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Effect of Transplanting Time on the Productivity and Grain Quality of Basmati Rice

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ABSTRACT

The demand of basmati rice has been increasing as the country is being more prosperous and approaching self-sufficiency in rice production. An experiment was carried out to find the optimum time of transplanting of elite genotypes of basmati rice for higher grain yield and its effect on the fertility and grain quality of basmati genotypes at the research farms of Rice Section of Department of Plant Breeding and Genetics, Punjab Agricultural University Ludhiana during *kharif* season. The experiment was conducted in split plot design by keeping dates of transplanting in main plots viz., 5th July, 15th July and 25th July and promising genotypes in subplots viz., RYT 3275, Bas 370, CR 2007, Pusa 1601, Pusa 1609, PB 3, Pusa Bas 1121 and UPR 3506 and replicated thrice. Pusa 1601 gave the highest grain yield (50.28 q/ha) when transplanted early on 5th of July but gave similar performance at other two dates of transplanting and similar trend for grain yield was seen in Pusa Basmati 1121 at 5th and 15th July transplanting. Filled grains per panicle and fertility (%) decreased with delay in transplanting. Basmati 370 gave highest brown rice recovery (80.4 %) when transplanted on 15th of July whereas Punjab basmati 3 had significantly higher head rice recovery at all the three dates of transplanting than all other genotypes. Basmati rice quality characters i.e., length, LB ratio, elongation ratio and grain breadth were found optimum at delayed transplanting. Pusa basmati 1121 has significantly longer grains after cooking than all other genotypes.

Keywords Basmati, Genotypes, Transplanting time, Grain yield, Head rice recovery.

INTRODUCTION

The demand of basmati rice has been increasing as the country is being more prosperous and approaching self-sufficiency in rice production. Grain yield of basmati rice is comparatively low than the coarse rice. But the price of basmati rice, especially the aromatic one is 2-3 times higher than the coarse rice. Basmati rices which are cultivated in the foothills of Himalayas are endowed with the unique quality features (Singh *et al.* 2018). This region consists of Punjab, Haryana, Himachal Pradesh,Delhi, Uttarakhand, Jammu and Kashmir and Western Uttar Pradesh in India. It has been earmarked as the Geographical Indication (GI) for Basmati rice and the GI status has been conferred to Basmati rice in 2016 (GI No. 145 of the Geographical Indication Registry, Government

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Table 1. Effect of date of transplanting on the plant height, effective tillers/m², number of days taken for 50 % flowering and grain yield (q/ha) of traditional basmati genotypes.

	RYT 3275	Bas 370	CR 2007	Pusa 1601	Pusa 1609	PB 3	Pusa bas 1121	UPR 3506
				Plant height at maturity (cms)				
5 July	103.3	155.2	112.9	98.7	105.3	104.3	117.5	121.1
15 July	100.9	152.7	109.1	95.5	104.4	98.3	107.3	115.9
25 July	99.0	141.1	110.3	98.1	104.7	95.0	107.9	112.6
CD (P=0.05)				2.4				
				Effective tillers/m²				
5 July	411	352	275	315	328	368	414	240
15 July	354	301	299	334	246	359	359	253
25 July	396	323	312	290	246	389	411	242
CD (P=0.05)				28.9				
				Number of days taken for 50 % flowering				
5 July	112	112	110	101	100	118	114	112
15 July	104	108	105	98	97	109	108	107
25 July	102	101	99	96	98	103	102	101
CD (P=0.05)				1.2				
				Grain yield (q/ha)				
5 July	40.44	28.25	46.39	50.28	44.56	42.88	46.92	42.13
15 July	41.62	34.42	47.24	48.24	46.78	43.39	49.91	44.47
25 July	40.67	28.31	41.80	49.10	40.77	35.00	40.89	30.49
CD (P=0.05)				2.68				

of India, vide certificate No. 238 dated 15.02.2016). Unique fragrance, taste and texture which develop under specific geographical demarcation make it best among the aromatic rices of the world (Lang *et al.* 2013). Moreover, the quality traits of aromatic rices depend upon their genetic make-up but their expression under natural conditions is very much dependent on environmental, soil and management practices. The milled grain appearance of rice is considered an important quality parameter by the consumers (Danbaba *et al.* 2012).

Information on the influence of management aspects on the yield and quality of rice are meagre. The production of basmati rice can be increased with the manipulation of transplanting time and selection of genotypes having high yield potential. The time of transplanting has a great influence on the growth, yield and yield contributing characters of rice (Vishwakarma *et al.* 2016). Due to genetic variability, the potentiality of the genotypes expressed differently due to planting in different dates. High ambient temperature during ripening phase also results in starch with more gelatinization temperature (Singh *et al.* 2013). Thus, by adjustment of transplanting time, the plant can take advantage of natural conditions favorable for its growth. The potential genotypes can give satisfactory yield when planted in appropriate time. The information for planting Basmati rice in optimum time and potential genotypes is still lacking.

