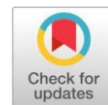


Original Research Article

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Influence of transplanting dates and varieties on productivity, nutrient uptake, quality, and soil health in basmati rice under intermediate hill conditions of Jammu and Kashmir



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ABSTRACT

An experiment was conducted to assess the evaluation of basmati rice (*Oryza sativa* L.) varieties at different dates of transplanting under the intermediate hill zone of Jammu. The study faced challenges due to the complex interactions between transplanting dates and rice varieties under the variable climatic and topographic conditions of the intermediate hills of Jammu & Kashmir, which impacted uniform field management, data accuracy, and long-term assessment of soil health. The soil of the experimental site was clay loam in texture, slightly alkaline in reaction, medium in organic carbon, available nitrogen, phosphorus and potassium, with electrical conductivity in the safer range. Based on the field experiment, Jammu basmati-123 transplanted on 10th June 2021, showed significant nutrient uptake in straw and straw yield. Whereas Chandak basmati local transplanted on same day recorded significant nutrient uptake in grain, and grain yield. Among the quality parameters, the kernel length and length breadth ratio were found highest in Jammu basmati-123 transplanted on 10th June 2021, whereas the crude protein content, amylose content, and kernel breadth were highest in Chandak basmati transplanted on the same day. However, with regard to net returns and B: C ratio, basmati rice transplanted on 10th June 2021 recorded highest net return, Among the varieties Chandak basmati recorded highest net returns which was closely followed by the variety Jammu basmati- 118 transplanted on same day.

Keywords: Amylose, Basmati rice, Crude protein, Transplanting dates, Nutrient uptake, Varieties.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is a staple food crop for over half of the global population, serving as a primary source of calories and energy, particularly in developing countries where it contributes 35–60% of daily calorie intake and 50–80% of total energy consumption [6]. Among cereal crops, rice holds a central role in global and national food security and is recognized as an affordable source of protein and energy. India ranks among the world's top rice producers, contributing about 20% of global production [20]. To meet the growing food demands, the country must increase rice output by an estimated 1.7 million tonnes annually, which can be achieved by adopting improved agronomic practices such as hybrid varieties, optimal seedling age, and appropriate transplanting times to enhance yield potential [5]. Currently, rice is cultivated over 44 million hectares in India, with an annual production of 112.44 million

tonnes and an average productivity of 2.56 tonnes per hectare [1]. In the Union Territory of Jammu & Kashmir, rice is grown on approximately 267.58 thousand hectares, producing 5816 thousand quintals with a productivity of 21.74 quintals per hectare. In Poonch district alone, rice covers around 2905 hectares [2]. Among the various rice types, basmati rice has gained global recognition for its unique qualities—extra-long slender grains, soft texture, elongation upon cooking, and aromatic fragrance. It is a region-specific crop grown exclusively in India and Pakistan, particularly in the Himalayan foothills [8]. While all basmati rice is aromatic, not all aromatic rice qualifies as basmati. In the Jammu district, basmati rice is cultivated over 60.5 thousand hectares, with a total production of 12,960 metric tonnes. To improve productivity and address the limitations of traditional varieties, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu) has released several high-yielding basmati varieties such as Jammu Basmati 118, 123, and 138. However, the performance of these improved varieties under the intermediate hill conditions of the Jammu division, particularly in the Poonch district, remains unexplored. In contrast, Chandak Basmati, a popular local variety in Poonch, is known for its fragrance but features coarse grains.

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Soil analysis: Following the harvest of the basmati rice crop, individual soil samples were collected from the surface layer of each plot to assess the levels of available nitrogen, phosphorus, and potassium. These samples were shade-dried, ground, and passed through a 2 mm sieve before analysis.

Quality Analysis: A digital vernier caliper was used to measure the length and breadth (in millimeters) of ten randomly selected rice kernels from the bulk yield of each treatment. The length-to-breadth ratio was calculated by dividing the kernel length by its breadth. Protein content in the basmati rice grains was estimated by multiplying the nitrogen content in the grain by a conversion factor of 6.25. Amylose content in milled rice kernels was determined using the colorimetric iodine assay method described by [9].

Calculations:

Absorbance corresponds to 2.5ml of test solution = 'X' mg amylose in a test solution.

