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

Mude Mohan Naik, Vikram Singh, Dhananjay Tiwari, Shruti G George and Mudiveti Venkat Ramana Reddy

Abstract
The Agronomic investigation entitled Evaluation of Rice (*Oryza sativa* L.) Hybrids under Agro-climatic conditions of Prayagraj were 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 of to study growth and yield attributes of rice hybrids and to study the economics of different rice hybrids. The field experiment was carried out in randomised block design with three replication having 15 different rice hybrids as treatments. The finding of the experiment indicated that the growth and yield parameters like maximum plant height (121.17 cm), higher number of tillers (14.33), maximum plant dry weight (57.69g) higher number of effective tillers (440.0 tillers/m2), panicle length (31.36 cm), maximum no of filled grain/panicle (160.67), test weight (22.67 g) and maximum grain yield (8.42 t/ha) were recorded in hybrid KR-39. The economics of the hybrid KR-39 was also found higher *i.e.* Maximum Net return (₹ 66659.91/ha), Gross returns (₹ 118201.6/ha) and B: C ratio (2.29).

Keywords: Rice hybrids, evaluation, growth, yield and economics

1. Introduction
Rice is the most important cereal crop of India, 24% of gross cropped area in the country is occupied by the rice. It contributes about 42% and 45% of total food grain production and total cereal production respectively. In the year 2017-18 the productivity of rice in Uttar Pradesh and India was 2283 kg/ha and 2578 kg/ha respectively. The forecasts of UN/FAO predicted that global food production will need to enlarge by over 40% by 2030 and 70% by 2050 (FAO, 2009) [1]. With increasing population to cope up with the requirements of rice production in India as well as in several other Asian countries must be doubled by the year. Utilization of heterosis is one of the alternatives to boost the production and productivity of rice. Heterotic hybrids cling to great latent for recuperating economic yield in order to convene the global food requirements (Hossain, 1996). A range of strategies like conventional hybridization and selection procedures, ideo-type breeding, hybrid breeding, wide hybridization and genetic engineering are present to heighten the yield and productivity, Among the accessible genetic options to augment the productivity, adoption of hybrid rice breeding technology is one of the practically viable and sustainable approaches. 20-30% of yield advantage may take place in hybrid when compared to non-hybrid rice (Lin and Yuan, 1980) [11].

1.1 Hybrid Rice Technology
The history of hybrid rice dates back to 1908 when Shull coined the term heterosis. At this instant, globally, across 20 countries the hybrid rice research and development and 10 of these countries have commercialized the technology, despite the fact that the area under hybrid rice is still very inadequate in all these countries in comparison with China. In 1979, IRRI began to explore the prospects and problems of hybrid rice technology. Then, some national rice research programs from India, Indonesia, South Korea, Malaysia, Philippines, Thailand, and Vietnam joined in this exploratory research. IRRI in collaboration with Japan has developed TGMS indica rice for breeding two-line hybrids in the tropics (Lu *et al.*, 1994). CMS restorer and TGMS lines possessing wide compatibility (WC) genes, which aided to trounce indica/japonica hybrid sterility (Ikehashi and Araki, 1986) [9], which are developed at IRRI to utilize indica/japonica heterosis. In late 80s India had started hybrid rice project, while in 1989 the Indian Council of Agricultural Research (ICAR), New Delhi, launched an aim oriented, time bound national project on hybrid rice. In 1994, India has developed its first hybrid variety ADHR 11and also commercial cultivation has started.

So far 59 hybrids have been released for commercial cultivation in India, in that 31 are from public sector and 28 are from private sector with the constant efforts for more than two decades. Rice is the most important cereal crop of India, 24% of gross cropped area in the country is occupied by the rice. It contributes about 42% and 45% of total food grain production and total cereal production respectively. In the year 2017-18 the productivity of rice in Uttar Pradesh and India was 2283 kg/ha and 2578 kg/ha respectively. The forecasts of UN/FAO predicted that global food production will need to enlarge by over 40% by 2030 and 70% by 2050 (FAO, 2009) [1]. With increasing population to cope up with the requirements of rice production in India as well as in several other Asian countries must be doubled by the year. Utilization of heterosis is one of the alternatives to boost the production and productivity of rice. Heterotic hybrids cling to great latent for recuperating economic yield in order to convene the global food requirements (Hossain, 1996). A range of strategies like conventional hybridization and selection procedures, ideotype breeding, hybrid breeding, wide hybridization and genetic engineering are present to heighten the yield and productivity, Among the accessible genetic options to augment the productivity, adoption of hybrid rice breeding technology is one of the practically viable and sustainable approaches. 20-30% of yield advantage may take place in hybrid when compared to non-hybrid rice (Lin and Yuan, 1980) [11].

