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Competitiveness of rice cultivars under stale seedbed in dry direct–seeded rice

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ABSTRACT

A field experiment was conducted to study the performance of cultivar and weed management practices under stale seed bed in dry direct seeded rice. The treatment consisted of combination of two methodsof rice sowing *i.e.* dry seeding after stale seed bed by glyphosate 1 kg/ha and shallow tillage and two weed management treatment (weedy and two hand weeding) in main plot and four cultivars *viz. 'BPT-5204, Sarjoo -52, PRH-10'* and *'HUBR2-1'* in sub-plot replicated thrice in split plot design. The results revealed that '*Sarjoo-52'* was found to be more competitive than other cultivars in terms of grain yield and economics. Studies on competitive traits revealed that number of grains/panicle had highest direct positive effect whereas number of panicles/m^2 via number of grains/panicle had more indirect effect on grain yield.

Key words: Competitive traits, Cultivars, Dry direct-seeded rice, Stale seed bed, Weed management

Due to climate change and changing weather patterns, there is change in the rainfall pattern. It has been observed at Varanasi (Uttar Pradesh, India) that the average rain fall has decreased in past decades, resulting in water scarcity (Singh *et al.* 2011). Increasing shortage of water had compelled farmers to adopt dry direct seeded rice (Dry-DSR). Weeds are a major constraints to the success of DSR in general and to Dry-DSR in particular (Johnson and Mortimer 2005, Singh *et al.* 2006, Rao *et al.* 2007). In absence of effective weed control measures, yield losses are high in direct seeded rice than in transplanted rice (Rao *et al.* 2007).

The success of stale seed bed depends on several factors like method of seed bed preparation, method of killing emerged weeds, weed species, duration of the stale seed bed (Ferrero 2003) and environmental condition (temperature during the stale seed bed period). Weed species especially *Cyperus iria, Cyperus difformis, Fimbristylis miliaceae* and *Eclipta prostrate*) can be relatively more susceptible to the stale seed bed technique combined with zero-till because of their low seed dormancy and their inability to emerge from a depth greater than one cm (Chauhan and Johnson 2009, 2010). Renu *et al.* (2000) found that a stale seed bed with herbicide (paraquat) was more effective in weed suppression than the mechanical method in dry-DSR because herbicides kill weeds without bringing new seeds to the germination zone.

Differences in the competitiveness of upland and rain fed low land rice cultivars against weed infestation have been well documented (IRRI 1994). Upland rice cultivars can differ by up to 75% in their suppression of weeds (Garrity*et al.* 1992). Studies have shown the competitive ability of rice cultivars against weeds like *Echinochloa phyllopogen, E. oryzoides, Brachiaria brizantha* or *B. decumbens* (Fischer and Gibson 2001). Rice establishment method is one of the important factors influencing nature of weed flora infesting DSR. In stale seed bed technique, after seed bed preparation, the field is irrigated and left unsown to allow weeds to germinate and which are killed either by a non-selective herbicide or by carrying out tillage prior to the sowing of rice. This technique not only reduces weeds emergence but also reduces the number of weed seeds in the soil seed bank (Rao *et al.* 2007). Keeping above facts in view, an experiment was conducted to study the performance of rice cultivars under stale bed method in dry direct-seeded rice.

