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Response of Hybrid Rice (*Oryza sativa* L.) to Different Dates of Transplanting, Spacing and Number of Seedlings/Hill

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A B S T R A C T

A field experiment was conducted during *kharif* season 2011 at Crop Research Farm, Department of Agronomy, SHIATS, Allahabad. The experiment consisted 18 treatments, laid out in RBD and replicated thrice. The treatments included three different dates of transplanting (15th July, 27th July and 9th August), three spacing's (20cm x 10cm, 20cm x 15cm and 20cm x 20cm) and two seedling rates (1 seedling hill^{-1} and 2 seedling hill^{-1}) in hybrid rice. Out of them treatment T_6 (15th July transplanting, 2 seedling/hill and 20cm x 20cm spacing) recorded the maximum value for plant height, no. of tillers/hill, no. of effective tillers/hill, plant dry weight and RGR. The yield attributes namely no. of grain panicle^{-1}, length of panicle (cm), test weight, straw yield and maximum grain yield were also obtained in the aforesaid treatment.

Introduction

Rice (*Oryza sativa* L.) is the world's most important food crops of Asian origin. It is an important food grain crop grown extensively in tropical and subtropical region of the world. About 90 per cent of all rice grown in the world is produced and consumed in the Asian region. Rice production always plays a key role in the global food situation as well as in commercial industrial preparations.

Rice is staple food of more than 60 % of Indian population. It accounts for about 43 % of total food grain production and 46 % of total cereal production in the country. In order to meet the domestic demand of the increasing population the present day production of 99 million tones of milled rice has to be increased to130 million tones by the year 2025. In Uttar Pradesh the area under rice is 5.63 m ha, production of 11.94 mt and productivity of 21.20 Q/ha.

Rice is an excellent source of carbohydrate and protein of regular human diet. It is a staple food of more than two thirds of world population. The slogan "Rice is life" is most appropriate for India as this crop plays a vital role in our national food security and is a means of livelihood for millions of rural people in India.

Transplanting rice in the optimum period of time is critical to achieve high grain yield. However, optimum rice planting dates are regional and vary with location and genotypes.

Rice plants require a particular temperature for its phonological affair such as panicle initiation; flowering, panicle exertions from flag leaf sheath and maturity and these are very much influenced by the planting dates during India season. Rice seeded before the window of optimum dates usually has slow germination and emergence, poor stand establishment and increased damages from soil borne seedling diseases.

Materials and Methods

A field experiment was conducted during *Kharif* season 2011 at Crop Research Farm, Department of Agronomy, Allahabad School of Agriculture, SHIATS, Allahabad. The soil was sandy loam in texture having 7.93 pH, 0.34% organic carbon, 85.45 kg/ha total N and available P_2O_5 and K_2O of 18.25 and 150.34 kg ha^{-1}, respectively. The experiment consisted different dates of transplanting (15^{th} July, 27^{th} July and 9^{th} August), spacing's (20cm x 10cm, 20cm x 15cm and 20cm x 20cm) and seedling rates(1 seedling $hill^{-1}$ and 2 seedling $hill^{-1}$) were tested in three replicated Randomized Block Design and replicated thrice.

Twenty one days old seedlings of hybrid rice 'Arize 6444' were transplanted on each date using uniform dose of 120 kg N, 80 kg P_2O_5 and 60 kg K_2O per ha^{-1} along with 30 kg zinc sulphate ha^{-1}. The half dose of N and entire dose of P, K and Zn were applied at the time of puddling and rest of N was given in 2 equal splits, at tillering and panicle initiation stages. Arize 6444 variety was used as planting materials in this study.

Results and Discussion

Plant height (cm)

The observations on the plant height of rice recorded at different interval were statistically analyzed and are being presented in table 1. A perusal of the table clearly shows that at 60 DAT the highest plant height 77.41cm was recorded in treatment T_2 (15 July + spacing of 20x10 cm + 2 Seedling $hill^{-1}$) although the difference amongst the treatments were non-significant. At 90 DAT significantly higher plant height 92.24 cm was recorded in treatment T_6 (15 July + 20x20 cm + 2 Seedling $hill^{-1}$).

