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Effect of herbicides combination for control of different weed flora in transplanted rice (*Oryza sativa* L.)

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Abstract
A field experiment was conducted in rice during kharif season 2012 and 2013 on sandy loam soil at Crop Research Centre, Chirori of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.), to evaluate the effect of herbicides combination for control of different weed flora in transplanted rice. The experiment was conducted in R.B.D with three replications comprising twelve treatments (T_1– Bispyribac-Na 25 g a.i. ha^{-1} 25 DAT, T_2–Pretilachlor 1000 g a. i ha^{-1}. 0-3 DAT, T_3– Penoxsulam 22.5 g a. i. ha^{-1} 8-12 DAT, T_4–Pyrazosulfuron 20 g a.i. ha^{-1} 0-3 DAT, T_5–Bispyribac + Ethoxysulfuron 25+18. g a.i. ha^{-1} 25 DAT, T_6–Bispyribac +Almix 20+4 g a.i. ha^{-1} 25 DAT, T_7–Pretilachlor *fb* Ethoxysulfuron – 75g a. i. ha^{-1} 25 DAT, T_8–Pretilachlor *fb* Almix 750/4 g a.i. ha^{-1} 25 DAT, T_9–Pyrazosulfuron fb Hand weeding 20 g a. i. ha^{-1} 0-3 fb 25 DAT, T_{10}–Pretilachlor(6%) + Bensulfuron(0.6%) 660(10 kg/ha) 0-5 DAT, T_{11}–two hand weeding at 20& 40 DAS and T_{12}–weedy check.. The results indicated that Herbicides combination of weed control significantly reduced the weed population and their dry weight effectively over weedy check. Among the herbicide application Bispyribac +Almix 20+4 g a.i. ha^{-1} 25 DAT was controlled the narrow and broad leaves weeds very effectively and recorded higher value of weed control efficiency and yield of rice. Thus, it may be concluded that application of Bispyribac +Almix 20+4 g a. i. ha^{-1} 25 DAT as proved most superior than other treatment with respect to higher weed control efficiency and yield of rice.

Keywords: Rice, weed management, chemical herbicides, weed dry matter and weed index

Introduction
Amongst cereals, rice (*Oryza sativa* L.) is the most important and extensively grown in tropical and subtropical regions of the world, is staple food for more than 60 per cent of the world population and major source of calories for about 40% of the world population. Rice is generally grown by transplanting in puddled soils, because the condition for higher productivity is more conducive in transplanted rice. Weed Management is essentially the most important aspect for the successful cultivation of rice. Weeds cause tremendous reduction in crop yield and elevate their production costs and causing severe competition with crop plants for nutrients, moisture, solar energy, CO_2 and space and also add large amount of seed to the soil as the source of infestation for the subsequent cropping year. Weeds are responsible for heavy rice yield losses, to the extent of complete crop loss under extreme conditions (Singh *et al*., 2005; Savary *et al*., 2005; Rao and Nagamani, 2007 and Rao *et al*., 2007) [12, 11, 8, 9]. The weed flora under transplanted condition is very much diverse and consists of grasses, sedges and broad-leaf weeds causing yield reduction of rice crop up to 76%. Recently, Penoxsulam is emerged as a new acetolactate synthase (ALS) inhibitor herbicide for post-emergence control of annual grasses, sedges and broadleaf weeds in rice culture (Jabusch and Tjeerdema, 2005) [5]. Bispyribac-sodium, a pyrimidinyl carboxy herbicide, is also effective to control many annual and perennial grasses, sedges and broad-leaved weeds in rice fields (Yun *et al*., 2005 Bensulfuron-methyl was studied for controlling sedges and non-grassy weeds in transplanted rice and Tank-mix application of Bensulfuron-methyl + Pretilachlor (50+500 g/ha) was found to be the most effective herbicide treatments with weed control efficiency 95% and produced 5.72 tonnes/ha yield (Sanjoy Saha, 2009) [10]. Hence, the present study was carried out to combination of herbicides to control weeds and increase productivity of rice.