Based on the above remarks, the present study was undertaken to find out the optimum planting time and to select the Basmati genotypes having high yield potential along with good quality in Punjab conditions.

MATERIALS AND METHODS

A field experiment to find the suitable time of trans-

Table 2. Effect of date of transplanting on the number of grains per panicle and fertility (%) of traditional basmati genotypes.

Treatments	Filled grains/ panicle	Total grains/ panicle	Fertility (%)
Dates of transplanting			
July 5	83	106	79.62
July 15	74	114	69.76
July 25	71	115	66.72
CD (P=0.05)	8.3	NS	4.93
Traditional basmati genotypes			
RYT 3275	49	54	85.99
Bas 370	82	117	69.87
CR 2007	81	117	69.86
Pusa 1601	93	130	72.24
Pusa 1609	99	159	62.02
PB 3	62	76	81.83
Pusa bas 1121	51	63	80.62
UPR 3506	93	174	53.85
CD (P=0.05)	16	18.6	7.24

planting of promising genotypes for obtaining higher grain yield and to see the effect of time of transplanting on the fertility and grain quality of basmati genotypes was carried at the research farms of rice section of department of plant breeding and genetics, Punjab Agricultural University Ludhiana during *kharif* 2014 season. The soil of the experimental site was loamy sand with low in available nitrogen, Phosphorus and organic carbon but medium in available Potassium. The experiment was carried with three dates of transplanting in main plots viz. 5th July, 15th July and 25th July where as eight promising genotypes were kept in subplots viz. RYT 3275, Bas 370, CR 2007, Pusa 1601, Pusa 1609, PB 3, Pusa Bas 1121 and UPR 3506 with three replications. The nursery of different genotypes was raised on broad beds with 1.3 kg Urea/100 m^2 and 1.5 kg Single Superphosphate /100 m^2 as per the different dates of transplanting. The nursery of the different genotypes transplanted in the field as per different dates of transplanting. The crop was raised with the application of 36 kg Urea/acre in two equal splits at 3 weeks and 6 weeks after transplanting. The weed control is done with 15 days continuous stagnation of water in the field after transplanting and with the application of Pretilachlor 50 EC @ 600ml / acre. For insect and pest control 10 kg Cartap hydrochloride was applied after 45 days of transplanting and one spray of chloropyriphos was done to control stem borers and leaf folders. Irrigation was applied two days after the drying of water in the field and irrigation was stopped 15 days prior the harvesting of the crop. The data was recorded pertaining to the yield attributes and yield as per the treatments. Standard procedures for analysis of variance were used for the statistical analysis of the data collected in the present study (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Yield attributes

The pertaining to the Table 1 indicated that there was a decrease in plant height across all the genotypes except Pusa 1601 and Pusa 1609 at maturity when we delayed the time of transplanting. The plant height owing to genetic character all genotypes had different plant height at maturity. The length of vegetative phase of rice progressively reduced due to delayed planting resulting in short plant height. The results are in conformity with the findings of Salam *et al.* (2004). However, the genotype Basmati 370 attained significantly higher plant than all other genotypes at all the three different transplanting times.

The genotype Pusa basmati 1121 produced significantly higher number of panicles/m^2 when transplanted on 5th of July than all other treatment combinations but at par with RYT 3275 at 5th July and 25th July transplanting and Pusa basmati 1121 and Punjab basmati 3 when transplanted on 15th of July. There was on significant decrease in panicle number in genotypes Basmati 370, CR 2007 and UPR 3506 with altered time of transplanting.

The number of days taken for 50% flowering was recorded significantly more in Punjab basmati 3 (118 days) when transplanted at the early date of transplanting. Across the genotypes, there was a decrease of 2-9 days with every delay of 10 days in transplanting time as shown in Table 1. The decrease was recorded minimum in Pusa 1601 (2-3 days) and Pusa 1609 (1-3 days) and maximum in Punjab basmati 3 (6-9 days). Across the transplanting dates, the genotypes Pusa 1601 and Pusa 1609 attained 50%

Table 3. Effect of date of transplanting on the grain weight of brown rice, brown rice, milled rice and head rice recovery (%) of traditional basmati genotypes.

