46 Mg ha^{-1} was recorded in hand weeded control, where highest WCE was also recorded. The next best treatments for grain yield were fenoxaprop-p-ethyl (5.88 Mg ha^{-1}) and cyhalofop butyl (5.46 Mg ha^{-1}) and lowest yield of 4.07 Mg ha^{-1} was obtained in unweeded control. In the case of straw, the highest yield was obtained in hand weeded control (5.87 Mg ha^{-1}) and lowest in azimsulfuron with 4.92 Mg ha^{-1}.

The major advantage in going for herbicidal control of weeds is reduction in the cost of cultivation. An analysis of the economics of rice cultivation shows that highest B:C ratio (2.1) was in fenoxaprop-p-ethyl (Table 2). The performance of metamifop was inferior compared to fenoxaprop p-ethyl, (though both are graminicides) with respect to grain yield and B:C ratio. However, fenoxaprop p-ethyl was on par with cyhalofop butyl in grain yield. With regard to WCE also, the same trend was observed. Hand weeding resulted in highest grain and straw yields, but the B:C ratio was not highest because of the high labour cost. Still a high B:C ratio of 1.9 was obtained. In the current context of labour shortage, herbicidal weed control is the practical alternative. However, in the present study, all the herbicides tried gave only a partial control of weed flora, comprising of a mixture of grasses or sedges or broad leaf weeds and so yield obtained was less than that in handweeded control. The best herbicide for control of grass weeds was either fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} or cyhalofop butyl @ 80 g a.i. ha^{-1}, both applied at 20 DAS. In areas where *Leptochloa chinensis* are not a problem, bispyribac sodium @ 30 g a.i. ha^{-1} applied at 20 DAS is the best herbicide. Combinations of herbicides to control a broad spectrum of weeds could give higher yield and B:C ratio.

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