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Effect of herbicides and their combinations on weed growth and yield of transplanted rice

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ABSTRACT

A field experiment was carried out at Norman E. Borlaug Crop Research Centre of G.B.P.U.A.&T, Pantnagar U.S. Nagar, Uttarakhand during *Kharif* season of 2012 and 2013 to find out the efficacy of different herbicide combinations in transplanted rice. The experimental site was silty clay loam in texture, medium in organic carbon (0.66%), available phosphorus (27.5 kg/ha) and potassium (243.5 kg/ha) with P^H 7.3. *Echinochloa colona, Echinochloa crus-galli*, *Leptochloa chinensis*, *Alternanthera sessilis, Ammania baccifera, Caesulia axillaris* and *Cyperus iria* were the major weeds in experimental field. Bispyribac–sodium + ethoxysulfuron 25 + 18.75 g/ha having statically similar with pretilachlor 750 g/ha *fb* ready mix of chlorimuron-ethyl + metsulfuron-methyl 4 g/ha and bispyribac-sodium + ready mix of chlorimuron-ethyl + metsulfuron-methyl 20 + 4 g/ha resulted in significantly lowest total weed density, dry matter accumulation and highest weed control efficiency, respectively. The maximum grain yield was recorded with twice hand weeding at 25 and 45 DAT, which was statistically at par with bispyribac–sodium + ethoxysulfuron 25 +18.75 g/ha, pretilachlor 750 g/ha *fb* ready mix of chlorimuron-ethyl + metsulfuron-methyl 4 g/ha, bispyribac–sodium + ready mix of chlorimuron-ethyl + metsulfuron-methyl 20 + 4 g/ha and pretilachlor 750 g/ha *fb* ethoxysulfuron 18.75 g/ha over the weedy check.

Key words: Grain yield, Herbicide combinations, Ready mix, Transplanted rice, Weed Control efficiency

Rice is the most important staple food crop of millions of mankind from dawn of civilization (Chakravarti *et al.* 2012). Among the cereal crops, it serves as the principal source of nourishment for over half of the global population (Davla *et al.* 2013). In Indian agriculture, rice is the main source of livelihood for more than 150 million rural households. The total area of rice crop in India in 2015 was 43.95 m ha, production is 106.65 mt and average productivity is 2.4 t/ha (Government of India, Ministry of Agriculture 2015). Weed management is one of the major factors, which affects rice yield. Uncontrolled weeds cause grain yield reduction up to 76% under transplanted conditions (Rao *et al.* 2007). The final choice of any weed control measures will depend largely on its effectiveness and economics. Use of herbicides to keep the crop weed free at critical crop weed competition stages will help in minimizing the cost of weeding as well as managing the weeds below the damaging level. Hand weeding is very easy and environment-friendly but tedious and highly labour intensive. Farmers very often fail to remove weeds due to unavailability of labour at peak periods. Therefore, hand weeding become difficult at early stages of growth due to morphological similarity between grassy weeds and rice seedlings (Rahman *et al*. 2012). Most of the herbicides have effective options for selective weed control but a single herbicide cannot control all weeds of the community (Corbelt *et al.* 2004). Bispyribac-sodium is effective for controling many annual and perennial grasses, sedges, and broad-leaved weeds in rice (Rawat *et al.* 2012). The combined application of different herbicides with different mode of action is required for most effective weed management and avoiding development of herbicide resistance. Therefore, for enhancing the efficacy of herbicides, their sequential and combined application is necessary for controlling mixed weed flora in transplanted rice. Keeping this in view, a field experiment was carried out to evaluate the efficacy of pre- and post-emergence herbicides alone and in combinations in transplanted rice.

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MATERIALS AND METHODS

A field experiment was conducted at N.E. Borlaug Crop Research Centre, G.B. Pant University of Agriculture & Technology Pantnagar, U.S. Nagar, Uttarakhand during *Kharif* seasons of 2012 and 2013. Twelve treatments, *viz*. bispyribac-sodium 25 g/ha, pretilachlor 1000 g/ha, penoxsulam 22.5 g/ha, pyrazosulfuron 20 g/ha, bispyribac-sodium +

