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Performance of different herbicides in transplanted basmati rice (*Oryza sativa L.*) under different conditions

Rajveer Singh Yadav, Vivek, Vinod Kumar Tiwari, Vineet Kumar, RK Naresh, Ashish Dwivedi and Ankit Kumar

Abstract
A field experiment was conducted in rice during *kharif* season 2011-12 on sandy loam soil at Crop Research Centre, Chirauri of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.).The experiment was conducted in R.B.D with three replications comprising ten treatments of weed management *viz.*, weedy in puddled condition, weed free in puddled condition, Pretilachlor @ 750 g a.i./ha in puddled condition, Oxyfluorfen @ 200 g a.i./ha in puddled condition, Pyrazosulfuron @ 20 g a.i./ha in puddled condition, weedy in unpuddled condition, weed free in unpuddled condition, Pretilachlor @ 750 g a.i. /ha in unpuddled condition, Oxyfluorfen @ 200 g a.i./ha in unpuddled condition and Pyrazosulfuron @ 20 g a.i./ha in unpuddled condition. The results indicated that chemical methods of weed control significantly reduced the weed population effectively over weedy check. The tallest plants, highest dry matter accumulation, nutrient uptake and grain yield (48.57 & 42.76 q/ha) were recorded with the application of Pretilachlor @ 750 g a.i./ha, which established its superiority over rest of the herbicides in puddled and unpuddled conditions. The total nitrogen, phosphorous and potassium uptake by rice crop was also highest under this treatment as 110.42 & 94.82, 30.05 & 26.97 and 124.56 & 117.23 kg/ha respectively in puddled and unpuddled conditions. Unlike that Significantly higher content and uptake of nitrogen, phosphorus and potassium were recorded with the application of Pyrazosulfuron @ 20 gai/ha in puddled condition. With the application of pretilachlor @ 750 g a.i./ha the per cent increase in grains and straw yield was 46.1 & 39 and 40.15 & 47.78 as compared to weedy check in both conditions.

Keywords: Basmati rice, Herbicides, Performance and Weed dynamics

1. Introduction

The world entered in the 21st century facing many challenges, often in an agricultural context. Prominent still is the concern for feeding an ever growing population with safe and healthy food and management of natural resources such as land, water, nutrients and energy etc. Rice occupying 163.20 million hectare of area, producing 719.73 million tonnes of rough rice with an average productivity of 4.41 tonnes ha^{-1}. Its cultivation is of immense importance to food security of Asia, where more than 90% of the global rice is produced and consumed. In India, it is cultivated on an area of 42.75 million hectare which is maximum among all rice growing countries having annual production about 105.24 million tonnes and productivity of 2.46 tonnes ha^{-1} and contributes to 15% of annual GDP (Anonymous, 2013-14) [2]. India's rice demand is estimated to rise to 122 million tons in 2020, which is equivalent to an overall increase of 22% in the next 10 years. Scented rice (*Oryza sativa* L.) cultivation is emerging as a new economic pursuit for the paddy farmers in some localities of Uttar Pradesh. Being a relatively recent introduction into Western Uttar Pradesh, adequate information on the population and weed management aspects of this crop are not locally available. Furthermore, weed competition is severe in scented paddy culture, in view of its early slow growth rates (Chander and Pandey, 2001) [4].

Weeds are the cause of serious concern on yield reduction in rice production worldwide. Losses caused by weeds vary from one country to another country, depending on the predominant weed flora and on the control methods practiced by farmers. Two examples give an idea of the dimensions of the problem about 10 million tonnes (Mt) of rice are lost annually due to weed competition (ZePu Zhang, 2001) [21]; such a quantity of rice is sufficient to feed at least 56 million people for 1 year. Weeds are the major biotic stress in rice production and account for 30 to 40 percent of yield losses (Abeysekera, 2001) [1].

