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Effect of herbicides combinations and hand weeding on growth, yield and weed population in transplanted rice (*Oryza sativa* L.)

Gourav Pratap Singh, DK Roy and Shashidhar Yadav

Abstract
The field experiment was conducted to study the "Effect of herbicides combinations and hand weeding on growth, yield and weed population in transplanted rice (*Oryza sativa* L.)" during *kharif* season of 2015 at the Research Farm of Rajendra Agricultural University, Pusa, Samastipur, Bihar, India. The experiment was laid out in a Randomized Block Design with thrice replication. There were 12 treatments viz. T_1 Bispyribac- Sodium 25 g/ha at 25 DAT (3-4 leaf stage), T_2 Penoxsulam 24 % SC 22.5 g/ha at 15 DAT, T_3 Bispyribac–Sodium+ ethoxysulfuron 25+18.75 g/ha at 25 DAT (3-4 leaf stage), T_4 Bispyribac–Sodium + Chlorimuron + metsulfuron (Almix) 20 + 4 g/ha at 25 DAT (3-4 leaf stage), T_5 Pretilachlor *fb* ethoxysulfuron 750/18.75 g/ha at 0–3 *fb* 25 DAT (3-4 leaf stage), T_6 Pretilachlor *fb* Chlorimuron + metsulfuron (Almix) 750/4 g/ha at 0–3 *fb* 25 DAT (3-4 leaf stage), T_7 Pyrazosulfuron ethyl *fb* Chlorimuron ethyl + metsulfuron methyl (Almix) 20/4 g/ha at 0–3 *fb* 25 DAT (3-4 leaf stage), T_8 Penoxsulam + cyhalofop butyl 6 % OD (RM) 135 g/ha at 15–20 DAT, T_9 Triafamone + ethoxysulfuron 30 % WG 60 g/ha at 15 DAT, T_{10} Pendimethalin (38.7 % CS) *fb* Bispyribac–Sodium 750/25 g/ha at 0–3/25 DAT, T_{11} Hand weeding at 25 and 45 DAT and T_{12} Weedy check.
The results revealed that the highest growth, yield attributes, yield and low weed population of rice were recorded by treatment T_{11}- weed free (2 hand weeding at 25 and 45 DAT). Among herbicidal treatments the highest growth yield attributes, yield and low weed population of rice were recorded by treatment T_{10}-pendimethalin (38.7 % CS) *fb* bispyribac-sodium and was significantly superior to other herbicidal treatments.

Keywords: rice, hand weeding, herbicides combinations, weed population and yield

Introduction
Rice (*Oryza sativa* L.) is a leading food crop providing 22% calories and 17% proteins of the world. Rice is staple food of lot of the world's population. In India, about 41.3 m ha of lands are under rice cultivation with production of 104.32 million tonnes and an average productivity of about 23.72 q/ha (Ministry of Agriculture 2014). In Bihar rice is cultivated in around 3.34 m ha with a production of 7.2 million tones and productivity of 21.58 q/ha (Agricultural Statistics at a Glance, 2012).
Rice (*Oryza sativa* L.) is an important food crop of India contributing about 45% of the total food grain production. Transplanted rice faces diverse type of weed flora, consisting of grasses, broad-leaved weeds and sedges. Competition offered by weeds is most important and it reduces the grain yield up to the extent of 15-45% (Chopra and Chopra, 2003) [2]. One of the most important methods to increase rice production is to minimize crop loss by weed competition. Weeds not only reduce rice production but also have an adverse effect on rice grain quality. Hand weeding is the most effective method, however, high labour wages and non-availability of labour during peak periods of agricultural operations, timely weeding is not possible. Most of the pre-emergence herbicides viz., butachlor, pretilachlor and thiobencarb were applied in large quantities for weed management in transplanted rice. These herbicides are very effective for grasses and less effective against sedges and broad-leaved weeds (Singh *et al*., 2009) [11]. Further, these herbicides are very effective for controlling weeds up to 20 DAT. Application of herbicide mixtures or sequential application of herbicides may be useful for broad-spectrum control of weeds in rice. Recent trend of herbicide use is to find out an alternative and effective weed management by using low dose high efficiency herbicides, which will not only reduce the total volume of herbicide per unit area, but also application becomes easier and economical to the farmer. Hence, the present investigation was carried out

to evaluate the relative efficacy of some of the newly developed pre and post-emergence herbicides for control of weeds in transplanted rice.