ethoxysulfuron 25 + 18.75 g/ha, bispyribac-sodium + ready mix of chlorimuron-ethyl + metsulfuron-methyl 20 + 4 g/ha, pretilachlor 750 g/ha *fb* ethoxysulfuron 18.75 g/ha, pretilachlor 750 g/ha *fb* ready mix of chlorimuron-ethyl + metsulfuron-methyl 4 g/ha, pyrazosulfuron 20 g/ha *fb* manual weeding at 25 DAT, pretilachlor (6%) + bensulfuron (0.6%) 6.6% GR 660 g/ha (10 kg/ha), hand weeding at 25 and 45 DAT and weedy check. Experiment was laid out in randomized block design with three replications. All herbicides were applied using knapsack sprayer fitted with flat fan nozzle at spray volume of 500 l/ha. Twenty-eight days old seedling of rice variety "*Sarjoo 52*" were transplanted on July 12, 2012 and June 27, 2013 at a spacing of 20 x 10 cm. The crop was raised by following recommended packages of practices for rice. The data on weed density and weed dry weight were collected from each unit plot at 60 DAT. A quadrate of 0.5 x 0.5 m was placed randomly and weed species within the quadrate were identified and their number was counted. The average number of sample was multiplied by four to obtain the weed density/meter square. The weeds inside the quadrate were uprooted, cleaned and then oven dried. Dry matter of weeds was recorded and expressed in g/m^2.

The data on weed density and weed dry matter were analyzed after subjecting to square root transformation by adding 1.0 to original values prior to statistical analysis. Weed control efficiency (WCE) was calculated on the basis of weed biomass. Yield and yield attributes were recorded at the time of harvesting. Each experimental plot was threshed by Paddy thresher to determine grain yield and it is presented as t/ha.

RESULTS AND DISCUSSION

Major weed flora in weedy plots at 60 days stage of crop growth comprised of *Echinochloa colona, Echinochloa crus-galli* and *Leptochloa chinensis* among grassy weeds; *Alternanthera sessilis, Ammania baccifera* and *Caesulia axillaris* among broad-leaved weeds and *Cyperus iria* among sedge during 2012 and 2013.

Effect on weeds

All the weed control treatments caused significant reduction in the density of all the weeds over weedy check at 60 DAS during 2012 and 2013 (Table 1). Combination of post-emergence application of bispyribac-sodium + ethoxysulfuron 25 + 18.75 g/ha was found to be very effective in reducing the density of *E. colona* which was at par with twice hand weeding at 25 and 45 DAT, bispyribac - sodium + ready mix of chlorimuron-ethyl + metsulfuron-methyl 20 + 4 g/ha, penoxsulam 22.5 g/ha and bispyribac-sodium 25 g/ha, pretilachlor 750 g/ha *fb* ready mix of chlorimuron-ethyl + metsulfuron-methyl 4 g/ha, pyrazosulfuron 20 g/ha *fb* MW at 25 DAT over the weedy check. All treatments except pyrozosulfuron 20 g/ha and pretilachlor (6%) + bensulfuron (0.6%) 6.6% GR 660 g/ha were superior to weedy check in suppressing the growth of *E. crus-galli* during both the years. Among the herbicidal treatments, pretilachlor 750 g/ha *fb* ready mix of chlorimuron-ethyl + metsulfuron-methyl 4 g/ha showed the effective control of *L. chinensis* followed by bispyribac-sodium + ready mix of chlorimuron-ethyl + metsulfuron-methyl 20 + 4 g/ha, pretilachlor 1000 g/ha, pretilachlor (6%) +

Table 1. Effect of different treatments on species- wise weed count in transplanted rice at 60 DAT (pooled of 2012 and 2013)

Treatment	Dose (g/ha)	Weed density (no./m^2)							Total weed density (no./m^2)
		E. colona	*E. crus-galli*	*L. chinensis*	*A. sessilis*	*A baccifera*	*C. axillaris*	*C. iria*	
Bispyribac-sodium	25	1.8(3.3)	1.4(1.3)	4.0(16.0)	3.2(9.3)	3.3(11.3)	1.8(2.7)	1.4(1.3)	6.7(45.2)
Pretilachor	1000	2.5(5.3)	1.9(3.3)	2.5(5.3)	4.4(18.7)	4.3(18.7)	3.6(12.7)	2.1(4.0)	8.2(68.0)
Penoxsulam	22.5	1.8(2.7)	1.8(2. 7)	2.8(7.3)	2.9(8.0)	3.1(9.3)	2.5(6.7)	2.6(6.0)	6.5(42.7)
Pyrazosulfuron	20	4.0(16.0)	3.2(10.0)	4.2(17.3)	3.3(11.3)	3.9(18.0)	3.0(9.3)	2.2(4.7)	9.3(86.6)
Bispyribac-sodium + ethoxysulfuron	25+18.75	1.2(0.7)	1.2(0.7)	3.9(14.7)	1.6(2.0)	2.0(3.3)	1.6(2.0)	1.0(0.0)	4.8(23.3)
Bispyribac-sodium + CME + MSM (RM)	20 + 4	1.6(2.0)	1.4(1.3)	2.4(5.3)	1.8(2.7)	2.8(8.0)	1.8(2.7)	1.6(2.0)	4.9(24.0)
Pretilachlor *fb* ethoxysulfuron	750/18.75	2.2(4.7)	1.4(1.3)	3.9(15.3)	1.9(3.3)	3.2(10. 7)	1.6(2.0)	1.0(0.0)	6.1(37.3)
Pretilachlor *fb* CME +MSM (RM)	750/4	1.9(3.3)	1.6(2.0)	2.1(4.5)	2.2(4.0)	2.8(7.7)	1.6(2.0)	1.0(0.0)	4.8(23.5)
Pyrazosulfuron *fb* MW at 25 DAT	20	2.1(4.0)	1.8(2.7)	3.0(8.7)	2.5(5.3)	3.1(11.3)	2.3(5.3)	1.2(0.7)	6.2(38.0)
Pretilachlor (6%) + bensulfuron (0.6%) 6.6% GR	660	2.8(7.3)	4.2(16.7)	2.7(6.7)	2.8(8.0)	3.3(12. 7)	2.4(6.7)	1.2(0.7)	7.7(58.8)
Hand weeding 25 and 45 DAT	-	1.4(1.3)	1.0(0.0)	1.4(1.3)	1.4(1.3)	1.0(0.0)	1.0(0.0)	1.2(0.7)	2.1(4.7)
Weedy check	-	4.8(23.3)	5.7 (48.7)	4.6(20.7)	4.7(21.3)	5.5(32. 7)	4.6(22.0)	4.5(20.0)	12.5(156.7)
LSD (P=0.05)		0.9	1.5	0.6	0.9	0.8	0.7	0.7	1.2

