



Integrated weed management and crop establishment method for higher yield in direct-seeded rice

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In recent years, there has been a shift from transplanted rice to direct-seeded rice (DSR) cultivation in several countries of South East Asia (Pandey and Velasco 2002). At present, 23% of rice is direct-seeded globally (Rao *et al.* 2007). Heavy weed infestation is one of the major constraints in DSR causing severe yield losses which is the major bottleneck in DSR cultivation especially in dry field conditions (Harada *et al.* 1996, Rao *et al.* 2007). Yield losses due to weeds varied from 40-100% in direct-seeded rice (Choubey *et al.* 2001). Rice establishment methods play an important role in influencing weed and crop growth and productivity. Mahajan and Chauhan (2011) observed that paired row planting pattern (15-30-15-cm row spacing) in DSR had a great influence on weeds as compared to normal row planting system (23-cm row spacing). Paired row planting greatly facilitates weed suppression by maintaining rice plant's dominant position over weeds through modification in canopy structure. At the same time Roy *et al.* (2009) reported that the yield of direct seeding of rice can be enhanced with square planting (20 x 20 cm) of rice.

Most of the herbicides recommended for DSR are applied as pre-emergence to control weeds during initial period, however, a combination of herbicides may be more effective to control various flushes of weed in DSR. In DSR, use of butachlor (1.5 kg/ha), pendimethalin (1.2 kg/ha) and anilophos (0.4 kg/ha) as pre-emergence are recommended for the control of grassy weeds (Gogoi and Sharma 1993). Mehta *et al.* (2010) reported good control of *Echinochloa crusgalli* with application of bispyribac-Na 30 g/ha. Azimsulfuron 17.5 g/ha is effective in controlling broad-leaf weeds and sedges including *Cyperus rotundus*. Therefore, for mixed type of weed flora, it can be tank mixed with other herbicide to target broad spectrum weed control. Keeping above facts in view, an experiment was conducted to study the effect of rice establishment and integrated weed management practices on weeds and the crop growth in direct-seeded rice.

A field trial was conducted at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (India) during *Kharif* 2012. The Agricultural Research Farm, is located in at 25°18'N latitude and 88°36'E latitude at an altitude of 129 metres above the mean sea level in the Northern Gangetic alluvial plains. Climatologically, Varanasi district has a subtropical climate and is subjected to extremes of weather conditions *i.e.*, extremely hot summer and cold winter. The area also receives some winter showers due to western disturbances during December to February. The maximum temperature usually fluctuates between 22 °C and 40.7 °C while minimum temperature varies from 8.6-29.9 °C. The soil of the experimental field was sandy clay loam in texture, slightly alkaline in reaction (pH 7.56) with low organic carbon content (0.43%), low available nitrogen (183.63 kg/ha), phosphorus (18.64kg/ha) and potassium (218.86 kg/ha) in which rice cultivar '*MTU 7029*' was dry direct seeded and the experiments were laid out in split plot design on 28th June 2012 with 20 treatment combinations replicated thrice.

Main plot consisted five rice establishment treatments, *viz.* i) Conventional tillage normal spacing (R x R -18 cm); ii) Conventional tillage square planting (R x R-20 cm, P x P-20 cm); iii) Conventional tillage paired row (9-27-9 cm); iv) Reduced tillage paired row (9-27-9 cm); v) Reduced tillage square planting (R x R -20 cm, P x P-20 cm) and sub-plot consisted of four weed management treatments, *viz.* weedy, two hand weeding, pendimethalin 1 kg/ha *fb* azimsulfuron 17.5 g/ha *fb* bispyribac 25 g/ha (tank mixed) at 15 DAS *fb* 1 HW, oxadiargyl 50 g/ha *fb* metsulfuron-methyl 2 g/ha + chlorimuron-ethyl 2 g/ha at 20 DAS *fb* 1 HW. All the standard practices were adopted to raise the crop. Biometric observations on weed growth parameters, crop growth attributes and yield were recorded to ascertain significant results.

The minimum weed density and weed biomass at 60 days stage was recorded under reduced till square

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Table 1. Effect of rice establishment method and weed management on weed growth at 60 DAS, yield attributes, and yield of direct-seeded rice

