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Influence of different dates of sowing and spacings on growth and yield of scented rice cv. *pusa sugandh*-3 under temperate conditions of Kashmir

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A field experiment was conducted during kharif seasons of 2013 and 2014 to determine the effect of different dates of sowing and spacing on growth and yield of scented rice *(Pusa sugandh -3*) under temperate condition of Kashmir. The soil of the experimental field was silty clay loam in texture with neutral pH, low in available nitrogen and medium in available phosphorus and potassium. The experiment comprised of 9 treatments, viz D_1S_1 (15^{th} meteorological week (10^{th} April) + (20 cm x 20 cm), D_1S_2 (15^{th} meteorological week (10^{th} April) + (20 cm x 15 cm), D_1S_3 (15^{th} meteorological week (10^{th} April + (15 cm x15 cm), D_2S_1 (16^{th} meteorological week (20^{th} April) + (20 cm x 20 cm),), D_2S_2 (16^{th} meteorological week (20^{th} April) + (20 cm x 15 cm), D_2S_3 (16^{th} meteorological week (20^{th} April + (15 cm x 15 cm), D_3S_1 (18^{th} meteorological week (30^{th} April) + (20 cm x 20 cm),D_3S_2 (18^{th} meteorological week (30^{th} April) + (20 cm x 15 cm), D_3S_3 (18^{th} meteorological week (30^{th} April + (15 cm x 15 cm) were laid out in a split plot design with 3 replications on plot size of 10 m^2. The growth parameters such as plant height, number of tillers $hill^{-1}$, SPAD and dry matter production was also observed significantly high in D_1S_2 with average Grain yield (48.01 q ha^{-1}), straw yield (77.26 q ha^1) were seen significantly higher in D_1S_2 (15^{th} meteorological week 10^{th} April and 20 cm x 15 cm) compared to other treatments. The yield attributes like number of panicles m^{-2}, number of grains $panicle^{-1}$, 1000-grain weight (g) and harvest index (%) was seen significantly higher in D_1S_2. The economic analysis showed that treatment D_1S_2 showed maximum benefit cost ratio (3.32) followed by D_1S_1 respectively.

Key words: Pusa Sugandh-3, growth, yield, spacing, sowing dates.

INTRODUCTION

Rice (*Oryza sativa* L.) one of the most important staple food crops of the world accounting for more than 20% of daily calorie intake of about 2.48 billion people. Aromatic rice a small, but an important sub-group of rice is rated best in quality and fetches much higher price than the high quality non-aromatic rice in international market, and

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Table 1. Influence of different environments and spacing on growth and growth parameters of scented rice cv.*pusa sugandh-3* under temperate conditions of Kashmir.

Treatment	Plant height(cm)			SPAD			Number of tillers(m^{-2})			Dry matter production(qha^{-1})		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
15th Meteorological week (10th April)	100.47	97.28	98.87	16.96	17.23	17.09	325.21	322.45	323.83	112.97	110.23	168.08
16th Meteorological week (20th April)	97.27	92.78	95.02	15.66	17.89	16.77	270.31	268.89	269.6	104.53	101.43	102.98
18th Meteorological Week (30th April)	89.87	84.23	87.05	13.27	15.45	14.36	260.86	259.98	260.42	100.01	99.64	99.82
SEm±	1.17	1.45	1.31	0.41	0.19	0.91	7.15	6.98	7.04	1.44	1.17	7.58
CD (p ≤ 0.05)	3.53	4.35	3.94	1.23	0.59	2.73	21.45	20.95	21.13	4.32	3.53	22.75
20 cm x 20 cm (S_1)	95.16	92.45	93.80	16.91	16.99	16.95	230.54	228.87	229.70	95.92	93.78	94.85
20 cm x 15 cm (S_2)	100.7	98.88	99.79	14.82	15.34	15.08	385.00	383.56	384.28	118.2	116.98	117.59
15 cm x 15 cm (S_3)	105.0	101.98	103.49	14.17	13.48	13.82	371.00	367.87	369.43	123.4	121.34	122.37
SEm±	1.09	1.05	1.07	0.30	0.39	0.34	11.10	17.18	1.65	3.05	3.06	0.53
CD (p ≤ 0.05)	3.28	3.17	3.23	0.91	1.17	1.04	51.48	51.56	4.95	9.16	9.18	1.59

