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Weed management in rice as influenced by nitrogen application and herbicide use

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ABSTRACT

A field experiment was conducted for two consecutive rainy seasons of 2010 and 2011 at Varanasi (U.P.) to evaluate the effect of nitrogen application and weed management on transplanted rice and associated weeds. Puddled transplanting recorded significantly reduced weed density and heigher weed control efficiency at 60 days after transplanting (DAT) as compared to unpuddled transplanting. Butachlor 1.5 kg/ha followed by cono-weeding at 20 and 40 DAT recorded significantly higher plant height, no. of tillers/hill, dry matter accumulation, leaf area index, 1000-grain weight, no. of panicles/hill, grains/panicle and grain yield as compared to pretilachlor 0.75 kg/ha followed by azimsulfuron 35 g/ha at 15 DAT, and butachlor 1.5 kg/ha followed by azimsulfuron 35 g /ha at 15 DAT. Significantly higher yield components and rice grain yield were recorded with the application of 1/4 at 10 DAT, 1/2 at tillering and 1/4 N at panicle initiation as compared to conventional scheduling of nitrogen application.

Key words: Azimsulfuron, Butachlor, Cono-weeding, Nitrogen timing, Transplanted rice

In India, rice is the staple food for millions of people and plays a vital role in the economy. It is generally grown by transplanting in puddled soils. Weeds are regarded as one of the major limiting factors of the crop production (Rao and Nagamani 2010). Weeds share light, nutrients and water with the crop and thus interfere with rice growth and production in many ways. The effective control of weeds at initial stages (0-40 DAT) can help in improving productivity of the crop. Aminpanah *et al.* (2013) observed that the highest grain yield were observed with pretilachlor. Suganthi *et al.* (2010) reported that pre-emergence application of pretilachlor 1.0 kg/ha and pretilachlor 0.75 kg/ha with a hand weeding at 45 DAT offered better weed control and resulted in increased yield and economics of transplanted rice compared to the recommended weed control methods of butachlor 1.25 kg/ha, anilofos 0.4 kg/ha and pretilachlor 0.75 kg/ha, and hand weeding twice. Application of azimsulfuron 27.5 g/ha + metsulfuron-methyl 2 g/ha + 0.2% surfactant was more effective in controlling weeds and recorded higher mean grain and straw yields (Jayadeva *et al.* 2010). Naresh *et al.* (2013) reported that yields of rice in conventional puddled transplanting were higher as compared to unpuddled transplanting, reduced-till transplanting, and direct-seeding systems.

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Nitrogen plays an important role in realising higher rice yield and maintaining the photosynthetic activity during grain filling stage of the crop. It is important to increase nitrogen utilization efficiency in rice production system through scheduling of nitrogen application as per the demand of crop plants. Singh and Thakur (2007) recorded that application of nitrogen up to 90 kg/ha in four splits (1/4 basal + 1/4 at active tillering + 1/4 at panicle initiation + 1/4 at boot stage) and 3 splits (1/4 at basal + 1/4 at active tillering and 1/4 at panicle initiation). The present study was undertaken to study the influence of nitrogen application and weed management on rice and weed growth, and yield of transplanted rice.

MATERIALS AND METHODS

A field experiment was conducted for consecutive two rainy seasons of 2010 and 2011 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The geographical location of the farm lies at $25^0$18’N latitude and $88^0$36’E latitude at an altitude of 129 m from the mean sea level in the Northern Indo-Gangetic alluvial plains. The soil of experimental site was sandy-clay-loam in texture with slightly basic reaction (pH-7.37). It was low in organic C (0.49%) and available N (197.5 kg/ha), medium in available P (24.0 kg/ha) and K (230.9 kg/ha). The total rainfall of 715.8 mm and 1137.7 mm was received during rice crop seasons of 2010 and 2011, respectively. The field experiment was conducted in split-plot design which was replicated thrice. Treatment combinations of two methods of rice transplanting (puddled and unpuddled) and five weed management methods (butachlor 1.5 kg/ha followed by azimsulfuron 35 g/ha + non-ionic surfactant (0.25%) at 25 DAT, pretilachlor 0.75 kg/ha followed by azimsulfuron 35 g/ha+NIS (0.25%) at 25 DAT, butachlor 1.5 kg/ha followed by cono-weeder at 20 DAT and two hand weedings at 20 and 40 DAT and weedy) were kept in main plots, and the sub-plot treatments were nitrogen (120 kg/ha) application timing as conventional scheduling of nitrogen application (1/2 at basal dressing, 1/4 at tillering and 1/4 at panicle initiation), and initial reduced dose and delayed nitrogen application (1/4 at 10 DAT, 1/2 at tillering and 1/4 at panicle initiation) with the cultivar *'BPT-5204'*.

