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Cultivar competitiveness and weed control in zero-till dry-seeded irrigated rice (*Oryza sativa*)*

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Dry-seeding of rice (*Oryza sativa* L.) is extensively practised in rainfed lowlands, uplands and flood-prone areas. It saves 15–20% irrigation water (Gupta *et al*. 2006) and reduces the production costs as compared to puddle transplanted rice. Direct-seeded rice needs only 34% of the total labour requirement and saves 27% of the total cost of the transplanted crop. Direct drilling of rice using zero tillage can be followed for growing good crop of rice in the soils with low infiltration rate (Mishra and Singh 2008). Weeds are a major constraint to dry-seeded rice production, causing 40-100% loss in grain yield (Bahar and Singh 2004). Manual weeding in upland rice is labour intensive and requires as high as 190 man-days/ha (Roder 2001). With the availability of proper weed management technology it is possible to raise the productivity of direct-seeded rice. The cost of weed control could partially or completely be compensated with savings in tillage operation in zero tillage. Using competitive cultivars to suppress weeds might substantially reduce herbicide use and labour costs, permitting weeds to be controlled with a single herbicide application or hand weeding. Competitive cultivars may therefore be an important component of integrated weed management strategies (Fisher *et al.* 2001). The present investigation was undertaken to evaluate the weed competitive ability of rice cultivars under zero-till conditions.

A field experiment was conducted during rainy *(kharif)* season of 2005 and 2006 at Directorate of Weed Science Research, Jabalpur (23^0 90' N, 79^0 58' E, 412 m above mean sea level), India. The soil was clay loam (Typic chromusterts), low in available nitrogen (240 kg N/ha), medium in available phosphorus (17.5 kg P/ha) and high in available potassium (308 kg K/ha) with organic carbon 0.52 % and *p*H 7.1. The experimental design was a split-plot with three replications. Main-plot treatments were weedy check, pendimethalin 1.0 kg/ha as pre-emergence and pendimethalin 1.0 kg/ha + 1 hand weeding (HW) at 30 days after sowing (DAS). Rice cultivars JR 3-45 and Vandana (early duration: 75–90 days), Kranti and Sugandha (medium duration: 110–120 days) and Pusa Basmati and Taraori Basmati (late: 140–150 days) were the sub-plot treatments. The seeding rate was 100 kg/ha. Rice was sown in dry soil after the harvest of preceding wheat with a zero till seed-cum-fertilizer drill on 13 July 2005 and 8 July 2006. Glyphosate at 1.0 kg/ha was applied 1 week before seeding to kill the existing vegetation. Pendimethalin was applied one day after sowing with 500 litres/ha water with knapsack sprayer, fitted with flat-fan nozzle. The crop was raised under irrigated conditions as per recommended package of practice. There was withdrawal of monsoon from last week of September (at post-flowering stage) during both the years. Density and dry matter accumulation of weeds were recorded at 60 DAS by placing a quadrate of 50 cm × 50 cm randomly at four places in each plot. These were subjected to square-root transformation [v(x+0.5)] before analysis. Rice leaf area was recorded at 60 DAS by removing all the leaves from each of five plants and passing them individually through a stationary leaf area meter (Model: LI-COR 3100). Plant height was determined by measuring the distance between the soil surface and tip of the growing point of five randomly selected plants. The treatments by year interactions were not significant, and data for both the years were pooled for all the variables and averages of two seasons were analyzed by the analysis of variance technique. In order to find out the relationship between weed dry matter and crop growth morphological parameters, data were subjected to correlation analysis.