Materials and Methods
A field experiment was conducted during 2012 and 2013 at Crop Research Centre, Chirori (29^0 07'N 77^0 44″E with 237 MSL) Meerut. The region has a semi-arid sub-tropical climate with an average annual temperature of 16.8 ^{0}C. The highest mean monthly temperature (38.9 ^{0}C) is recorded in May, and the lowest mean monthly temperature (4.5 ^{0}C) is recorded in

January. The average annual rainfall is about 665 to 726 mm (constituting 44% of pan evaporation) of which around 80% is acknowledged for the duration of monsoon period. Remaining 20% rainfall is received during the non-monsoon period in the wake of western disturbances and thunder storms.

The experimental field was sandy loam with pH–7.70, EC–1.65 dS/m, SOM–0.42%, available N–155 kg/ha, available P–14.8 kg/ha and available K–140 kg/ha. The treatments were T_1–Bispyribac-Na 25 g a.i. ha^{-1} 25 DAT, T_2–Pretilachlor 1000 g a. i ha^{-1}. 0-3 DAT, T_3– Penoxsulam 22.5 g a. i. ha^{-1} 8-12 DAT, T_4–Pyrazosulfuron 20 g a.i. ha^{-1} 0-3 DAT, T_5–Bispyribac + Ethoxysulfuron 25+18. g a.i. ha^{-1} 25 DAT, T_6–Bispyribac +Almix 20+4 g a.i. ha^{-1} 25 DAT, T_7–Pretilachlor *fb* Ethoxysulfuron –75g a. i. ha^{-1} 25 DAT, T_8–Pretilachlor *fb* Almix 750/4 g a.i. ha^{-1} 25 DAT, T_9–Pyrazosulfuron fb Hand weeding 20 g a. i. ha^{-1} 0-3 fb 25 DAT, T_{10}–Pretilachlor(6%) + Bensulfuron(0.6%) 660(10 kg/ha) 0-5 DAT, T_{11}–two hand weeding at 20& 40 DAS and T_{12}–weedy check. The required quantities of herbicides were sprayed in the field. Pre emergence application of Pyrazosulfuron and Pretilachlor was done after the transplanting of crop but before the emergence of weeds (3 DAT) as well as post emergence herbicides like Bispyribac sodium, Ethoxysulfuron, Almix and Bensulfuron were applied at (25 DAT), and Early-post herbicide Penoxsulam are applied at (8-12 DAT) sprayed on crop with a knapsack sprayer using a spray volume of 500 liters of water /ha. Care was taken to ensure uniform application of herbicides in each plot as per treatments. Weed-free plots were maintained free from weeds throughout the cropping cycle by manual weeding. The experiment was laid out in a randomized block design with three replications with gross plot size of 5.0× 3.0 m^2. There were twelve treatment combinations, Rice variety Pusa Sugandha-5 Nursery raising on 24 Jun, 2012 & 25 Jun 2014 and with a seed rate of 20 kg ha^{-1} and transplanting on 19 July 2012 & 20 July, 2013 in rows spaced at 20 cm and plant to plant 10 cm. One week after transplanting, gap filling was done from the same nursery for maintaining the optimum plant population. Half dose of N and full dose of P and were broadcasted and mixed at the time of puddling and remaining half dose of nitrogen was top dressed in two equal splits at tillering (25 DAT) and panicle initiation (47 DAT) stage of crop growth. Zinc sulphate (25 kg ha^{-1}) was applied at before transplanting. Nitrogen, P and K were given in the form of urea, di-ammonium phosphate and muriate of potash, respectively. Population and dry weight of weeds were recorded at 60 days after sowing stage by placing a quadrate of 0.5 m × 0.5 m randomly from three places in each plot. Data on number and dry weight of weeds were subjected to square-root ($\sqrt{X} + 1$) transformation before analysis of variance. Weed control efficiency (WCE) was calculated at harvest by using the following formula.

$$WCE = \frac{DMC - DMT}{DMC} x100$$

Where,

DMC = Dry matter production of weeds/m^2 in weedy check

DMT = Dry matter production of weeds/m^2 in the treatment to be compared and Weed index It is the per cent reduction in grain yield due to weeds as compared to total yield of weed free treatment. The weed index was calculated by using the formula as suggested by Yadav *et al.* (2007) [14].

$$\text{Weed index} = \frac{X - Y}{X} x100$$

X = Grain yield from weed free plot

Y = Grain yield from treatment for which weed index is to be worked out Weed index was expressed in percentage.

