

## Effect of dates of transplanting on seed quality characters of basmati rice (*Oryza sativa*) cultivars

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**ABSTRACT** A field experiment was conducted on three cultivars of basmati rice (*Oryza sativa* L.) viz. Pusa Basmati 1, Pusa Basmati 6 and Pusa Basmati 1121 to study the effect of different dates of transplanting on seed quality characters during *kharif* season (2009) at Indian Agricultural Research Institute, New Delhi. The seedlings of all three varieties were transplanted at 10 days interval starting from 1 July and up to 1 August, Pusa Basmati 1121 exhibited maximum 1,000-seed weight (29.87 g) in 1 July transplanted plot and minimum 1,000-seed weight (27.47 g) in 1 August transplanted plot. However, seed weight was drastically reduced in Pusa Basmati 6 and Pusa Basmati 1 when subjected to delayed transplanting. Pusa Basmati 1121 recorded maximum germination (94.33%), followed by Pusa Basmati 1 (86.5%) and Pusa Basmati 6 (89.83%) in 1 July transplanting. Gradual decrease in germination was observed with each delay in transplanting dates, irrespective of varieties. However, seed germination (Including fresh ungerminated/dormant seed) was higher than the Indian Minimum Seed Certification Standards (80%) in all dates of transplanting. Superior seed quality in relation to electrical conductivity was observed in early transplanting, contrary to the late transplanting. Significant reduction in seedling vigour was also recorded in 1 August, compared to 1 July transplanting. Amongst three cultivars, highest seedling vigour was observed in Pusa Basmati 1121 (2578.1), followed by Pusa Basmati 6 (2071.3) and Pusa Basmati 1 (1777.3) in early transplanting dates.

**Key words:** Rice, transplanting dates, seed quality, germination, seedling vigour, electrical conductivity

Rice (*Oryza sativa* L.) is main staple food crop in India. 'Basmati rice' with fine long grains and pleasant aroma has highest consumer preference in Northern India. A large number of high-yielding basmati varieties are cultivated throughout India. Three cultivars selected for the present study are popular in northern states of the country, including Delhi. Total area under cultivation of these three varieties viz. Pusa Basmati 1, Pusa Basmati 1121 and Pusa Basmati 6 in India is about 0.6, 1.2 and 0.05 million ha, respectively. The success of production technology of scented varieties primarily depends on quality seeds. Under natural conditions, environmental factors are most difficult to control and they exert pronounced effect on

production and quality of rice seed. Seed quality plays a crucial role in realizing the full genetic potential of varieties as well as benefits of other agricultural inputs [1]. The important factors which affect production of quality seed in rice is maturity stage which in turn is subject to modifications in cultural practices. The use of quality seeds alone can increase the productivity up to 15-20%. Owing to uncertainty and irregular distribution of rainfall and shortage of irrigation water, farmers are being forced to take up late transplanting of rice cultivars. Besides, rice crop is taken after harvesting of wheat by most of the farmers in northern states. Chopra *et al.* [2] showed the effect of different transplanting dates on seed yield and quality of

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Pusa Basmati 1. Transplanting on 30 June resulted in significantly higher panicle length, panicle weight, 1,000-seed weight and seed yield (56.53) units than that of 21, 28 July and 4 August. Significant reduction in seedling vigour was registered in 20 July (18%) as compared to 30 June transplanting. A significant loss in seed yield and seed vigour with increased seedling age for transplanting from 21 to 51 days in Pusa Basmati 1.

Hence, present experiment was conducted to compare three Basmati varieties transplanted at different dates for seed quality parameters, including seed health status.