Treatment	Weed density (no./m ²)**	Weed biomass (g/m ²)	Plant height (cm)	Number of tillers/m ²	Dry matter accumulation (g/running m)	Panicle length (cm)	No. of panicle/m ²	Number of grains/panicle	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
<i>Rice establishment method</i>											
CT-Normal spacing	7.1(67.7)	16.6(371)	51.0	223.6	48.1	24.9	413.7	115.0	23.5	5.84	8.40
CT-Square planting	7.2(66.2)	15.8(333)	50.1	217.8	38.3	25.2	427.7	116.9	23.3	5.72	7.77
CT-Paired row	7.6(70.5)	14.7(286)	50.7	244.8	47.8	24.7	481.0	115.8	24.2	5.91	9.07
RT-Paired Row	6.9(62.7)	13.7(249)	49.9	244.0	33.0	24.9	382.3	109.8	22.2	5.72	8.43
RT-Square planting	6.3(49.0)	13.0(226)	49.6	207.3	34.9	25.0	350.3	119.0	22.4	5.11	6.51
LSD (P=0.05)	0.50	0.34	NS	9.90	1.14	NS	17.81	3.90	0.61	0.467	1.59
<i>Weed management</i>											
Weedy	12.3(151)	23.9(575)	47.7	159.9	29.5	25.0	315.2	89.5	22.3	2.80	6.92
Two hand weeding	5.7(33.1)	14.3(205)	53.1	287.1	53.4	25.2	474.4	131.9	25.0	7.20	8.74
Pendimethalin <i>fb</i> azimsulfuron + bispyribac 15 DAS <i>fb</i> 1HW	6.5(42.4)	15.6(245)	51.1	235.4	43.5	25.1	446.7	125.1	23.2	6.59	8.37
Oxadiagryl <i>fb</i> metsulfuron-methyl + chlorimuron-ethyl 20 DAS <i>fb</i> 1HW	7.4(55.3)	18.0(293)	49.2	227.5	35.3	24.5	407.7	114.7	22.0	6.05	8.12
LSD (P=0.05)	0.28	0.29	0.75	9.71	1.99	0.44	13.54	3.60	0.55	0.38	1.13

*CT = Conventional tillage, RT = Reduced tillage, HW = Hand weeding, *fb* = followed by, DAS = Days after seeding

**values given in parentheses are original means

planting which was found significantly lesser than rest of rice establishment methods (Table 1). Whereas amongst weed management practices, pendimethalin 1 kg/ha *fb* azimsulfuron 17.5 g/ha + bispyribac 25 g/ha 15 DAS *fb* 1HW significantly reduced weed density and weed biomass in comparison to oxadiagryl 50 g/ha *fb* metsulfuron-methyl 2 g/ha + chlorimuron-ethyl 2 g/ha 20 DAS *fb* 1 HW. Two hand weeding significantly reduced weed density and weed biomass as compared to rest of the weed management treatments.

Variations in plant height were non-significant due to rice establishment methods. However, conventional till paired row planting and reduced till paired row had comparable number of tillers/m² and both these treatments were found significantly better than square planting under reduced and conventional till method of rice establishment. In case of dry matter (g/plant) accumulation, conventional till normal spacing and CT paired row had significantly more dry matter accumulation than square planting method of rice sowing under both conventional till (CT) and reduced till (RT). All the weed management treatments recorded significantly taller plants. Two hand weeding recorded significant higher values of plant height, number of tillers/m², dry matter accumulation followed by azimsulfuron 17.5 g/ha + bispyribac 25 g/ha *fb* 1 HW and metsulfuron-methyl 2 g/ha + chlorimuron-ethyl 2 g/ha *fb* 1 HW.

Observations on panicle length data were non-significant as influenced by rice establishment methods. CT paired row recorded the maximum number of panicles/m² and test weight and it was found significantly better than all the rice establishment methods. RT square planting, CT paired row and CT square planting recorded statistically comparable number of grains/panicle and it was significantly superior than RT paired row, where as in case of grain and straw yield, CT paired row was statistically at par with CT normal spacing, CT square planting and RT paired row. The maximum gain and straw yields were recorded under weed free which was found significantly better than all the weed management treatments. Amongst weed management practices, pendimethalin 1 kg/ha *fb* azimsulfuron 17.5 g/ha + bispyribac 25 g/ha *fb* 1 HW recorded higher values of yield attributing characters and yield, viz. number of panicles/m², number of grains/panicle, test weight and grain yield and it was found significantly better than oxadiagryl 50 g/ha *fb* metsulfuron-methyl 2 g/ha + chlorimuron-ethyl 2 g/ha *fb* 1 HW, however, in case of panicle length it was at par with all the weed management treatments.

SUMMARY

A field trial was conducted during *Kharif* 2012 at Agricultural Research Farm, Institute of Agricultural sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (India) to study effect of rice establishment

and integrated weed management practices on weed growth and grain yield. Pendimethalin 1.0 kg/ha fb azimsulfuron 17.5 g/ha + bispyribac 25 g/ha 15 DAS fb 1 HW significantly reduced weed density and weed biomass in comparison to oxadiagryl 50 g/ha fb metsulfuron-methyl 2 g/ha + chlorimuron-ethyl 2 g/ha 20 DAS fb 1 HW. Rice grain yield in CT paired row was statistically at par with CT normal spacing, CT square planting and RT paired row. It was significantly higher as compared to RT square planting. Amongst weed management practices, pendimethalin 1 kg/ha fb azimsulfuron 17.5 g/ha + bispyribac 25g/ha fb 1HW recorded higher rice grain yield attributing characters viz. number of panicles/m², number of grains/panicle, test weight and grain yield and it was found significantly better than oxadiagryl 50 g/ha fb metsulfuron methyl 2g/ha+ chlorimuron-ethyl 2g/ha fb 1 HW.

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