Results and Discussion

Weed studies

The crop was infested with *Echinochloa colona, Echinochloa crusgalli, Ischaemum rugosum, Eleusine indica, Dactyloctenium aegyptium, Cyondon dactylon, Commelina benghalensi, Phyllanthus niruri, Cyperus iria, Cyprus rotundus* and *Eclipta alba* etc. The most dominant weed species found in the experimental field were *Echinochloa colona, Echinochloa crusgalli, Cyperus iria, Cyprus rotundus, Phyllanthus niruri, Eclipta alba and Caesulia axillaris.*

The differential effects of herbicides, their dose and time of application led to a large variability in weed flora in paddy across the treatments. Highest weeds were recorded under treatment in weedy check followed by Pretilachlor *fb* Ethoxysulfuron. However weed free recorded trace weeds but was no economic than rest treatment but it prove more economic than weedy check. Application of Economically Bispiribac-Na + Almix recorded lowest weeds followed by Bispiribac-Na alone and Pyrazosulfuron *fb* hand weeding. Similar variation in the distribution of weeds has been reported across locations and crop growth stages (Das *et al*. 2015, Singh *et al*. 2017) [2, 13]. Higher tolerance and persistent nature of perennial *Cyperus rotundus* was responsible for its consistent existence in many weed control treatments. All weed control treatments adopted in the study resulted in significant reductions in populations of broadleaved, sedges, grassy weeds as well as total weeds at 60 DAT compared to weedy check (Table 1). The weed management practices significantly influenced the weed density and dry weight at 60 DAT (Table 1). In weedy check, the total weed population was significantly higher than all the herbicidal treatments. The weed menace was minimum under hand weeding done at 20 and 40 DAT, but it was marginal at 60 DAT due to emergence of weeds during later part of crop treatments,

Weed control efficiency

The data respect, effect of different herbicidal weed control treatment on weed control efficiency has been embedded in Table 1 indicated that weed free (T_{11}) treatment at the highest weed control efficiency, it was followed by Bispyribac-Na+Almix (T_6), Pyrazosulfuron fb Hand weeding (T_9) with weed control efficiency of 75.75% and 71.23% respectively among herbicide the lowest weed control efficiency 54.15% was noted with application Pretilachlor fb Ethoxysulfuron (T_7) followed by Pyrazosulfuron 54.50% (T_4), application of various herbicide like Bispyribac-Na (T_1) and Bispyribac+Ethoxysulfuron (T_5) were statistically at par and significantly superior then the rest of the treatment but use of different herbicide that is Pretilachlor (T_2), Pretilachlor+Bensulfuron (T_{10}) and Pretilachlor fb Almix (T_8) were found statistically *at par* with each other in respect weed control efficiency. This is due to lower weed population and lower dry matter production of weeds. During application of this herbicide control of weeds and provide weed free and congenial environment to the crop.

Table 1: Effect of various weed management treatments on weed density, dry weight and weed control efficiency at 60 DAP

Treatments	Grassy weed population (M^{-2})	Broad leaved population (M^{-2})	Sedges population (M^{-2})	Total weed population (M^{-2})	Total Weed dry wt. (g M^{-2})	WCE (%)
T_1 Bispyribac-Na	4.36 (18.55)	4.03(15.75)	4.55(20.25)	7.45(55)	6.41(40.65)	68.88
T_2 Pretilachlor	6.11(36.85)	4.78(22.33)	4.86(23.15)	8.97(80)	7.37(61.64)	52.82
T_3 Penoxsulam	6.30(39.20)	4.36(18.55)	4.24(17.50)	8.68(75)	7.79(60.42)	53.75
T_4 Pyrazosulfuron	6.06(36.25)	4.28(17.85)	4.91(23.75)	8.85(78)	7.82(60.72)	53.52
T_5 Bispyribac + Ethoxysulfuron	5.39(28.65)	3.64(12.75)	2.95(8.25)	7.10(50)	6.18(37.80)	71.06
T_6 Bispyribac-Na + Almix	3.71(13.30)	2.78(7.25)	2.30(5.20)	5.04(25)	5.48(29.60)	77.34
T_7 Pretilachlor *fb* Ethoxysulfuron	6.85(46.54)	4.64(21.10)	3.97(15.30)	9.13(84)	8.03(54.15)	50.89
T_8 Pretilachlor *fb* Almix	5.57(30.65)	4.44(19.25)	5.02(24.75)	8.68(75)	7.49(35.25)	57.43
T_9 Pyrazosulfuron fb hand weeding	4.90(23.55)	3.42(11.25)	3.56(12.20)	6.88(47)	5.97(35.25)	73.02
T_{10} Pretilachlor + Bensulfuron	6.16(37.55)	4.66(21.55)	4.30(18.00)	8.80(77)	7.80(60.54)	53.64
T_{11} Weed free(two hand weeding)	00.0	0.00	0.00	00	0.00	100
T_{12} Weedy check	10.97(120.00)	9.06(81.70)	9.53(90.33)	16.90(285)	11.45(130.64)	00.0
SEm ±	0.18	0.13	0.12	0.07	0.11	0.48
CD (P=0.05)	0.54	0.38	0.36	0.21	0.33	1.44