Materials and methods

The field experiment was conducted to study the "Effect of herbicides combinations and hand weeding on growth, yield and weed population in transplanted rice (*Oryza sativa* L.)" during *kharif* season of 2015 at the Research Farm of Rajendra Agricultural University, Pusa, Samastipur, Bihar, India. It is situated at 25.59^0 North latitude and 84.40^0 East longitude with an altitude of 52.3 m above the mean sea level (MSL). The experiment was laid out in nursery Jhilli field at above mentioned Research Farm. Experimental field was homogeneously fertile with even topography and uniform textural make up and was attached to the main irrigation channel connecting the farm tube well for quick, regular and timely irrigation. Proper drainage facility was also provided in order to remove excess water during experimental period.

The experiment was laid out in a Randomized Block design with thrice replication. There were 12 treatments viz. T_1 Bispyribac-Sodium 25 g/ha at 25 DAT (3-4 leaf stage), T_2 Penoxsulam 24 % SC 22.5 g/ha at 15 DAT, T_3 Bispyribac–Sodium + ethoxysulfuron 25 + 18.75 g/ha at 25 DAT (3-4 leaf stage), T_4 Bispyribac–Sodium + Chlorimuron + metsulfuron (Almix) 20 + 4 g/ha at 25 DAT (3-4 leaf stage), T_5 Pretilachlor *fb* ethoxysulfuron 750/18.75 g/ha at 0 – 3 *fb* 25 DAT (3-4 leaf stage), T_6 Pretilachlor *fb* Chlorimuron + metsulfuron (Almix) 750/4 g/ha at 0 – 3 *fb* 25 DAT (3-4 leaf stage), T_7 Pyrazosulfuron ethyl *fb* Chlorimuron ethyl + metsulfuron methyl (Almix) 20/4 g/ha at 0 – 3 *fb* 25 DAT (3-4 leaf stage), T_8 Penoxsulam + cyhalofop butyl 6 % OD (RM) 135 g/ha at 15 – 20 DAT, T_9 Triafamone + ethoxysulfuron 30 % WG 60 g/ha at 15 DAT, T_{10} Pendimethalin (38.7 % CS) *fb* Bispyribac–Sodium 750/25 g/ha at 0 – 3/25 DAT, T_{11} Hand weeding at 25 and 45 DAT and T_{12} Weedy check.

The land was ploughed by soil turning plough followed by two disking. The seed rate of 35 kg/ha was used establishment methods. The fertilizer dose viz. 120-60-40 kg N - P_2O_5 - K_2O/ha were applied in experimental field. Nitrogen was applied through urea and P_2O_5 as DAP where as K_2O was applied through MOP. One third dose of nitrogen and full dose of phosphorus and potash were applied as basal dose at the time of sowing and remaining two third dose of nitrogen was applied in two equal splits at 30 and 60 DAT. For plant protection Furadon 3G was applied for the control of insect pest. The crop was harvested by serrated edged sickles manually at physiological maturity. At first border rows around the individual plots were harvested and removed leaving only the net plot area. The harvesting of each net plot area was done separately and the harvested material from each plot were carefully bundled, tagged and taken to the threshing floor and kept separately for sun drying. Each bundle was weighed after proper sun drying and then threshed plot wise. The grain yield was recorded separately after winnowing and cleaning. The straw yields were calculated by subtracting seed yield from the bundle weight and were converted to quintal/ha based on net plot size harvest. Sample plants were selected at random in net plot area and tagged for recording observations.

The height of randomly selected five tagged rice plants in net plot area was measured from the base of the plant to the tip of the upper most leaf at harvest. The number of tillers per m^2 was visual counted at harvest stage. The plant collected for dry weight enclosed in a quadrant of 0.50 m^2 placed randomly in the border area and were uprooted from each plot. The samples were washed, sun dried and then kept in oven at 65^0C $\pm$ 5 till constant weight reached. The dry matter production was converted into g/m^2.

The total number of panicles bearing tillers/m^2 were counted at the time of harvesting from the net plot area with the help of quadrant (0.50 m^2) placed randomly at three places in each plot and were counted and then converted as per square meter. The total number of grains/panicle was calculated by adding the numbers of filled. To avoid biasness, handful seeds were taken from each net plot and thousand seeds were counted randomly and weighed. The grain yield was determined from the net plot area and was weighed in kg and converted into t/ha. The sun dried straw obtained from net plot area were weighed plot wise in kg and converted into t/ha separately at 10 per cent moisture level.

Weed population was counted from an area enclosed in a quadrant of 0.50 m^2 from each plot and then converted into per meter square. For more accuracy, reliability and validity, the data on weed count was subjected to $\sqrt{x+0.5}$ transformation as they have shown high degree of variation. A relationship between the means and variance was observed.

