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Evaluation of rice (*Oryza sativa* L.) hybrids under Agro-climatic conditions of Prayagraj, U.P.

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Abstract
The Agronomic investigation entitled "Evaluation of Rice (*Oryza sativa* L.) Hybrids under Agro-climatic conditions of Prayagraj, U.P." was carried out during *kharif* 2020. The experimental site was located at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) with the objective to study growth and yield attributes of rice hybrids and to study the economics of different rice hybrids. The soil of experimental field is identified as sandy loam in texture, nearly neutral in soil reaction (pH7.2), low inorganic Carbon (0.48%), available N (108.0 kg/ha), available P (22.5 kg/ha) and available K is (280 kg/ha). The field experiment was carried out in Randomized block design with three replications having 15 different hybrids as treatments. The finding of the experiment indicated that KR-14 showed best results in growth parameters like germination percentage, maximum plant height (100.53 cm), higher number of tillers (11.33), maximum plant dry weight (48.16), higher number in Crop growth rate (22.55 g/m2/day), higher number of Relative growth rate (0.016 g/g/day), higher number of effective tillers (340.00 tillers/m2), maximum no. of filled grain/panicle (163.00), maximum test weight (25.00 g), maximum grain yield/hill (27.67 g), maximum grain yield (9.37 t/ha), maximum biological yield (22.89 t/ha) and maximum harvest index (40.96%).

Keywords: Rice hybrids, agro-climatic conditions, yield, Prayagraj

Introduction
Rice (*Oryza sativa* L.) is one of the most important staple cereals in the world and it is one of the main sources of carbohydrates for nearly one half of the world's population. More than 90% of the rice is produced and consumed in Asia, where it is a staple for the region's 560 million hungry people. India has a long history of rice cultivation and stands first in rice area and second in rice production after China (Yadav *et al*., 2010) [11]. About 55 per cent of the rice area is irrigated that accounts 75 percent of the rice production in the world (Bouman and Toung, 2001) [1].

Hybrid rice offers an opportunity to boost yield potential of rice. So, expansion of hybrid rice cultivation area may be an effective and economic way to meet the future rice demands of growing population (Shrivastava *et al*., 2015) [8]. It has a yield advantage of 20-30% over conventional high yielding varieties (Virmani *et al*., 2003) [10] Hybrid rice plays a most important role for increase is yield in unit area. The yield advantage of 15-20% over the best pure line varieties (6.5 t/ha as against 5.4 t/ha) proved the key factor for wide adoption of the hybrid rice technology. More than 80% of the total hybrids rice area is in eastern India states like Uttar Pradesh, Jharkhand, Bihar, Chhattisgarh, with some little area like states like M.P, Assam, Punjab, and Haryana. The present status of hybrids rice India, the major challenges and future outlook for this innovative technology. Presently cultivated varieties and hybrids although having high yield potential, they are erratic in their performance even under less varied conditions of cultivation (Saidaiah *et al*., 2011) [7]. Environmental changes have serious implications on genotypic yield manifestations leads to inconsistency in performance due to genotype x environment interactions (Meena *et al*., 2014) [6]. In order to initiate an appropriate varietal selection program for high yielding characters is important to improve the present yield to meet the rice requirement gap to feed the ever-increasing population of India. Thus, it is very much important to consider the identification and selection of high yielding varieties, quality characteristics in rice amongst the existing lines.

Materials and Methods
This experiment was carried out during kharif season 2020 at Crop Research Farm,

Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS), 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 (0.48%), available Nitrogen (108.0 kg/ha), Phosphorus (22.5 kg/ha) and Potassium (280.0 kg/ha). The climate of the region is semi-arid subtropical. To reduce crop-weed competition one hand weeding was carried out at 4O days after sowing. Two irrigations were provided at 40 days interval. The observations pertaining to growth attributes were recorded using standard procedure at 15 days intervals, and presented at 90 DAS. Yield parameters were observed on the day of harvest, 31st March, 2020. All the attributes were recorded and analyzed statistically by using appropriate analysis of Variance adopting Gomez and Gomez (1984) [5].