More duration and higher heat accumulation might have favored most of the growth parameters in July 17^{th} planting as compared to 24^{th} and 31^{th} July planting. These results confirm the findings of (Gautam *et al.*, 2003) and Nayak *et al.*, (2003).

Plant dry weight (g)

The observations on response of hybrid rice on the plant dry weight at different intervals was statistically analyzed and is being presented in table 1. A perusal of the table clearly shows that at 60 DAT the highest dry matter (3.70g) was recorded in treatment T_1 (15 July +20x10 cm + 1 Seedling $hill^{-1}$) which was found to be non significant and at 90 DAT significantly higher dry matter accumulation (17.33g) was recorded in treatment T_6 **(**15 July +20x20 cm + 2 Seedling $hill^{-1}$).

16^{th} July of transplanting of rice found significantly higher dry weight of plant. Dry matter accumulation was low in late transplanting, this may due to prevalence of low temperature coupled with less humidity at the reproductive stage or at flag leaf stage might have reduced the yield as compared to

earlier planting. These results confirm the findings of Yadav and Tripathi (2008).

No. of tillers hill^{-1}

The observations on response of hybrid rice to the total number of tillers/hill recorded at different intervals were statistically analyzed and are being presented in table 2. A critical review of the table clearly shows that at 90 DAT the highest no. of tillers per hill was recorded in treatment T_6 **(**15 July +20x20 cm + 2 Seedling hill^{-1}) which was found to be significant. At 60 DAT the highest no. of tillers per hill was observed in treatment T_{15} (09 August + 20x15 cm + 1 Seedling hill^{-1}) which was non-significant.

July 14th transplanting crop was observed more duration and higher heat accumulation which might have favored most of the growth parameters. In the early transplanting improves the canopy's photosynthesis and increase tillers (Kumar *et al*., 1998).

Crop growth rate (CGR)

A critical review of the table clearly shows that at 30 DAT the highest crop growth rate (2.50 g/m^2/day) was recorded in T_{13} (09 August + 20x10 cm + 1 Seedling hill^{-1}). At 60 DAT highest CGR (4.50 g/m^2/day) was observed in treatment T_1 (15 July + 20x10 cm + 1 Seedling hill^{-1}). Although the difference among the treatments was non-significant both at 30 and 60 DAT. At 90 DAT significantly higher crop growth rate (18.57 g/m^2/day) was recorded in treatment T_2 (15 July + 20x10 cm + 2 Seedling hill^{-1}), than all the other treatments.

Relative growth rate (RGR)

A perusal of the table clearly shows that at 30-60 DAT the highest relative growth rate (0.0537 g/g/day) was recorded under treatment T_5 (15 July+20x20 cm + 1 Seedling hill^{-1}). At 60-90 DAT the higher RGR (0.0578 g/g/day) was recorded in treatment T_6 (15 July + 20x20 cm + 2 Seedling hill^{-1}). However, the difference was non significant among at the different treatments at both the intervals.

Number of effective tillers/hill

The observations on response of hybrid rice on the number of panicles were statistically analyzed and are being presented in table 2. A critical review of the table clearly shows that the significantly higher number of effective tillers/hill (33.27) was recorded under treatment T_6 (15 July +20x20 cm + 2 Seedling hill^{-1}).

Effective tillers production was low in late transplanting. This may due to prevalence of low temperature coupled with less humidity at the time of reproductive stages (Kumar *et al*., 2006).

Transplanting of rice at a wider spacing of 20x20 cm^2 produces a significantly higher number of effective tillers/hill as compared to closer spacing of 20x10 cm^2 and 20x15 cm^2 (Gautam *et al*., 2008).

Length of panicle (cm)

The observations on response of hybrid rice on the length of panicle were statistically analyzed and are being presented in table 2. A perusal of the table clearly shows that the significantly higher length of panicle (27.33) was recorded under treatment T_6 (15 July +20x20 cm + 2 Seedling hill^{-1}).