the demand for this rice is showing an increasing trend in international markets. Among management practices, efficient use of non-monetary inputs such as spacing and time of planting, method of fertilizer application, selection of cultivar, plant density, seedling age, transplanting and harvesting schedules are some of the important means to enhance the rice productivity. Transplanting rice at optimum period is critical to achieve high grain yield. The optimum rice planting dates are regional and vary with location and genotypes (Bruns and Abbas, 2006). The present study was, therefore designed to study the response of pusa sugandh-3 to different dates of sowing and spacing under temperate conditions of Kashmir.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Research Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar (J&K) during *Kharif* 2013 and 2014 on silty clay loam soil with average neutral pH (6.3), low in available nitrogen (407.68 $kgha^{-1}$) and medium in available phosphorus (26.57 $kgha^{-1}$) and potassium (178.0 $kgha^{-1}$). The experimental site is located at 34°08'N latitude and 74°83' east longitude at a height of 1587 m above mean sea level. The experiment comprised of 9 treatments, viz D_1S_1 (15th meteorological week (10th April) + (20 cm x 20 cm), D_1S_2 (15th meteorological week (10th April) + (20 cm x 15 cm), D_1S_3 (15th meteorological week (10th April + (15 cm x 15 cm), D_2S_1 (16th meteorological week (20th April) + (20 cm x 20 cm),), D_2S_2 (16th meteorological week (20th April) + (20 cm x 15 cm), D_2S_3 (16th meteorological week (20th April + (15 cm x 15 cm), D_3S_1 (18th meteorological week (30th April) + (20 cm x 20 cm), D_3S_2 (18th meteorological week (30th April) + (20 cm x 15 cm), D_3S_3 (18th meteorological week (30th April + (15 cm x 15 cm) were laid out in a split plot design with 3 replications on plot size of 10 m^2. The three different spacing and sowing dates were evaluated for yield and growth parameters shown in Tables 1 and 2. After land preparation full dose of phosphorus, potassium and zinc and half dose of nitrogen was applied in different plots in the form of DAP, MOP, $ZnSO_4$ and urea respectively. The other half of nitrogen was applied in two equal splits one at active tillering and other at panicle initiation stage. 40 day old seedlings were transplanted at a spacing of 15 × 15 cm, 20 x 20 cm, 20 x 15 cm with 3 robust seedlings $hill^{-1}$ on the defined dates of transplanting (22nd May, 2nd June, 11th June). Pre emergence application of herbicide Butachlor 5% G was applied at 1.5 kg a.i. 5 days after transplanting in uniform layer and water was impounded in the field for three days. First manual weeding was done after 30 DAT for complete removal of weeds. During both 2013 and 2014, dates of harvesting were 3rd October, 11th October and 16th October for D_1, D2 and D_3 respectively. The data collected was subjected to analysis of variance technique as described by Cochron and Cox (1958). The objectives of this study are: Effect of variable environments on growth, yield and maturity, effect of spacing on growth, yield and maturity and to work out the relative economics.

RESULTS AND DISCUSSION

Growth attributes viz; plant height, number of tillers, dry matter production and SPAD reading were significantly influenced by different treatments shown in Table 1. Treatment D_1S_3

Table 2. Influence of different environments and spacing on yield of scented rice cv.*pusa sugandh -3* under temperate conditions of Kashmir.

