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Agronomic Evaluation of Rice (*Oryza sativa* L.) Hybrids for the Agro-climatic Conditions of Prayagraj in *Kharif* – 2022, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) during *Kharif*, 2022. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), organic carbon (0.75%), available N (269.96 kg/ha), available P (33.10 kg/ha), and available K (336 kg/ha). The experiment was laid out in Randomized Block Design with 10 hybrids each replicated thrice. Results was recorded as higher plant height (112.03 cm), number of tillers (16.34), plant dry weight (50.91 g/plant), crop growth rate at 80-100 DAT (32.14 g/m^2/day), tillers/m^2 (371.23), panicle length (29.73 cm), filled grains (245.87), grain yield/hill (31.37 g), seed yield (4.97 t/ha), straw yield (9.54 t/ha) were recorded significantly higher in hybrid R-170. However, harvest index (34.41 %) were recorded significantly higher in hybrid R-151. Further, the maximum gross returns (INR 128020/ha) and net returns (INR 78974/ha) and B:C ratio was highest in 1.61 were recorded significantly higher in hybrid R-170.

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1. INTRODUCTION

"India is the world's largest rice producer, with an area of 43.79 million hectares, a production of 112.91 million tonnes, and a productivity of 2.572 t/ha (Directorate of Economics and Statistics 2017-2018). In Uttar Pradesh, there are 5.9 million ha and 13.27 million tonnes produced, with an average productivity of 2447 kg/ha and 14.63 million tonnes produced" (Agriculture Statistics 2016). Rice is India's most important cereal food crop, accounting for around 24% of the country's gross planted area. Rice is India's most important cereal food crop, accounting for around 24% of the country's gross planted area. It accounts for 42% of the country's total food grain production and 45% of overall cereal production. In 2010, India's rice yield was 120.62 million tonnes 44 million ha, followed by China (197.21 million tonnes). In 2017-18, the area, production, and productivity in Uttar Pradesh and India were 5.81 million hectares, 13.21 million tonnes, 2283 kg/ha, and 43.79 million hectares, 112.91 million tonnes, 2578 kg/ha, respectively. Hybrid rice accounts for more than half of the crop area and has contributed significantly to yield and output increases even after land has been repurposed for other agricultural and non-agricultural uses. More than 80% of total hybrid rice acreage is in eastern India states such as Uttar Pradesh, Jharkhand, Bihar, and Chhattisgarh, with a little amount in states such as M.P, Assam, Punjab, and Haryana. Hybrid rice was planted on an area of 1.3 million hectares, resulting in an increase in rice production of 1.5 to 2.5 million tonnes.

"The introduction of hybrid rice is a significant step towards increasing rice productivity. Hybrid rice produces approximately 15-20% more than prospective high-yielding commercial cultivars. Previous research has shown that using fertilisers wisely and properly can significantly boost production and enhance rice quality" [1]. "Given the importance of nitrogen fertilisation on rice plant yield, it is necessary to know what the best dose is for each variety, as well as its influence on yield components and other agronomic parameters such as the cycle, plant height, lodging, and grain moisture content, in order to gain a better understanding of said productive response. Tanaka et al. (1966) discovered that the height of a rice plant is proportional to the length of the maturation cycle. A taller plant is more prone to lodging and responds to nitrogen less well" [2]. "Panicles with a low percentage of sterile fl owers allow for higher nitrogen applications and higher yields" [3]. Some factors, like as early sowing, achieve the dual goals of increasing yields and enhancing grain quality [2,4]. Other factors, like as higher nitrogen fertiliser rates, may boost output while decreasing grain quality [5]. "A sufficient supply of nitrogen to agricultural plants during their early growth period is critical for the beginning of leaves and floret primordia" [6]. Rice is grown in a variety of agro-ecologies in India, with the majority of them facing biotic and abiotic pressures such as quantitative and qualitative deterioration of natural resources (such as land and water), increasing frequency of extreme climatic events (such as droughts and floods), rising input costs, declining profits, and shrinking farm sizes. For the past three decades, India's land border appears to have achieved its broad range of exploitation—the net sown area has been stable at roughly 142 million hectares (India, MoAFW 2018). Rice acreage has increased as well, to roughly 43 million hectares. As a result, chances for growth through area extension are dim. Another major barrier to rice cultivation (a water-guzzling crop) is growing water scarcity. Water scarcity affects more than half of India's land area.