Rice was transplanted in July and harvested in November. The land was prepared by giving two ploughings each followed by planking with the help of a tractor-drawn cultivator. The puddling was done at the time of transplanting only in puddled transplanting treatments, while in unpuddled transplanting the water was given after ploughing the field twice followed by planking after receipt of monsoonal rainfall. A uniform fertilizer dose of 120, 60, 60 kg N, P_2O_5 and K_2O/ha in the form of urea, single super phosphate and muriate of potash was applied to each experimental unit. All P and K were applied at sowing while N was applied according to treatments. Two rice seedlings per hill were transplanted at 20 cm x 15 cm spacing in experimental field. Rice was harvested at full physiological maturity, sun-dried for a week and threshed manually. Weed and crop samples were collected from each individual plot for studying various crop and weed characters. Weed samples were collected by placing a quadrat (0.5 m x 0.5 m) randomly at two places in each plot. Treatment-wise pre- and post-emergence herbicides were applied by knapsack sprayer fitted with flat fan nozzle using water volume of 300 L/ha. The data on weed density were subjected to square root $(\sqrt{x+1})$ transformation before statistical analysis to obtain homogeneity of variances.

RESULTS AND DISCUSSION

Effect on weeds

The experimental field was infested with grassy weeds, *viz. Echinochloa colona*, *Echinochloa crusgalli*, *Cynodon dactylon*, *Panicum repens* and *Paspalum distichum;* broad-leaved weeds, *viz. Ammania baccifera*, *Eclipta alba*, *Caesulia axillaris*, *Commelina benghalensis*, *Euphorbia hirta* and *Ludwigia parviflora;* and sedges, *viz. Cyperus iria*, *Cyperus difformis* and *Fimbristylis miliaceae*.

Method of rice transplanting significantly influenced the weed density at 60 DAT (Table 1). The lower weed density was recorded under puddled transplanting, which was significantly superior to unpuddled transplanting. This might be due to effective control of all categories of weeds during intensive puddling, which was started two weeks before transplanting and sufficient time allowed for germination of weed seeds present in the soil.

Amongst weed management methods, lower density of grasses, broad-leaved weeds and sedges at 60 DAT and higher weed control efficiency (Table 1, 3) was recorded with butachlor 1.5 kg/ha followed by cono-weeding at 20 DAT. Pretilachlor 0.75 kg/ha followed by azimsulfuron 35 g/ha at 15 DAT had significantly lower broad-leaved weeds and sedges and higher weed control efficiency as compared to the butachlor 1.50 kg/ha followed by azimsulfuron 35 g/ha at 15 DAT at 60 DAT. This was due to integration of chemical and mechanical method of weed control resulting in broad-spectrum control of weeds.

Initial reduced dose and delayed N application (1/4 at 10 DAT, 1/2 at tillering and 1/4 at panicle initiation) recorded significantly reduced weed density and significantly higher weed control efficiency as compared to conventional scheduling of nitrogen application. It might be due to the dynamics of N supply synchronized to meet the demand by the rice crop as reported by Mukherjee and Maity (2011).

Effect on rice

In case of rice transplanting methods, puddled transplanting recorded significantly higher plant height, number of tillers/hill, dry matter accumulation and leaf area index as compared to unpuddled transplanting (Table 2). It might be due to low crop-weed competition on growth attributes in puddled transplanting as compared to unpuddled transplanting.

Amongst weed control methods, butachlor 1.5 kg/ha followed by cono-weeding at 20 DAT recorded significantly higher plant height, no. of tillers/hill, dry matter accumulation and leaf area index. This might be due to comparatively less weed competition for nutrients, and better weed control as reported by Rajendran *et al.* (2003).

Table 1. Effect of methods of rice transplanting, nitrogen application and weed management on weed density rice at 60 DAT