Experimental design

The experiment was conducted in Randomized block design consisting of 15 hybrids i.e., from KR-1 to KR-15 with 3 replications and was allocated randomly in each replication.

Results and Discussion

The research part was divided into growth attributes and the yield attributes. In the growth attributes plant height, tillers/hill, plant dry weight, crop growth rate and relative growth rate are taken. Plant height is not a yield component especially in grain crops but it indicates of various essential plant nutrients on plant metabolism. At 90 DAT the highest plant height was observed in KR-14 (100.53 cm) where KR-3 and KR-13 was found to be statistically at par with hybrid KR-14 as shown in (Table. 1) respectively. The increased plant height might be due to genetic makeup like genetic character and genetic disparity of the cultivar, increase in plant height may also be due to synchronized availability of all the essential plant nutrients especially nitrogen for a longer period during growth stages (Singh *et al.*, 2019) [9]. The tillers/hill of various hybrids at 90 DAT observed where the highest tillers/hill was seen in KR-14 (11.33) and KR-3, KR-10 and KR-5 were found to be statistically at par shown in (Table.1), the higher tillers production was due to better inducement of root growth for anchor age. It leads to better nutrient and water uptake and ultimately leads to higher number of tillers, dry matter accumulation (Bahure *et al*., 2019) [4]. At 90 DAT highest plant dry weight was found in KR-14 (48.16 g) whereas, KR-13 was found to be statistically at par with hybrid KR-14, as shown in (Table. 1) high dry matter accumulation is might be due to the significant increase in morphological parameters which responsible for the photosynthetic capacity of the plant there by increasing the dry matter accumulation, result conformed by (Bozorgi *et al.*, 2011) [2]. At 75-90 DAT significantly higher crop growth rate (22.55 g/m2/day) was found in hybrids KR-14 whereas, KR-1, KR-7, KR-9 and KR-13 were found to be at par with hybrid KR-14 show in (Table. 1). At 75-90 DAT significant and maximum Relative growth rate (0.016 g/g/day) was found in hybrid KR-14 as shown in (Table. 1).