Therefore 100 ml contains = $(X/2.5) \times 100 = \% \text{ amylose}$

RESULTS AND DISCUSSION

Grain and straw yield: The data on the effect of transplanting dates and varieties on grain and straw yield of basmati rice recorded at harvest is depicted figure 2. A Comparison of different transplanting dates indicate that the basmati crop transplanted on 10th June recorded significantly highest grain yield (2.76 t/ha) and straw yield (5.32 t/ha) as compared to other two transplanting dates. Early transplanting *i.e.* 31st May also resulted in a significant increase in grain and straw yield of basmati crop in comparison to late transplanting on 20th June which might have resulted due to a higher rate of photosynthesis, a better translocation of photosynthates and better source-sink association coupled with a better expression of yield attributes. The number of tillers produced during the vegetative growth phase, number of panicles produced at the end of the vegetative stage, the number of spikelet's formed in each panicle during panicle development, number grains/panicles determined during the flowering stage and higher test weight determined during the grain filling phase all contributed towards the yield potential of a plant [15] also reported the similar type of findings in their respective studies. Among the varieties Chandak basmati recorded significantly the highest grain yield (3.52 t/ha) followed by Jammu basmati-118, Ranbir basmati, Jammu basmati-138 and Jammu basmati-123. The process of grain filling is significantly influenced by temperature. Low temperatures harm rice plants in a variety of ways, but the most significant one is spikelet sterility. Particularly in photo-insensitive cultivars, low temperature during the pollen development stage may cause a dramatic drop in viable or filled spikelets, which leads to poor pollen germination and consequently poorer yields. The lower grain yield in Jammu Basmati 123 and Jammu Basmati 138 was obviously due to low temperature at the grain filling and maturity stage. The higher grain yield in Chandak basmati was also due to superior yield attributes *viz.*, number of panicles/m² at harvest, number of grains/panicle and 1000-grain weight. Similar type of findings was also observed by [16]. With respect to straw yield Jammu Basmati-123 recorded the significantly highest straw yield followed by Jammu Basmati-118, Jammu Basmati-138, Chandak basmati and Ranbir basmati which might have been attributed to superior growth parameters *viz.*, plant height, number of tillers/m², leaf area index, and dry matter accumulation. [3]

Also similar type of research findings in their respective studies.

Nutrient uptake (kg/ha): The data on the effect of transplanting dates and varieties on nutrients uptake by grain and straw (kg/ha) of basmati rice at harvest in given Table 1. Nutrient uptake (NPK) is a function of dry matter production and is partly due to increase in nutrient concentration. However, there is a close relationship between the total uptake of nutrients and grain and straw yields of the basmati rice crop. Different times of transplanting and varieties showed pronounced effect on NPK uptake by basmati rice crop. Crop transplanted on 10th June recorded significantly higher nitrogen, phosphorous and potassium uptake by grain and straw followed by crop transplanted on 31st May and 20th June. This might have resulted due to higher dry matter accumulation in crop transplanted on 10th June. A similar type of findings was also observed by [14]. Among the varieties, Chandak basmati recorded significantly highest nitrogen, phosphorous and potassium uptake by grains followed by Jammu basmati-118, Ranbir basmati, Jammu basmati-138 and Jammu basmati-123. This might have happened due to higher grain yield of Chandak basmati. Jammu basmati-123 recorded significantly the highest nitrogen uptake by straw and was followed by Ranbir basmati. Maximum phosphorous and potassium (54.45 kg/ha) uptake by straw was recorded in Jammu basmati-123 which was due to higher straw yield of Jammu basmati-123. A similar type of findings was also observed by [13].

Available nutrients in soil after harvest: As it is evident from Table 2 different transplanting dates and varieties had no significant effect on available N, P and K of the soil after harvest of basmati rice crop. Further the data revealed a slight decrease in available N, P and K in all the treatments over the initial nutrient status of soil which might have happened due to 48 more uptakes of nutrients. The results were following the findings of [11] and [21].

Quality parameters: The data on the effect of transplanting dates and varieties on quality parameters of basmati rice recorded at harvest is presented in Table 3. Quality parameters *viz.*, kernel length, kernel breadth, length breadth ratio, crude protein content and amylose content were not significantly affected by different dates of transplanting. Similar type of findings were also observed by [15] and [10]. Among the varieties Jammu basmati-123 recorded a higher kernel length and length breadth ratio followed by Jammu basmati-138, Jammu basmati-118 and Ranbir basmati.