### MATERIALS AND METHODS

The seed material of elite basmati genotypes *i.e.* Pusa Basmati 1, Pusa Basmati 1121 and Pusa Basmati 6 was obtained from the Division of Genetics, IARI, New Delhi. The nursery-beds of 8 m (length) x 1.5 m (width) and 4 inches height were prepared and seeds of all cultivars were sown in line in June in a staggered manner. Twenty-one days old seedlings were transplanted @ single seedling hill, having a spacing of 20 cm x 15 cm for all the treatments. Four transplanting dates (1 July, 10 July, 20 July and 1 August) were tried in randomized block design using three replications at each transplanting date, for each variety. The net plot size of each treatment was kept at 4 m x 4 m. The fertilizer was applied @100 kg N, 60 kg P, 50 kg K and 25 kg/ha of zinc sulphate. Full dose of phosphorus, potash, and zinc was applied at the last puddling operation. Nitrogen was applied in 2 equal splits, 10 and 50 days from transplanting. All the cultivation practices were followed as per the standard recommendations.

Seeds of all the three rice cultivars were harvested from each plot. The seed from each plot was considered as a separate seed lot and sampling was done by hand method to obtain uniform and representative sample for further evaluation. In Pusa Basmati 1, days to maturity was 133 (1 July), 135 (10 July), 131 (20 July) and 127 days (1 August). Similarly, Pusa Basmati 1 recorded days to maturity as 144 (1 July), 148 (10 July), 143 (20 July) and 139 days (1 August). Likewise, days to maturity in Pusa Basmati 6 was 133 (1 July), 135

(10 July), 131 (20 July) and 127 days (1 August). A working sample of 70 g was obtained from submitted sample using Soil type seed divider and evaluated in laboratory to assess seed quality. The 1,000-seed weight, germination (%) and electrical conductivity were recorded as per the standard procedures of ISTA. To determine the seedling length, 10 seedlings from each replication were taken randomly on fourteenth day from incubation, whereas seedling length was measured from the tip of the primary root to the tip of primary leaf. The mean length of 10 seedlings was calculated and expressed in centimeters. Subsequently, seedlings were dried in a hot air oven maintained at 80°C for 24 hr.

For determination of shoot and root ratio, shoot and root length was recorded in 10 normal seedlings and mean ratio per seedling was determined. Seedling vigour index was calculated by using seedling growth parameters and expressed as a whole number as reported by Abdul-Baki and Aderson [3]. Seed health tests were carried out for identification of pathogenic and saprophytic fungi. Standard blotter method and agar plate method were used for the detection of seed mycoflora.

### RESULTS AND DISCUSSION

After seed processing, all three varieties showed physical purity more than 98%. The data showed significant effect of interaction of varieties and transplanting dates on 1,000-seed weight (Table 1). The 1,000-seed weight was maximum in 1 July as compared to other transplanting dates. Pusa Basmati 1121 exhibited maximum 1,000-seed weight (29.87 g) in 1 July transplanted plot and showed minimum variation when subjected to different transplanting conditions. However, seed weight was drastically reduced in Pusa Basmati 6 and Pusa Basmati 1 when subjected to delayed transplanting conditions. Pusa Basmati 6 recorded lowest 1,000-seed weight (18.83 g) on 1 August transplanting. Significantly higher 1,000-seed weight in earlier plantings was primarily owing to favourable temperature during plant growth, seed development and maturity, resulting in better growth and uptake of nutrients, which facilitated translocation from vegetative parts to reproductive parts, thereby resulting in bolder seeds. Safdar *et al.* [4] reported that fine grain rice transplanted

Table 1. Effect of transplanting dates on 1,000-seed weight (g) and seed germination in basmati rice cultivars