The second division of the research shown in (Table 2) & (Table 3) will be about the yield and yield contributing characters, which covers the characters like number of effective tillers/m^2, panicle length (cm), filled grain/panicle (No.), un filled grain/panicle (No.), test weight (g), grain yield/hill (g), grain yield (t/ha), Straw yield (t/ha), biological yield (t/ha), harvest index (%). During the period of investigation as data showed in (Table 2) that tillers/m^2 was much influenced under various hybrids at 90 DAT the highest tillers/m^2 was observed in KR-14 (340.00) which was significantly superior over rest of the rice hybrids except hybrids KR-3, KR-5 and KR-10 which are statistically at par with hybrid KR-14. The data shows significantly higher panicle length (28.63 cm) in hybrid KR-6 whereas, hybrids KR-1, KR-2, KR-3, KR-4, KR-7, KR-8, KR-9, KR-13, KR-14 and KR-15 were found to be statistically at par with hybrid KR-6 shown in (Table 2) the nitrogen level exerted significant effect on panicle length in hybrid rice, the significant differences in panicle length among the hybrid rice varieties could be attributed to their genetic make-up (Bhuiyan *et al*., 2014) [3]. The results in (Table 2) showed that filled grains/panicle was much influenced under various hybrids at harvest. The highest significant number of filled grains/panicle (163.00) was recorded under the hybrid KR-14, whereas, hybrids KR-1, KR-3, KR-4, KR-9, KR-11, KR-13, and KR-15 were found to be statistically at par with hybrid KR-14, this might be that hybrid rice produces long roots and broad leaves that enable them to take up more nutrients and produce more grains. Similar results have also been reported by (Bhuiyan *et al*., 2014) [3]. The results showed (Table 2) that the lowest unfilled grains (no.) panicle (31.60) was recorded under the hybrid KR-5, the hybrid KR-9 (60.47) was found to be highest unfilled grains (No.) panicle, is unsuited to existing climatic condition of the place especially during the grain-filling stage of the panicle development. Test weight of the hybrids were measured and presented in (Table 2) the observed data shows significantly higher test weight of 25.00 g recorded in hybrid KR-14 whereas, hybrid KR-3 was found to be statistically at par with hybrid KR-14. The observed data (Table 3) shows the significantly higher grain yield/hill (27.67 g) was recorded in hybrid KR-14. Whereas, hybrids KR-2, KR-3, KR-4, KR-6, KR-7, KR-9, KR-12 and KR-13 were found to be statistically at par with hybrid KR-14. The observed data (Table 3) shows significantly higher Grain yield of (9.37) t/ha found in hybrid KR-14. However, hybrids KR-2, KR-3, KR-4 and KR-13 were found to be statistically at par with hybrid KR-14. As mentioned in (Table 3) significantly higher Straw yield (14.32 t/ha) was found in hybrids KR-9 whereas, hybrids KR-1, KR-2, KR-4, KR-7, KR-12, KR-13, KR-14 and KR-15 were found to be at par with hybrid KR-9 This high dry matter accumulation is might be due to the significant increase in morphological parameters which is responsible for the photosynthetic capacity of the plant thereby increasing the straw yield. The result conformed by (Bozorgi *et al.* 2011) [2]. Recorded in (Table 3) the data shows significantly higher biological yield (22.89 t/ha) and significantly higher harvest index (40.96%) was found in hybrid KR-14. Economics of the hybrids shown in (Table. 4) shows that Cost of cultivation *i.e*., 55374.4 ₹/ha was recorded in all treatments KR-1 to KR-15, where the gross return varies from minimum 122685 ₹/ha in KR-11 to maximum 188925 ₹/ha in KR-14. The maximum net return 133550.6 ₹/ha of hybrid rice has been found in KR-14 presented in (Table. 4) and KR-11 recorded least net return *i.e.*, 67310.6 ₹/ha and at last Maximum benefit cost ratio (2.41) was recorded in KR-14, which was found to be higher among all other treatments as shown in (Table.4).

Table 1: Evaluation of Rice hybrids on Growth attributes like (Plant height, Tillers/hill, Dry weight, CGR, RGR) under Agro-climatic conditions of Prayagraj, U.P.

Rice hybrids	Plant height	Tillers/hill	Dry weight	CGR (Crop growth rate)	RGR (Relative growth rate)
KR-1	96.38	9.33	41.32	18.98	0.015
KR-2	94.13	9.13	41.15	17.09	0.014
KR-3	98.23	11.07	43.68	16.92	0.013
KR-4	96.33	8.07	43.44	8.56	0.006
KR-5	94.21	9.67	44.11	9.72	0.007
KR-6	95.58	9.07	42.18	15.88	0.012
KR-7	93.01	9.00	42.18	19.24	0.015
KR-8	94.53	9.07	40.80	11.92	0.009
KR-9	96.45	9.13	40.24	19.20	0.016
KR-10	92.53	10.00	41.51	13.46	0.011
KR-11	96.61	9.53	43.67	13.47	0.010
KR-12	94.03	7.53	45.11	17.29	0.013
KR-13	97.73	9.60	46.57	20.98	0.015
KR-14	100.53	11.33	48.16	22.55	0.016
KR-15	93.56	8.53	44.10	13.07	0.010
SE(m)±	1.24	0.58	0.68	1.70	0.00
CD(P=0.05)	3.60	1.69	1.97	4.92	0.00

Table 2: Evaluation of Rice hybrids on yield attributes like (number of effective tillers/m^2, panicle length (cm), filled grain/panicle (No.), Unfilled grain/panicle (No.), test weight (g) under Agro-climatic conditions of Prayagraj, U.P.