1.2 Hybrid Rice Technology

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2. Materials and Methods

A field experiment was conducted during the *Kharif* season of 2020, at the SHUATS, Prayagraj to study the evaluation of Rice (*Oryza sativa* L.) hybrids under Agro-climatic conditions of Prayagraj at the Crop Research Farm of Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj, Uttar Pradesh, India which is located at 25^0 39' 42'' N latitude, 81^0 67' 56'' E longitude and 98 m altitude above the mean sea level The soil of the experimental plot was sandy loam in texture, neutral in soil reaction (pH 7.2), low organic carbon (0.48%), available P (22.5 kg/ha), EC (0.38 ds/m), available K (280 kg/ha). The experiment consists of different rice Hybrids *viz*., KR-31, KR-32, KR-33, KR-34, KR-35, KR-36, KR-37, KR-38, KR-39, KR-40, KR-41, KR-42 KR-43, KR-44 and KR-45. It was administered through a statistical design of Randomized Block Design (RBD) with three replications. Basal dose of fertilizer was applied just before last puddling. Half dose of nitrogen and full dose of phosphorus and potassium followed by two topdressings of 1/4th dose of nitrogen at 23 DAT & 50 DAT, respectively. At the rate of 25 kg/ha zinc was applied. An appropriate sampling technique was adopted in order to generate scientific and reliable data for statistical analysis. Five plants were selected from each plot leaving the first 2 border rows and taking the 3rd plant from the edges and 1 from the centre of the 3rd row and were tagged. Pre-harvest observations like Plant height (cm), No. of tillers/hill, Dry weight (g/hill), Crop growth rate (g/m^2/day), Relative growth rate (g/g/day) were recorded from the tagged plants, after which the final data was subjected to statistical analysis. Net plot area of 1 m^2 was harvested from each plot and dried and threshing and winnowed manually. Weighed the grain per net plot value, the grain yield per ha was computed and expressed in tonnes per hectare. Yield attributing characters *viz.* Number of effective tillers/m^2, Panicle length (cm), No. filled grain/panicle, No. unfilled grain/panicle, test weight (g) and Harvest Index (%) were recorded**.** Economic Analysis was done for following parameters *viz.*, Cost of cultivation (₹/ha), Gross return (₹/ha), Net return (₹/ha) and Benefit cost ratio. The data were computed and analyzed by following the statistical method of Gomez and Gomez (1984) [6].

3. Results and Discussion

3.1 Evaluation of growth parameters of the rice hybrids:

The statistical data regarding growth parameters were presented in Table-1.

At harvest the maximum plant height (121.16 cm) was found in hybrid KR-39 and the treatment was found to be most significant among all other treatment. The amplified 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 [17]. At harvest stage higher number of tiller/hill (14.33) was recorded in hybrid KR-39. However hybrid KR-36 and hybrid KR-44 found to

be statistically at par with hybrid KR-39. The significant differences might be ascribed to the statement that high yielding varieties have comparatively soaring tillering capacity Yadav *et al., (*2010). The superior tiller production was due to enhanced inducement of root growth for anchorage. It leads to improved nutrient and water uptake and eventually leads to elevated number of tillers, dry matter accumulation Bahure *et al.,* (2019) [2]. At final stage the utmost plant dry weight g/hill (57.69g) was observed in hybrid KR-39. However hybrid KR-36 was found to be statistically at par with hybrid KR-39. Lofty dry matter accumulation is might be due to the momentous boost in morphological parameters which accountable for the photosynthetic capacity of the plant thereby escalating the straw yield. The results are in close conformity with the Bozorgi *et al.,* (2011) [4]. At maturity stage the higher crop growth rate (92.874 g/m2/day) was recorded in hybrid KR-36 however, hybrid KR-32, KR-39, KR-40, KR-42, KR-44 and KR-45 was found to be at par with hybrid KR-36. Maximum Relative growth rate (0.033 g/g/day) was seen in hybrid KR-40 and minimum (0.021 g/g/day) in hybrid KR-41 non-significant results were recorded. This might be due to pervasiveness of low temperature together with less humidity at the growth and reproductive stage especially during flag leaf stage Similar results have also been reported by Yadav *et al.,* (2004) [18].

