Indian Journal of Weed Science **45**(2): 76–79, 2013

Evaluation of cultivars and herbicides for control of barnyard grass and nutsedge in *boro* rice

Pramod Kumar*, Yashwant Singh and U.P. Singh

Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh 221 005

Received: 1 February 2013; Revised: 27 April 2013

ABSTRACT

A field experiment was conducted to test the efficacy of different herbicides and cultivars during *boro* seasons of 2009 and 2010 on clay loam soils at BHU, Varanasi. The herbicides used were butachlor 1500 g/ha (pre-emergence) *fb* 2,4–D 500 g/ha + NIS (0.25%) at 20-25 DAT, pretilachlor 750 g/ha (pre-emergence) *fb* azimsulfuron 35 g/ha + NIS (0.2%) at 15 DAT, penoxsulam 22.5 g/ha + NIS (0.25%) at 15 DAT, ethoxysulfuron 18 g/ha + fenoxaprop + safner 56 g/ha + (NIS 0.25%) at 15 DAT, propanil 3000 g/ha + trichlorpyr 500 g/ha + NIS (0.25%) at 20-25 DAT and pyrazosulfuron 20 g/ha (pre-emergence) *fb* bispyribac 25 g/ha + NIS (0.25%) at 25 DAT under *'Gautam'*, *'Prabhat'* and *'Krishna Hamsa'* cultivars. Weed count and its dry matter under *'Prabhat'* cultivar were lower than that with other two cultivars for both *Echinochola* and *Cyperus* spp. resulting in higher weed control efficiency with *Prabhat* as compared to other two cultivars where as, significantly highest grain yield of 4.15 t/ha was obtained in *Gautam* cultivar due to higher growth and yield attributes. The application of ethoxysulfuron + fenoxaprop was most effective in minimizing population of *Cyperus* spp. and its dry matter with highest WCE. *'Gautam'* cultivar with highest net return of ₹ 24,898/ha and benefit cost ratio of 1.19 and pretilachlor *fb* azimsulfuron with net return of ₹ 27,461/ha and benefit: cost ratio of 1.32 were found most profitable among the cultivars and herbicidal treatments, respectively.

Key words: *Boro* rice, Cultivars, Herbicides, Unweeded control, Weed free

In India, rice occupies an area of 45.5 million hectares with production of 99.2 million tonnes and occupies second position, after China among the rice growing countries of the world. contributing about 41.8% of total food grain production and accounting 20-25% of the agricultural GDP (Rai 2006). Uttar Pradesh is the second largest rice growing state in the country, with an area of 6.03 million ha and production of 13.1 million tonnes (Anonymous 2010). Productivity of *boro* rice in eastern Uttar Pradesh is only two-third (2.0 t/ha) as against the average productivity of 3.0 t/ha of eastern India. Weed competition is one of the prime yield limiting biotic constraints resulting into yield reduction to the tune of 28 to 45% (Raju and Reddy 1995, Singh *et al*. 2003). *Echinochloa* spp. and *Cyperus* spp. are major weeds responsible for yield reduction in rice. Varieties with their characters such as growth, vigor and smothering effects affect the weed growth in boro rice cultivation. The present study was carried out to evaluate the performance of different rice cultivars along with promising herbicides for appropriate weed management programme.

***Corresponding author:** pramod.ran.bhu@gmail.com

MATERIALS AND METHODS

Field experiment was conducted during *boro* seasons of 2009 and 2010 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The soil of the experimental field was Gangetic alluvial having clay loam in texture with pH 7.49. It was moderately fertile, being medium in available organic carbon (0.51%), low in available nitrogen (196 kg/ha), and medium in available phosphorus (24.05 kg P_2O_5 ha) and potassium (230.05 kg/ha). The experiment was laid out in split-plot design with three cultivars (*'Gautam'*, *'Prabhat'* and *'Krishna Hamsa'*) in main plots and nine weed control treatments (unweeded control, weed free, and weeding twice at 30 and 50 DAT, butachlor 1500 g/ha (pre-emergence) *fb* 2,4-D 500 g/ha + NIS (0.25%) at 20-25 DAT, pretilachlor 1.0 kg *fb* azimsulfuron (pre-emergence) 35 g/ha + NIS (0.25%) at 15 DAT, penoxsulam 22.5 g/ha + NIS (0.25%) at 15 DAT, ethoxysulfuron 18 g/ha + fenoxaprop + safner 56 g/ha + (NIS 0.25%) at 15 DAT, propanil 3000 g/ha + trichlorpyr 500 g/ha + NIS (0.25%) at 20-25 DAT and pyrazosulfuron 20 g/ha (pre-emergence) *fb* bispyribac 25 g/ha + NIS (0.25%) at 25 DAT) in sub-plots. All the herbicides were applied in satu-