The major weeds associated with zero-till dry-seeded rice were *Echinochloa colona* (L.) Link (jungle rice, 16.2 %), *Alternanthera sessilis* (L.) D C (alligator weed, 17.5 %), *Caesulia axillaris* Roxb (caesulia, 43.6 %), *Cyperus iria* L. (rice flat sedge, 14.7 %) and others (8.0 %). Pre-emergence application of pendimethalin at 1.0 kg/ha did not reduce the weed population at 60 days after sowing (Table 1). Although

*Short note

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pendimethalin is very effective against *Echinochloa* spp under good surface soil-moisture (Singh 2008, Mishra and Singh 2008), its poor efficacy on weed density in present investigation might be due to lower soil moisture availability under dry-seeded zero-till condition and emergence of second flush of weeds by 60 days. However, the weed dry matter of *E. colona* was significantly reduced due to pendimethalin (Table 1). Different varieties varied significantly in reducing weed density. Rice cultivars Vandana and Kranti were more effective in reducing weed population as compared to other cultivars. Pendimethalin caused 57 % and 32 % reduction in total weed dry matter, respectively at 60 DAS and at harvest due to significant reduction in dry weight of *E. colona*. However, this herbicide was not effective against broad-leaved weeds and sedges. Singh (2008) also reported poor efficacy of pendimethalin against broad-leaved weeds and sedges. Among different cultivars, Kranti being at par with JR3-45 was more effective in reducing weed biomass, followed by Vandana and Sugandha, where as Pusa Basmati and Taraori Basmati were the least effective.

Plant height, panicle length and 1 000-grain weight did not vary significantly due to different weed control treatments (Table 2). Application of pendimethalin alone or in combination with 1 hand weeding significantly improved leaf area index, no of panicles/m row, grains/panicle and grain yield of rice as compared to weedy check. Maximum rice yield (2 288 kg/ha) was obtained from integration of pendimethalin + 1 hand weeding, followed by pendimethalin alone (2 069 kg/ha). Infestation of weeds throughout the crop growth period caused 26 % reduction in grain yield of zero-till dry-seeded rice compared with pendimethalin + one hand weeding. Among the rice cultivars Vandana recorded maximum plant height and leaf area index, whereas JR 3-45 produced maximum number of panicles/m row and Sugandha, maximum panicle length and grains/panicle. The highest grain yield (3 059 kg/ha) was obtained with JR 3-45 followed by Kranti and Sugandha. Higher yields of early maturing cultivars were attributed to reduced weed competition stress and significant improvement in yield attributes due to shorter growing period, escaping the late-season drought. Poor yields of late-maturing Basmati rice (801–918 kg/ha) was attributed to lower leaf area index, number of panicles/m, grains/panicle and 1 000-seed weight due to higher weed competition stress and withdrawal of monsoon at post-flowering stage.

Correlation coefficients between weed dry weight and growth and yield attributes of rice indicated that weed dry

Table 1 Effect of varieties and weed control methods on weed population and weed dry weight at 60 DAS (pooled data of two years)

Treatment	Weed population (no./m^2)					Weed dry weight (g/m^2)				
	E. colona	*A. sessilis*	*C. iria*	*C. axillaris*	Total	*E. colona*	*A. sessilis*	*C. iria*	*C. axillaris*	Total
Weed control										
Weedy check	3.09 (9.05)	3.20 (9.74)	2.95 (8.20)	4.98 (24.3)	7.5 (55.75)	6.90 (47.11)	1.56 (1.93)	1.85 (2.92)	3.30 (10.39)	8.37 (69.56)
Pendimethalin 1.0 kg/ha	3.18 (9.61)	4.28 (17.82)	4.35 (18.42)	4.92 (23.71)	8.5 (71.75)	2.76 (7.12)	1.52 (1.81)	1.97 (3.38)	3.46 (11.47)	5.49 (29.64)
Pendimethalin + 1 HW at 30 DAS	2.45 (5.50)	4.37 (18.6)	5.03 (24.8)	3.48 (11.61)	7.7 (58.79)	1.45 (1.60)	1.32 (1.24)	1.61 (2.09)	1.34 (1.30)	2.79 (7.28)
LSD (P=0.05)	0.69	NS	0.81	0.28	NS	0.72	NS	0.31	0.51	0.36
Varieties										
JR 3-45	2.73 (6.95)	4.26 (17.65)	3.85 (14.32)	4.69 (21.50)	8.1 (65.11)	3.11 (9.17)	1.36 (1.35)	1.70 (2.39)	2.29 (4.74)	4.82 (22.73)
Vandana	2.50 (5.75)	3.93 (14.94)	3.30 (10.39)	4.36 (10.51)	7.3 (52.79)	3.48 (11.61)	1.49 (1.72)	1.59 (2.03)	3.15 (9.42)	5.58 (30.64)
Kranti	2.31 (4.84)	4.09 (16.23)	3.42 (11.20)	4.20 (17.14)	7.3 (52.79)	2.63 (6.42)	1.33 (1.37)	2.49 (5.70)	2.37 (5.12)	4.71 (21.68)
Sugandha	3.07 (8.92)	2.95 (8.20)	4.68 (21.40)	4.92 (23.71)	7.8 (60.34)	3.94 (15.02)	1.16 (0.85)	1.71 (2.42)	3.04 (8.74)	5.76 (32.68)
Pusa Basmati	3.59 (12.39)	4.76 (22.16)	4.88 (23.31)	4.28 (17.82)	9.0 (80.5)	5.28 (27.38)	1.91 (3.15)	2.09 (3.87)	2.71 (6.84)	6.98 (48.22)
Taraori Basmati'	3.17 (9.55)	3.70 (13.19)	4.54 (20.11)	4.29 (17.90)	8.2 (66.74)	4.78 (22.35)	1.54 (1.87)	1.29 (1.16)	2.64 (6.47)	6.46 (41.23)
LSD (P=0.05)	0.51	0.65	0.75	0.39	1.6	0.81	0.42	0.31	0.38	0.62

