



Influence of sowing dates and nitrogen levels on growth, yield and quality of scented rice cv. *Pusa Sugandh-3* in Kashmir valley

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Abstract: A field experiment was carried out to determine the optimum sowing date and nitrogen (N) level for the scented rice cv. *Pusa Sugandh-3*. Twelve treatment combinations of 3 sowing dates, viz., 15th, 16th and 18th standard meteorological week (SMW) at an interval of 10 days and 4 nitrogen levels ('0', '40', '60' and '80' kg N ha⁻¹) were tested randomized in split plot design with three replications. Significant highest plant height (98.56 cm), tillers m⁻² (333.41), dry matter (98.38 q ha⁻¹), panicles m⁻² (310.05), spikelets panicle⁻¹ (130.25) and grains panicle⁻¹ (98.55), grain yield (45.2 q ha⁻¹), harvest index (41.20 %), head rice recovery (47.5 %) and B:C ratio (3.03) were recorded for the early sown 15th SMW crop. Among the different nitrogen levels tested significant highest plant height (98.12 cm), tillers m⁻² (342.33), dry matter (100.68 q ha⁻¹), panicles m⁻² (321.83), spikelets panicle⁻¹ (132.83) grains panicle⁻¹ (96.79), grain yield (48.0 q ha⁻¹), harvest index (42.68 %), head rice recovery (44.54 %) and B:C ratio (3.38) were recorded with the application of 80 kg N ha⁻¹. Therefore, the variety, *Pusa Sugandh-3* should be sown earlier in season from 15th to 16th SMW and with nitrogen application of 60-80 kg N ha⁻¹ for realizing economically higher grain yield and profit under the temperate climatic conditions of Kashmir valley.

Keywords: Grain yield, Head rice, Nitrogen levels, *Pusa Sugandh-3*, Sowing dates

INTRODUCTION

Most of the basmati varieties grown in our country including the state Jammu and Kashmir are traditional varieties, which are tall statured, weak stemmed, disease susceptible and non-responsive to fertilizers, resulting in their lower yield, but are recognized for their reputed aroma. However, some new high yielding semi dwarf basmati varieties have been released which have revolutionized the basmati rice production of the country. Recently some of these high yielding varieties like *Pusa Basmati-1*, *Pusa Sugandh-2* and *Pusa Sugandh-3* have also been introduced in the valley and evaluated for their performance under temperate climatic conditions. Among these *Pusa Sugandh-3* has been found to perform comparatively better than other varieties and in terms of yield potential, disease resistance and duration. The higher sterility percentage noted for the variety is attributed to the lower temperature during anthesis to grain filling stage in the valley, when sown at dates recommended for the non-aromatic types. Also the higher fertilizer doses especially nitrogen recommended for non-aromatic types do not suit the basmati types. Higher nitrogen doses produce crop of poor grain quality, predisposes crop to more disease attacks, increases the crop duration and also exposes the vari-

ety to the lower temperature stress prevalent in valley late in the season.

Since rice yield and quality are not only controlled by genetic factors, but are also largely influenced by environmental factors (Gao and Zhang, 1994), such as light, temperature, soil type, soil water, cultivation measures, etc. (Hiroyuki *et al.*, 2002), which can be manipulated to optimum level for higher crop yields through different management factors of which sowing date and nitrogen fertilization are of prime importance. Time of sowing assumes greater importance, owing to shorter growing season of 140-145 days available under Kashmir valley conditions. The important growth phases of rice crop especially the grain filling stage coincides with very low temperature resulting in very high sterility percentage, when sown late (Hussain *et al.*, 2009).

Nitrogen is one of the most important nutritional elements for the higher productivity of cereal crops and a major factor that limits agricultural yields (Balasubramanian *et al.*, 2000 and Islam, 2009). Nitrogen absorbed by rice during the vegetative growth stages contributes in growth during reproduction and grain-filling through translocation (Norman *et al.*, 1992; Bufogle *et al.*, 1997). The application of nitrogen fertilizer either in excess or less than optimum rate affects both yield and quality of rice to remarkable

extent, hence proper management of crop nutrition is of immense importance (Manzoor *et al.*, 2006). Recommendation on nitrogen requirement and planting dates for growing coarse rice is available, but in case of basmati rice such information is lacking. The variety *Pusa Sugandh-3* being comparatively new to the valley, therefore much work has not been done yet on these aspects and as such there is lack of information of these agronomic treatments on the yield of this variety. So keeping in view these facts, the experiment was conducted to synchronize the important growth stages of the scented rice with the optimum environmental conditions after application of proper nitrogen dose in order to get timely matured crop with higher yields and better quality.