Transplanting, which is the popular method of crop establishment in rice particularly during kharif season, demands more quantity of labour and hence increases the cost of production and also often results in delay in planting due to labour scarcity. It would be advantageous, if transplanting could be substituted by a low-cost method of crop establishment. Rice transplanting has been reported to be the best establishment method but due to high labour charges and unavailability of field workers during peak period The loss of nutrients through weeds was minimum with transplanting under puddled field as compare to unpuddled condition but unpuddled condition many weed infested and less growth, yield. Manna (1991) [13] reported yield reduction due to weeds to the extent of 25% in transplanted rice, 32% in puddled broadcast rice and 52% in direct sown rice. Weed infestation are severe in puddled seeded rice as compaired to unpuddled transplanted rice because of the simultaneous growth of both crops and weeds. Reduction in yield to the tune of 34% in transplanted rice, 45% direct seeded rice and 67% in upland rice due to weeds. Keeping in view these facts, an attempt has been made to find out the best weed management practice for different establishment methods are direct seeded and transplanting methods. Direct seeding of rice (DSR) refers to the process of establishing a rice crop from seeds sown in the field rather than by transplanting in Asia, conventional transplanted unpuddled rice has been replaced by transplanted puddled rice because higher yield and low infestation of weed population. Transplanted rice is mainly infested by barnyard grass besides some sedges and broad-leaved weeds. Moreover, recommended herbicides are effective against grasses only when used as pre-emergence and assure availability of water at least for 48 hours after its application. Additionally, continuous use of the same herbicide may lead to change in weed flora and their intensity with respect to time and may also result in evolution of resistance in some weed species. Pretilachlor 0.75 and 1.0 kg/ha oxadiargyl (75-120 kg/ha) provided effective control of *echinochloa colona* and also of sedges in transplanted unpuddled rice. Therefore, the present study was carried out to investigate the performance of different herbicides in transplanted basmati rice (*Oryza sativa L.*) under different conditions vis-à-vis sustainability of Basmati rice.

2. Materials and Methods

A field experiment was conducted during *kharif* 2012 at crop research centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (UP) located at a latitude of 29º 40' North and longitude of 77º 42' East with an elevation of 237 meters above mean sea level. The mean maximum and minimum temperatures of 40^0 to 45^0 and 4.2^0c were recorded in the month of June and January, respectively. The mean annual rainfall during crop period was 815 mm (75-80% of which is received during July to September) and average relative humility varied in between 69 to 83% throughout the year. The experimental field was well drained, sandy loam in texture (46.2% sand, 18.4% silt and 17.4% clay, Bouyoucos hydrometer method) and slightly alkaline in reaction (pH 7.8, Glass electrode pH meter). It was medium in organic carbon (0.50%), available nitrogen (202.6 kg/ha) and available phosphorus (16.6 kg/ha) but high in available potassium (239.0 kg/ha) with an electrical conductivity (1:2, soil: water suspension) and a bulk density of 1.6 dS/m and 1.42 Mg/m^3, respectively. All the physic-chemical properties were analyzed as per the slandered procedures given by Jackson, 1973 [10].