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MATERIALS AND METHODS

A field experiment was conducted during rainy season of 2009, 2010 and 2011 at Agricultural Research Farm, Institute of Agricultural Sciences, Varanasi, Uttar Pradesh. The soil of the experimental field was sandy clay loam in texture having pH 7.5, organic carbon 0.40%, available N 284 kg/ha, P 16.9 kg/ha and K 140 kg/ha. Treatment comprised of two rice establishment methods *viz.*, dry seeding after using (i) stale seed bed method by shallow ploughing (ii) glyphosate 1 kg/ha, two hand weeding and weedy check in main plot and four cultivar in sub plot, *viz. 'BPT-5204, Sarjoo -52, PRH-10'* and *'HUBR2-1'* in a split plot design replicated thrice. In stale bed treatment to facilitate weed emergence, irrigation was applied in first week of June 2009, 2010 and 2011, thereafter, first flush of weeds was controlled either by application of glyphosate 1 kg/ha or shallow tillage. The crop was sown by the help of zero till ferti - cum seed drill using seed rate of 30 kg/ha on 20, 19 and 21st June, 2009, 2010 and 2011, respectively on dry beds and irrigated thereafter to facilitate germination of rice seeds. A uniform dose of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O were applied in the form of urea, DAP and potassium in each experimental plot. One third of nitrogen and full dose of phosphorus and potassium were applied as basal dose and remaining amount of nitrogen was applied in two equal splits at tillering and panicle initiation stages. Glyphosate 1 kg/ha was applied as pre planting treatment in stale seed bed treatment with the help of hand operated knapsack sprayer, fitted with flat fan nozzle using water at 300 liter/ha. Weed density and weed dry weight data were recorded at 30 and 60 DAS. Observations on weed density and weed dry weight were recorded randomly from two places in each plot using 0.25 m^2 quadrate. The data recorded on weeds were subjected to square root transformation ($\sqrt{\times+0.5}$) to satisfy the condition of homogeneity of variance. Biometrical observations on growth attributes, yield attributes and yields were also recorded during course of investigation.

Path coefficient analysis was carried out to study the relationship between two characters through direct and by way of indirect influence of the other characters under weedy conditions. Path coefficient analysis of yield attribute and yield data under weedy condition was done with a software SPAR developed by Indian Agricultural Statistical Research Institute (Huan *et al.* 1999)

RESULTS AND DISCUSSION

Weed composition

The major weeds infesting experimental field at 40 days after sowing were: *Cynodon dactylon* (6.2%), *Dactyloctenum aegypticum* (2.2%) *Echinochloa colona* (20.3%), *Echinochloa crusgalli* (5.9%), *Leptochloa chinenis* (1.7%) among grasses; *Ammannia baccifera* (1.9%), *Caesulia axillaries* (4.5%), *Commelina benghalensis* (6.1%), *Physalis minima* (6.3%), *Eclipta alba* (3.3%), *Euphorbia hirta* (5.1%), *Phyllanthus niruri* (12.6%), *Ludwigia* spp. (1.3%), *Trianthema monogyna* (3.8%) among broad-leaved weeds and *Cyperus difformis* (5.4%) among Sedges.

Effect on weed and growth attributes

Non significant variations in dry weight was observed due to stale bed method of rice establishment and cultivars at 30 and 60 days of crop growth except weed density at 30 days stage (Table 1) where stale bed using glyphosate 1kg/ha significantly reduced weed density in comparison to stale bed using shallow tillage. Stale bed using glyphosate 1 kg/ha recorded significantly better performance of growth attributes, *viz*. plant height, number of tillers/m^2, dry matter accumulation, crop growth rate and leaf area index as compared to stale bed method using shallow tillage. However, during 30 to 60 days growth period stale bed using shallow tillage recorded significantly higher relative growth rate in comparison to stale bed using glyphosate 1 kg/ha.

Amongst cultivars, '*Sarjoo-52*' had better performance of growth attributes as compared to '*BPT-5204*' and '*PRH-10*'. Rice cultivar '*HUBR2-1*' and '*Sarjoo-52*' had statistically comparable values of dry matter accumulation, RGR, CGR and leaf area index whereas with respect to plant height and number of tillers/m^2, both cultivars were at par with each other. Similarly, rice cultivar '*BPT-5204*' and '*PRH-10*' were at par with each other with respect to dry matter accumulation, RGR, CGR and leaf area index. Weed free plots recorded significantly better performance of all the growth attributes in comparison to weedy plots.