MATERIALS AND METHODS

The study was conducted at the Agronomy Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir during summer season 2013. The study area is situated at 34° 05' N latitude and 74° 89' East longitude having an altitude of 1587 m above mean sea level. The mean temperatures ranged from 13.11 °C and 26.90 °C, respectively. Twelve treatment combinations (D₁N₀, D₁N₁, D₁N₂, D₁N₃, D₂N₀, D₂N₁, D₂N₂, D₂N₃, D₃N₀, D₃N₁, D₃N₂, D₃N₃) of 3 sowing dates, viz., 15th, 16th and 18th Standard meteorological week (SMW) at an interval of 10 days and 4 nitrogen levels ('0', '40', '60' and '80' kg N ha⁻¹), respectively were tested and randomized in split plot design with three replications. The soil of the experimental field was silty clay loam in texture with neutral pH, normal electrical conductivity (0.23 dSm⁻¹), medium available nitrogen (407.68 kg ha⁻¹), low available potassium (178.08 kg ha⁻¹), high available phosphorus (26.57 kg ha⁻¹) and organic carbon (0.95%). The nursery was raised in low polythene tunnels during a period of low temperature (<10°C). Forty days old seedlings were transplanted at a spacing of 15 cm × 15 cm. A uniform dose of phosphorous (P), potassium (K) and zinc (Zn) at the rate of 60 kg P₂O₅, 40 kg K₂O and 15 kg ZnSO₄ ha⁻¹ was applied in all plots. The nitrogen was applied as per treatments in three splits. Entire quantity of P, K and Zn and 50% N was applied before transplanting and the remaining nitrogen was applied in two equal splits at mid tillering, i.e., 30 days after tillering (DAT) and panicle initiation (60 DAT) stages as per treatments. Anthesis was determined when 50 % of panicles were visible in the centre of the plot. The crop reached physiological maturity when 95 % of spikelets had turned yellow. At panicle emergence, 12 randomly selected panicles (one from each separate plant) were tagged in each cultivar. These tagged panicles were harvested at physiological maturity and data on number of filled grains per panicle and sterility percentage were recorded. Grain yield was calculated on 14% moisture basis. Harvest index, head rice recovery and B:C ratio were also calculated.

All the data were analysed using split plot design for analysis of variance (ANOVA) and differences among treatments were compared at P ≤ 0.05 level of significance using the IRRISTAT data analysis package (IRRI 2000).

RESULTS AND DISCUSSION

Growth parameters : The plant growth parameters showed significant variation due to the effect of sowing time (Table 1). Significantly higher plant height (98.56 cm), tillers m⁻² (333.41) and dry matter accumulation (9838 kg ha⁻¹) were recorded for early sown 15th SMW but was at par with 16th SMW while the 18th SMW sown crop recorded the significantly lowest growth parameters. Higher growth parameters in the earlier sown rice crop were also reported by (Hussain *et al.*, 2009; Nahar *et al.*, 2009 and Singh *et al.*, 2012). Haghverdian (2010) also reported lower plant height during earlier stages of crop under earlier sowing due to the effect of low environmental temperature on plants growth. However, from 60 DAT, crop sown in 15th SMW recorded highest plant height but was at par with that sown in 16th SMW. The increase in plant height in the crops sown on early dates during the later stages might have been due to better temperature and weather conditions experienced by the crop at later growth stages especially at the internode elongation stage which is favoured more at higher temperatures. Also early sown crops had longer vegetative and overall growth period due to which plants synthesized more photosynthates which were utilized for growth of vegetative organs of the plant. Nitrogen played a significant role in the different growth parameters (Table 1). The significantly highest plant height (98.12 cm), tillers m⁻² (343.33) and dry matter accumulation (1006 kg ha⁻¹) were recorded for N₈₀ level but was at par with N₆₀ level. The nitrogen levels N₄₀ and control recorded significantly lower growth parameters than N₈₀ and N₆₀. However, control recorded significantly lowest growth parameters among all the nitrogen levels tested. The increase in plant height with increased nitrogen levels may be attributed to the fact that nitrogen enhances the vegetative growth of plants owing to increase in cell size and meristematic activity. Enhanced tillering by increased nitrogen application might be attributed to more nitrogen supply to plant at active tillering stage. The increase in dry matter with successive nitrogen levels is due to the fact that increased nitrogen levels caused increase in plant height, tiller m⁻² which subsequently increased dry matter production. Zhilin *et al.* (1997) also reported increase in the plant height with successive increments of nitrogen. The results were also in accordance with the findings of Haefele *et al.* (2008)