The experiment was laid out in randomized block design under thrice replication. The ten treatments of weed management in the study included (weedy in puddled condition, weed free in puddled condition, Pretilachlor @ 750 g a.i. /ha in puddled condition, Oxyfluorfen @ 200 g a.i./ha in puddled condition, Pyrazosulfuron @ 20 g a.i./ha in puddled condition, weedy in unpuddled condition, weed free in unpuddled condition, Pretilachlor @ 750 g a.i. /ha in unpuddled condition, Oxyfluorfen @ 200 g a.i./ha in unpuddled condition and Pyrazosulfuron @ 20 g a.i./ha in unpuddled condition. A uniform dose of 50 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha as basal through urea, single super phosphate and muriate of potash, respectively and rest of the 50 kg N/ha was top dressed at maximum tillering and panicle initiation in two equal splits through urea. Zinc sulphate was applied at 30 days stage through foliar spray @ 0.5 percent solution with two percent urea. Transplanting was done manually as per treatments using two seedlings $plant^{-1}$. One week after transplanting, gap filling was done from the seedlings of same nursery for maintaining the optimum plant population on 5th July 2012. Uniform irrigation was applied to ensure proper crop establishment. The crop was grown as per recommended package of practices and harvested on 07th November 2012. Observations on grasses, broad leaf and sedges weeds population at 30 DAT, 60 DAT and at harvest, growth parameters *viz.*, plant height and dry matter accumulation/plant and yield attributes were recorded at harvest stage. The yield was estimated by the produce obtained from net plot area, treatment wise and finally expressed at 14% moisture. Analysis of plant sample at harvest was carried out for their nitrogen, phosphorus and potassium contents by adopting the standard procedures as described by Jackson (1973) [10]. The data obtained were subjected to statistical analysis as outlined by Gomez and Gomez (1984) [9]. The treatment differences were tested by using "F" test and critical differences (at 5 per cent probability).

3. Results and Discussion

Weed density

Data shown in Table 1 revealed that the different chemicals (Pretilachlor @ 750 g a.i./ha, Oxyflorfen @ 200 g a.i./ha and Pyrazosulfuron @ 20 g a.i./ha) control the weeds effectively as compared to unweeded check in both condition puddled and unpuddled but puddled condition has better control performance than unpuddled condition. Significantly the lowest weed population recorded under weed free treatment because weed free treatment was kept free of weeds by hand weeding. Highest weed population were recorded in unweeded check plots due to un checked growth of weeds which compete for all the resources upto maturity with crop. Pretilachlor @ 750 g a.i./ha proved to be the best treatment among the herbicides. Similar finding was also reported by Malik *et al* 2011. The density of broad leaved and sedges weed was found significantly higher in weedy plots at all the stages as compared to other weed management practices. Density of sedges weeds recorded in Pretilachlor @ 750 g a.i./ha treated plots was lowest as compared to rest of all treatments in both conditions puddled and unpuddled. Similar observations were also recorded by Chopra and Chopra (2003) [5].

Crop performance

Perusal of the data shown in Table 2 makes it clear that all the weed management practices influenced the crop growth over

weedy check. The highest plant height at harvest stages was recorded in weed free plots. Among the chemical treated plots in puddled and unpuddled conditions least plant height at harvest stages was recorded in pyrazosulfuron @ 20 g a.i./ha treated plots but highest plant height was observed under pretilachlor @ 750 g a.i./ha applied treatment. Over all lowest plant height was recorded in weedy plots at all the stages in puddled and unpuddled conditions. This may be due to lower dry weight of weeds in pretilachlor @ 750 g a.i./ha applied plots, which resulted in less crop-weed competition. Similar results were also reported by Malik *et al.* (2011). Among the herbicides, maximum dry matter accumulation was recorded with application of Pretilachlor @ 750 g a.i./ha which was closely followed by Oxyflorfen 200 g a.i./ha at all the stages of crop growth. This may be due to more vegetative growth of the crop at the cost of proper development of sink. These findings were also supported by the results of Pathak *et al.* (2001) [14].

