International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452
Maths 2024; SP-9(6): 01-03

www.mathsjournal.com
Received: 02-08-2024
Accepted: 07-09-2024

Sheikh Aadil Mushtaq
Division of Farm Machinery and Power Engineering, Faculty of Agricultural Engineering, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

Sanjay Khar
Division of Farm Machinery and Power Engineering, Faculty of Agricultural Engineering, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

Sushil Sharma
Division of Farm Machinery and Power Engineering, Faculty of Agricultural Engineering, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

JP Singh
Division of Farm Machinery and Power Engineering, Faculty of Agricultural Engineering, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

Corresponding Author:
Sheikh Aadil Mushtaq
Division of Farm Machinery and Power Engineering, Faculty of Agricultural Engineering, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

Study of morphological characteristics of basmati-370 paddy variety pertinent to paddy harvester design

Sheikh Aadil Mushtaq, Sanjay Khar, Sushil Sharma and JP Singh

Abstract
Basmati 370 is one of the outstanding varieties of Basmati rice with higher aroma, elongated grains and better cooking quality. The knowledge regarding the morphological and engineering properties of an agricultural crop is important for designing/developing different parts of the farm machinery and also for developing an ergonomically suited machine. This paper presents detailed morphological parameters of Basmati 370 paddy crop variety, especially with reference to its cultivation in the Jammu Division of UT of J&K. The parameters noted were plant height, number of tillers, leaf dimensions, along with panicle length, stem morphology and grain characterization. The findings revealed the essential dimensions and operational requirements for harvester that can handle the physical characteristics of Basmati-370 effectively, aiming to enhance efficiency, reduce crop losses, and support the mechanization of harvesting for small-scale and marginal farmers in Jammu. Understanding the morphological characteristics of Basmati 370 will better guide the development of harvesting units, planters, and other equipment toward equipping them for the specific needs of the crop and region.

Keywords: Basmati rice-370 (*Oryza sativa* L.), farm machinery, agro-morphological, Plant height

Introduction
Basmati rice, *Oryza sativa* L., is known for its specific characteristics of aroma, long slender grains, and excellent cooking properties. Basmati rice is popularly known as the "scented pearls" (Sharma *et al.*, 2014) [11]. It has been cultivated in the Indian subcontinent for more than 250 years (Ashfaq *et al*., 2015) [1]. Basmati has exceptional market value worldwide for its scented, aromatic flavour and fluffy, easily digestible texture, long shelf life, and the expansion of its grains in length when cooked without swelling much in width (Mehta *et al.*, 2019 and Mondal *et al.*, 2021) [5, 8]. The basmati rice market size has grown rapidly in recent years. It has grown from $11.64 billion in 2023 to $13.08 billion world-wide in 2024 at a compound annual growth rate (CAGR) of 12.4%. The basmati rice market size is expected to see a rapid growth in the next few years. It will grow to $20.82 billion in 2028 at a compound annual growth rate (CAGR) of 12.3%. As per the data from the Ministry of Commerce and Industry, an India-based government department, in December 2021, India's rice exports, including both basmati and non-basmati varieties, were estimated to be 17.72 metric tons in the fiscal year 2021–2022 (Basmati Rice Global Market Report 2024). The surge in demand for aromatic rice is a key factor propelling the growth of the basmati rice market.