"Rice contains 80% carbs, 7-8% protein, and an amino acid profile that reveals it is rich in Glutamic acid and aspartic acid, with the highest quality cereal protein containing lysine (3.8%), 3% fibre, iron 1.0 mg, and zinc 0.5 mg" [7]. The history of hybrid rice development dates back to 1908, when Shull invented the word heterosis. Heterotic hybrids have a high potential for increasing economic production and meeting global food demands [8]. During the first decades after the release of rice hybrids for commercial cultivation, the technology did not spread as quickly as expected due to a variety of factors such as low heterosis, poor grain and cooking quality, hybrid susceptibility to pests and diseases, and problems with seed production and delivery, among others.

2. MATERIALS AND METHODS

"This experiment was carried out during *kharif* season 2022 at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (U.P.) which is located at 25^0 28' 42" N latitude, 81^0 50' 56" E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Prayagraj Rewa Road about 5 km away from Prayagraj city. Organic carbon (0.87%), available Nitrogen (225 kg/ha), Phosphorus (41.8 kg/ha) and Potassium (261.2 kg/ha)" [9]. The climate of the region is semi-arid subtropical. To reduce crop-weed competition three hand weeding was carried out at 35 days after sowing. Nursery sowing date 27-06-2022, Spacing 20×10 cm and 5-7 irrigations were provided. "The observations pertaining to growth attributes were recorded using the standard procedure at 20 days intervals and presented at 100 DAS. Yield parameters were observed on the day of harvest, 23rd November 2022. All the attributes were recorded and analyzed statistically by using appropriate analysis of Variance adopting" Gomez and Gomez [10].

2.1 Experimental Design

The experiment was conducted in Randomized block design consisting of 10 hybrids *i.e*., from R-127 to R-205 with 3 replications and was allocated randomly in each replication.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height (cm)

"At 100 DAT the significantly tallest plant height was observed in R-170 (112.03 cm). However, R-127 (110.44 cm) was statistically at par with R-170. The genetic makeup of the variety is a significant contributing component", as documented by Haque et al. [11]. "The increased plant height could possibly be attributed to the synchronised availability of all critical plant nutrients, particularly nitrogen, over a longer period of time during growth phases" [12].

3.1.2 Numbers of tillers/hill

"At 100 DAT the highest number of tillers was observed in R 170 (16.34). However, R 151 (15.96) and R 160 (16.02) were statistically at par with R 170. Significant variances could be attributed to differences in the genetic make-up of high yielding types, which could be modified by heredity" [9]. It could also be attributed to a high availability of nutrients.

3.1.3 Plant dry weight (g)

"At 100 DAT the highest plant dry weight was observed in R 170 (50.91 g). However, R 127 (50.45 g/plant), and R 196 (49.32 g/plant) were statistically at par with R 170. The most likely cause of maximal dry matter accumulation is enhanced photosynthesis and respiration rate, which ultimately promotes plant development in terms of increased plant height, leaf area, and tillers/hill, among other things. Thus, the treatment that achieved maximal growth also gathered the mostdry matter". A similar conclusion was reported by Kumar [13]. "Another explanation for increased dry matter buildup in might be a large increase in morphological factors that are responsible for the plant's photosynthetic capacity, hence enhancing straw yield". The outcome was consistent with Bozorgi et al. [14].

3.2 Yield Parameters

3.2.1 Number of tillers/meter^2

The Significantly highest number of tillers/m^2 was observed in R 170 (371.23 tillers/m^2). However, R 160 (359.67 tillers/m^2), R 190 (333.54) and R-205 (329.80) statistically at par with R 170. High tillering capacity is the most likely reason for high producing cultivars. Yadav et al., [15] observed similar findings. According to Wang et al. [16], "the unequal distribution of photo- synthetically active radiation (PAR) was the source of heterogeneity in individual tiller yields, as early emerging superior tillers pre-empted the uppermost light source and shaded the late emerging tillers under limited light conditions". "Higher tiller production was owing to improved root growth induction for anchoring. It improves nutrient and water intake, resulting in a greater number of tillers and dry matter accumulation" [17].