Panicle length and 1000-grains weight differed significantly due to various weed management practices. The number of grains per panicle were also boost up significantly when the crop was treated with Pretilachlor @ 750 g/ha as compared to oxyflorfen @ 200 g./ha and pyrazosulfuron @ 20 g a.i./ha in both condition puddled and unpuddled. Similar results were also reported by Kathirvelam and Vaiyapuri (2004) [11]. Due to reduced crop-weed competition and better sink capacity increase in the sink capacity of crop was expressed in terms of panicle length and 1000-grains weight. The yield attributes are decided by genetic makeup of the crop and variety, but the agronomic manipulation also affects them to a great extent. The reproductive growth depends on vegetative growth of plant. More vegetative growth increases the photosynthetic area and supply of photosynthates toward sink which decided the yield attributes and ultimately the yield. The higher values of yield attributes may probably due to increased synthesis and translocation of metabolites for the panicle development and grains formation. Besides, thousand grains weight was also maintained because of high mobilization of photosynthates from source to sink, essential for protein synthesis and carbon assimilation. Similar findings were also reported by Subramanian *et al*. (2006) [18 and Yadav *et al.* (2008) [20]. The final yield of the crop is the cumulative effect of yield attributes and the factor which directly effect and/ or indirectly influenced them. A crop can performed best only when the display of foliage on the ground surface is in such a manner that utilizes maximum natural resources. In present study, the grain yield/ha was significantly influenced by the different weed management practices. The increase in grain yield/ha in weed free and Pretilachlor @ 750 g a.i. / ha applied plots were mainly due to the increase in yield attributes. Besides, plant population at maturity the increase in yield attributes also the most deciding factor for higher grain yield. The result was also supported by Rana *et al* (2000) [15] Ghuman *et al.* (2008) [8].

A cursory glance at the data presented in Table 2 reveals that the maximum grain yield (49.99) q/ha was observed in weed free plots and it was 50.34% higher than weedy plots in puddled condition whereas in unpuddled condition the maximum grain yield (44.65) q/ha was observed in weed free plots and it was 47.79% higher than weedy plots. Grain yield recorded in weed free plots was found *at par* with the grain yield recorded in Pretilachlor @ 750 g a.i./ha treated plots. This significant increase in grain yield of rice over weedy check was due to reduced crop weed competition and better sinks capacity brought about by controlling the weeds. Such effects of weed management practices on attributes have also been reported by Dubey *et al.* (2005) [7] and Walia *et al.* (2008) [8]. Moreover, higher straw yield was due to more accumulation of dry matter m^{-2} along with higher plant height number of tillers/plant. The sum of higher grain and straw yield resulted into higher biological yield under these treatments as compared to the weedy check in puddled and unpuddled conditions. The application of Pretilachlor @ 750 g a.i./ha, the grain yield (46.1 & 39%) increase than weedy check in puddled and unpuddled conditions. Weed free plots has 40.15% more straw yield than weedy check plot in puddled condition. In unpuddled condition Weed free plots has 47.87% more straw yield than weedy check plot due to better vegetative growth and more dry matter accumulation of the crop in weed free plot and thereby increase in straw yield of rice. Similar findings were also reported by Subramanian *et al*. (2006) [18].

Nutrient uptake by crop

A cursory glance at the data presented in Table 2 reveals that the highest total nitrogen uptake (110.42 & 110.34 kg/ha) by crop plant was recorded in weed free treatment in puddled and unpuddled conditions. Among the herbicides, Pretilachlor @ 750 g a.i./ha showed higher total nitrogen uptake (104.68 & 94.82 kg/ha) as compared to other herbicidal treatments in both conditions puddled and unpuddled. The lowest total nitrogen uptake (65.51 kg/ha) by crop was recorded in weedy check plots in puddled condition whereas in unpuddled condition also the lowest uptake (57.58 kg/ha) by crop was recorded in weedy check plots. The similar finding was also reported by Sanjay *et al* (2006) [6].

Highest total phosphorus uptake (32.90 kg/ha) observed in weed free treatment in puddled condition. Among the herbicidal treatments the highest total P uptake (30.05 & 26.97 kg/ha) was observed in Pretilachlor @ 750 g a.i./ha treated plots which was significant higher over the weedy check treatments in both conditions puddled and unpuddled. The lowest total P uptake (18.57 & 15.65 kg/ha) was observed in weedy check plots. These findings confirm the results of Deepa and Jaykumar. (2008) [6].

