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Response of *Mushk Budji* Rice to Microclimate Modifications under Temperate Environmental Conditions

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***Abstract*:** Field experiment was conducted during *Kharif*-2021 at Division of Agronomy, SKUAST-K, Wadura with three dates of transplanting *viz*. 05^{th} June, 15^{th} June and 25^{th} June and three crop geometries *viz*., 15 cm x 10 cm, 15 cm x 15 cm and 20 cm x 15 cm. The study used microclimatic modifications by adjusting the sowing time and crop geometry. The early transplanted treatment (5^{th} June) did better than those transplanted in latter weeks of June in terms of growth, phenology, grain yield and low blast disease incidence of scented rice-*MushkBudji*. Variations among crop geometries were also observed, with crop spacing 20 cm x 15 cm required more time to attain different phenological stages thus producing a higher yield at harvest and low blast disease incidence of rice-*MushkBudji*. Moreover, statistically significant interactions between the transplanting dates and crop geometries on grain yield were identified, where early transplanted rice crop (5^{th} June) at spacing 20 cm x 15 cm (T_1S_3) proved to be the better combination for maximum yield. The study concluded that early transplanting (5^{th} June) with spacing 20 cm x 15 cm (S_3) realized higher growth, yield parameters and low blast disease incidence of rice- *MushkBudji* under lower altitude belts (1590 amsl) of Kashmir.

Keywords: Rice, Sowing environment, Crop geometry, Phenology and yield

Scented rice, traditionally grown by farmers constitutes about 4% of total rice cultivation grown across the globe. Cultivation of aromatic rice is very remunerative as it fetches a higher price compared to other rice indicating better income of the cultivators. Despite 12% growth of scented rice globally, its production is declining in India. However, the area under Basmati rice in major grown states of India is around 1.938 million hectares. Haryana is leading with an area of 0.84 million hectares, followed by the Punjab (0.5501), Uttar Pradesh (0.463) (APEDA 2019). The temperature of Kashmir valley is naturally feasible for the local special aromatic rice landraces including more than 100 documented landraces of Japonica type (Parry et al 2008). Among them, *Mushk Budji, Kamad, Nun-boeul,* and *Zag* are the most popular and have a great commercial demand because of their aroma and taste. Therefore, these varieties are an effective way to stabilize a farmer's income. However, in the past three decades, the land has dwindled and receded drastically (MRCFC, SKUAST-K report, 2014). Rice blast disease is a major limiting biotic factor and is endemic to most rice growing areas of J&K. Blast-conducive environmental conditions during the crop season, have drastically affected the production, causing massive economic loss. The crippling nature of this disease makes it a hazardous biological weapon. Most of the indigenous landraces are highly susceptible to the disease. A total loss of 70% yield has been reported due to the outbreak of rice blast disease (Ali et al 2009).

The study used microclimatic modifications by adjusting the sowing time and crop geometry. The study aimed to manage the climatic factors on a microscale, to create an environment favorable for plant growth. The best outcome of rice cultivation is directly proportional to the appropriate temperature range, which can be managed and controlled by sowing at the proper time. Optimum plant spacing is another important factor that ensures proper plant growth (Basha et al 2017). Field-level adjustments enable us to standardize management practices to control blast disease severity. Although chemical control of the disease is feasible, it is economically impractical for resource poor farmers and is environmentally undesirable. Thus, the present study aims to determine the optimum sowing date and crop geometry and its effect on growth, phenology, yield, and blast disease incidence of aromatic rice-*Mushk Budji* grown under lower altitude conditions of Kashmir valley.

MATERIAL AND METHODS

The field experiment was carried out at Division of Agronomy Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadura (34°21'N and