Effect on yield attributes and yield

Dry seeded after stale bed using glyphosate 1 kg/ha recorded significantly more number of panicles/m^2, longer panicles, more number of grains/panicle and panicle weight, grain yield and harvest index (Table 2). Cultivar '*Sarjoo-52*' exhibited significantly better performance of yield attributes, *viz*. number of panicles/m^2, number of grains/ panicle and panicle weight in comparison to '*PRH-10, BPT-5204*' and '*HUBR 2-1*'. the cultivars '*Sarjoo-52*' and '*HUBR 2-1*' had comparable panicle length and test weight. However, the harvest index of '*PRH-10*' was maximum and it was at par with '*Sarjoo-52*' which recorded maximum grain yield and it was significantly superior to all the cultivars. The cultivars '*HUBR 2-1*' and '*PRH-10*' had statistically comparable grain yield and the former cultivar had significantly higher grain yield than '*BPT-5204*'. Weed free treatment recorded significantly higher yield attributes and yield in comparison to weedy.

Path coefficient analysis was done to study the relationship between two characters through their direct and by way of indirect influence of the other characters. (Table 3). On which basis path diagram was developed to show relationship between and yield attributes yield. Genotypic correlations were partitioned into direct and indirect effects on grain yield. The analysis revealed that among

Table 1. Effect of stale bed method, weed management and cultivar on weed and crop growth in direct-seeded rice (mean data of three years)

Treatment	Weed density (no./m^2)		Weed dry weight (g/m^2)		60 DAS			Relative growth rate (g/g/day)	60 DAS	
	30 DAS	60 DAS	30 DAS	60 DAS	Plant height (cm)	No. of tillers /m^2	Dry matter accumulation (g/m/row)	30-60 DAS	Crop growth rate (g/m^2/day)	Leaf area index
Rice establishment										
Dry seeded after stale bed using shallow tillage	8.15 (60.4)	11.30 (125.1)	4.75 (19.8)	10.51 (118.9)	50.8	175.6	31.15	0.044	0.75	2.89
Dry seeded after stale bed using glyphosate1kg/ ha	7.25 (63.8)	10.49 (118.6)	4.74 (19.8)	10.27 (115.7)	54.2	195.9	36.66	0.038	0.84	3.28
LSD(P=0.05)	0.82	NS	NS	NS	1.1		5.75	0.005	0.18	0.28
Weed management										
Weedy	14.69 (212.2)	21.08 (400.7)	8.79 (69.6)	20.07 (441.6)	46.6	114.1	24.97	0.044	0.61	1.55
Two hand weedings	0.71	NS	0.71	0.71	58.3	257.4	42.84	0.038	0.98	4.62
LSD(P=0.05)	0.82	0.49	0.77	0.84	1.1	69.9	5.75	0.005	0.18	0.28
Cultivar										
'BPT- 5204'	7.98 (59.2)	10.58 (109.4)	4.84 (28.3)	9.93 (93.1)	46.1	188.8	28.09	0.038	0.65	2.62
'HUBR 2-1'	7.50 (55.7)	11.20 (128.0)	4.60 (25.2)	10.28 (114.6)	54.5	176.6	37.80	0.045	0.92	3.35
'PRH-10'	7.78 (57.7)	11.22 (131.4)	4.73 (27.6)	11.23 (125.6)	50.8	165.7	27.63	0.036	0.59	2.72
'Sarjoo – 52'	7.53 (55.9)	10.58 (108.6)	4.83 (27.2)	10.12 (109.0)	58.4	212.0	42.09	0.045	1.02	3.66
LSD (P=0.05)	NS	NS	NS	NS	2.5	18.1	5.26	0.005	0.18	0.72

DAS – Days after sowing. Original data are subjected to square root transformation

Table 2. Effect of stale bed method, weed management and cultivar on yield attributes, grain and straw yields, harvest index, B:C ratio and production efficiency in direct-seeded rice (average data of three years)