Phenology: The days taken to reach flowering and harvest varied significantly among the sowing dates (Table 1). The significantly higher number of days was

Table 1. Effect of sowing dates and nitrogen levels on plant height, tiller per square metre, dry matter accumulation, panicles per square metre, grains per panicle, sterility percentage, 1000 grain weight, days to flowering and days to harvest of scented rice. Values are of 3 replicates.

Treatment	Plant Height (cm)	Tiller m ⁻²	Dry matter accumulation (kg ha ⁻¹)	Panicles m ⁻²	Grains panicle ⁻¹	Sterility %	1000 Grain wt	Days to flowering	Days to harvest
Sowing dates									
15 th SMV	98.56	333.41	9838	301.05	98.55	25.15	23.34	95.06	135.06
16 th SMV	96.93	322.43	9598	295.02	93.93	27.57	23.27	93.05	132.06
18 th SMV	85.89	307.25	8253	270.99	72.89	39.80	23.17	90.06	127.23
SEm±	0.72	4.42	51.87	4.18	1.70	0.59	0.03	0.68	1.05
CD (p≤0.05)	2.82	13.50	61.96	16.33	5.12	2.34	NS	2.01	3.14
Nitrogen levels (kg ha⁻¹)									
Control (N ₀)	86.54	292.52	8133	268.21	79.21	28.07	23.15	90.17	128.95
40 kg N ha ⁻¹ (N ₄₀)	94.43	315.44	8945	282.70	85.10	29.97	23.22	91.23	129.98
60 kg N ha ⁻¹ (N ₆₀)	96.06	332.83	9779	295.34	92.73	32.46	23.35	94.16	132.92
80 kg N ha ⁻¹ (N ₈₀)	98.12	343.33	1006	310.83	96.79	32.86	23.42	95.20	133.95
SEm±	0.51	3.81	10.83	2.88	1.09	0.39	0.04	0.53	0.61
CD (p≤0.05)	1.54	11.55	32.20	8.55	3.26	1.17	NS	1.63	1.87
Interaction (Sowing dates × Nitrogen levels)									
SMV= Standard meteorological week									

Table 2. Effect of sowing dates and nitrogen levels on grain yield, harvest index, head rice percentage and benefit cost ratio of scented rice.

Treatment	Grain yield (kg ha ⁻¹)	Harvest index (%)	Head rice (%)	B: C ratio
Sowing dates				
15 th SMV	4520	41.20	47.50	3.03
16 th SMV	4360	41.10	43.84	2.05
18 th SMV	3230	37.69	39.50	0.14
SEm±	53.04	0.51	0.36	0.41
CD (p≤0.05)	207.09	1.5	1.43	1.22
Nitrogen levels (kg ha⁻¹)				
0 kg N ha ⁻¹ (N ₀)	3080	36.34	42.57	2.03
40 kg N ha ⁻¹ (N ₄₀)	3850	39.74	43.36	2.49
60 kg N ha ⁻¹ (N ₆₀)	4420	41.23	43.99	3.10
80 kg N ha ⁻¹ (N ₈₀)	4800	42.68	44.54	3.38
SEm±	44.65	0.43	0.12	0.11
CD (p≤0.05)	132.70	1.3	0.37	0.33
Interaction (Sowing dates × Nitrogen levels)				
SMV= Standard meteorological week				