Yield and yield attributes

The yield and yield attributes was significantly influenced due to weed management practices (Table 2). Among the weed management practices significantly increase the yield attributes effective tiller m^{-2}, no. of filled grains per panicle and test weight. Grain yield and straw yield was found 5.55, and 7.55 t ha^{-1}, respectively in with two hands weeding. Weed control by herbicide the grain yield 5.43 t ha^{-1} and straw yield 7.34 t ha^{-1} was recorded significantly higher under Bispyribac +Almix 20+4 g a.i. ha^{-1} 25 DAT. The grain yield and straw yield was recorded significantly higher with Bispyribac +Almix 20+4 g a.i. ha^{-1} 25 DAT due to reduced crop weed competition, effectively suppressed predominant throughout crop growth period. The application of hand weeding and herbicidal weed control treatments gave significantly higher grain and straw yields that then weedy check similar results were also reported by Dubey *et al*. (2005) [3], Kumar *et al*. (2013) [7] Singh *et al*. (2018) and Kabdal *et al*. (2018) [6] Herbicide mixtures are reported to have complementary effect and cause greater effect on complex weed flora than individual application.

Table 2: Effect of various weed management treatments on yield attributes and yield of rice and weed index

Treatments	Effective tillers (M^{-2})	Panicle length (cm)	Filled grains $panicle^{-1}$	Unfilled grains $panicle^{-1}$	1000 grains wt.(g)	Grain yield (t h^{-1})	Straw yield (t h^{-1})	Weed index (%)
T_1 Bispyribac-Na	167.40	26.23	138.50	22.30	23.77	4.84	6.25	12.80
T_2 Pretilachlor	142.00	23.92	122.10	29.70	22.82	4.00	6.04	28.58
T_3 Penoxsulam	157.16	25.43	133.21	25.00	23.51	4.55	6.74	17.94
T_4 Pyrazosulfuron	152.30	25.12	128.30	28.10	23.27	4.26	6.46	23.08
T_5 Bispyribac + Ethoxysulfuron	169.70	25.71	134.78	18.00	24.24	5.15	7.05	7.12
T_6 Bispyribac-Na + Almix	176.30	26.91	139.01	15.00	24.52	5.43	7.34	2.16
T_7 Pretilachlor *fb* Ethoxysulfuron	147.70	26.43	125.00	29.00	23.00	4.26	6.07	23.17
T_8 Pretilachlor *fb* Almix	154.20	24.76	133.20	26.50	23.33	4.45	6.43	19.74
T_9 Pyrazosulfuron fb hand weeding	173.00	25.90	135.20	18.80	24.16	5.36	7.26	3.24
T_{10} Pretilachlor + Bensulfuron	163.80	25.64	133.33	23.10	23.70	4.55	6.70	17.94
T_{11} Weed free(two hand weeding)	181.20	27.90	140.50	14.30	24.81	5.55	7.55	0.00
T_{12} Weedy check	114.04	22.63	115.10	35.30	22.42	3.16	5.98	42.93
SEm ±	1.58	0.54	0.70	0.63	0.62	0.04	0.06	0.18
CD (P=0.05)	4.68	1.63	2.09	1.87	1.86	0.12	0.18	0.53

Conclusion

Among the herbicide application Bispyribac +Almix 20+4 g a.i. ha^{-1} 25 DAT was controlled the narrow and broad leaves weeds very effectively and recorded higher value of weed control efficiency and yield of rice. Thus, it may be concluded that application of Bispyribac +Almix 20+4 g a.i. ha^{-1} 25 DAT as proved most superior than other treatment with respect to higher weed control efficiency and yield of rice.

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