rated soil moisture as per protocol of application time. Two to three seedlings per hill were transplanted at spacing of 20 x 10 cm on 27th January, 2009 and 2nd February, 2010. Crop was supplied with nutrients *i.e.* 120, 60, 60 kg N, P_2O_5 and K_2O as well as 5 kg Zn/ha. Full quantity of P_2O_5, K_2O and Zn through diammonium phosphate, muriate of potash and zinc sulphate and one half of N was applied as basal dose at the time of puddling. Remaining N in form of urea was top dressed in two equal splits, at active tillering and panicle initiation stage. The data on weed count and their dry matter (at 20, 40, 60, 80 DAT and harvest) were recorded with the help of a quadrate (0.5 x 0.5 m) at two places per plot and then converted into per square metre. Weed control efficiency (WCE) was calculated based on weed dry weight. The data on weed count and dry weight were analysed using square root ($\sqrt{x+0.5}$) transformation.

RESULTS AND DISCUSSION

The most dominant weed species found in the experimental field throughout the crop growth in rice were; *Cynodon dactylon* and *Echinochloa* spp. among grasses: *Cyperus* spp. among sedges and *Ipomoea aquatica, Marsilea minuta, Nymphaea nouchali, Pistia stratiotes, Veronica anagallis-aquatica, Ranunculus sceleratus* among broad-leaved. *Echinochola* spp. constituted 28.3% and *Cyperus* spp. 24.9% of total weed population at maximum weed flush (80 DAT).

Effect on weeds

The pooled data of two years indicated that '*Prabhat*' cultivar registered significantly lower number of *Echinochloa* spp. (Table 1) and *Cyperus* spp. (Table 2), as well as its dry matter at almost all the stages of crop growth. Vigorous crop growth and droopy lower leaves

Table 1. Effect of cultivars and herbicides on weed count and weed dry matter of *Echinochola* spp. and weed control efficiency (pooled data of two years)

Treatment	Weed count (no./m²) at different DAT					Weed dry matter (g/m²) at different DAT				
	20	40	60	80	Harvest	20	40	60	80	Harvest
Cultivars										
'Gautam'	1.01	2.83	2.37	2.60	2.86	0.93	1.38	3.23	3.76	5.13
	(0.96)	(13.74)	(8.00)	(10.59)	(12.59)	(0.66)	(2.39)	(15.27)	(23.54)	(40.23)
'Prabhat'	0.93	2.63	2.21	2.38	2.66	0.91	1.58	2.97	3.28	4.80
	(0.59)	(11.04)	(7.07)	(8.85)	(11.04)	(0.71)	(3.41)	(14.13)	(17.67)	(33.93)
'Krishna Hamsa'	1.11	2.80	2.67	3.08	3.28	0.94	1.88	3.30	4.47	5.34
	(1.15)	(12.89)	(13.56)	(18.22)	(17.44)	(0.59)	(5.23)	(18.65)	(30.54)	(44.45)
LSD (P=0.05)	N.S.	N.S.	0.42	0.12	0.26	N.S.	0.26	0.44	0.25	0.23
Herbicides										
Hand weeding twice	1.16	3.23	1.22	2.00	2.17	1.10	1.60	1.80	3.36	4.96
	(1.44)	(12.11)	(1.33)	(4.56)	(4.56)	(1.33)	(2.55)	(3.74)	(14.28)	(27.23)
Butachlor *fb* 2,4-D	0.98	1.73	2.67	1.89	2.92	0.84	1.48	4.84	3.21	5.68
	(0.78)	(3.00)	(7.67)	(3.67)	(10.44)	(0.31)	(2.30)	(25.09)	(11.13)	(35.58)
Pretilachlor *fb* azimsulfuron	1.20	1.17	1.51	1.48	1.48	1.04	0.91	1.22	1.76	2.17
	(1.44)	(1.44)	(2.78)	(2.44)	(2.33)	(1.11)	(0.52)	(1.43)	(3.92)	(5.74)
Penoxsulam	0.90	1.79	1.77	1.53	1.77	0.80	1.15	1.92	2.30	3.07
	(0.44)	(3.67)	(3.89)	(3.56)	(3.67)	(0.19)	(1.23)	(4.96)	(8.04)	(11.08)
Ethoxysufuron + fenoxaprop	0.96	2.16	1.92	2.27	2.83	0.90	1.17	3.19	3.65	4.64
	(0.67)	(7.22)	(4.11)	(5.78)	(8.67)	(0.49)	(1.29)	(10.72)	(14.76)	(22.91)
Propanil + trichlopyr	0.91	4.22	4.02	4.61	4.73	0.92	2.20	5.03	6.49	8.47
	(0.56)	(19.11)	(18.44)	(23.67)	(24.67)	(0.59)	(5.16)	(27.26)	(43.27)	(77.53)
Pyrazosulfuron *fb* bispyribac	0.95	2.05	1.44	1.99	2.27	0.78	1.08	1.58	2.79	4.02
	(0.67)	(5.78)	(2.11)	(4.56)	(6.44)	(0.14)	(0.94)	(2.63)	(9.98)	(17.38)
Unweeded	1.40	7.71	6.49	7.68	7.55	1.27	4.20	8.21	10.22	12.06
	(2.11)	(60.67)	(45.56)	(64.78)	(62.44)	(1.69)	(19.08)	(68.32)	(109.88)	(158.38)
Weed free	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LSD (P=0.05)	0.32	0.56	0.54	0.54	0.49	0.30	0.45	0.56	0.76	0.64