Treatment	Weed density (no./m^2) Grasses 2010	Grasses 2011	Broad-leaved weeds 2010	Broad-leaved weeds 2011	Sedges 2010	Sedges 2011	Total weed density (no./m^2) 2010	Total weed density (no./m^2) 2011
Rice transplanting								
Puddled transplanting	2.91* (9.5)	2.85 (9.1)	2.60 (7.8)	2.55 (7.5)	2.24 (6.0)	2.19 (5.79)	4.39 (20.2)	4.29 (19.4)
Unpuddled transplanting	3.33 (12.0)	3.25 (11.6)	3.07 (10.4)	3.00 (10.0)	2.56 (7.5)	2.51 (7.3)	5.16 (27.6)	5.04 (26.4)
LSD (P=0.05)	0.26	0.24	0.21	0.20	0.18	0.17	0.27	0.25
Weed management								
Butachlor 1.5 kg/ha(PE) *fb* azimsulfuron 35 g/ha at 15 DAT	2.81 (8.9)	2.75 (8.6)	3.47 (13.0)	3.39 (12.5)	3.34 (12.1)	3.26 (11.6)	5.60 (32.3)	5.46 (30.8)
Pretilachlor 0.75 kg/ha (PE) *fb* azimsulfuron 35 g/ha at 15 DAT	2.49 (7.2)	2.44 (6.9)	2.91 (8.5)	2.85 (9.1)	1.51 (3.28)	1.49 (3.2)	4.03 (17.2)	3.93 (16.4)
Butachlor 1.5 kg/ha *fb* cono-weeding at 20 DAT	1.70 (3.9)	1.67 (3.8)	2.21 (5.9)	2.17 (5.7)	1.26 (2.6)	1.25 (2.6)	2.82 (8.9)	2.76 (8.6)
Two hand weedings at 20 and 40 DAT	1.0 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.0 (0.0)	1.00 (0.0)	1.00 (0.0)
Weedy	7.60 (58.7)	7.41 (55.9)	4.57 (21.8)	4.46 (20.8)	4.90 (25.1)	4.75 (23.5)	10.42 (109.5)	10.1 (104.2)
LSD (P=0.05)	0.41	0.38	0.34	0.32	0.29	0.27	0.43	0.41
Nitrogen application								
½ N at basal, ¼ N at tillering, ¼ N at panicle initiation	3.29 (11.8)	3.22 (11.3)	2.99 (9.9)	2.92 (9.5)	2.53 (7.4)	2.47 (7.1)	5.07 (26.7)	4.95 (25.5)
¼ N at 10 DAT, ½ N at tillering, ¼ N at panicle initiation	2.95 (9.7)	2.89 (9.3)	2.68 (8.2)	2.63 (7.9)	2.27 (6.1)	2.23 (6.0)	4.48 (21.1)	4.38 (20.1)
LSD (P=0.05)	0.18	0.15	0.20	0.19	0.14	0.13	0.19	0.18

*Population figures are transformed to $(\sqrt{x+1})$ and actual figures are given in parentheses, DAT- Days after transplanting

Table 2. Effect of methods of rice transplanting, nitrogen application and weed management on growth attributes in rice at 60 DAT

Treatment	Plant height (cm) 2010	Plant height (cm) 2011	No. of tillers/hill 2010	No. of tillers/hill 2011	Dry matter accumulation (g/hill) 2010	Dry matter accumulation (g/hill) 2011	Leaf area index 2010	Leaf area index 2011
Rice transplanting								
Puddled transplanting	85.5	87.3	11.3	11.4	27.1	27.9	4.74	4.76
Unpuddled transplanting	78.9	80.7	9.7	9.9	24.3	24.5	4.34	4.36
LSD (P=0.05)	4.21	4.31	0.72	0.65	1.34	1.52	0.23	0.19
Weed management								
Butachlor 1.5 kg/ha (PE) *fb* azimsulfuron 35 g/ha at 15DAT	77.0	78.8	9.9	10.0	23.5	23.9	4.37	4.39
Pretilachlor 0.75 kg/ha (PE) *fb*azimsulfuron 35 g/ha at 15 DAT	80.1	81.9	10.4	10.6	24.9	25.1	4.59	4.61
Butachlor 1.5 kg /ha *fb* cono-weeding at 20 DAT	89.9	92.4	11.6	11.7	28.9	29.1	5.24	5.26
Two hand weedings at 20 and 40 DAT	93.2	95.4	12.3	12.5	30.9	31.5	5.59	5.61
Weedy	70.6	72.3	8.3	8.4	20.2	21.3	2.93	2.94
LSD (P=0.05)	6.66	6.82	1.14	1.03	2.12	2.41	0.36	0.30
Nitrogen application								
½ N at basal, ¼ N at tillering, ¼ N at panicle initiation stages	77.1	78.9	9.9	10.1	24.0	24.5	4.32	4.34
¼ N at 10 DAT, ½ N at tillering, ¼ N at panicle initiation	87.3	89.2	11.1	11.2	27.3	27.9	4.77	4.78
LSD (P=0.05)	3.74	4.04	0.49	0.59	1.22	0.97	0.21	0.18

DAT- Days after transplanting

Initial reduced dose and delayed nitrogen application (1/4 at 10 DAT, 1/2 at tillering and 1/4 at panicle initiation) resulted in significantly higher plant height, no. of tillers/hill, dry matter accumulation and leaf area index in comparison to conventional scheduling of nitrogen. The significant variations in growth attributes were observed due to nitrogen application when needed by crop as observed by Islam *et al.* (2009).