taken by 15th SMW sown crop, however, was at par with 16th SMW crop while the significantly lowest number of days was taken by 18th SMW sown crop. Sowing date primarily influences the length of vegetative period of rice with early sown rice requiring a greater number of days to accumulate the same number of degree days units compared with later sown rice. A linear negative correlation between sowing dates and growth period, in the later sowing dates was also reported by Peng-fei *et al.* (2013). Among the nitrogen levels 80 and 60 kg N ha⁻¹ took significantly more number of days to reach flowering and harvest than 40 kg N ha⁻¹ and control. Delayed flowering with higher nitrogen dose may be due to more vegetative growth, as reflected by increased plant height, which delayed maturity. Haque *et al.* (2006) conducted an experiment to study the effect of nitrogen fertilizer on yielding ability of indigenous aromatic rice varieties with three levels of nitrogen fertilizer (0, 60 and 120 kg N ha⁻¹). They reported that irrespective of cultivars, the days required to flowering and maturity significantly increased with the increase in the amount of nitrogen applied. Crop maturity was delayed by almost 9, 6, 13 and 7 days at 60 kg N ha⁻¹ and by 17, 14, 11 and 12 days at 120 kg N ha⁻¹. Accelerated vegetative growth might be a factor for delaying flowering and crop maturity with the increase in the amount of nitrogen fertilizer.

Yield attributes: Significant variation in the yield attributes was noticed among the sowing dates (Table 1). The 15th SMW sowing date recorded significantly higher number of panicles m⁻² (301.05) and grains panicle m⁻² (98.55) over 18th SMW sowing date but was at par with 16th SMW sowing. However, sterility percent, a negative yield attribute was found highest (39.80 %) in the late sowing date (18th SMW). Higher panicles m⁻² and grains per panicle in earlier sowing dates might be due to more favourable weather conditions during the critical growth stages like panicle initiation, flowering and grain filling periods and also due to higher tillers m⁻² in earlier sown dates. The higher sterility per cent in the later sown 18th SMW crop was due to lower number of filled grains per panicle. This might be attributed to the lower temperature prevalent during the flowering and grain filling period which caused the lower pollen germination and, consequently, increased the unfilled grains per panicle which therefore increased the sterility per cent. Hussain *et al.* (2009) also reported that delayed sowing under Kashmir conditions exposes the flowering period of rice to lower temperature and increases the sterility percentage considerably. Nahar *et al.* (2009) reported that low temperature causes various types of injuries in rice plants, but the most important one is spikelet sterility. They reported that filled grains production decreased significantly with the delay of transplanting which was due to occurrence of low temperature at anthesis and spikelet primordial formation. The 1000-seed weight

showed no significant difference among the different sowing dates is due to the fact that it is usually a stable varietal character and the management practice has less effect on its variation. Haque *et al.* (2006) also reported no significant change in 1000-grain weight with change in planting dates. In present study, nitrogen levels also significantly influenced different yield attributes (Table 1). A significantly higher number of panicles m⁻² (310.83), and grains per panicle (96.79) were recorded for N₈₀ but was at par with N₆₀ level while as N₄₀ and N₀ (control) recorded lower yield attributes. The sterility percent was found highest (32.86 %) for the N₈₀ level and lowest for control (28.07 %). The increase in panicles m⁻² observed for N₈₀ and N₆₀ levels might be due to the fact that highest nitrogen levels ensured better availability of nitrogen to plants during the tillering period of rice, which might have resulted in more productive tillers and consequently the panicle m⁻². Increasing trend of panicle at the higher levels of nitrogen was also observed by (Awan *et al.*, 2011). However, the higher sterility percentage recorded in the treatments received highest nitrogen doses, might be due to the reason that higher doses of nitrogen produced profuse tillering, which led to competition among the tillers and reduces the quantity of photosynthates from source to sink, which would have resulted in more number of ill-filled grains. The increase in spikelet sterility with an increase in nitrogen levels were also reported by (Manan *et al.*, 2010). The 1000-seed weight is usually a stable varietal character and the management practice has lower effect on its variation. Haque *et al.* (2006) did not find any significant variation in the 1000-seed weight of rice varieties because of variation in nitrogen dosage. The interaction effect between sowing dates and nitrogen levels was however non-significant.