The total potassium uptake varied significantly under different weed management practices. The highest total K uptake (131.55 kg/ha) was recorded in weed free plots in puddled condition. Among the herbicides, the highest total K uptake (124.56 kg/ha) was recorded in Pretilachlor @ 750 g a.i./ha treated plots. This might be due to less crop weed competition in these plots. Similar findings were also reported by Barbar and Velayutham (2012) [3].

Nutrient content and uptake by weed

Data presented in Table 1 revealed that the uptake of nitrogen, phosphorus and potassium in weed is a product of their nitrogen, phosphorus and potassium contents with respective dry matter of weed. Significantly higher content and uptake of nitrogen, phosphorus and potassium were recorded with the application of Pyrazosulfuron @ 20 gai/ha in puddled followed by Pyrazosulfuron @ 20 gai/ha in unpuddled. The higher content and uptake of nitrogen, phosphorus and potassium with Pyrazosulfuron @ 20 gai/ha in puddled and weed free treatments might be due to increased supply of most essential nutrients directly to the crop, indirectly through checking the loss of nutrients and increasing the nutrient use efficiency. This results in improved growth parameters, more yield and higher nutrient concentration than weedy check. The similar finding was also reported by Sanjay *et al* (2006) [16].

Table 1: Effect of different herbicides on weed population in transplanted basmati rice

Treatment	Grassy weed population (m^{-2})			Broad leaved weeds (m^{-2})			Sedges population (m^{-2})		
	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest
Weedy in puddled condition	9.65 (92.66)	9.92 (98.00)	9.70 (93.66)	6.79 (45.66)	7.01 (48.66)	6.80 (45.67)	.12 (82.66)	9.21 (84.00)	9.10 (82.00)
Weed free puddled conditions	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Pretilachlore @ 750 g ai /ha in puddled	4.14 (16.66)	4.56 (20.33)	4.34 (18.33)	2.61 (6.33)	3.08 (9.00)	2.61 (6.33)	3.65 (13.34)	4.10 (16.33)	3.76 (13.67)
Oxyfluorfen @ 200 g ai/ha in puddled	5.59 (30.66)	5.36 (28.33)	4.98 (23.33)	3.24 (10.00)	3.48 (10.66)	3.34 (10.67)	3.97 (15.33)	4.33 (18.33)	4.14 (16.66)
Pyrazosulfuron @ 20 gai/ha in puddled	5.96 (35.00)	5.58 (30.66)	5.58 (30.33)	3.29 (10.33)	3.90 (14.67)	3.43 (11.33)	4.18 (17.00)	4.52 (20.00)	4.37 (18.66)
Weedy in unpuddled condition	10.33 (116.00)	10.59 (111.66)	10.44 (108.67)	7.92 (62.33)	8.19 (66.67)	8.05 (64.33)	9.79 (95.33)	10.50 (102.33)	9.94 (98.33)
Weedy free in unpuddled condition	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Pretilachlor @ 750 g ai/hain unpuddled	4.33 (18.33)	4.70 (21.67)	4.61 (20.66)	2.91 (8.00)	3.48 (11.66)	3.13 (9.33)	3.86 (14.00)	4.14 (16.66)	3.97 (15.34)
Oxyfluorfen @ 200 g ai/ha in unpuddled	5.83 (33.33)	5.0 (32.33)	5.67 (30.67)	3.28 (10.33)	3.76 (13.67)	3.39 (11.00)	4.01 (15.66)	4.48 (19.66)	4.22 (17.33)
Pyrazosulfuron @ 20 g ai/ha in unpuddled	5.98 (35.33)	6.49 (41.66)	6.01 (35.67)	3.58 (12.33)	4.22 (17.33)	4.15 (16.66)	4.15 (17.67)	4.88 (23.33)	4.48 (22.66)
SEm±	0.03	0.06	0.04	0.04	0.05	0.05	0.03	0.05	0.04
CD(P=0.05)	0.11	0.20	0.14	0.13	0.15	0.15	0.11	0.16	0.12