Treatment	Grain yield(qha^{-1})			Straw yield(qha^{-1})			Biological yield (qha^{-1})			Harvest index (%)		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
15th Meteorological week (10th April)	49.59	46.43	48.01	72.70	69.45	71.07	122.29	115.88	119.08	40.55	40.06	40.30
16th Meteorological week (20th April)	42.38	40.65	41.51	71.04	68.23	69.63	113.42	108.88	111.15	37.36	37.33	37.34
18th Meteorological Week (30th April)	30.73	30.10	30.41	66.00	65.36	65.68	96.73	95.46	96.09	31.76	31.53	31.64
SEm±	2.09	1.92	2.49	0.74	1.36	1.31	2.84	6.80	5.5	0.97	0.5	0.5
CD (p ≤ 0.05)	6.28	5.78	7.49	2.23	4.09	3.95	8.52	20.42	18.45	2.93	1.49	1.48
20 cm x 20 cm (S_1)	40.59	37.45	39.02	72.96	70.10	71.53	112.55	107.55	110.05	36.06	34.82	35.44
20 cm x 15 cm (S_2)	44.78	42.45	43.61	78.55	75.98	77.26	123.33	118.43	120.88	36.30	35.84	36.07
15 cm x 15 cm (S_3)	31.52	30.67	31.09	60.11	59.56	59.83	91.63	90.23	90.93	34.39	33.99	34.19
SEm±	1.47	1.35	1.53	2.04	1.96	2.07	3.52	3.13	3.44	0.21	0.20	0.20
CD (p ≤ 0.05)	4.41	4.04	4.59	6.14	5.88	6.23	10.56	9.41	10.31	0.63	0.61	0.62

(15th meteorological week (10th April) + (15 cm x 15 cm) recorded highest plant height at harvest followed by D_2S_2 (16th meteorological week (20th April) + (20 cm x 15 cm) during both the years. This might be due to the fact that earlier sowing gets early transplanted in the field and temperature variation in the transplanting environment (Pattar et al., 2001). Besides spacing also has mutual shading at higher densities which has encouraged the plants to grow taller to capture sunshine (Kumari et al., 2000; Moorthy and Saha, 1997). Highest number of tillers were recorded in D_1S_2 (15th meteorological week (10th April) + (20 cm x 15 cm) during both years this was due to the fact that in earlier sowing the crop gets optimum requirement of heat units for conversion into secondary tillers which are direct index of the grain yield and optimum spacing of 20 cm x 15 cm attains optimum plant population m^{-2} or per hectare resulting in more number of primary, secondary and tertiary tillers. Highest SPAD value was recorded during both years in treatment D_1S_2 (15th meteorological week (10th April) + (20 x 15 cm) at earlier stages of transplanting, plants remained more green in colour. Thus provides more SPAD reading as compared to later growth stages. Highest dry matter production was recorded during both years in treatment D_1S_3 (15th meteorological week (10th April) + (15 x 15 cm) may be because of the fact that early sowing coincides with favorable period of crop growth reducing death of tiller and senescence of leaf thus accumulating more dry matter of Hari et al. (1997); Pandey et al. (2001), Manjappa and Kumar (2002) and Poussin et al (2003).

The average highest grain yield (48.01 qha^{-1}), biological yield (120.88 qha^{-1}), straw yield (77.26 qha^{-1}) and harvest index (40.30) were recorded in treatment D_1S_2 (15th meteorological week (10th April) + (20 x 15 cm) shown in Table 2 which was significantly superior over the other treatments. Further average lowest grain yield (30.41 ha^{-1}), biological yield (90.93 ha^{-1}) and straw yield (59.83 ha^{-1}) and harvest index (30.41) was obtained in D_3S_3 (18th meteorological week (30th April+ (15 x 15 cm). This might be due to early transplanting and optimum plant population planted in normal sowing of 20 x 15 cm as compared to wider and closer spacing by Rajarathinam and Balasubramaniyan (1999), Varma et al. (1991); Verma et al. (1988); Kumari et al. (2000); Singh et al. (2003a); Singh et al. (2003b); Pothiraj et al. (1977a); Ahmed and Rao (1966) and Shastry and Freeman (1971).

The average highest net return (Rs 176150.00 ha^{-1}) and benefit: cost ratio (3.32) was registered with 15th meteorological week and 20 x 15 cm followed by D_1S_2 (15th meteorological week (10th April) + (20 x 15 cm) with net return of (Rs 172010.00 ha^{-1}). This might be due to the fact that the earlier and at optimum population at an spacing of 20 x 15 cm which accounts to 440000

hills per hectare gives the maximum profit as compared to closer spacing (Menete et al., 2008). Thus its concluded that the *Pusa sugandh-3* under temperate conditions of Kashmir can be sown earlier, that is, in the 15th meteorological week under protected conditions and transplanted at normal rice spacing of 20 cm x 15 cm to get maximum B:C ratio and net returns.

Conflict of Interest

The authors have not declared any conflict of interest.

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