Table 2 Effect of treatments on weed dry weight, growth and yield attributes and yield (pooled data of two years)

Treatment	Total weed dry weight at harvest (g/m^2)*	Plant height (cm)	Leaf area index at 60 DAS	Panicles/ m row (cm)	Panicle length	Grains/ panicle	1000-grain weight (g)	Grain yield (kg/ha)		
								2005	2006	Mean
Weed control										
Weedy check	10.33 (106)	56.27	1.46	50.8	20.59	83	25.8	1 699	1 692	1 696
Pendimethalin 1.0 kg/ha	8.52 (72)	59.04	2.02	55.1	20.57	90	26.4	2 096	2 041	2 069
Pendimethalin + 1 HW at 30 DAS	5.35 (28)	55.66	2.12	58.5	21.86	93	27.0	2 349	2 227	2 288
LSD (*P*=0.05)	1.35	NS	0.44	5.4	NS	8	NS	229	231	230
Varieties										
JR 3-45	6.18 (37)	59.69	1.93	66.9	20.77	118	26.6	2 867	3 251	3 059
Vandana	5.35 (28)	72.49	2.32	50.5	20.62	98	27.0	2 460	2 067	2 264
Kranti	7.00 (48)	37.11	2.04	55.4	17.86	72	28.7	2 778	2 324	2 551
Sugandha	7.37 (54)	61.62	2.02	63.6	24.52	122	28.3	2 453	2 570	2 512
Pusa Basmati	10.09 (101)	51.76	1.44	43.9	20.94	54	22.3	807	795	801
Taraori Basmati	8.79 (77)	59.27	1.46	48.6	21.33	69	25.5	922	914	918
LSD (*P*=0.05)	1.30	7.98	0.36	6.1	1.61	8	3.4	340	306	323

weight was significantly negatively correlated with leaf area index (–0.8808**) and grain yield (–0.7147*) of rice. Grain yield of rice was significantly correlated with its leaf area index and yield attributes. Plant height contributed neither in reducing weed dry matter nor in improving grain yield.

The results suggest that early duration rice cultivars, viz JR 3-45 perform better than those of late-duration under zero-till conditions.

SUMMARY

Six rice cultivars of different maturity duration, viz early (JR 3-45 and Vandana), medium (Kranti and Sugandha), and late (Pusa Basmati and Taraori Basmati) were evaluated for weed suppression and productivity under three weed competitional stress, viz weedy check, pendimethalin at 1.0 kg alone and in combination with one hand weeding at 30 days after sowing, during rainy season of 2005 and 2006 at Jabalpur. Weeds caused 26 % reduction in grain yield compared with pendimethalin + one hand weeding. Early duration rice cultivar JR 3-45 and integration of pendimethalin at 1.0 kg/ha + 1 hand weeding at 30 days after sowing was found to be the most effective.

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