Yield attributes and yield

The differences in 1000-grain weight were non-significant due to rice transplanting method. Puddled transplanting had significantly higher number of panicles/hill, no. of grains/panicle and higher grain yield as compared to unpuddled transplanting (Table 3). Higher values of yield attributes and grain yield under puddled transplanting were perhaps due to better partitioning of photosynthates from source to sink as a result of lower crop-weed competition owing to favourable growing conditions in puddled transplanting. The results were corroborated with the findings of Jaiswal and Singh (2001).

Amongst weed control treatments, butachlor 1.5 kg/ha followed by cono-weeding at 20 DAT had significantly more 1000-grain weight, no. of panicles/hill, no. of grains/panicle and grain yield. This might be due to effective control of weeds which in turn significantly increased the no. of panicles/hill and grains/panicle consequently improving the grain yield. Control of weeds by herbicides during early stages of rice followed by cono-weeding resulted in lower competition for growth resources that influenced the crop to grow better as evidenced in increased yield attributes. Similar findings were also observed by Singh *et al.* (2005) and Ramachandra *et al.* (2012).

Initial reduced dose and delayed nitrogen application (1/4 at 10 DAT, 1/2 at tillering and 1/4 at panicle initiation) resulted in significantly more 1000-grain weight, no. of panicles/hill, grains/panicle and grain yield in comparison to conventional scheduling of nitrogen application. Higher values of yield attributes and grain yield were probably owing to more utilization and uptake of nitrogen at active growing stages, *viz.* tillering and panicle initition. Similar findings were also observed by Awasthe (2009) and Gill and Walia (2013).

It can be concluded that butachlor 1.5 kg/ha followed by cono-weeding at 20 DAT and scheduling of N (1/4 at 10 DAT, 1/2 at tillering stage and 1/4 at panicle initiation stage) under puddled transplanting could be recommended for effective weed management and higher rice yield.

Table 3. Effect of methods of rice transplanting, nitrogen application and weed management on yield attributes, yield and weed control efficiency

Treatment	Rice yield attributes						Rice grain yield (t/ha)		Weed control efficiency (%)	
	Test weight (g/1000 seeds)		No. of panicles/hill		No. of grains/panicle					
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Rice transplanting										
Puddled transplanting	16.5	16.5	12.6	12.8	181.9	184.7	4.64	4.75	65.9	65.7
Unpuddled transplanting	16.1	16.2	11.5	11.8	161.2	163.8	4.20	4.26	53.6	53.5
LSD (P=0.05)	NS	NS	0.50	0.59	11.7	9.28	0.17	0.21	-	-
Weed management										
Butachlor 1.5 kg/ha (PE) *fb* azimsulfuron 35 g/ha at 15DAT	15.1	15.2	11.3	11.4	150.5	152.8	4.37	4.42	33.9	34.6
Pretilachlor 0.75 kg/ha (PE) *fb* azimsulfuron 35 g/ha at 15 DAT	16.1	16.2	11.9	12.0	172.8	175.5	4.52	4.63	45.7	45.7
Butachlor 1.5 kg /ha *fb* cono-weeding at 20 DAT	17.3	17.4	13.1	13.2	204.5	207.7	4.93	5.03	71.0	71.0
Two hand weedings at 20 and 40 DAT	19.2	19.2	14.3	14.5	233.7	237.4	5.42	5.53	100.0	100.0
Weedy	13.8	13.8	9.94	10.3	96.3	97.8	2.85	2.94	0.00	0.00
LSD (P=0.05)	1.18	1.18	0.80	0.93	18.6	14.6	0.28	0.33	-	-
Nitrogen application										
½ N at basal, ¼ N at tillering, ¼ N at panicle initiation	15.9	15.9	11.8	12.0	165.0	167.6	4.22	4.31	55.3	55.1
¼ N at 10 DAT, ½ N at tillering, ¼ N at panicle initiation	16.7	16.8	12.4	12.6	178.1	180.9	4.61	4.71	64.4	64.2
LSD (P=0.05)	0.66	0.66	0.48	0.49	8.51	8.46	0.14	0.15	-	-

DAT- Days after transplanting

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