3.2 Yield attributes of rice hybrids

The range of the effective tillers/m^2 with a least number of 240.0 in hybrid KR-43 to maximum of 440 in hybrid KR-39. However the superior number of tiller/m2 440 tiller/m2 was found in hybrid KR-39. However hybrid KR-44 was found to be at par with treatment hybrid KR-39. Significant results were recorded in panicle length. The panicle length ranged from 23.5 cm in hybrid KR-43 to 31.36 cm in hybrid KR-39. Maximum panicle length was observed in hybrid KR-39 *i.e.* 31.36 cm. However hybrid KR-31, KR-32, KR-33, KR-36, KR-37, KR-38, KR-40, and KR-44 are statistically at par with hybrid KR-39. Genetic makeup could have ascribed the significant differences in panicle length among the hybrid rice varieties Bhuiyan *et al.,* (2014) [3]. Maximum filled grains/panicle *i.e.* 160.66 grain/panicle was observed in hybrid KR-39. However hybrids KR-31, KR-32, KR-34, KR-36, KR-37, KR-40, KR-41 and KR-44 has shared parity with hybrid KR-39. Capacity to produce long roots and broad leaves that might have induced them for more uptake of nutrients and eventually generate more grains. Similar results were reported by Bhuiyan *et al.,* (2014) [3]. Significant results are observed, the minimum unfilled grains/panicle was recorded in hybrid KR-39, However hybrids KR-31, KR-32, KR-35, KR-36, KR-37, KR-38, KR-42, KR-44 and KR-45 has shared statistical uniformity with hybrid KR-39. Superior yield/hill 34.00g recorded in hybrid KR-39. However hybrid KR-31, KR-32, KR-34, KR-36, KR-37 and KR-44 found to be statistically at par with hybrid KR-39. This disparity in grain yield/hill might be due to the optimum exploitation of nutrient. The hybrids of short duration high yielding have the latent to give the highest grain yield then rest of the varieties. The another reason of the high yield of hybrid KR-39 is due to the improved growth attributes consequential to produce higher grain yield. Similar findings were reported by Ranjitha *et al.,* (2013) [16]. Elevated test weight of 22.66 g recorded in hybrid KR-39, However Treatment hybrid KR-31, KR-34, KR-36 and KR-44 found to be statistically at parity with hybrid KR-39. Heavier filled and healthy grain higher test weight might be due to the espousal of 20x 10 cm^2 spacing for rice transplanting. These results are in supportive to Haquee *et al.,* (2015) [7].

3.3 Yield parameters of rice hybrids

Superior Grain yield of 8.42 (t/ha) was found in hybrid KR-39. However hybrids KR-31, KR-32, KR-33, KR-36 and KR-44 has shared statistical parity with hybrid KR-39. Grain yield per plant had extremely noteworthy optimistic correlation with plant height, panicle length, harvest index, grain yield per plot, grain yield /$meter^2$ and with grain yield /hectare. These results are in conformity with the findings of (Rahman *et al.,* (2013) [15]. Non- significant results were recorded in straw yield. Maximum Straw yield of 10.717 (t/ha) was found in hybrid KR-39 followed by the hybrids KR-44 and KR-36. Towering dry matter accumulation is may be due to the important swell in morphological parameters which liable for the photosynthetic ability of the plant thus mounting the straw yield. The result conformed to Bozorgi *et al.* (2011) [4]. Similar trend of stover yield of non-significant was observed in harvest index. Maximum harvest index 45.43% observed in hybrid KR-36. The raise in harvest index might be due to privileged rate of translocation of photosynthates to grains at grain filling stage. Harvest index reflects the physiological capacity of a crop variety to marshal and translocate the photosynthates to the sink (Marri *et al.,* 2005) [13].

3.4 Economics of rice Hybrids

Cost of cultivation *i.e.* ₹ 51466.69/ha was recorded in all hybrids from KR-31 to KR-45 as the same farm management practices was done. The cost of cultivation was higher due to cost of transplanting. The result confirms the findings of Haque *et al.* (2015) [7]. The Maximum gross return recorded ₹ 118201.6/ha in hybrid KR-39 the hybrid KR-43 was recorded least gross return *i.e.*, ₹ 72759.31/ha. The maximum net return ₹ 66659.91/ha of hybrid rice has been found in KR-39 and the hybrid KR-43 was recorded least net return *i.e.* ₹ 21217.62/ha. Maximum benefit cost ratio 2.29 was recorded in the hybrid KR-39 while the least 1.41 was recorded in the hybrid KR-43.