Result and discussion

The results obtained from the present investigation are presented in Table 1, 2 and 3.

Plant height

Significantly maximum plant height (104.44 cm) was observed in T_{11}- weed free (2 hand weeding 25 and 45 DAT) which was statistically at par with (101.82 cm) T_{10}-pendimithlin 750 g/ha (0-3 DAT) *fb* bispyribac-sodium 25 g/ha (25 DAT). This might be due to effective weed control by weed free treatment which resulted into less or nearly no crop weed competition for nutrient, light, moisture and space which leads to higher accumulation of photosynthate and subsequently resulted in longest plant height. This result is in close conformity of Singh *et al*. (2006) [10].

Table 1: Effect of different weed management treatments on plant height, number of tillers and plant dry matter production of transplanted rice.

Treatments		Plant height (cm)	Number of tillers/m^2	plant dry matter production(g/m^2)
T_1-	Bispyribac- Sodium	95.69	270.00	996.30
T_2-	Penoxsulam 24 % SC	95.04	264.00	983.50
T_3-	Bispyribac – Sodium + Ethoxysulfuron	99.08	301.00	1,061.50
T_4-	Bispyribac – Sodium + Chlorimuron + Metsulfuron (Almix)	98.47	296.00	1,053.00
T_5-	Pretilachlor *fb* Ethoxysulfuron	98.05	290.00	1,030.00
T_6-	Pretilachlor *fb* Chlorimuron + Metsulfuron (Almix)	98.32	294.00	1,039.50
T_7-	Pyrazosulfuron *fb* Chlorimuron + Metsulfuron (Almix)	97.13	287.00	1,020.00
T_8-	Penoxsulam + Cyhalofop 6 % OD	96.95	283.00	1,015.00
T_9-	Triafamone + Ethoxysulfuron 30 % WG	96.03	275.00	1,005.00
T_{10}-	Pendimethalin (38.7 % CS) *fb* Bispyribac –Sodium	101.82	305.00	1,068.00

T_{11}-	Hand weeding at 25 and 45 DAT	104.44	328.00	1,083.02
T_{12}-	Weedy check	94.17	215.00	962.09
	SEm±	1.306	1.623	9.002
	LSD (P=0.05)	3.85	4.79	27.13

Number of tillers/m^2

Number of tillers/m^2 differed significantly under different weed management practices. The maximum number of tillers/m^2 (328) was recorded under treatment T_{11}- weed free (2 hand weeding at 25 and 45 DAT). This might be due to the facts that weed free environment helps the crop for better establishment and subsequence growth. Similar view was expressed by Akabar *et al.* (2011) [1].

Plant dry matter production (g/m^2)

Significantly maximum dry matter (1083.02 g/m^2) was recorded under T_{11} receiving two hand weeding at 25 and 45 DAT which was significantly superior to rest of the weed management practices. This might be due to the facts that weed free environment helps the crop for better plant dry matter production. Similar opinion has also been expressed by Uma *et al*. (2014) [12] and Kiran *et al*. (2010) [4].

Effect of different weed management practices on yield attributing characters

The highest number of panicle/m^2, panicle length and number of grains/panicle were obtained under weed free (2 hand weeding at 25 and 45 DAT) treatment (Dixit and Varshney, 2008) and lowest under weedy check (T_{12}). Better expression of growth parameters under the conditions in which plots were kept weed free is self-explanatory. Panicle length and number of grains/panicle were higher in all weed control treatments than the weedy check, while test weight was found to be almost similar in all the treatments. This might be due to the reason that lower weed population had provided favorable and least crop-weed competition environment to the crop, which has resulted in higher photosynthetic accumulation rate and better translocation of the sink as compared to weedy check. This is in conformity with results of Payman and Singh (2008) [7].

Yield

Significantly maximum grain yield (5.05 t/ha) was obtained under T_{11}-weed free (2 hand weeding at 25 and 45 DAT), which was statistically at par with (4.84 t/ha cm) T_{10}-pendimithlin 750 g/ha (0-3 DAT) *fb* bispyribac-sodium 25 g/ha (25 DAT). This might be due to excellent performance of these treatments in terms of grain and straw yield due to better management practices and reduction in weed dry weight and its population. The result was close conformity to those given by Prakash *et al.* (2013) [8] and Singh *et al*. (2007) [9]. So far as straw yield is concerned the similar trend was recorded as that in grain yield of the rice crop.

