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Evaluation of Rice (*Oryza sativa* L.) under Agro-climatic Zone of Prayagraj, 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, Naini Agriculture Institute, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during Kharif, 2022 on sandy loamy soil. The experiment was laid out in Randomized Block Design, replicated thrice, consisting of ten hybrids *i.e.*, R-205, R-210, R-212, R-218, R-242, R-248, R-256, R-300, R-305, R-311. The field experiment result revealed that R-305 has significantly increased the growth parameters *viz*., Plant height (125.87 cm), Number of tillers (16.30), Plant dry weight (47.60 g/plant), Tillers/m^2 (388.10), Panicle length (29.34 cm), Grain yield (6.95 t/ha) and Straw yield (12.80 t/ha). Maximum gross return (INR 200625/ha), net return (INR151579/ha), and highest B:C ratio (3.09) was also in recorded R-305.

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1. INTRODUCTION

"Rice is one of the most important staple food crops, supporting two-thirds of the global population." India is a significant rice-growing country. It accounts for the majority of daily calories for many companion animals and humans" [1]. Rice, a complex carbohydrate, provides energy to more than half of the world's population, primarily in Asia. It gives the body glucose, which is necessary for normal brain and body function. Other complex carbs, such as whole grains, legumes, fruits, and vegetables, are vital sources of energy for the body as well as key nutrients such as fibre, vitamins, and minerals, which are needed for maintaining good health and lowering the risk of disease. "Rice is a nutritional staple food that provides instant energy due to its carbohydrate (starch) component; it also provides 27% of dietary energy supply, 20% of dietary protein, and 3% of dietary fat" [2]. "India grew rice on 44 million hectors of land." Total rice production of 130.29 million tonnes in 2021-22, up 3% from 118.87 million tonnes the previous year. West Bengal is first in rice output, producing 14.76 million tonnes" [3]. "It is 13.85 million tonnes higher than the five-year average production of 116.44 million tonnes." It is India's most rice-producing state, with a yield of 2600 kilogrammes per hectare. Uttar Pradesh with 14.02 million tons of rice production, Uttar Pradesh ranks on the 2nd position in the country" [4].

"Hybrid rice has the potential to increase rice yields. Thus, expanding hybrid rice farming area may be an effective and cost-effective strategy to meet future rice demand from a growing population" [5]. It outperforms typical high producing cultivars by 20-30% [6]. "The most critical contribution in increasing yield per unit area is played by hybrid rice. The yield advantage of 15-20% over the best pure line varieties (6.5 t/ha vs. 5.4 t/ha) proved to be the deciding factor in the widespread adoption of hybrid rice technology. 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. The current state of hybrid rice in India, as well as the significant difficulties and prospects for this unique technology. Although currently produced types and hybrids have high production potential, their performance is inconsistent even under less diverse growing settings" [7]. "Environmental variations have a significant impact on genotypic yield manifestations, resulting in performance inconsistency due to genotype x environment interactions" [8]. It is critical to undertake an adequate varietal selection programme for high yielding traits in order to boost current yield and close the rice need gap in order to feed India's ever-increasing population. As a result, it is critical to evaluate the discovery and selection of high yielding varieties and quality attributes in rice among current lines.

2. MATERIALS AND METHODS

This experiment was conducted during the *kharif* season of 2022 at the Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (U.P.), which is located at 250 28' 42" N latitude, 810 50' 56" E longitude, and 98 m altitude above mean sea level. This area is located on the right bank of the Yamuna River, along the Prayagraj, Rewa Road, about 5 km from Prayagraj city. Organic carbon (0.87%), accessible nitrogen (225 kg/ha), phosphorus (41.8 kg/ha), and potassium (261.2 kg/ha) are the most abundant elements. The region has a semi-arid subtropical climate. One hand weeding was performed 35 days following sowing to prevent crop-weed competition. Two irrigations were administered at 40-day intervals. The growth characteristics observations were recorded using conventional technique at 20-day intervals and displayed at 100 DAS. Yield metrics were measured on harvest day, November 23rd, 2022. All of the parameters were recorded and statistically analysed using appropriate analysis of variance techniques as described by Gomez and Gomez [9].