Values within parentheses are original. Data are subjected to square root transformation ($\sqrt{x+0.5}$). *fb* : followed by; DAT: Day after transplanting

of '*Prabhat*' cultivar might be responsible for intercepting the sunlight to restrict the profused weed growth, ultimately reduced weed infestation. These observations were in conformity with reports of Pillai (1977), Thakur *et al.* (1995) and Singh *et al.* (2004). The higher weed control efficiencies of 67.9 and 60.2 for *Echinochloa* spp. as well as 67.7 and 52.7 for *Cyperus* spp. at 80 DAT and harvest respectively in *'Prabhat'* cultivar were might be due to lower weed dry matter accumulation as compared to other two cultivars (Table 3).

Application of pretilachlor (pre-emergence) *fb* azimsulfuron 15 DAT was most effective in controlling *Echinochloa* spp. with significantly lower weed count and dry matter and highest weed control efficiencies (82.78 and 82.01% at 80 DAT and harvest) which might be due to higher efficacy of these herbicides. Other herbicidal treatments except propanil + trichlopyr were also effective in controlling *Echinochloa* spp.

The application of ethoxysulfuron + fenoxaprop at 15 DAT had the best performance in reducing the population of *Cyperus* spp. recording significantly lower weed count and its dry matter. The herbicidal treatment butachlor *fb 2,4-D* as well as pyrazosulfuron *fb* bispyribac was also very effective for control of *Cyperus* spp. The highest weed control efficiencies were achieved with ethoxysulfuron + fenoxaprop recording a WCE of 84.02 and 70.61% at 80 DAT and harvest.

Effect on crop

Among all the three cultivars, *'Gautam'* recorded significantly higher grain yield (4.14 t/ha) than *'Prabhat'* (3.78 t/ha) and *'Krishna Hamsa'* (3.65 t/ha) despite of higher weed count and dry matter than *'Prabhat'* cultivar due to higher growth and yield attributes which might have resulted in higher yield (Table 3). Similar results have also been reported by Singh *et al.* (2004).

Table 2. Effect of cultivars and herbicides on weed count and weed dry matter of *Cyperus* spp. and weed control efficiency (pooled data of two years)