Weed population/m^2 at 90 DAT

An appraisal of data regarding minimum weed population/m^2 (5.11) at 90 DAT indicated that different weed management treatments exerted significant effect on weed population/m^2. Minimum weed population/m^2 (5.11) was obtained under treatment T_{11}- weed free (2 hand weeding 25 and 45 DAT). This might be due to timely reduction of weed below threshold level by intercultural tools. The weeds were uprooted and killed. Similar findings were observed by Singh (2012). Among herbicidal treatments application of T_{10}-pendimethalin @ 750 g/ha *fb* bispyribac @ 25 g/ha (8.44) which was significantly superior to rest of the herbicidal treatments. This may be attributed due to earlier and effective control of weeds by pendimethalin and subsequently flushes of weeds were controlled by bispyribac-sodium efficiently. This result was similar to that of the experiment at findings of Narolia *et al*. (2014) [6].

Table 2: Effect of different weed management treatments on yield attributes of transplanted rice

Treatments		No. of panicles/m^2	Panicle length (cm)	No. of grains/ Panicle	1000 grains weight (g)
T_1-	Bispyribac- Sodium	270	17.47	54	21.15
T_2-	Penoxsulam 24 % SC	264	17.18	53	20.79
T_3-	Bispyribac – Sodium + Ethoxysulfuron	301	19.09	63	22.21
T_4-	Bispyribac – Sodium + Chlorimuron + Metsulfuron (Almix)	296	18.30	62	22.03
T_5-	Pretilachlor *fb* Ethoxysulfuron	290	18.10	60	21.92
T_6-	Pretilachlor *fb* Chlorimuron + Metsulfuron (Almix)	294	18.01	59	21.89
T_7-	Pyrazosulfuron *fb* Chlorimuron + Metsulfuron (Almix)	287	19.97	58	21.83
T_8-	Penoxsulam + Cyhalofop 6 % OD	283	17.85	56	21.51
T_9-	Triafamone + Ethoxysulfuron 30 % WG	275	17.82	55	21.32
T_{10}-	Pendimethalin (38.7 % CS) *fb* Bispyribac –Sodium	305	19.12	64	22.87
T_{11}-	Hand weeding at 25 and 45 DAT	328	19.23	67	23.21
T_{12}-	Weedy check	215	16.15	39	17.89
	SEm±	1.623	1.126	1.486	0.957
	LSD (P=0.05)	4.79	N/A	4.38	NS

Table 3: Effect of different weed management treatments on grain yield (t/ha), straw yield (t/ha) and weed population of transplanted rice

Treatments		Grain yield (t/ha)	Straw yield (t/ha)	Weed population at 90 DAT
T_1-	Bispyribac- Sodium	4.01	4.88	18.44 (4.35)
T_2-	Penoxsulam 24 % SC	4.05	4.93	18.94 (4.41)
T_3-	Bispyribac – Sodium + Ethoxysulfuron	4.68	5.71	10.81 (3.36)
T_4-	Bispyribac – Sodium + Chlorimuron + Metsulfuron (Almix)	4.31	5.53	12.33 (3.38)
T_5-	Pretilachlor *fb* Ethoxysulfuron	4.30	5.37	13.94 (3.80)
T_6-	Pretilachlor *fb* Chlorimuron + Metsulfuron (Almix)	4.37	5.62	13.58 (3.75)
T_7-	Pyrazosulfuron *fb* Chlorimuron + Metsulfuron (Almix)	4.35	5.49	14.74 (3.90)

T_8-	Penoxsulam + Cyhalofop 6 % OD	4.27	5.17	17.35 (4.22)
T_9-	Triafamone + Ethoxysulfuron 30 % WG	4.18	5.09	16.83 (4.16)
T_{10}-	Pendimethalin (38.7 % CS) *fb* Bispyribac –Sodium	4.84	5.83	8.44 (2.99)
T_{11}-	Hand weeding at 25 and 45 DAT	5.05	6.35	5.11 (2.37)
T_{12}-	Weedy check	2.92	3.62	34.41 (5.91)
	SEm±	0.113	0.14	0.831
	LSD (P=0.05)	0.33	0.43	2.45

Conclusion

From data presented it might reasonably be argued that the highest growth, yield attributes, yield and low weed population of rice were recorded by treatment T_{11}- weed free (2 hand weeding at 25 and 45 DAT). Among herbicidal treatments the highest growth yield attributes, yield and low weed population of rice were recorded by treatment T_{10} - pendimethalin (38.7 % CS) *fb* bispyribac-sodium and was significantly superior to other herbicidal treatments.

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