Yaday and Tripathi (2008) reported that maximum panicle length (26.63cm) was found to be at the transplanting date 15th July with 20x20cm plant spacing and 2 seedlings/hill as compare to other transplanting dates, 30th July and 14th August.

Number of grains/panicle

The observations on response of hybrid rice on the number of grains per panicle were statistically analyzed and are being presented in table 2. A perusal of the table clearly shows that the significantly higher number of grains/panicle (202.33) was recorded under treatment T_6 (15 July +20x20 cm + 2 Seedling $hill^{-1}$). Number of grains/panicle, was significantly higher in 15th July planted crop than the 30th July and 14th August planted crop which might be due to availability of more time for better development of plant parts which may result in the better development of yield attributing characters.

Table.1a Effect of different transplanting dates, spacing and No. of seedlings/hill on growth attributes of hybrid rice at different Intervals

	Treatments combination	Plant height (cm)		Dry weight (g)	
		60 DAT	90 DAT	60 DAT	90 DAT
T1	15th July, sowing of 1 seedling/ hill at 20cm x 10cm spacing	66.85	71.89	3.70	13.88
T2	15th July, sowing of 2 seedling/ hill at 20cm x 10cm spacing	77.41	71.97	2.86	14.00
T3	15th July, sowing of 1 seedling/ hill at 20cm x 15cm spacing	75.07	78.69	3.17	15.07
T4	15th July, sowing of 2 seedling/ hill at 20cm x 15cm spacing	76.22	80.09	3.42	15.33
T5	15th July, sowing of 1 seedling/ hill at 20cm x 20cm spacing	71.88	90.22	3.44	16.67
T6	15th July, sowing of 2 seedling/ hill at 20cm x 20cm spacing	74.42	92.24	3.12	17.33
T7	27th July, sowing of 1 seedling/ hill at 20cm x 10cm spacing	72.15	70.55	2.67	13.44
T8	27th July, sowing of 2 seedling/ hill at 20cm x 10cm spacing	69.13	70.61	3.47	13.67
T9	27th July, sowing of 1 seedling/ hill at 20cm x 15cm spacing	68.87	73.28	3.35	14.67
T10	27th July, sowing of 2 seedling/ hill at 20cm x 15cm spacing	72.12	75.01	3.19	14.88
T11	27th July, sowing of 1 seedling/ hill at 20cm x 20cm spacing	66.60	89.83	3.23	16.17
T12	27th July, sowing of 2 seedling/ hill at 20cm x 20cm spacing	62.99	89.83	3.13	16.44
T13	9th Aug., sowing of 1 seedling/ hill at 20cm x 10cm spacing	60.41	68.67	3.33	11.88
T14	9th Aug., sowing of 2 seedling/ hill at 20cm x 10cm spacing	58.22	69.77	3.03	12.77
T15	9th Aug., sowing of 1 seedling/ hill at 20cm x 15cm spacing	65.49	72.15	3.06	14.17
T16	9th Aug., sowing of 2 seedling/ hill at 20cm x 15cm spacing	57.84	72.78	3.41	14.33
T17	9th Aug., sowing of 1 seedling/ hill at 20cm x 20cm spacing	63.40	84.86	3.24	15.55
T18	9th Aug., sowing of 2 seedling/ hill at 20cm x 20cm spacing	60.89	85.64	3.26	15.77
	F-test	NS	S	NS	S
	C.D. (P = 0.05)	-	0.09	-	0.09

Table.1b Effect of different transplanting dates, spacing and No. of seedlings/hill on the growth attributes of hybrid rice