74° 23' E), Sopore. The experiments were conducted during the *Kharif* Season of 2021 at lower altitude (1590 meters). The treatments included three transplanting dates viz. T_1: June 5 (early), D_2: June 15 (mid) and D_3: June 25 (late) and three crop geometries viz. S_1: 15 cm x 10 cm, S_2: 15 cm x 15 cm and S_3: 20 cm x 15 cm. The experiment was laid out in a factorial randomized complete block design (RCBD) with three replications. The soil of the experimental site was silty clay loam in texture, neutral in reaction with low available nitrogen (158.92 kg/ha), medium available phosphorus (158.92 kg/ha) and medium available potassium (132.71 kg/ha). Weather data were obtained from a weather station set up at the experimental site during the period of May to September of 2021, indicating that the crop had experienced mean maximum and minimum temperature of 29.6°C and 13.5°C, average precipitation of 9.35 mm and mean maximum and minimum relative humidity of 82.6 % and 52.6 % respectively during the growth period (Fig. 1). Applied well decomposed FYM @ 5,000 kg/ha at the time of land preparation. Seedlings of 30 days were uprooted carefully from nursery beds on the defined and decided dates and were transplanted in the experimental field with 2-3 seedlings per hill at different spacings. Applied Urea, DAP, MOP and ZnSO4 @ 50, 90, 34 and 15 kg/ha at the time of transplanting and top dose of Urea @ 20 kg at 25 days after transplanting. Plant protection measures were also taken by using only two chemical sprays of fungicides (Total four sprays recommended by SKUAST-K). First spray of Carbendazim @ 1 g/litre of water was after 30 days after transplanting. Second spray of Mancozeb @ 3 g/litre of water was applied 20 days after first spray. The data on growth (plant height, leaf area index), phenology, yield attributes viz. number of effective panicles/m^2, panicle length, panicle weight, 1000-grain weight and yield of rice were recorded following standard procedures. For analysis of variance, data was analyzed using a factorial randomized block design using the OP-STAT data analysis package (Sheoran et al 1998).

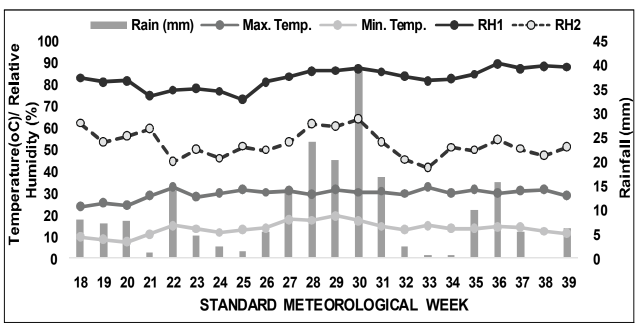

Fig. 1. Weather conditions prevailed during the crop growth period of *Kharif* 2021

RESULTS AND DISCUSSION

Rice growth parameters: Various transplanting dates and crop geometries caused substantial variations in growth parameters. The crop transplanted early recorded maximum plant height and LAI compared to mid and late transplanting (Table 1). The crop sown late in the season experienced comparatively lower temperatures during later growth stages had shorter growing period due to photoperiodic response and thus plant height and LAI remained low (Bashir et al 2010, Sulieman et al 2014 and Osman et al 2015). The maximum plant height and LAI was recorded in 15 cm x 10 cm, followed by 15 cm x 15 cm and minimum plant height and LAI was recorded in 20 cm x 15 cm (Table 1). To get more radiations, plants grow faster and get more height as supported by Kumar and Kumar (2018). Bashir et al (2010) revealed that leaf area, total dry matter, absolute growth rate increased with increasing spacing, while leaf area index showed a reverse trend (Pokharel 2018).

Rice yield attributes: Yield attributes viz. number of

Table 1. Growth and yield attributing characters of rice-*MushkBudji* as influenced by transplanting date and crop geometry

Treatments	Plant height (cm)	Leaf area index	No. of effective tillers /m^2	Panicle length (cm)	Panicle weight (g)	1000-grain weight (g)
Transplanting dates						
5 June	128.83	2.20	317.52	20.27	2.79	19.09
15 June	123.99	2.12	306.16	18.46	2.51	17.91
25 June	112.72	2.00	299.67	17.07	1.45	16.17
CD (p=0.05)	4.52	0.04	14.14	1.13	0.30	0.51
Crop geometries						
15 cm x 10 cm	125.55	2.15	294.07	17.17	1.98	16.70
15 cm x 15 cm	123.64	2.12	313.67	18.51	2.32	18.13
20 cm x 15 cm	116.36	2.04	315.62	20.11	2.44	18.33
CD (p=0.05)	4.52	0.04	14.14	1.13	0.30	0.51

effective tillers/m^2, panicle length, panicle weight, and 1000-grain weights in crop transplanted on June 5 were significantly superior over late transplanting (June 15 and June 25) (Table 1). This might be due to favorable environmental factors and prolonged overall growing season which increased the accumulation of carbohydrates in plants, ultimately the yield attributes (Akbar et al 2010). There were significantly higher number of yield attributing characters under 20 cm x 15 cm compared to 15 cm x 15 cm and 15 cm x 10 cm (Table 1). Wider spacing showed an advantageous factor for better development of panicles, hence more panicle length, panicle weight. Efficient utilization of growth resources, less intra-species competition coupled with higher availability of nutrients among widely spaced crop plants may be ascribed the reason for superiority of yield components of rice (Pawar et al 2017).