Rice establishment	No. of panicles/ m^2	Panicle length (cm)	No. of grains /panicle	Panicle weight (g)	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	B: C ratio	Production efficiency (` /ha/day)
Dry seeded after stale bed using shallow tillage	265.3	21.6	81.1	8.9	21.9	2.32	4.17	34.9	1.9	389.0
Dry seeded after stale bed using glyphosate 1 kg/ha	325.1	22.2	100.6	9.3	23.5	2.59	4.34	37.5	2.0	430.8
LSD (P=0.05)	26.5	0.8	15.4	0.7	0.5	0.18	NS	1.7		
Weed management										
Weedy	168.5	20.3	71.4	7.0	21.3	1.24	2.23	35.1	1.1	211.8
Two hand weeding	421.9	23.5	110.3	11.3	24.0	3.67	6.25	37.4	2.7	603.6
LSD (P=0.05)	26.5	0.8	15.4	0.7	0.5	0.18	0.31	1.7		
Cultivar										
'BPT- 5204'	282.2	20.5	91.8	8.0	21.5	2.13	3.76	35.3	1.8	321.4
'HUBR 2-1'	285.9	22.5	88.9	9.4	23.3	2.35	4.32	34.5	2.4	465.6
'PRH-10'	287.8	21.8	84.4	8.1	22.1	2.23	3.66	37.9	1.6	412.4
'Sarjoo – 52'	324.9	22.9	98.3	11.1	23.8	3.10	5.28	37.2	2.4	477.1
LSD (P=0.05)	23.6	0.6	6.2	0.9	0.4	0.171	0.27	2.4		

Table 3. Correlation matrix of yield attributes and yield under weedy conditions

	No of panicles /m^2	No of grains/ panicle	Test weight	Grain yield
No of panicles/m^2	1	0.946 (r_{12})	0.8346 (r_{13})	0.6757 (r_{14})
No of grains/panicle		1	0.6665 (r_{32})	0.6471 (r_{24})
Test weight			1	0.5939 (r_{34})
Grain yield				1

Direct and indirect effects based on path coefficient analysis

No of panicles/m^2 and grain yield (r_{14})
Direct effect P_{14} = 0.119
Indirect effect via number of grains/ panicle $P_{24}r_{12}$ = 0.3483
Indirect effect via test weight $P_{34}r_{13}$ = 0.2075
Total (direct + indirect effect) r_{14} = 0.6757

Number of grains/panicle and grain yield (r_{24})
Direct effect P_{24} = 0.3682
Indirect via number of panicle/ m^2 ($P_{14}r_{12}$) =0.1134
Indirect via test weight ($P_{34}r_{23}$) = 0.1655
Total (direct + indirect) r_{24} = 0.6471

Test weight and grain yield (r_{34})
Direct effect P_{34} = 0.2483
Indirect via number of panicle /m^2 ($P_{24}.r_{13}$) = 0.1002
Indirect via number of grains /panicle (r_{23} P_{24})=0.2454
Total (direct + indirect) (r_{34}) = 0.5939

three characters studied, number of grains/panicle exerted maximum positive direct effect on grain yield followed by test weight and number of panicles /m^2. When indirect positive contributions were considered number of panicles/ m^2 via number of grains/panicle and test weight via number of grains/panicle were proved to be better characters influencing grain yield.Cultiv ar '*Sarjoo-52'* recorded the highest B: C ratio and production efficiency amongst all the cultivars. Amongst rest of the cultivars,' *HUBR 2-1'* recorded higher B: C ratio and production efficiency as compared to '*BPT-5204'* and '*PRH-10'*. This might be due to '*HUBR 2-1'* being aromatic rice consequently recorded better price of grain and B:C ratio. Cultivar '*Sarjoo-52'* proved to be more competitive than rest of the cultivar with respect to yield and economics point of view. Number of grains/panicle had highest positive direct effect and indirect positive effect via number of panicles/m^2 on yield under weedy condition.

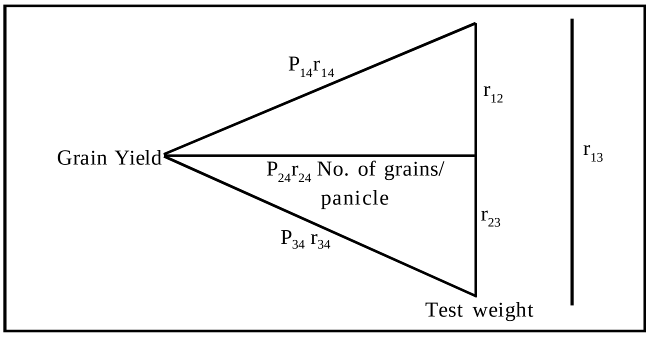

Fig.1. Path diagram showing causal relationship between yields attribute and yield

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