Values are square root (X + 0.5) transformed and the actual are given in parenthesis

Table 2: Effect of different herbicides on growth (at harvest), yield attributes, yield and total nutrient uptake by basmati rice crop

Treatment	Plant height (cm)	Dry matter accumulation (g m^{-2})	Panicle Length (cm)	1000 grains weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Total uptake (kg/ha) by rice crop		
							Nitrogen	Phosphorus	Potassium
Weedy in puddled condition	94.6	950.33	20.6	22.65	33.25	52.03	65.51	18.57	77.35
Weed free puddled conditions	118.3	1360.67	24.3	24.39	49.99	72.92	110.42	32.90	131.55
Pretilachlore @ 750 g ai /ha in puddled	117.3	1270.33	23.5	24.22	48.57	69.80	104.68	30.05	124.56
Oxyfluorfen @ 200 g ai/ha in puddled	112.3	1210.67	21.8	23.81	45.96	67.48	98.91	27.95	118.49
Pyrazosulfuron @ 20 gai/ha in puddled	104.6	1155.33	20.8	23.41	43.29	65.76	93.46	25.65	108.02
Weedy in unpuddled condition	92.6	938.33	19.6	22.10	30.21	45.45	57.58	15.65	64.77
Weedy free in unpuddled condition	116.3	1290.67	24.0	24.36	44.65	67.21	100.34	29.26	120.36
Pretilachlor @ 750 g ai/hain unpuddled	111.4	1235.33	22.8	23.62	42.76	66.78	94.82	26.97	117.23
Oxyfluorfen @ 200 g ai/ha in unpuddled	106.6	1175.67	21.6	23.31	40.91	63.95	89.75	25.03	105.75
Pyrazosulfuron @ 20 g ai/ha in unpuddled	104.0	1095.33	20.2	22.95	38.66	61.15	85.61	22.73	96.84
SEm±	1.2	4.18	0.2	0.10	1.25	1.83	2.48	0.69	3.22
CD(P=0.05)	3.6	12.51	0.8	0.31	3.74	5.49	7.43	2.08	9.64

Table 3: Effect of different herbicides on nutrient content and uptake by weed in transplanted basmati rice

Treatment	Nutrient content (%) in weed			Nutrient uptake (kg/ha) by weed		
	N	P	K	N	P	K
Weedy in puddled condition	0.960	0.125	0.993	12.54	1.63	12.97
Weed free puddled conditions	0.000	0.000	0.000	0.00	0.00	0.00
Pretilachlore @ 750 g ai /ha in puddled	0.964	0.166	1.066	5.62	0.96	6.22
Oxyfluorfen @ 200 g ai/ha in puddled	1.122	0.191	1.163	7.79	1.33	8.07
Pyrazosulfuron @ 20 gai/ha in puddled	1.161	0.197	1.207	9.24	1.56	9.60
Weedy in unpuddled condition	0.955	0.124	0.988	12.66	1.64	13.10
Weedy free in unpuddled condition	0.000	0.000	0.000	0.00	0.00	0.00
Pretilachlor @ 750 g ai/hain unpuddled	0.892	0.153	1.043	5.69	0.98	6.65
Oxyfluorfen @ 200 g ai/ha in unpuddled	1.015	0.177	1.141	7.83	1.36	8.80
Pyrazosulfuron @ 20 g ai/ha in unpuddled	1.142	0.194	1.201	9.58	1.62	10.07
SEm±	0.009	0.001	0.004	0.29	0.04	0.27
CD(P=0.05)	0.028	0.003	0.013	0.88	0.13	0.81

4. Conclusion

Finding of the present study suggest that the application of Pretilachlor @ 750 g a.i./ha proved better than all other herbicides in transplanted rice in puddled and unpuddled conditions due to its broad spectrum nature of controling weeds in the sandy loam soil of western Uttar Pradesh.

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