	Treatments combination	CGR		RGR	
		30-60 DAT	60-90 DAT	30-60 DAT	60-90 DAT
T_1	15th July, sowing of 1 seedling/ hill at 20cm x 10cm spacing	4.50	16.96	0.0504	0.0445
T_2	15th July, sowing of 2 seedling/ hill at 20cm x 10cm spacing	2.18	18.57	0.0210	0.0533
T_3	15th July, sowing of 1 seedling/ hill at 20cm x 15cm spacing	2.63	13.09	0.0476	0.0520
T_4	15th July, sowing of 2 seedling/ hill at 20cm x 15cm spacing	2.23	13.10	0.0313	0.0502
T_5	15th July, sowing of 1 seedling/ hill at 20cm x 20cm spacing	2.19	11.02	0.0537	0.0529
T_6	15th July, sowing of 2 seedling/ hill at 20cm x 20cm spacing	1.46	17.95	0.0287	0.0578
T_7	27th July, sowing of 1 seedling/ hill at 20cm x 10cm spacing	2.97	11.84	0.0372	0.0539
T_8	27th July, sowing of 2 seedling/ hill at 20cm x 10cm spacing	3.83	16.99	0.0377	0.0457
T_9	27th July, sowing of 1 seedling/ hill at 20cm x 15cm spacing	2.77	12.46	0.0470	0.0497
T_{10}	27th July, sowing of 2 seedling/ hill at 20cm x 15cm spacing	2.21	12.86	0.0330	0.0519
T_{11}	27th July, sowing of 1 seedling/ hill at 20cm x 20cm spacing	1.26	10.78	0.0208	0.0539
T_{12}	27th July, sowing of 2 seedling/ hill at 20cm x 20cm spacing	1.62	11.09	0.0327	0.0557
T_{13}	9th Aug., sowing of 1 seedling/ hill at 20cm x 10cm spacing	3.04	14.26	0.0293	0.0427
T_{14}	9th Aug., sowing of 2 seedling/ hill at 20cm x 10cm spacing	2.89	16.24	0.0286	0.0480
T_{15}	9th Aug., sowing of 1 seedling/ hill at 20cm x 15cm spacing	2.28	12.22	0.0414	0.0518
T_{16}	9th Aug., sowing of 2 seedling/ hill at 20cm x 15cm spacing	2.45	12.01	0.0350	0.0485
T_{17}	9th Aug., sowing of 1 seedling/ hill at 20cm x 20cm spacing	1.80	10.26	0.0392	0.0526
T_{18}	9th Aug., sowing of 2 seedling/ hill at 20cm x 20cm spacing	1.90	10.43	0.0450	0.0537
	F-test	NS	S	NS	NS
	C.D. (P = 0.05)	-	1.11	-	-

Table.2a Effect of different transplanting dates, spacing and No. of seedlings/hill on the yield attributes and yield of hybrid rice

	Treatments combination	No. of effective tiller / hill	Length of panicle (cm)	No. of grains / panicle
T_1	15th July, sowing of 1 seedling/ hill at 20cm x 10cm spacing	18.77	23.17	160.44
T_2	15th July, sowing of 2 seedling/ hill at 20cm x 10cm spacing	19.17	23.33	162.67
T_3	15th July, sowing of 1 seedling/ hill at 20cm x 15cm spacing	21.55	24.17	176.17
T_4	15th July, sowing of 2 seedling/ hill at 20cm x 15cm spacing	21.88	24.33	179.00
T_5	15th July, sowing of 1 seedling/ hill at 20cm x 20cm spacing	29.55	25.67	193.55
T_6	15th July, sowing of 2 seedling/ hill at 20cm x 20cm spacing	33.27	27.33	202.33
T_7	27th July, sowing of 1 seedling/ hill at 20cm x 10cm spacing	18.00	22.27	155.67
T_8	27th July, sowing of 2 seedling/ hill at 20cm x 10cm spacing	18.33	23.07	158.00
T_9	27th July, sowing of 1 seedling/ hill at 20cm x 15cm spacing	20.17	23.88	170.33
T_{10}	27th July, sowing of 2 seedling/ hill at 20cm x 15cm spacing	21.27	24.00	173.27
T_{11}	27th July, sowing of 1 seedling/ hill at 20cm x 20cm spacing	25.33	24.88	187.33
T_{12}	27th July, sowing of 2 seedling/ hill at 20cm x 20cm spacing	27.07	25.17	190.44
T_{13}	9th Aug., sowing of 1 seedling/ hill at 20cm x 10cm spacing	17.07	20.27	150.67
T_{14}	9th Aug., sowing of 2 seedling/ hill at 20cm x 10cm spacing	17.67	22.17	153.55
T_{15}	9th Aug., sowing of 1 seedling/ hill at 20cm x 15cm spacing	19.55	23.55	165.00
T_{16}	9th Aug., sowing of 2 seedling/ hill at 20cm x 15cm spacing	19.88	23.67	167.27
T_{17}	9th Aug., sowing of 1 seedling/ hill at 20cm x 20cm spacing	22.67	24.55	182.17
T_{18}	9th Aug., sowing of 2 seedling/ hill at 20cm x 20cm spacing	23.67	24.67	185.27
	F-test	S	S	S
	C.D. (P = 0.05)	0.24	0.26	1.89