Treatment	Weed count (no./m^2) at different DAT					Weed dry matter (g/m^2) at different DAT				
	20	40	60	80	Harvest	20	40	60	80	Harvest
Cultivars										
'Gautam'	0.85	1.09	2.33	2.30	1.42	0.73	0.79	1.43	2.00	1.24
	(0.63)	(1.78)	(12.52)	(10.00)	(3.48)	(0.06)	(0.19)	(3.63)	(6.46)	(2.22)
'Prabhat'	0.76	0.72	1.68	2.10	1.40	0.73	0.71	1.20	1.72	1.24
	(0.15)	(0.04)	(6.04)	(7.52)	(3.69)	(0.06)	(0.01)	(2.13)	(4.66)	(2.34)
'Krishna Hamsa'	0.84	0.74	2.74	2.83	1.84	0.78	0.72	1.44	2.22	1.43
	(0.44)	(0.11)	(13.33)	(15.22)	(5.96)	(0.21)	(0.03)	(2.81)	(8.98)	(3.66)
LSD (P=0.05)	N.S.	0.20	0.40	0.35	N.S.	N.S.	0.04	0.12	0.26	N.S.
Herbicides										
Hand weeding twice	0.86	0.93	1.62	2.27	1.92	0.77	0.75	0.90	1.62	1.78
	(0.44)	(1.22)	(5.33)	(6.67)	(5.56)	(0.17)	(0.09)	(0.44)	(2.94)	(4.46)
Butachlor *fb* 2,4-D	0.71	0.71	1.23	1.24	1.15	0.71	0.71	1.44	0.99	0.94
	(0.00)	(0.00)	(2.67)	(2.22)	(1.56)	(0.00)	(0.00)	(3.47)	(0.68)	(0.69)
Pretilachlor *fb* azimsulfuron	1.13	1.16	3.00	2.73	1.63	0.77	0.81	0.92	1.84	1.09
	(1.89)	(1.94)	(17.33)	(12.89)	(4.17)	(0.17)	(0.23)	(0.58)	(4.10)	(1.03)
Penoxsulam	0.71	0.71	1.41	1.73	1.12	0.71	0.71	0.86	1.55	0.82
	(0.00)	(0.00)	(2.89)	(6.89)	(1.67)	(0.00)	(0.00)	(0.38)	(4.92)	(0.39)
Ethoxysufuron + fenoxaprop	0.76	0.71	0.71	0.93	0.97	0.75	0.71	0.71	0.85	0.77
	(0.11)	(0.00)	(0.00)	(0.78)	(1.00)	(0.09)	(0.00)	(0.00)	(0.40)	(0.14)
Propanil + trichlopyr	0.94	0.96	4.26	4.28	2.58	0.83	0.76	1.94	3.63	2.29
	(0.89)	(0.78)	(23.67)	(23.33)	(10.44)	(0.44)	(0.10)	(4.58)	(16.26)	(7.97)
Pyrazosulfuron *fb* bispyribac	0.71	0.71	1.33	1.38	0.85	0.71	0.71	1.25	1.31	0.78
	(0.00)	(0.00)	(3.11)	(2.33)	(0.56)	(0.00)	(0.00)	(2.63)	(1.78)	(0.19)
Unweeded	0.81	1.07	5.98	6.44	3.06	0.76	0.81	3.51	5.32	2.62
	(0.33)	(1.83)	(40.67)	(43.11)	(14.44)	(0.11)	(0.24)	(13.63)	(29.24)	(9.78)
Weed free	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LSD (P=0.05)	0.22	0.34	0.66	0.73	0.51	N.S.	0.08	0.34	0.44	0.41

Values within parentheses are original. Data are subjected to square root transformation ($\sqrt{x+0.5}$). *fb* : followed by; DAT: Day after transplanting

Table 3. Effect of cultivars and herbicides on weed control efficiency, 1000-grain weight, tillers/hill, yield and economics in *boro* rice (pooled data of two years)