Values in the parentheses are the means of original values. Data are subjected to square root transformation $(\sqrt{x+1})$, CME+MSM-chlorimuron-ethyl + metsulfuron- methyl , RM- Readymix, DAT- Days after transplanting, MW- Manual Weeding

bensulfuron (0.6%) 6.6% GR 660 g/ha and penoxsulam 22.5 g/ha, as compared to rest of the herbicidal treatments. Combination of bispyribac-sodium + ethoxysulfuron 25 + 18.75 g/ha being at par with bispyribac-sodium + ready mix of chlorimuron-ethyl + metsulfuron-methyl 20 + 4 g/ha, pretilachlor 750 g/ha *fb* ethoxysulfuron 18.75 g/ha, pretilachlor 750 *fb* chlorimuron-ethyl + metsulfuron-methyl 4 g/ha, pyrazosulfuron 20 g/ha *fb* MW at 25 DAT and hand weeding at 25 and 45 DAT proved effective against the density of *A. sessilis* and *C. axillaris* over the weedy check.

Combination of bispyribac-sodium + ethoxysulfuron 25 + 18.75 g/ha treated plots recorded the significantly lower number of *A. baccifera* followed by bispyribac-sodium + ready mix of chlorimuron-ethyl + metsulfuron-methyl 20 + 4 g/ha, pretilachlor 750 g/ha, *fb* ready mix of chlorimuron-ethyl + metsulfuron-methyl 4 g/ha and hand weeding at 25 and 45 DAT as compared to remaining herbicidal treatments. Complete reduction of *C. iria* was recorded with bispyribac-sodium + ethoxysulfuron 25 + 18.75 g/ha, pretilachlor 750 g/ha *fb* ethoxysulfuron 18.75 g/ha and pretilachlor 750 g/ha *fb* ready mix of chlorimuron-ethyl + metsulfuron-methyl 4 g/ha as compared to rest of the herbicidal treatments.

Total weed density was significantly reduced with bispyribac-sodium + ethoxysulfuron 25 + 18.75 g/ha which remained at par with bispyribac-sodium + ready mix of chlorimuron-ethyl + metsulfuron-methyl 20 + 4 g/ha and pretilachlor 750 g/ha *fb* ready mix of chlorimuron-ethyl + metsulfuron-methyl 4 g/ha as compared to other treatments. The better performance of this treatment might be attributed due to broad spectrum effect of bispyribac-sodium and ethoxysulfuron, which controls broad-leaved weeds and sedges effectively. Similar results were also reported by Hossain *et al.* (2014).

Effect on weed dry matter

Different weed control treatments significantly reduced the biomass of different weed species over the weedy check during both the years at 60 DAT (Table 2). Significantly, total lowest weed dry matter was recorded in bispyribac-sodium + ethoxysulfuron 25 + 18.75 g/ha being at par with pretilachlor 750 g/ha *fb* ready mix of chlorimuron-ethyl 4 g/ha and bispyribac-sodium + ready mix of chlorimuron-ethyl +metsulfuron-methyl 20 + 4 g/ha over rest of the herbicidal treatments. The broad spectrum effect of bispyribac-sodium, penoxsulam and effective control of broad-leaf weeds and sedges by ethoxysulfuron might be the reason for reducing weed biomass in these treatments. Pretilachlor 750 g/ha *fb* ethoxysulfuron 18.75 g/ha and bispyribac-sodium + chlorimuron-ethyl + metsulfuron-methyl 20 + 4 g/ha were at par with each other indicating the significant effect of sequential application of pre-emergence and post-emergence herbicides. These were significantly superior to alone application of bispyribac-sodium, pretilachlor 1000 g/ha and pyrazosulfuron-ethyl 20 g/ha.