Variety	Treatment	1,000-seed weight (g)	Normal seedlings (%)	Abnormal seedlings (%)	Dead seeds (%)	Fresh ungerminated (Dormant) seeds
Pusa Basmati 1	T <sub>1</sub>	23.13 (68.44)	86.50 (11.53)	4.00 (5.73)	1.00 (15.3)	7.00
	T <sub>2</sub>	22.30 (64.22)	81.50 (19.21)	10.83 (4.69)	0.66 (15.7)	7.33
	T <sub>3</sub>	21.83 (61.80)	77.66 (22.38)	14.16 (4.05)	0.50 (16.6)	8.16
	T <sub>4</sub>	18.97 (60.55)	75.16 (17.95)	9.50 (8.13)	2.00 (20.26)	12.00
	Mean	21.6 (63.70)	80.38 (18.15)	9.71 (5.85)	1.04 (17.68)	8.63
Pusa Basmatit 1121	T <sub>1</sub>	29.87 (76.22)	94.33 (10.51)	3.33 (2.3)	0.16 (8.4)	2.16
	T <sub>2</sub>	28.80 (75.03)	93.33 (9.68)	2.83 (0.0)	0.00 (11.2)	3.83
	T <sub>3</sub>	27.83 (70.03)	88.83 (12.48)	4.66 (7.03)	1.50 (12.0)	4.33
	T <sub>4</sub>	27.47 (68.42)	86.50 (16.77)	8.33 (5.2)	0.83 (13.97)	5.83
	Mean	28.5 (72.29)	90.75 (12.64)	4.79 (4.55)	0.63 (11.5)	4.04
Pusa Basmati 6	T <sub>1</sub>	25.13 (71.40)	89.83 (13.97)	5.83 (4.6)	0.66 (9.4)	2.66
	T <sub>2</sub>	24.87 (69.5)	88.16 (16.50)	8.16 (5.7)	1.00 (11.04)	3.66
	T <sub>3</sub>	22.10 (60.88)	76.33 (20.58)	12.83 (8.4)	2.16 (13.5)	5.50
	T <sub>4</sub>	18.83 (63.62)	80.33 (21.57)	13.16 (5.7)	1.00 (15.7)	7.33
	Mean	22.7 (66.16)	83.67 (18.43)	10.00 (6.31)	1.21 (12.6)	4.79
CD (0.05)	Variety	0.048	2.73	2.10	N.S.	1.65
	Treatments	0.055	3.15	2.42	N.S.	1.90
	V x T	0.095	N.S.	4.19	N.S.	N.S.

T<sub>1</sub>: 1 July transplanting; T<sub>2</sub>: 10 July transplanting; T<sub>3</sub>: 20 July transplanting; T<sub>4</sub>: 1 August transplanting

Note : Figures in parantheses represent the arc sine transformed values for germination value

between June and July attained maximum grain weight due to availability of suitable temperature during grain growth. Higher 1,000-grain weight was found in earlier transplanting dates due to higher conservation of light energy into chemical energy and its subsequent translocation from source to sink was also reported by Patra and Biswas [5].

The germination (%) including fresh ungermination and/or dormant seed was found to be above Indian Minimum Seed Certification Standards (80%) at all transplanting dates in all the cultivars. The data (Table 1) showed that maximum germination (%) in early transplanting, viz. 1 July, followed by 10 July. However, delayed transplanting beyond 20 July resulted in lower germination (%) and increase in abnormal seedlings, dead seeds and dormant seeds. Pusa Basmati 1121 recorded highest percentage of germination (97.1%) on 10 July transplanting. The seeds of all three cultivars obtained under different transplanting dates showed a gradual decrease in germination (%) with delayed transplanting dates. Basmati rice cultivars exhibit seed dormancy in general up to 3-4 months from harvesting. The percentage of fresh un-germinated and dormant seeds was higher in seeds harvested from 20 July transplanting and later. This low germination may be attributed to low temperature at flowering, seed setting and seed maturity resulting in low seed setting and poor seed development [6]. Kotlunow and Brennan [7] had reported the need to select for early transplantation to reduce the possible environmental epistatic effects on gene expression over longer growth period for seed development.

The maximum number of normal seedlings was observed in Pusa Basmati 1121 on 1 July transplanting (94.33%). However, abnormal seedlings registered an increasing trend with delay in transplanting (Table 1). In Pusa Basmati 1121, highest number of abnormal seedlings was observed in 1<sup>st</sup> August transplanting (8.33%). Similar trends were also observed in Pusa Basmati 1 and Pusa Basmati 6. All the three cultivars showed presence of fresh un-germinated seeds due to dormancy. However, lowest percentage of fresh un-germinated seeds were observed in Pusa Basmati 1121, followed by Pusa Basmati 1 and Pusa Basmati 6. Their percentage was highest in seeds produced under 1<sup>st</sup> August transplanting in

all the three cultivars (Table 1).