As far as the Union Territory of Jammu and Kashmir is concerned, the paddy crop assumes great importance for the livelihood of the people of this hilly and sub-mountainous area. The different varieties of paddy cultivated in Jammu province of Union territory Jammu and Kashmir are IET 1410, Ratna, Tawi (PC-19), SJR-5, Jaya, PR-113, RR-8585 KHR-2 (Hybrid), PHB-71 (Hybrid), China-1039, K-39 (SKAU-5) and Basmati varieties that are Basmati-370, Basmati-564, Ranbir Basmati, Saanwal, Basmati, PRH-10 (Basmati hybrid) and Pusa 1121 (NCML 2019 and Parihar *et al.*, 2021) [9, 10]. Among the traditional varieties, Basmati 370 has a value in both the domestic and international markets. It is highly flavoured variety of superfine paddy grown in the Sub-tropical area of the UT namely R.S. Pura, Bishnah, Jammu, Akhnoor, Samba, Hiranagar and Kathua Tehsils of Jammu Division. In Jammu & Kashmir, the total basmati area is 68,450 ha. Out of which, Pusa Basmati-1121 has 6,290 ha and Basmati-370, 59, 970 ha. The estimated production of Pusa Basmati-1121 and Basmati 370 are likely

22, 330 metric tons and 2, 10, 440 metric tons respectively. (Directorate of Economic & Statistics, 2024) [2]. Cultivated for its superior aromatic quality and grain, this crop is widely grown here, thus forming a primary component of the local economy and diet. Its characteristic morphological features, such as stem diameter, plant height, number of tillers and grain size, pose both challenges and opportunities for the mechanized harvesting. This rice variety is so valued in the region that it demands its cultivation and improvement (Sinha and Mishra, 2013) [13]. The cultivation of Basmati Rice 370 under diversified cropping system is ideally suited for its low water requirements with very less attack of insect pests and disease. Despite its economic importance, detailed morphological studies on Basmati 370 are limited. This study aims to fill this gap by providing an in-depth analysis of the morphological characteristics of Basmati 370 variety, which is essential for agronomic assessment, crop improvement, and sustainable cultivation practices.

Materials and Methods

Study Area and Experimental Design

The study was conducted at the Organic Farming Research Centre, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus Chatha, located at 32º 40´ North latitude and 74º 58´ East longitude with an altitude of 332 meters above mean sea level in the Shiwalik foothills of North-Western Himalayas which is the primary region for Basmati-370 cultivation. The temperature of the region varies from 30 °C – 41 °C during the course of distinct growth phases of rice, starting from the broadcasting of seeds in a nursery in mid-May to maturity stages at the end of October. The representative samples of Basmati-370 were collected from a fully mature paddy field, ensuring accurate and reliable data for morphological assessment. The experimental design was a randomized complete block design (RCBD) with three replications to ensure statistical reliability.

Morphological Parameters Assessed

The five randomly selected plants in the net plot of each of the experimental plots (1×1 m^2) were located and tagged. Then at harvest time, the length was measured using a measuring tape from the base to the apex of the last fully expanded leaf before the beginning of panicle formation to the tip of the panicle. The readings were summed up to determine the average plant height in centimetres for each plot. The count of tillers in a one-meter row length was determined from the third and fourth rows on the net area of each plot before harvest. These counts were then averaged to determine the average number of tillers per meter of row length, which was then converted into its equivalent number of tillers per square meter. The number of effective tillers in a one-meter row length was counted, by using the third and fourth rows in the net area of each plot just before harvesting, averaged and multiplied by ten to make a number of effective tillers per square meter. The number of grains per panicle five panicles randomly collected from the tagged plants on the sampling rows of the plot net area. The grains on the panicles were counted and averaged by dividing by five, and then expressed as the number of grains per panicle. The grain yield per plot was determined after harvesting and threshing, with the grains dried to a uniform moisture content of 14% and weighed using an electronic balance as shown in Fig 1. The data was analysed using ANOVA to test the significance of the characteristics, and the means were compared using the Least Significant Difference (LSD) test at a significance level of 5%.

Fig 1: Morphological traits assessed in the Basmati-370 paddy variety

Results and Discussion

The agro-morphological traits of Basmati-370 paddy crop were evaluated, showing a significant variability for the traits assessed (Table 1). The results presented in this section summarize the range, mean values, standard deviations, and coefficients of variation for each trait, providing a clear understanding of the trait diversity present. This variability offers promising potential for selective breeding and mechanization adjustments to enhance yield stability, quality, and harvesting efficiency for Basmati-370 in the Jammu region.