Treatments	RYT 3275	Bas 370	CR 2007	Pusa 1601	Pusa 1609	PB 3	Pusa bas 1121	UPR 3506
				1000 grain wt. of brown rice (g)				
5 July	22.5	17.7	20.7	21.2	22.4	22.6	23.5	22.0
15 July	22.6	18.2	20.6	21.5	23.8	23.0	23.9	21.8
25 July	22.5	17.1	19.8	22.6	25.3	21.5	23.7	22.1
CD (P=0.05)				0.62				
				Brown rice (%)				
5 July	76.3	77.5	76.8	79.07	76.66	75.68	75.05	76.92
15 July	77.8	80.4	78.9	78.90	76.32	77.60	77.59	76.59
25 July	78.3	77.3	78.3	77.70	78.00	75.35	75.58	76.98
CD (P=0.05)				1.49				
				Milled rice (%)				
5 July	62.29	67.58	67.66	69.07	64.33	65.86	65.64	67.06
15 July	63.80	70.30	67.70	70.01	67.57	67.59	67.87	63.84
25 July	66.63	67.06	68.45	67.98	69.43	64.88	62.92	63.86
CD (P=0.05)				3.49				
				Head rice (%)				
5 July	45.50	45.11	48.65	47.15	44.86	57.18	41.66	52.41
15 July	42.67	52.58	47.13	54.68	47.52	54.66	46.55	46.53
25 July	53.84	53.55	45.21	51.62	51.77	54.24	47.74	51.70
CD (P=0.05)				3.87				

flowering in minimum number of days i.e. 96-101 days than all other genotypes.

Across the genotypes, the maximum number of filled grains per panicle (83) and fertility (79.6%) was obtained when transplanting was done 5th of July (Table 2). The number of filled grains per panicle and fertility (%) reduced significantly with delay in late transplanting.

Grain yield

The data in the Table 1 depicted that the significantly more grain yield was obtained by the genotype Pusa 1601 (50.28 q/ha) in the early transplanting owing to more number of filled grains per panicle but statistically at par at all the three dates of transplanting and it was also statistically at par with Pusa basmati 1121 at 5th and 15th July transplanting for grain yield. The grain yield as more in Pusa basmati 1121 due to profuse tillering habit as depicted in the Table 1. Amongst the genotypes, all genotypes gave more grain yield when transplanted upto 15th of July except the RYT 3275 and Pusa 1601 genotypes which gave statistically similar grain yields irrespective to the time of transplanting. There was significant decrease in grain yield in the late transplanting due to reduced tillering, early flowering and reduced number of filled grains per panicle and decreased fertility (%). Similar results are also reported by Safdar *et al.* (2013) for rice under different dates of transplanting.

Milling characters

The highest brown rice recovery (80.4 %) was obtained with the genotype Basmati 370 when transplanted on 15th of July and it was statistically at par with the genotype Pusa 1601 (79.1%) in early trans-

Table 4. Effect of date of transplanting on the length, breadth, LB ratio of grains before cooking of traditional basmati genotypes.

Treatments	RYT 3275	Bas 370	CR 2007	Pusa 1601	Pusa 1609	PB 3	Pusa bas 1121	UPR 3506
				Length of grains (mm)				
5 July	8.23	7.21	8.13	8.33	8.67	8.76	9.23	8.74
15 July	7.87	7.30	7.98	8.30	8.81	8.74	8.95	8.71
25 July	8.42	7.25	7.88	8.37	9.00	8.69	9.02	8.80
CD (P=0.05)					0.23			
				Breadth of grains (mm)				
5 July	1.88	1.69	1.79	1.74	1.79	1.75	1.87	1.77
15 July	1.75	1.73	1.75	1.78	1.81	1.83	1.84	1.72
25 July	1.88	1.72	1.64	1.73	1.73	1.72	1.89	1.77
CD (P=0.05)					0.06			
				LB ratio of grains (mm)				
5 July	4.38	4.27	4.56	4.80	4.85	5.00	4.96	4.95
15 July	4.51	4.22	4.57	4.66	4.88	4.79	4.86	5.07
25 July	4.50	4.23	4.83	4.85	5.21	5.08	4.77	4.98
CD (P=0.05)					0.20			

planting and with CR 2007 and Pusa 1601 on second date of transplanting, and RYT 3275 and Pusa 1609 in late transplanting (Table 3). There was no change in the milled rice recovery in the genotype UPR 3506 across the varied times of transplanting.

The significantly higher 1000 grain weight (25.3g) was obtained in the genotype Pusa 1609 in late transplanting. It was noticed that the grain weight of brown rice of Pusa 1601, Pusa 1609, Pusa basmati 1121 and UPR 3506 increased with delay in transplanting. However, there was no significant change in grain weight of brown rice in the genotype UPR 3506 across the different times of transplanting.

The significantly more milled rice recovery (80.4%) was recorded in the genotype Basmati 370 when transplanted on 15th July. Across the different genotypes, there was no significant effect of time of transplanting on the milled rice recovery of RYT 3275, Basmati 370, CR 2007, Pusa 1601, Punjab basmati 3 and UPR 3506, they had statistically similar milled rice recovery at the three times of transplanting.