Kernel Length: Different basmati rice varieties show significant variation in grain length. Varieties like JB-118, JB-123, JB-138 and Ranbir Basmati are known for their long, slender grains, a characteristic highly desired in basmati rice [22]. On the other hand, local varieties such as Chandak Basmati may have slightly shorter grains, though still long compared to other rice types. The length of the kernel is influenced by genetic factors, with specific varieties being bred to exhibit longer grains. Research by [7] highlighted that varieties like Jammu Basmati 123 tend to have longer kernels compared to traditional local varieties.

Whereas, Chandak basmati recorded the highest kernel breadth, crude protein content and amylose content. The highest kernel breadth in Chandak basmati recorded might be attributed as its varietal characteristics. which contributes to a firm and non-sticky texture after cooking [22]. Amylose content can vary significantly across basmati rice varieties, with newer

varieties often bred to optimize amylose levels for better cooking quality. Research by [4] revealed that varieties with higher amylose content are favored in regions where rice is consumed in its dry, fluffy form. Chandak Basmati is a local rice variety referred as basmati because of its taste, however, considering the length of basmati grain, it does not fail under the preview of the basmati standards. It has typically short bold grain line non-basmati types and possesses higher amylose content compared to basmati rice which was the obvious reasons for higher amylose content in this variety. Similar type of findings were also observed by [10]. Higher protein content due to their improved agronomic characteristics and nutrient uptake efficiency [19]. The length-to-breadth ratio is an essential quality parameter, as a higher ratio is more desirable in basmati rice for its aesthetic appeal and cooking characteristics. Varieties with longer grains, such as JB-123, have a significantly higher length-to-breadth ratio [18]. In contrast, varieties like Chandak Basmati may have a lower ratio, as they tend to produce shorter and thicker grains. This ratio impacts the texture and appearance of cooked rice, and the higher the ratio, the better the grain elongation during cooking.

In summary, varietal selection plays a significant role in determining the quality of basmati rice, influencing important parameters such as kernel length, kernel breadth, length-to-breadth ratio, crude protein content, and amylose content. Modern varieties like JB-118, JB-123, JB-138 and Ranbir Basmati typically offer superior quality in terms of longer, narrower grains, higher protein, and amylose content, making them more desirable for both commercial and culinary purposes. Local varieties, while still aromatic and valued for their unique characteristics, may exhibit variations in these quality parameters.

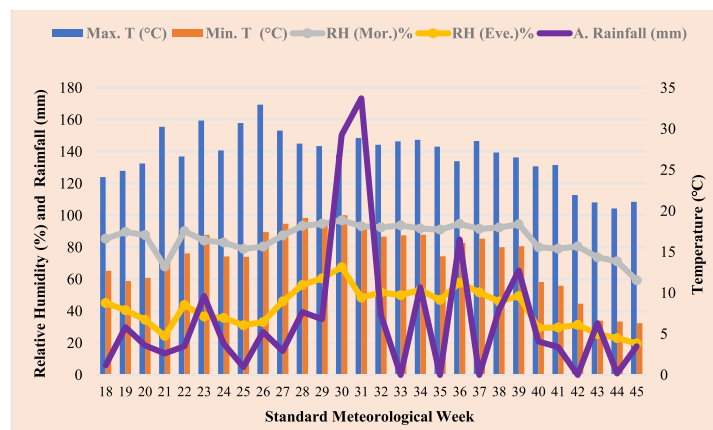


Figure 1: Graphical representation of meteorological data during Kharif 2021

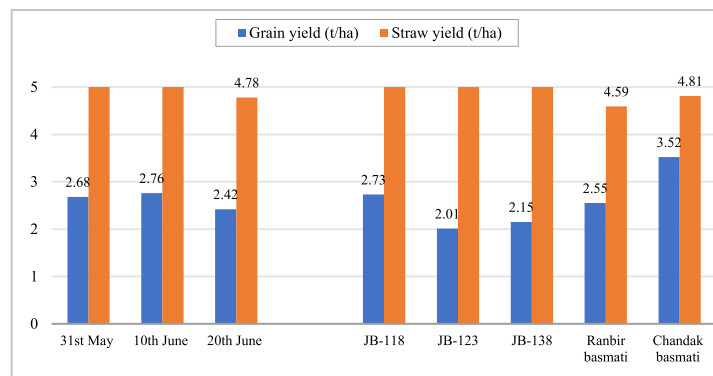


Fig. 2. Effect of different transplanting dates and varieties on grain and straw yield (t/ha)