There was a continuous decrease in seedling growth with delayed transplanting (Table 2). Seedling growth was found to be highest in early transplanting, whereas it was least in seedlings of 1 August transplanting. Amongst three cultivars, highest seedling length was found in Pusa Basmati 1121 (27.15 cm), followed by Pusa Basmati 6 (23.37 cm). The highest shoot: root ratio was also recorded in Pusa Basmati 1121 (1.13), whereas lowest shoot: root ratio was observed in Pusa Basmati 6 (1.05). The effect of transplanting dates on shoot: root ratio was found to be statistically non-significant. Seedling dry weight was found to be statistically non-significant in different cultivars. The highest seedling dry weight was obtained from seedlings on early transplanting (1 July). There was a continuous decrease in seedling dry weight with delay in transplanting, irrespective of cultivar (Table 2).

The data in Table 2 showed significant effect of interaction of varieties and transplanting dates on vigour index I. Seedling vigour index I was more in early transplanting compared to late transplanting. Pusa Basmati 1121, registered highest seedling vigour in 10 July transplanting (2890.5), whereas least seedling vigour was obtained in Pusa Basmati 1 when transplanting was carried out on 1 August (1522).

Similarly, significant effect of interaction of varieties and transplanting dates was observed on vigour index II though it was statistically non-significant among varieties. Seedling vigour index II was more in early transplanting compared to late transplanting.

The seedling vigour decreased significantly with each delay in transplanting dates. Amongst all varieties, Pusa Basmati 1121 again showed highest seedling vigour (8619). The factors viz. easy breakdown of food material and translocation as well as utilization of simple carbon chain in shoot elongation system, accounts much to show the vigour potential of seed [6].

The electrical conductivity is negatively correlated with seed quality, lesser the values, higher the probability of good quality of seed. The electrical conductivity increased significantly with

Table 2. Effect of transplanting dates on seed and seedling vigour

Variety	Treatment	Seedling growth (cm)	Shoot: root ratio	Seedling dry weight (mg)	Vigour index-I	Vigour index-II	Electrical conductivity (dS/m/g)
Pusa Basmati 1	T <sub>1</sub>	23.38	1.102	96.7	2186.0	9155	0.492
	T <sub>2</sub>	19.93	1.173	87.2	1770.3	7717	0.579
	T <sub>3</sub>	19.00	1.081	82.1	1630.6	6979	0.693
	T <sub>4</sub>	17.33	1.066	78.3	1522.0	6877	0.710
	Mean	19.91	1.11	86	1777.3	7682	0.619
Pusa Basmati 1121	T <sub>1</sub>	28.51	0.999	99.3	2751.2	9582	0.356
	T <sub>2</sub>	29.75	1.085	96.4	2890.5	9367	0.374
	T <sub>3</sub>	26.64	1.167	88.5	2481.7	8378	0.458
	T <sub>4</sub>	23.71	1.254	78.7	2189.1	7148	0.580
	Mean	27.15	1.13	90.75	2578.1	8619	0.442
Pusa Basmati 6	T <sub>1</sub>	25.09	1.160	97.3	2320.8	9098	0.428
	T <sub>2</sub>	24.72	0.902	93.1	2270.2	8456	0.474
	T <sub>3</sub>	22.83	1.028	85.5	1868.1	7167	0.504
	T <sub>4</sub>	20.83	1.117	77.9	1825.9	6686	0.673
	Mean	23.37	1.05	88.45	2071.3	7852	0.520
CD (0.05)	Variety	1.04	N.S.	N.S.	92.80	N.S.	0.044
	Treatment	1.20	N.S.	0.02	107.16	1023.15	0.051
	V × T	N.S.	0.190	N.S.	185.60	N.S.	0.088