Rice hybrids	Tillers m2	Panicle length	Filled grains	Unfilled grains	Test weight
KR-1	280.00	26.53	134.33	57.87	18.67
KR-2	274.00	25.87	108.67	39.27	21.33
KR-3	332.00	27.33	156.00	42.53	24.33
KR-4	242.00	26.67	141.33	43.33	21.00
KR-5	290.00	23.73	107.33	31.60	18.00
KR-6	272.00	28.63	123.67	59.13	18.67
KR-7	270.00	26.70	142.33	54.80	19.33
KR-8	272.00	26.77	127.33	32.53	18.33
KR-9	274.00	28.30	137.33	60.47	19.00
KR-10	300.00	23.03	121.00	34.93	18.33
KR-11	286.00	23.87	147.00	51.40	17.67
KR-12	226.00	23.97	115.33	34.73	19.00
KR-13	288.00	26.27	158.00	37.67	19.67
KR-14	340.00	28.57	163.00	38.67	25.00
KR-15	256.00	28.30	146.33	43.60	20.00
SE(m)±	17.49	1.12	10.42	5.99	1.12
CD(P=0.05)	50.67	3.24	30.19	17.34	3.25

Table 3: Evaluation of Rice hybrids on yield attributes like (grain yield/hill (g), grain yield (t/ha), Straw yield (t/ha), biological yield (t/ha), harvest index %) under Agro-climatic conditions of Prayagraj, U.P.

Rice hybrids	Grain yield/hill (g)	Grain yield (t/ha)	Straw yield (t/ha)	biological yield (t/ha)	harvest index %
KR-1	24.00	8.69	13.95	22.63	38.40
KR-2	24.67	8.83	13.35	22.18	39.80
KR-3	27.00	8.89	12.97	21.86	40.65
KR-4	24.67	8.82	13.37	22.18	39.83
KR-5	21.00	6.59	11.91	18.50	35.62
KR-6	23.33	7.64	13.11	20.75	36.80
KR-7	24.67	8.44	13.98	22.42	37.71
KR-8	22.00	6.72	12.00	18.72	35.86
KR-9	24.67	8.48	14.32	22.80	37.21
KR-10	22.00	7.20	12.51	19.71	36.50
KR-11	19.33	5.90	10.99	16.89	34.86
KR-12	25.00	8.62	13.92	22.54	38.25
KR-13	25.67	8.79	13.50	22.29	39.42
KR-14	27.67	9.37	13.51	22.89	40.96
KR-15	23.67	8.72	13.76	22.48	38.81
SE(m)±	1.05	0.20	0.37	0.42	0.88
CD(P=0.05)	3.05	0.58	1.06	1.22	2.55

Table 4: Evaluation of Rice hybrids on Economics like (cost of cultivation, gross return, net return, B: C) under Agro-climatic conditions of Prayagraj, U.P.

Hybrids	Cost of cultivation	Gross return	Net Return	B:C
KR-1	55374.4	177345	121970.6	2.20
KR-2	55374.4	178965	123590.6	2.23
KR-3	55374.4	179475	124100.6	2.24
KR-4	55374.4	178815	123440.6	2.23
KR-5	55374.4	136485	81110.6	1.46
KR-6	55374.4	157185	101810.6	1.84
KR-7	55374.4	172890	117515.6	2.12
KR-8	55374.4	138960	83585.6	1.51
KR-9	55374.4	174120	118745.6	2.14
KR-10	55374.4	148365	92990.6	1.68
KR-11	55374.4	122685	67310.6	1.22
KR-12	55374.4	176040	120665.6	2.18
KR-13	55374.4	178470	123095.6	2.22
KR-14	55374.4	188925	133550.6	2.41
KR-15	55374.4	177600	122225.6	2.21

Conclusion

On the basis of *Kharif* season experimentation, it can be concluded that the hybrid KR 14 was found to be more productive with higher plan height, maximum tillers/hill, maximum dry weight, higher CGR & RGR, higher tillers m^2, maximum filled grains, maximum grain yield (9.37 t/ha) with gross return (188925 ₹/ha) and B:C ratio (2.41). These conclusions drawn are based on one season data only, which requires further confirmation for recommendation.

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