Table 1: Growth parameters of rice hybrids

Hybrids	Effective tillers/hill	Panicle Length (cm)	Filled grains/Panicle	Unfilled grains/panicle	Grain Yield/hill (g)	Test weight (g)
KR-31	310.00	28.25	149.07	32.20	31.67	19.67
KR-32	300.00	29.59	155.00	31.67	32.33	15.33
KR-33	250.00	31.07	125.33	50.20	23.67	12.00
KR-34	320.00	27.30	156.67	64.60	30.67	18.33
KR-35	300.00	25.63	138.73	40.53	27.33	15.67
KR-36	410.00	30.00	156.47	30.67	32.67	20.33
KR-37	310.00	29.10	154.33	44.47	32.00	14.33
KR-38	370.00	29.17	147.27	41.27	26.67	17.67

KR-39	440.00	31.36	160.67	26.67	34.00	22.67
KR-40	370.00	29.27	158.00	54.60	27.33	15.33
KR-41	300.00	26.63	154.67	49.53	24.67	16.33
KR-42	360.00	25.70	144.47	41.27	24.67	16.67
KR-43	240.00	23.50	121.67	52.73	22.33	10.67
KR-44	430.00	30.67	157.13	28.73	33.00	21.67
KR-45	260.00	25.13	130.40	40.93	25.00	13.33
SE(m)±	21.70	1.10	4.21	6.62	1.67	1.53
CD (P=0.05)	63.19	3.20	12.25	19.29	4.88	4.46
CV (%)	11.34	6.74	4.95	27.31	10.17	15.91

Table 2: Yield attributes of rice hybrids

Hybrids	Effective tillers/hill	Panicle Length (cm)	Filled grains/Panicle	Unfilled grains/Panicle	Grain Yield/hill (g)	Test weight (g)
KR-31	310.00	28.25	149.07	32.20	31.67	19.67
KR-32	300.00	29.59	155.00	31.67	32.33	15.33
KR-33	250.00	31.07	125.33	50.20	23.67	12.00
KR-34	320.00	27.30	156.67	64.60	30.67	18.33
KR-35	300.00	25.63	138.73	40.53	27.33	15.67
KR-36	410.00	30.00	156.47	30.67	32.67	20.33
KR-37	310.00	29.10	154.33	44.47	32.00	14.33
KR-38	370.00	29.17	147.27	41.27	26.67	17.67
KR-39	440.00	31.36	160.67	26.67	34.00	22.67
KR-40	370.00	29.27	158.00	54.60	27.33	15.33
KR-41	300.00	26.63	154.67	49.53	24.67	16.33
KR-42	360.00	25.70	144.47	41.27	24.67	16.67
KR-43	240.00	23.50	121.67	52.73	22.33	10.67
KR-44	430.00	30.67	157.13	28.73	33.00	21.67
KR-45	260.00	25.13	130.40	40.93	25.00	13.33
SE(m)±	21.70	1.10	4.21	6.62	1.67	1.53
CD (P=0.05)	63.19	3.20	12.25	19.29	4.88	4.46
CV (%)	11.34	6.74	4.95	27.31	10.17	15.91

Table 3: Yield parameters of rice hybrids

Hybrids	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
KR-31	7.24	9.66	42.92
KR-32	7.54	9.53	44.22
KR-33	6.29	9.47	39.93
KR-34	7.13	9.03	44.12
KR-35	6.57	9.70	40.42
KR-36	8.29	9.95	45.43
KR-37	7.50	9.73	43.54
KR-38	6.97	9.23	43.22
KR-39	8.42	10.72	44.00
KR-40	6.92	9.48	42.25
KR-41	6.83	9.68	41.37
KR-42	6.97	9.37	42.80
KR-43	6.10	9.13	40.04
KR-44	8.40	10.41	44.68
KR-45	6.93	9.57	42.10
SE(m)±	0.27	0.50	1.20
CD (P=0.05)	0.79	-	-
CV (%)	6.54	8.61	8.01

Table 4: Economics of rice hybrids

Rice hybrids	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net return (₹/ha)	B:C ratio
KR-31	51541.69	94752.87	43211.18	1.84
KR-32	51541.69	100340.5	48798.81	1.95
KR-33	51541.69	76629.87	25088.18	1.49
KR-34	51541.69	92162.35	40620.66	1.79
KR-35	51541.69	82143.27	30601.58	1.59
KR-36	51541.69	114869.9	63328.21	2.23
KR-37	51541.69	99791.31	48249.62	1.94
KR-38	51541.69	89228.27	37686.58	1.73
KR-39	51541.69	118201.6	66659.91	2.29
KR-40	51541.69	88641.55	37099.86	1.72
KR-41	51541.69	87142.35	35600.66	1.69

KR-42	51541.69	89362.27	37820.58	1.73
KR-43	51541.69	72759.31	21217.62	1.41
KR-44	51541.69	117460.3	65918.61	2.28
KR-45	51541.69	88920.35	37378.66	1.73

4. Conclusion

It is concluded that the Hybrid KR 39 was found to be the best that recorded number of tillers/hill, number of effective tillers/m^2, panicle length, number of filled grains/panicle, grain yield and harvest index. It also fetched the maximum gross return, net return and B:C ratio as compared to other treatments.

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