Plant Height

The Basmati-370 paddy exhibited plant heights ranging from 135.0 to 174.0 cm, with an average height of 157.6 cm and a standard deviation of 18.9 cm. The coefficient of variation (CV) for plant height was 12.2%, suggesting moderate variability. Similarly, a distinguishable volume of variation was observed in the study conducted by Mishra *et al*. (2016) [7]. The moderate height is advantageous for harvester design, providing a suitable range for positioning the cutter bar to avoid excessive crop loss during cutting. While the plant height of Basmati-370 provides moderate resistance to lodging, taller plants are generally more susceptible to lodging, especially under adverse weather conditions. This increased lodging risk can impact stability during mechanized harvesting, making optimal height an important consideration for the effective harvester design.

Days to Flowering and Maturity

The days to 50% flowering ranged from 96.0 to 125.5 days, with a mean of 119.0 days and a CV of 6.9%, reflecting a relatively consistent flowering period across the sampled plants. This stability is beneficial for synchronizing harvesting operations, making it easier for engineers to develop harvester mechanisms that are compatible with the typical growth cycle of Basmati-370. Similarly, days to maturity spanned from 132.0 to 157.0 days, averaging 147.5 days with a low CV of 3.7%. The results are consistent with the conclusions drawn by Islam *et al*. (2016) [4]. This consistency in maturity helps in planning harvesting times, which is advantageous for designing harvesters to handle bulk harvesting efficiently.

Tillering Traits

The total tillers per plant ranged from 12.0 to 17.0, with an average of 14.3 and a high CV of 16.8%, indicating significant variability. The effective tillers ranged from 7.0 to 12.0, with a mean of 9.5 and a CV of 22.1%. The significant variations in both the total and effective tillers reflects the potential for selection to enhance yield, as tillering capacity is directly correlated with grain production. The results correspond with the findings of Sholikhah *et al.* 2019 [12], reinforcing the significance of effective tillering in optimizing yield potential.

Stem diameter

The stem diameter of Basmati-370 variety plants ranged from 3.1 to 4.9 mm, with an average of 4.0 mm and a CV of 7.3%. The moderately slender stem structure demands specific harvester modifications, particularly in the blade and guard spacing, to prevent excessive bending or lodging during cutting. This slender diameter requires sharp, high-carbon steel blades and precise guard spacing to ensure a clean cut, reduce shattering, and maintain crop integrity during harvesting in areas like Jammu, where strong monsoon winds are common.

Grain Characteristics

The grain breadth ranged from 1.5 to 2.0 mm, with an average of 1.9 mm and a CV of 5.3%, indicating minimal variability. The length-to-breadth (L/B) ratio, with a mean of 3.9 and a range of 2.8 to 5.6, is an essential trait as it affects the market value and mechanical handling of grains. The 1000-grain weight averaged 20.7 g with a CV of 10.2%, which is crucial for engineers when designing machines to handle yield distribution efficiently. The grain yield per plant ranged from 7.7 to 23.8 g, with a mean yield of 14.6 g and a high CV of 27.1%, underscoring the importance of accommodating yield variability in harvester design to optimize collection and minimize losses.

Table 1: Data of the agro-morphological traits assessed in Basmati 370 Paddy Variety

Traits	Minimum	Maximum	Mean	Standard Deviation	Coefficient of Variation
Plant Height (cm)	135.0	174.0	157.6	18.9	12.2
Days to 50% Flowering	96.0	125.5	119.0	8.3	6.9
Days to Maturity	132.0	157.0	147.5	5.5	3.7
Total Tillers per Plant	12.0	17.0	14.3	2.4	16.8
Effective Tillers per Plant	7.0	12.0	9.5	1.9	20.0
Stem diameter	3.1	4.9	4.0	0.29	7.3
Grain Breadth (mm)	1.5	2.0	1.9	0.1	5.3
Length/Breadth (L/B) Ratio	2.8	5.6	3.9	0.4	10.3
1000 Grain Weight (g)	10.0	25.0	20.7	2.1	10.2
Grain Yield per Plant (g)	7.7	23.8	14.6	3.9	27.1