Grain yield and harvest index: The significantly highest grain yield (4520 kg ha⁻¹), and harvest index (41.20) was recorded for crop sown on 15th SMW but was at par with 16th SMW sown crop while the lowest grain yield (3220 kg ha⁻¹) and harvest index (37.69 %) was recorded from the later sown 18th SMW crop (Table 2). Yield increase in the 15th SMW sown crop was 3.53 and 28.53 per cent over 16th and 18th SMW sown crop, respectively. The higher yield in the earlier sowing dates might be attributed to the result of higher number of panicles m⁻² and grains per panicle. Nahar *et al.* (2009) reported significant reductions in yield attributes and yields after delayed transplanting. Spikelet sterility was increased by late transplanting due to low temperature at panicle emergence stage. The important growth phases of rice crop especially the grain filling stage coincides with very low temperature resulting in very high sterility percentage thereby reduction in yield, when sown late (Hussain *et al.*, 2009). Higher harvest index might be due to the proper crop growth and development and assimilate accumu-

lation in the grains. Singh *et al.* (2012) reported that under late sown conditions there was reduction in harvest index of rice cultivars in sequence of (Shalimar Rice 1 > Jhelum > Chenab > China 1039). The nitrogen levels also exerted a significant effect on the yield of basmati rice (Table 2). The highest grain yield (4800 kg ha⁻¹), and harvest index (42.68) was produced in crop received 80 kg N ha⁻¹ and was at par with N₆₀ level but was significantly superior to N₄₀ and control treatments. The increase in grain yield by applying 80 kg N ha⁻¹ was 7.9, 19.79 and 35.83 per cent than nitrogen levels of 60, 40 and 0 kg ha⁻¹, respectively. This could mainly be attributed to the increase in the number of panicles m⁻² and total number of filled grains per panicle in the earlier sown dates. Bali and Uppal (1995); Awan *et al.* (2011) and Rao *et al.* (2013) also reported higher yield with successive increase in nitrogen levels. The decrease in harvest index at the lower nitrogen levels might be due to lower availability of translocates required for grain filling. The results are in conformity with those of (Awan *et al.*, 2011). The interaction effect between sowing dates and nitrogen levels was however non-significant.

Quality and economics: Head rice recovery is one of the most important criteria of rice quality especially in basmati rice from the standpoint of marketing. A variety should possess a high turnout of whole grain (head) rice and total milled rice to fetch higher income (Webb, 1985). Head rice recovery showed a significant variation among sowing dates (Table 2). Significantly higher head rice percentage was recorded for the 15th SMW sowing date (47.50) and lowest for the 18th SMW sowing date (39.50). Similar results were obtained by Bali and Uppal (1995) from Ludhiana, who reported that basmati rice sown earlier had higher head rice recovery than late sown crop. As regards the different levels of nitrogen significant difference in head rice recovery was noticed (Table 2). The significantly higher head rice per cent was recorded for crop receiving 80 kg N ha⁻¹ (44.54) and lowest for control (41.84). The results were also in accordance with the findings of Khalid and Chaudhry (1999) who also reported improvement in the quality parameters of aromatic rice with an increase in nitrogen levels. Significant differences were noticed on the economics of *Pusa Sugandh 3* among the sowing dates and nitrogen levels (Table 2). The higher B:C ratio (3.03) was recorded with sowing date of 15th SMW. Among the nitrogen levels the highest B:C ratio (3.38) was recorded in relation to the application of 80 kg N ha⁻¹. Higher B:C ratio in the early planted crop with application of higher nitrogen level was also reported by (Kumar and Ikramullah, 2004) under tropical conditions

Conclusion

Based on the results of the study, it is concluded that *Pusa Sugandh-3* should be sown earlier in season from

15th to 16th SMW and with nitrogen application of 60- 80 kg N ha⁻¹ for realizing economically higher grain yield and profit under the temperate climatic conditions of Kashmir valley. This study will be useful to create awareness among the farming community about the optimum dose of nitrogen fertilizer (80 kg N ha⁻¹) and sowing date (15th SMW) of scented rice in Kashmir valley to get maximum production and remunerative returns.

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