Table.2b Effect of different transplanting dates, spacing and No. of seedlings/hill on the yield attributes and yield of hybrid rice

	Treatments combinations	Grain Yield (t ha^{-1})	Test weight (g)	Harvest index (%)
T_1	15th July, sowing of 1 seedling/ hill at 20cm x 10cm spacing	4.53	19.17	42.40
T_2	15th July, sowing of 2 seedling/ hill at 20cm x 10cm spacing	4.70	19.33	42.40
T_3	15th July, sowing of 1 seedling/ hill at 20cm x 15cm spacing	4.83	22.33	42.39
T_4	15th July, sowing of 2 seedling/ hill at 20cm x 15cm spacing	5.06	23.67	42.50
T_5	15th July, sowing of 1 seedling/ hill at 20cm x 20cm spacing	6.03	29.67	43.19
T_6	15th July, sowing of 2 seedling/ hill at 20cm x 20cm spacing	6.43	32.55	44.37
T_7	27th July, sowing of 1 seedling/ hill at 20cm x 10cm spacing	4.27	18.44	42.43
T_8	27th July, sowing of 2 seedling/ hill at 20cm x 10cm spacing	4.40	18.88	42.36
T_9	27th July, sowing of 1 seedling/ hill at 20cm x 15cm spacing	4.36	20.44	42.40
T_{10}	27th July, sowing of 2 seedling/ hill at 20cm x 15cm spacing	4.62	20.77	42.38
T_{11}	27th July, sowing of 1 seedling/ hill at 20cm x 20cm spacing	5.62	27.55	42.68
T_{12}	27th July, sowing of 2 seedling/ hill at 20cm x 20cm spacing	5.83	29.33	43.34
T_{13}	9th Aug., sowing of 1 seedling/ hill at 20cm x 10cm spacing	3.85	14.67	40.66
T_{14}	9th Aug., sowing of 2 seedling/ hill at 20cm x 10cm spacing	4.03	16.27	41.73
T_{15}	9th Aug., sowing of 1 seedling/ hill at 20cm x 15cm spacing	4.86	19.67	42.39
T_{16}	9th Aug., sowing of 2 seedling/ hill at 20cm x 15cm spacing	4.17	20.00	42.39
T_{17}	9th Aug., sowing of 1 seedling/ hill at 20cm x 20cm spacing	5.23	25.17	42.17
T_{18}	9th Aug., sowing of 2 seedling/ hill at 20cm x 20cm spacing	5.46	25.88	42.38
	F-test	S	S	NS
	C.D. (P = 0.05)	0.64	0.22	-

Table.3 Effect of different transplanting dates, spacing and No. of seedlings/hill on the economics of hybrid rice