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height (cm)

At 100 DAS the significantly and higher plant height was observed in R-305 (125.87 cm). However, R-300 (124.52 cm) R-256 (121.70 cm) and R-248 (120.09 cm) were statistically at par with R-305. The genetic makeup of the variety is a significant contributing component, as documented by [10]. Increased plant height could

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-205	114.44	14.24	38.19
2.	R-210	115.02	14.51	38.11
3.	R-212	115.79	14.73	35.02
4.	R-218	116.26	14.61	39.92
5.	R-242	117.00	15.48	40.72
6.	R-248	120.09	15.77	42.33
7.	R-256	121.70	15.95	42.78
8.	R-300	124.52	16.17	46.53
9.	R-305	125.87	16.30	47.60
10.	R-311	106.77	13.60	37.98
	F-test	S	S	S
	SEm±	2.87	0.49	1.96
	CD (p=0.05)	8.55	1.47	5.85

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-205	337.95	25.37	4.98	10.47
2.	R-210	344.42	25.51	5.32	10.76
3.	R-212	349.04	25.73	5.45	10.99
4.	R-218	354.54	26.01	5.68	11.43
5.	R-242	360.70	27.26	5.99	11.74
6.	R-248	366.54	27.76	6.23	11.97
7.	R-256	373.23	28.01	6.40	12.27
8.	R-300	380.53	28.22	6.67	12.44
9.	R-305	388.10	29.34	6.95	12.80
10.	R-311	249.42	22.98	4.46	9.79
	F-test	S	S	S	S
	SEm±	10.49	1.12	0.19	0.45
	CD (p=0.05)	31.18	3.33	0.57	1.35

also be attributed to the synchronised availability of all important plant nutrients, particularly nitrogen, for a longer period of time during growth phases [11]. Also, [12] discovered that the reason for maximum plant height could be related to more favourable weather conditions, which was criticised by the greater growing degree days and hydrothermal units achieved in these hybrids.

3.1.2 Numbers of tillers/hill

At 100 DAT the highest number of tillers was observed in R-305 (16.30). However, R-300 (16.17), R-256 (15.95) and R-248 (15.77) were statistically at par with R-305. Significant variances could be attributed to differences in the genetic make-up of high producing types, which could be modified by heredity. A comparative study of the performance of rice hybrids exhibited that R-305 recorded significantly higher tillers/hill. The differences in growth parameters between cultivars are mainly due to their genetic build up [13].

3.1.3 Plant dry Weight (g/plant)

At 100 DAT the highest dry weight was observed in R-305 (47.60 g/plant). However, R-300 (46.53 g/plant), R-256 (42.78 g/plant) and R-248 (42.33 g/plant) were statistically at par with R-305. 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 development also accumulated more dry matter. A similar result was reported by [14]. 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 [15].

3.2 Yield Parameters

3.2.1 Number of tillers/meter^2

The highest tillers/m2 was observed in R-305 (388.10 tillers/m^2). However, R-300 (380.53 tillers/m^2), R-256 (373.23 tillers/m^2) and R-248 (366.54 tillers/m^2) was statistically at par with R-305. The probable reason for high yielding varieties have high tillering capacity. [16], [17] also report similar findings. The unequal distribution of photo- synthetically active radiation (PAR) was found to be the source of variation in individual tiller yields, as early emerging superior tillers pre-empted the topmost light source and shaded the late appearing 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 buildup [12].

3.2.2 Panicle length

R-305 recorded significantly higher panicle length/hill (29.34 cm). However, R-300 (28.22cm), R-256 (28.01 cm) and R-248 (27.76cm) were statistically at par with R- 305. 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 results confirm the findings of [18].

3.2.3 Grain yield (t/ha)

The data showed the significantly highest grain yield was observed in R-305 (6.95 t/ha). However, R-300 (6.67 t/ha) and R-256 (6.40 t/ha) were statistically at par with R-305. Grain yield per plant correlated strongly with tillers/hill, panicle length, harvest index, grain yield per plot, grain yield/meter2, and grain yield/hectare. These findings support those of [18]. “Higher yield qualities might be attributed to higher growth and development parameters, which resulted in greater grain. This results in conformity with the work of” [19].

3.2.4 Straw yield (t/ha)

The data showed the significantly highest straw yield was observed in R-305 (12.80 t/ha). However, R-300 (12.44 t/ha), R-256 (12.27 t/ha) and R-248 (11.97 t/ha) were statistically at par with R-305. According to Padmavathi's research in 1997, the potential of hybrid rice to use more nitrogen through the expression of improved growth caused by the good influence on nutrient uptake and physiological growth increases straw production. 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. The outcome was consistent with [15].

4. ECONOMICS

The result showed that [Table 3] the maximum gross return (200625 INR/ha), net return (151579 INR/ha) and B:C ratio (3.09) was recorded in R-305 as compared to other Hybrids.

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-205	49046	148305	99259	2.02
2.	R-210	49046	157420	108374	2.20
3.	R-212	49046	161135	112089	2.28
4.	R-218	49046	167840	118794	2.42
5.	R-242	49046	175745	126699	2.58
6.	R-248	49046	181825	132779	2.70
7.	R-256	49046	186680	137634	2.80
8.	R-300	49046	193165	144119	2.93
9.	R-305	49046	200625	151579	3.09
10.	R-311	49046	135050	86004	1.75

5. CONCLUSION

It is concluded that hybrid R-305 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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