The better performance of herbicide combinations indicates their superiority over alone application. The highest weed density and dry matter were recorded in weedy check. This suggests that without proper management of weeds in transplanted

Table 2. Effect of different treatments on weed dry weight, weed control efficiency and grain yield of transplanted rice (pooled of 2012 and 2013)

Treatment	Weed dry weight (g/m^2)	WCE (%)	No. of grains/ panicle	Grain yield (t/ha)
Bispyribac-sodium (25 g/ha)	6.2(39.6)	67.5	169	5.38
Pretilachor (1000 g/ha)	7.9(66.4)	45.6	152	5.14
Penoxsulam (22.5 g/ha)	5.8(35.2)	71.1	170	5.64
Pyrazosulfuron (20 g/ha)	8.6(75.8)	37.9	146	4.75
Bispyribac-sodium + ethoxysulfuron (25 + 18.75 g/ha)	3.5(15.7)	87.1	193	6.11
Bispyribac-sodium + CME + MSM (RM) (20 + 4 g/ha)	4.2(18.6)	84.8	180	5.97
Pretilachlor *fb* ethoxysulfuron (750/18.75 g/ha)	4.7(23.1)	81.1	176	5.86
Pretilachlor fb CME +MSM (RM) (750/4 g/ha)	3.9(16.8)	86.2	186	6.02
Pyrazosulfuron *fb* MW at 25 DAT (20 g/ha)	5.2(26.9)	77.9	172	5.66
Pretilachlor (6%) + bensulfuron (0.6%) 6.6% GR (660 g/ha)	7.4(56.5)	53.7	161	5.17
Hand weeding 25 and 45 DAT	2.6(9.1)	92.5	199	6.23
Weedy check	10.9(122.0)	-	135	3.52
LSD (P=0.05)	0.7		14.7	0.44

Values in the parentheses are the means of original values. Data are subjected to square root transformation $(\sqrt{x+1})$; CME+MSM-chlorimuron-ethyl +metsulfuron-methyl, RM- Readymix, DAT- Days after transplanting, MW-Manual Weeding

rice, the weed growth will be at peak and hamper crop growth. Among herbicidal treatments, highest weed control efficiency (81.7%) was recorded with bispyribac-sodium + ethoxysulfuron 25 + 18.75 g/ha followed by pretilachlor 750 g/ha *fb* chlorimuron-ethyl + metsulfuron-methyl 4 g/ha and bispyribac-sodium + chlorimuron-ethyl + metsulfuron-methyl 20 + 4 g/ha than rest of the herbicidal treatments, while the lowest weed control efficiency was recorded with alone application of pyrazosulfuron20 g/ha and pretilachlor 1000 g/ha than other treatments.

Effect on crop

Pooled data revealed that the average number of grains/panicle and grain yield were affected significantly by different treatments. It was observed that significantly highest grain yield (6.11 t/ha) was recorded with bispyribac-sodium + ethoxysulfuron 25 + 18.75 g/ha which was at par with pretilachlor 750 g/ha *fb* chlorimuron-ethyl + metsulfuron-methyl 4 g/ha, bispyribac-sodium + ready mix of chlorimuron-ethyl + metsulfuron-methyl 20 + 4 g/ha and pretilachlor 750 g/ha *fb* ethoxysulfuron 18.75 g/ha as compared to rest of the herbicidal treatments (Table 2). Uncontrolled weeds in weedy check plots caused an average reduction in grain yield to the extent of 42.4% when compared with bispyribac-sodium + ethoxysulfuron 25 + 18.75 g/ha mainly due to highest density and dry matter accumulation by weeds in weedy check plots. Ethoxysulfuron being an ALS inhibitor also significantly increased the grain yield when applied in combination with other herbicides. The results were in conformity with the findings of Dewangan (2011). Chlorimuron-ethyl + metsulfuron-methyl 4 g/ha (RM) also proved to increase the grain yield when applied in combination with other herbicides as post-emergence by suppressing weed population and reducing the weed biomass. Similar results were reported by Upasani *et al.* (2012).

It was inferred that combination of bispyribac-sodium + ethoxysulfuron 25 + 18.75 g/ha was found most effective in controlling weeds with the highest weed control efficiency and grain yield.

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