Table 1: Effect of transplanting dates and varieties on total nutrient uptake (kg/ha)

Treatments	Total nitrogen (kg/ha)			Total phosphorus (kg/ha)			Total potassium (kg/ha)		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Dates of Transplanting									
31 st May	32.86	29.11	61.97	7.48	7.70	15.18	12.51	47.15	59.52
10 th June	34.35	31.04	65.38	8.00	8.21	16.20	13.34	49.04	62.65
20 th June	31.70	28.25	59.94	7.24	7.43	14.67	11.94	46.79	58.60
SEm (±)	0.48	0.69	0.94	0.16	0.12	0.21	0.21	0.56	0.57
CD (5%)	1.40	1.98	2.72	0.45	0.36	0.61	0.60	1.63	1.63
Varieties									
Jammu basmati-118	33.75	28.54	62.30	7.31	7.34	14.66	12.87	48.84	61.71
Jammu basmati-123	25.57	33.07	58.65	6.56	9.66	16.22	10.27	54.45	64.72
Jammu basmati-138	27.44	26.00	53.44	6.80	7.67	14.47	10.81	46.03	56.84
Ranbir basmati	32.64	30.24	62.88	7.59	6.91	14.49	12.18	42.57	54.75
Chandak basmati (local)	45.43	29.47	74.89	9.60	7.31	16.91	16.86	46.41	63.27
SEm (±)	0.68	0.97	1.33	0.22	0.18	0.30	0.30	0.80	0.80
CD (5%)	1.98	2.81	3.84	0.64	0.51	0.86	0.86	2.30	2.31

Table 2: Effect of transplanting dates and varieties on available nutrients (kg/ha) in soil after harvest

Treatments	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)
Dates of Transplanting			
31 st May	267.01	14.46	196.25
10 th June	268.10	14.78	199.22
20 th June	262.38	14.36	195.78
SEm (±)	2.20	0.21	1.96
CD (5%)	NS	NS	NS
Varieties			
Jammu basmati-118	266.95	14.51	199.15
Jammu basmati-123	271.15	14.86	201.28
Jammu basmati-138	265.83	14.39	197.87
Ranbir basmati	261.60	14.34	190.29
Chandak basmati (local)	263.62	14.58	196.83
SEm (±)	3.12	0.29	2.78
CD (5%)	NS	NS	NS

Table 3: Effect of transplanting dates and varieties on quality parameters

Treatments	Kernel length (mm)	Kernel breadth (mm)	Length breadth ratio	Crude protein content (%)	Amylose content (%)
Dates of Transplanting					
31 st May	6.52	1.77	3.68	7.92	23.17
10 th June	6.61	1.79	3.70	8.04	23.81
20 th June	6.43	1.75	3.65	7.85	23.09
SEm (±)	0.21	0.08	0.24	0.06	0.20
CD (5%)	NS	NS	NS	NS	NS
Varieties					
Jammu basmati-118	6.83	1.59	4.30	7.81	22.58
Jammu basmati-123	6.89	1.60	4.31	7.95	22.96
Jammu basmati-138	6.84	1.59	4.30	7.97	22.65
Ranbir basmati	6.75	1.58	4.27	8.00	22.70
Chandak basmati (local)	5.24	2.57	2.05	8.04	25.91
SEm (±)	0.30	0.12	0.34	0.08	0.28
CD (5%)	0.87	0.34	0.99	NS	0.82

CONCLUSION

Between all dates of transplanting, the 10th June transplanting crop recorded significantly highest grain, straw yield, total N, P and K uptake and quality parameters with there were minimal changes in the soil's Nitrogen, Phosphorus and Potassium. However, Among the basmati rice varieties Chandak basmati rice variety recorded significantly higher total N and P uptake, quality parameters viz., kernel breadth, amylose content and was higher in crude protein content.

Future Scope: The study can be extended by evaluating additional Basmati rice varieties and transplanting windows over multiple years to better understand long-term impacts on soil health and crop sustainability under changing climatic conditions in hill ecosystems.

Compliance with Ethical Standards

Conflict of interest: The authors declare that they have no conflict of interest.

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Author's contribution

S. N. K. (Shesh Narayan Kumawat) conducted the experiment and analyzed the data; A. J. (Ajay Gupta) conceptualized the research and guided throughout the experiment; R. B., S. K, and M. S. helped in the main manuscript writing and forming tables; A. A., R. S. B. V.M., T. and M.N.S. helped in data curation.

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