Rice phenology: The crop transplanted early prolongs maximum tillering, panicle initiation, anthesis, and physiological maturity compared to crop transplanted in mid to end June (Fig. 2). Considerably lower temperature during the early growth stages resulted in the prolonged vegetative phase in case of early transplanting date (Abhilash et al 2017). Crop geometries also reacted differently for number of days required to attain distinct phenological stages (Fig. 2). Rice transplanted at spacing 20 cm x 15 cm took a greater number of days to reach maximum tillering, panicle initiation, anthesis and physiological maturity than spacing 15 cm x 15 cm and 15 cm x 10 cm. The reason being more of crop growth and nutrient availability at wider spacing than the closer spacing (Rasool et al 2013).

Rice yield: Crop transplanted early recorded significantly higher grain yield (4.14 t/ha), straw yield (9.52 t/ha), and harvest index (30.23%) as compared to mid to late June transplanting (Table 2). Late transplanted rice has always lower yield than normal transplanted rice which may be due to improper root growth and development causing less absorption of nutrients from soil, shortened duration of various phenophases of crop development, low temperature during grain filling and grain maturation time (Kushwaha 2018). Concerning crop geometries, 20 cm x 15 cm recorded a significantly higher yield for grain (3.95 t/ha) and straw (9.35 t/ha) and the harvest index (29.50%) as compared to 15 cm x 15 cm and 15 cm x 10 cm crop geometries (Table 2). The higher yield in wider spacing could be due to higher number of effective tillers/m^2 and number of filled grains/panicle. Optimum spacing ensures the plant to grow in their both aerial and underground parts through efficient utilization of solar radiation and nutrients, plants had linearly increasing effect on the performance of individual plants (Thavaprakash et al 2017).

Interaction effect: Interaction effect of transplanting dates and crop geometries on grain yield of rice was significant (Fig. 3). The interaction effect between transplanting date and crop geometry for grain yield indicated that early transplanted crop with spacing 20 cm x 15 cm produced

Table 2. Yield and harvest index of rice-*MushkBudji* as influenced by transplanting date and crop geometry

Treatments	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
Transplanting dates			
5 June	4.14	9.52	30.23
15 June	3.71	9.09	28.93
25 June	2.83	8.45	25.13
CD (p=0.05)	0.18	0.34	1.64
Crop geometries			
15 cm x 10 cm	3.11	8.65	26.40
15 cm x 15 cm	3.63	9.06	28.39
20 cm x 15 cm	3.95	9.35	29.50
CD (p=0.05)	0.18	0.34	1.64

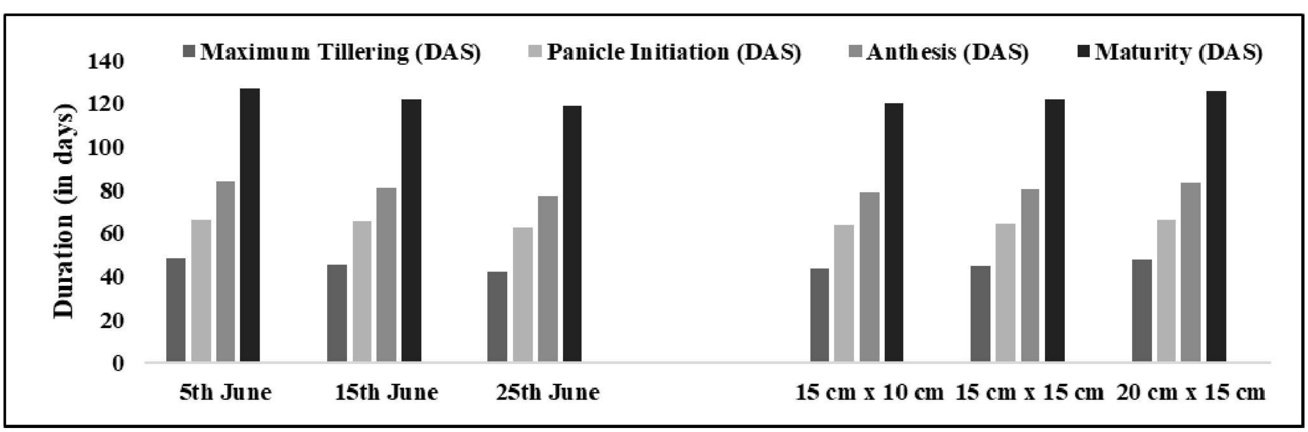

Fig. 2. Days taken to phenological stages of rice- *MushkBudji* as influenced by transplanting dates and crop geometry

significantly higher grain yield (4.67 t/ha) than other treatment combinations. Fayaz et al (2015) and Yumnam et al (2021) also reported significant interaction between planting date and spacing.