S.No.	Treatments combination	Cost of cultivation (ha^{-1})	Gross return (ha^{-1})	Net return (ha^{-1})	B:C ratio
T_1	15th July, sowing of 1 seedling/ hill at 20cm x 10cm spacing	50754.47	63996.00	13241.53	1.26
T_2	15th July, sowing of 2 seedling/ hill at 20cm x 10cm spacing	54022.60	66454.00	12431.40	1.23
T_3	15th July, sowing of 1 seedling/ hill at 20cm x 15cm spacing	49618.41	71130.00	21511.59	1.43
T_4	15th July, sowing of 2 seedling/ hill at 20cm x 15cm spacing	52248.47	74514.00	22265.53	1.42
T_5	15th July, sowing of 1 seedling/ hill at 20cm x 20cm spacing	48637.97	88178.00	39540.03	1.81
T_6	15th July, sowing of 2 seedling/ hill at 20cm x 20cm spacing	50816.45	93330.00	42513.55	1.83
T_7	27th July, sowing of 1 seedling/ hill at 20cm x 10cm spacing	50754.47	60070.00	9315.53	1.18
T_8	27th July, sowing of 2 seedling/ hill at 20cm x 10cm spacing	54022.60	62054.00	8031.14	1.14
T_9	27th July, sowing of 1 seedling/ hill at 20cm x 15cm spacing	49618.41	64270.00	14651.59	1.29
T_{10}	27th July, sowing of seedling/ hill at 20cm x 15cm spacing	52248.47	67958.00	15709.53	1.30
T_{11}	27th July, sowing of 1 seedling/ hill at 20cm x 20cm spacing	48637.97	82492.00	33854.03	1.69
T_{12}	27th July, sowing of 2 seedling/ hill at 20cm x 20cm spacing	50816.45	85250.00	34433.55	1.67
T_{13}	9th Aug., sowing of 1 seedling/ hill at 20cm x 10cm spacing	50754.47	54594.00	3839.53	1.07
T_{14}	9th Aug., sowing of 2 seedling/ hill at 20cm x 10cm spacing	54022.60	56778.00	2755.40	1.05
T_{15}	9th Aug., sowing of 1 seedling/ hill at 20cm x 15cm spacing	49618.41	68914.00	19295.59	1.38
T_{16}	9th Aug., sowing of 2 seedling/ hill at 20cm x 15cm spacing	52248.47	61478.00	9229.53	1.17
T_{17}	9th Aug., sowing of 1 seedling/ hill at 20cm x 20cm spacing	48637.97	82058.00	33420.03	1.68
T_{18}	9th Aug., sowing of 2 seedling/ hill at 20cm x 20cm spacing	50816.45	80470.00	29653.53	1.58

Similar results have been also reported by Paliwal *et al*., (1996) and Singh *et al*., (2004).

Test weight (g)

The observations on response of hybrid rice on the test weight were statistically analyzed and are being presented in table 3. A critical review of the table clearly shows that the significantly highest test weight (32.55 g) was recorded under treatment T_6 (15 July+20x20 cm + 2 Seedling hill^{-1}).

Test weight, was significantly higher in 15th July planted crop than the 30th July and 14th August planted crop which might be due to availability of more time for better development of plant parts which may result in the better development of yield attributing characters. Similar results have been also reported by Paliwal *et al*., (1996) and Singh *et al*., (2004).

Grain yield t/ha

The observations on response of hybrid rice on grain yield were statistically analyzed and are being presented in table 3. A critical review of the table clearly shows that the significantly highest grain yield (6.43 t/ha) was recorded under treatment T_6 (15 July +20x20 cm + 2 Seedling hill^{-1}).

Planting on 16th July recorded the maximum grain yield. A fortnight delay in planting from 16th July reduced the grain yield by 7.6 and 3.3 percent during the first and second year respectively. One day delay in planting, on an average, reduced the grain yield by 14.5kg and one month delay in planting from 16th July reduced the grain yield by 24.3 percent. Per day reduction on grain yield was 38kg/ha respectively. The results confirms the findings of Parihar *et al*., (1995), Pandey *et al*., (2001) and Nayak *et al*., (2003) and Mahajan *et al*., (2010).

It may be concluded that 15th July of transplanting, 2 seedlings of rice hill^{-1} at 20cm x 20cm spacing was found to be the best for obtaining highest grain yield and benefit cost ratio in hybrid rice Arise 6444. Although these findings are based on one year experimentation, therefore further trials are required to confirm the findings.

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