The genotype Punjab basmati 3 had significantly higher head rice recovery at all the three dates of transplanting than all other genotypes and also statistically at par with Pusa 1601 in second date of transplanting, and RYT 3275 and Basmati 370 in late transplanting (Table 3).

Table 5. Effect of date of transplanting on the cooking characteristics of traditional basmati genotypes.

Treatments	Grain characters after cooking Length (mm)	Breadth (mm)	LB ratio	Elongation ratio
	Dates of transplanting			
July 5	14.51	2.53	5.77	1.73
July 15	14.57	2.48	5.92	1.75
July 25	15.03	2.49	6.05	1.78
CD (P=0.05)	NS	NS	NS	NS
	Traditional basmati genotypes			
RYT 3275	13.43	2.53	5.30	1.65
Bas 370	14.07	2.33	6.03	1.94
CR 2007	12.87	2.53	5.08	1.61
Pusa 1601	14.72	2.62	5.63	1.77
Pusa 1609	14.22	2.60	5.47	1.61
PB 3	14.93	2.47	6.07	1.71
Pusa bas 1121	19.17	2.35	8.17	2.12
UPR 3506	14.20	2.57	5.54	1.62
CD (P=0.05)	0.74	0.08	0.35	0.09

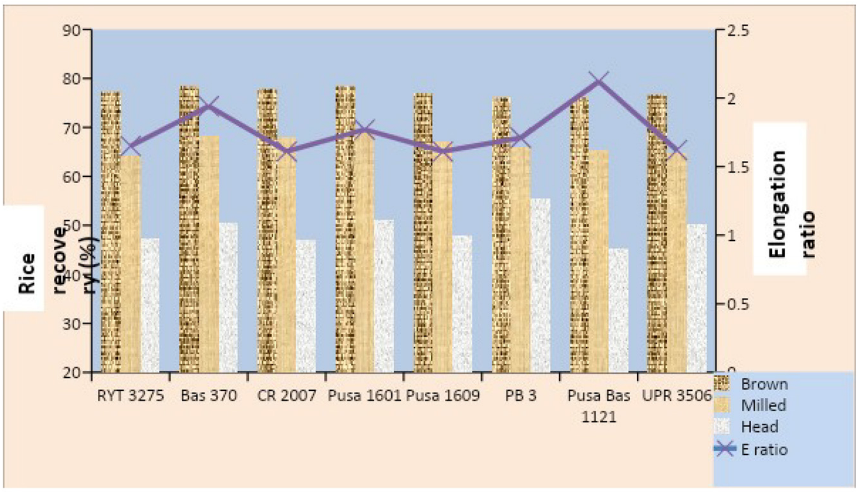

Fig. 1. The milling characters, and elongation ratio of basmati genotypes as affected by time of transplanting.

Grain characters before cooking

The genotype Pusa basmati 1121 had significantly more length of grains when transplanted early and statistically at par with the same genotype grains when transplanted on 15th of July than all other genotypes at different transplanting dates as depicted in Table 4. Across the transplanting dates, the grain length of genotype Basmati 370, Pusa 1601, Punjab basmati 3 and UPR 3506 did not varied with the changing time of transplanting. Most of the genotypes grain breadth did not vary much with date of transplanting. The grain breadth of Pusa basmati 112 was higher and that of basmati 370 was lower than all other genotypes. The LB ratio did not vary much across the transplanting time but Pusa 1609 had significantly higher LB ratio and it was very closely followed by Punjab basmati 3 and UPR 3506. Similar results were also reported for length breadth ration by Verma *et al.* (2013).

Grain characters after cooking

The data in the Table 5 showed that across the genotypes, the varied time of transplanting had no significant effect on the cooking characteristics. But there was a slight increase in the length, LB ratio, elongation ratio and a decrease in grain breadth with the delay in transplanted time. The genotype Pusa basmati 1121 has significantly longer grains after cooking than all other genotypes. The genotype Punjab basmati 3 had shorter grain length than Pusa basmati 1121 and longer than Basmati 370 but statistically similar grain length with the genotypes Pusa 1601, Pusa 1609 and UPR 3506. The genotypes Basmati 370 and Pusa basmati 1121 had lesser grain breadth but the genotypes Pusa 1601, Pusa 1609, UPR 3506 had thicker grains than all other genotypes. The LB ratio was recorded highest in Pusa basmati 1121 and it was closely followed by Punjab basmati 3 and Basmati 370. Similarly, the highest elongation ratio was also observed in Pusa basmati 1121 and it was followed by basmati 370 for elongation ratio (Fig. 1).

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