Rice blast disease incidence and intensity : The rice blast development is influenced by temperature and humidity. The different dates of transplanting had a significant effect on blast disease incidence and intensity (Table 3). The early transplanted crop had least leaf, neck and node blast incidence and leaf blast intensity score followed by mid transplanted crop while the maximum blast incidence and intensity score was recorded by late transplanted crop. Early planting date helped susceptible cultivars to escape from severe infection of blast because of low temperature and low humidity levels. Higher humidity levels and frequent rainfall create environmental conditions conducive for rice blast infection. Both growth and sporulation increased up to a temperature ($27^{\circ}C$) and decline further in response to increased or decreased with temperature ($32^{\circ}C$ and $22^{\circ}C$) as reported by Rajput et al (2017). Crop geometry showed a significant effect on the blast disease incidence and intensity score. Maximum blast disease incidence and intensity score was under closer spacing 15 cm x 10 cm followed by 15 cm x 15 cm; however, the minimum blast incidence and intensity was under wider spacing 20 cm x 15 cm (Table 3). The density of the plant canopy directly impacts the susceptibility of plant tissues to the pathogen, creating a favorable environment for disease development. Canopy structure, radiation, air circulation, soil temperature, and wind are the primary factors that determine the moisture profile under the canopy, which in turn influences disease development, especially through plant spacing and canopy gaps that enhance ventilation and reduce canopy wetness. These findings align with those reported by Sopialena and Palupi (2017) and Nugroho et al (2021).

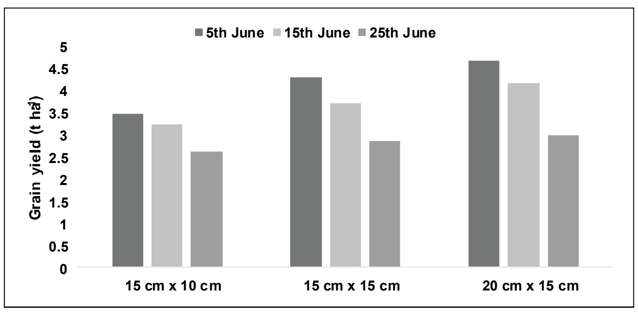

Fig. 3. Interaction effect of transplanting date and crop geometry on grain yield

Table 3. Effect of transplanting dates and crop geometry on diseases of rice-*MushkBudji*

Treatments	Leaf blast incidence (%)	Leaf blast intensity (%)	Neck blast incidence (%)	Node blast incidence (%)
Transplanting dates				
5 June	28.33	14.60	15.36	12.13
15 June	34.03	18.49	20.15	16.12
25 June	39.69	25.31	25.77	22.51
CD (p=0.05)	2.21	2.29	2.39	2.43
Crop geometries				
15 cm x 10 cm	37.75	23.89	24.73	21.21
15 cm x 15 cm	33.43	18.31	19.18	15.98
20 cm x 15 cm	30.87	16.19	17.37	13.58
CD (p=0.05)	2.21	2.29	2.39	2.43

CONCLUSIONS

This study showed how rice-*MushkBudji* under different transplanting dates and crop geometry responded regarding their growth, phenology, and yield. Apart from that, we were able to see the impact of agronomic manipulations upon the blast disease incidence, achieved by altering the crop geometry. Wider spacing 20 cm x 15 cm between plants creates a dilution effect, resulting in better disease control and reduced the number of two chemical sprays as recommended by SKUAST-K. The better growth, higher grain yield and low blast disease incidence of scented rice-*MushBudji* under lower altitude belts (1590 amsl) of Kashmir can be achieved by transplanting the rice- *MushkBudji* earlier in the season during 23rd standard meteorological week (4th June -10th June) with the spacing of 20 cm x 15 cm.

AUTHORS CONTRIBUTION

Ifrah Taranum is PG scholar who conducted research, S. Sheraz Mahdi has conceptualized the research idea, Rukhsana Jan assisted in field experiment and data observation, Fayaz Ahmad Bahar has assisted in manuscript writing, Amal Saxena, assisted in manuscript writing and final editing, Shaista Nazir assisted in soil sampling & analysis, Fehim Jeelani Wani planned Layout of field experiment and data analysis and Bhagyashree Dhekale helped in designing of field experiment and data tabulation and analysis.

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