3.2.2 Panicle length

R 170 recorded significantly higher panicle length/hill (29.73 cm). However, R 190 (27.92 cm) and R 145 (28.34 cm) were statistically at par with R 170. "In hybrid rice, the nitrogen content had a substantial effect on panicle length. The large variability in panicle length amongst hybrid rice varieties could be attributable to genetic variances". The findings support those of Rahman et al. [18].

3.2.3 Grain yield (t/ha)

"The data showed the significantly highest grain yield was observed in R 170 (4.97 t/ha). However, R 145 (4.20 t/ha) and R-190 (4.53 t/ha)

Table 1. Field evaluation of different varieties on growth attributes of rice hybrids

S. No.	Hybrids	Growth parameters		
		Plant height (cm)	**Tillers/hill (No.)**	**Dry weight (g/plant)**
1.	R-127	110.44	14.95	50.45
2.	R-145	108.37	14.86	48.19
3.	R-151	103.23	15.96	46.50
4.	R-160	104.53	16.02	43.91
5.	R-165	107.97	11.93	46.34
6.	R-170	112.03	16.34	50.91
7.	R-180	107.20	11.77	47.42
8.	R-190	106.30	14.49	45.89
9.	R-196	109.37	12.84	49.32
10.	R-205	102.18	12.05	46.35
	F-test	S	S	S
	SEm±	1.29	0.32	0.60
	CD (p=0.05)	3.87	1.02	1.86

Table 2. Field evaluation of different varieties on yield attributes of rice hybrids

S. No.	Hybrids	Tillers/m^2	Panicle length (cm)	Grain yield (t/ha)	Straw yield (t/ha)
1.	R-127	308.33	25.32	3.87	8.03
2.	R-145	250.33	28.34	4.20	9.06
3.	R-151	258.33	25.33	3.40	6.48
4.	R-160	359.67	23.87	3.18	8.55
5.	R-165	318.67	26.26	2.84	6.62
6.	R-170	371.23	29.73	4.97	9.54
7.	R-180	299.78	27.39	3.22	6.53
8.	R-190	333.54	27.92	4.53	9.03
9.	R-196	259.67	24.56	2.68	7.86
10.	R-205	329.80	23.34	3.08	7.31
	F-test	S	S	S	S
	SEm±	15.01	1.01	0.30	0.27
	CD (p=0.05)	45.05	3.04	0.92	0.84

Table 3. Field evaluation of different varieties on economics of rice hybrids

S. No.	Hybrids	Economics			
		Cost of cultivation (INR/ha)	**Gross return (INR/ha)**	**Net return (INR/ha)**	**B:C ratio**
1.	R 127	49046	101490	52444	1.07
2.	R 145	49046	111180	62134	1.27
3.	R 151	49046	87440	38394	0.78
4.	R 160	49046	89250	40204	0.82
5.	R 165	49046	76660	27614	0.56
6.	R 170	49046	128020	78974	1.61
7.	R 180	49046	83990	34944	0.71
8.	R 190	49046	117690	68644	1.40
9.	R 196	49046	77180	28134	0.57
10.	R 205	49046	83530	34484	0.70

were statistically at par with R 170. Grain yield was highly correlated with tillers/hill, panicle length, and harvest index. higher yield qualities might be attributed to higher growth and development parameters, which resulted in greater grain". This results in agreement with the work of Vishwakarma [19].

3.2.4 Straw yield (t/ha)

The data showed the significantly highest straw yield was observed in R 170 (9.54/ha). However, R 145 (9.06 t/ha) and R 190 (9.03 t/ha) were statistically at par with R 170. According to Padmavathi's [20], "the potential of hybrid rice to use more nitrogen through the expression of superior growth caused by the improved influence on nutrient uptake and physiological growth increases straw yield. High dry matter accumulation could be attributed to a large increase in morphological factors that are responsible for the plant's photosynthetic capacity, hence enhancing straw output".

Economics: The result showed that [Table 3] the maximum gross return (128020. INR/ha), net return (78974 INR/ha) and B:C ratio (1.61) was recorded in R-170 as compared to other Hybrids.

4. CONCLUSION

It is concluded that Hybrid R-170 was found to be best for obtaining maximum grain yield. It also fetched the maximum gross return, net return and B:C ratio.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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