Conclusion

In summary, the study of agro-morphological characteristics of crops, such as Basmati rice 370 variety, is necessary for steering the development and improvement of agricultural machinery. A holistic understanding of critical features, including plant height, stem diameter, and grain characters, allows engineers to manufacture equipments that functions effectively, reduces crop damage, and helps prevent losses during harvesting and processing. This understanding allows for the development of an adaptable and precise apparatus tailored to specific crop type and environmental conditions, thus ultimately enhances productivity and sustainability in the agricultural industry. As a result, the infusion of agro-morphological knowledge into the design of machinery not only contributes to increased operational efficiency but also significantly contributes to the attainment of the broader goal of food security.

References

1. Ashfaq M, Haider MS, Saleem I, Ali M, Ali A, Chohan SA. Basmati-Rice a Class Apart (A review). Journal Rice Research. 2015, 3(4).
2. Directorate of Economic & Statistics. Statistical Digest of Jammu and Kashmir. Government of Jammu and Kashmir; c2024.
3. Food and Agriculture Organization of the United Nations (FAO). Conservation Agriculture Website. http://www.fao.org/ag/ca/. Accessed October 26, 2024.
4. Islam MZ, Khalequzzaman M, Bashar MK, Ivy NA, Haque MM, Mian MAK. Variability assessment of aromatic and fine rice germplasm in Bangladesh based on quantitative traits. The Scientific World Journal. 2016;2016(1):2796720.
5. Mehata SD, Dhillon SB, Dhillon SS. Performance of basmati rice (*Oryza sativa* L.) under different transplanting dates and plant spacings in south west Punjab. International Journal of Current Microbiology and Applied Sciences. 2019;8(7):2016-2020.
6. Market Research Future. Global Basmati Rice Market Report; c2024. Available at: https://www.marketresearchfuture.com. Accessed October 2024.
7. Mishra A, Kumar P, Sengar RS, Kumar P, Singh R, Chaudhary R, *et al*. Assessment of diversity by using morphological, biochemical and molecular approaches of selected basmati rice (*Oryza sativa* L.) varieties. Journal of Applied and Natural Science. 2016;8(1):69-76.
8. Mondal D, Kantamraju P, Jha S, Sundarrao GS, Bhowmik A, Chakdar H, *et al*. Evaluation of indigenous aromatic rice cultivars from sub-Himalayan Terai region of India for nutritional attributes and blast resistance. Scientific Reports. 2021;11(1):4786.
9. NCML, Gurugram. Basmati Crop Survey Report. Basmati Export Development Foundation, APEDA, New Delhi; c2019.
10. Parihar NS, Kumar V, Ankit. Engineering properties of Basmati-370. International Journal of Chemical Studies. 2021;9(2):11944. https://doi.org/10.22271/chemi.2021.v9.i2b.11944
11. Sharma RITESH, Gangwar RK, Yadav V, Kumar R. Response of basmati rice (*Oryza sativa*) cultivars to graded nitrogen levels under transplanted condition. International Journal of Research in Applied, Natural and Social Sciences. 2014;2(9):33-38.
12. Sholikhah U, Parjanto P, Handoyo T, Yunus A. Morphological characters of several black and aromatic rice (*Oryza sativa* L.) in Indonesia. In: AIP Conference Proceedings. Vol. 2120. No. 1. AIP Publishing; c2019.
13. Sinha AK, Mishra PK. Agro-morphological characterization and morphology-based genetic diversity analysis of landraces of rice variety (*Oryza sativa* L.) of Bankura district of West Bengal. International Journal of Current Research. 2013;5(10):2764-2769.