Treatment	WCE (%) in *Echinochloa*		WCE (%) in *Cyperus*		1000-grains weight (g)	Tillers /hill at 80 DAT	Grain yield (t/ha)	Net returns (x10^3 ₹/ha)	Benefit : cost ratio
	80 DAT	Harvest	80 DAT	Harvest					
Cultivars									
'Gautam'	63.2	57.5	62.4	52.7	22.76	17.48	4.15	24.89	1.19
'Prabhat'	67.9	60.2	67.7	52.7	22.29	16.70	3.78	21.35	1.01
'Krishna Hamsa'	56.3	55.7	58.3	45.4	21.83	14.90	3.65	19.85	0.94
LSD (P=0.05)	-	-	-	-	0.48	1.25	0.09	0.10	0.05
Herbicides									
Hand weeding twice	67.1	58.9	69.5	32.1	22.89	18.78	4.41	26.80	1.21
Butachlor *fb* 2,4 – D	68.6	52.9	81.4	64.1	21.80	14.54	3.59	20.57	1.05
Pretilachlor *fb* azimsulfuron	82.8	82.0	65.4	58.4	22.61	17.76	4.35	27.46	1.32
Penoxsulam	77.5	74.5	70.9	68.7	22.06	15.61	3.84	23.08	1.17
Ethoxysufuron + fenoxaprop	64.3	61.5	84.0	70.6	22.46	16.99	4.12	25.78	1.30
Propanil + trichlopyr	36.5	29.8	31.8	12.6	21.58	13.78	3.38	17.85	0.89
Pyrazosulfuron *fb* bispyribac	72.7	66.7	75.4	70.2	22.44	16.24	3.95	21.74	0.98
Unweeded	0.0	0.0	0.0	0.0	21.36	12.34	2.41	9.20	0.50
Weed free	-	-	-	-	23.43	21.21	4.65	25.79	1.00
LSD (P=0.05)	-	-	-	-	0.63	0.95	0.10	1.14	0.06

Maximum grain yield was recorded in the treatment hand weeding twice at 30 and 50 DAT with an increase of 82.7% in yield over unweeded control. Pretilachlor *fb* azimsulfuron was the most effective among herbicidal treatments realizing 80.2% higher grain yield over unweeded control which was also statistically similar to hand weeding twice.

On the basis of two years mean, the maximum net returns and benefit : cost ratio were obtained by *'Gautam'* followed by *'Prabhat'* cultivar. The corresponding values for net returns and benefit : cost ratio were ₹ 24.898/ha and 1.19 and ₹ 21,352/ha and 1.01, respectively. Among herbicides, pretilachlor *fb* azimsulfuron recorded highest net returns (₹ 27,461/ha) and benefit: cost ratio (1.32) which was followed by ethoxysulfuron + fenoxaprop with net return of ₹ 25,783/ha and benefit : cost ratio as 1.30. Though, weed free condition gave the highest yield but net returns and benefit : cost ratio were not highest due to involvement of more labour, resulting in higher cost.

It was concluded that *'Prabhat'* followed by *'Gautam'* was found to be the most effective boro rice cultivar in respect of minimizing weed count of *Echinochola* and *Cyperus* spp., The cultivar *'Gautam'* showed its superiority over *'Prabhat'* and *'Krishna Hamsa'* in respect of yield attributes and yield. The herbicidal treatment pretilachlor 750 g/ha (pre-emergence) *fb* azimsulfuron 35 g/ha + NIS (0.25%) at 15 DAT was most effective in reducing the population and dry matter of *Echinochloa* spp. where as ethoxysulfuron 18 g/ha + fenoxaprop + safner 56 g/ha + (NIS 0.25%) at 15 DAT was most effective in reducing population of *Cyperus* spp. *'Gautam'* cultivar gave significantly higher net return (₹ 24,898/ha) and benefi:cost ratio (1.19) over *'Prabhat'* and *'Krishna Hamsa'*. Pretilachlor 750 g/ha (pre-emergence) *fb* azimsulfuron 35 g/ha + NIS (0.25%) at 15 DAT recorded significantly higher yield attributes and yield fetching significantly higher net return (₹ 27,461/ha) and benefit : cost ratio (1.32).

REFERENCES

Anonymous. 2010. Agricultural Statistics at a Glance. Directorate of Economics and Statistics, Department of Agriculture and Co-operation, Government of India, New Delhi.

Pillai KG. 1977. Integrated weed management in rice. *Indian Farming* **26**(12) : 17-23.

Raju RA and Reddy MN. 1995. Performance of herbicide mixtures for weed control in transplanted rice. *Indian Journal of Weed Science* **27**: 106-107.

Singh G, Singh VP, Singh M and Singh SP. 2003. Effect of anilofos and triclopyr on grassy and non-grassy weeds in transplanted rice. *Indian Journal of Weed Science* **35**: 30-32.

Singh UP, Singh Y and Kumar Vinod. 2004. Effect of weed management and cultivars on boro rice (*Oryza sativa* L.) and weeds. *Indian Journal of Weed Science* **36**(1&2): 57-59.

Thakur R, Singh RK and Chaudhary RL. 1995. Prabhat- a very early maturing rice variety released in Bihar. *International Rice Research Newsletter* **20**(2): 11.