T<sub>1</sub>: 1 July transplanting; T<sub>2</sub>: 10 July transplanting; T<sub>3</sub>: 20 July transplanting; T<sub>4</sub>: 1 August transplanting

each delay in transplanting dates. The data in table 2 showed that lowest electrical conductivity was observed when transplanting was done on 1 July. Highest electrical conductivity was recorded in 1 August transplanting. Of all the varieties Pusa Basmati 1121 depicted lowest electrical conductivity (0.356 dS/m/g) on 1 July transplanting. Hence seeds harvested from 1 July transplanting maintained its superiority in terms of electrical conductivity of seed leachate. The differences in loss of leachates from seeds of different transplanting dates may be due to difference in

relative amount of sugars present in seed or due to difference in sensitivity in uptake of water during imbibitions or both [8]. Moreover, Chopra and Chopra [9] studied the phenology, growing degree-days (GDD) and their subsequent effects on seed yield and quality of Pusa Basmati 1. They reported that plant traits, 1,000-seed weight, germination (%), vigour and seed yield showed a significant decline with delay in transplanting. The plantings done up to the mid-July were safe for higher seed yield and quality. However, adverse effects of late plating (28 July and 4 August) were

reflected in lower yield and increased electrical conductivity values of ripening phase.

The seeds of three different basmati rice cultivars produced under different transplanting dates were also analyzed for seed health. The detection of seed-mycoflora was done by standard blotter method as well as agar plate method following ISTA rules [10]. Among different seed-borne fungi, *Alternaria alternata* was found to be most commonly associated with seed samples of all three cultivars. Other fungi detected were *Bipolaris oryzae*, *Curvularia lunata*, *Cladosporium* spp., *Drechslera tetramera*, *Fusarium monilliforme*, *Trichoconiella padwickii* and *Penicillium* sp. In general, healthy seeds were obtained when transplanting was done on 1 July. The incidence increased with delay in transplanting dates. Maximum per cent incidence was recorded when transplanting was done on 1<sup>st</sup> August, in all the cultivars. The incidence of *Alternaria alternata* was maximum in seeds obtained from 1 August transplanting, irrespective of varieties. The incidence varied from 22 to 25 and 15 to 29% as detected through standard blotter method and agar plate method, respectively. The *Bipolaris oryzae* was another important seed-borne fungi found to be associated with all the three cultivars. Its incidence ranged from 2 to 8, 2 to 4 and 1 to 6% in Pusa Basmati 1, Pusa Basmati 1121 and Pusa Basmati 6, respectively. The incidence was higher in seeds produced at later transplanting dates. Other fungi namely, *Curvularia lunata*, *Cladosporium* sp. and *Drechslera tetramera* were also recorded in seeds and their association was also invariably increased with delayed transplanting. However, incidence of *Fusarium monilliforme* decreased with delayed transplanting in Pusa Basmati 1. Maximum and minimum incidence were observed in seeds obtained from 1 July (10%) and 1<sup>st</sup> August (0%) transplanting, respectively. However, similar trends were not found in other two cultivars. The incidence of *Trichoconiella padwickii* and *Penicillium* sp. was recorded in low frequency compared to other fungi. Moreover, *Penicillium* sp. was observed only with agar plate method but could not be detected through standard blotter method.

The factors such as favourable environmental conditions for fungal growth, reduced seed vigour, loss of membrane integrity and subsequent loss of

seed metabolites through seed membranes may have contributed for the increased percentage of seed-borne and saprophytic seed-mycoflora under delayed transplanting of basmati rice cultivars. Among three cultivars, Pusa Basmati 1 was found to be susceptible, whereas Pusa Basmati 6 was fairly resistant to seed-borne and saprophytic seed-mycoflora. Thus, it was concluded that for better seed quality attributes, seed crop of scented rice cultivars Pusa Basmati 1, Pusa Basmati 1121 and Pusa Basmati 6 should be transplanted in the first fortnight of July, under Delhi conditions.

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