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Mahaboob Ali Shaik
Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology Sciences Prayagraj, Uttar Pradesh, India

Vikram Singh
Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology Sciences Prayagraj, Uttar Pradesh, India

Dhananjay Tiwari
Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology Sciences Prayagraj, Uttar Pradesh, India

Lakshman jonnagorla
Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology Sciences Prayagraj, Uttar Pradesh, India

Harikrishna Balla
Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology Sciences Prayagraj, Uttar Pradesh, India

Corresponding Author:
Mahaboob Ali Shaik
Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology Sciences Prayagraj, Uttar Pradesh, India

Studies on growth and yield of rice (*Oryza sativa* L.) Hybrids under eastern U.P conditions

Mahaboob Ali Shaik, Vikram Singh, Dhananjay Tiwari, Lakshman Jonnagorla and Harikrishna Balla

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Abstract
A field experiment was conducted during *kharif* season of 2019 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) to evaluate rice (*Oryza sativa* L.) hybrids under agro-climatic conditions of U.P. The experiment was carried out to find the performance of 10 hybrids, which laid out in Randomized Block Design (RBD) & replicated thrice. The experiment finding revealed that the treatmentKHR-27 performed better than other treatment i.e. plant height (113.60), tillers/hill (11.07), grain yield (8.16 t/ha), stover yield (11.37 t/ha) and harvest index (41.78%).

Keywords: Hybrid rice, varietal response, yield, *Oryza sativa* L

Introduction
Improving rice (*Oryza sativa* L.) production per unit area will be amajor threat in future due to the increasing global population and rice demand in the world. Rice is the main food of majority of the world' spopulation. It provides at least 27% of the nutritional diet and 20% of the protein consumption in the developing world. India is major rice growing country in world with an area of 43.79 million hectares, having production 112.91 million tonnes and productivity of 2.572 t/ha (Directorate of Economics and Statistics 2017-2018). In Uttar Pradesh 5.9 million ha and production 13.27 million tonnes with an average productivity of 2447 kg/ha and production of 14.63 million tonnes (Agriculture statistics 2016). The present status of hybrids rice India, the major challenges and future outlook for this innovative technology. Since the population increasing hence there is a urgent need to provide high yield rice varieties but yield already stagnated hence hybrid rice break the yield barriers which give 15- 20% higher yield. In order to initiate a appropriate varietal selection programme 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 to amongst the existing lines. The present investigation was carried out with objective to find out hybrid varieties suitable for U. P. conditions

Materials and Methods
The experiment was carried out during *kharif* season of 2019 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad (U.P.) which is located at 250 24' 42" N latitude, 810 50' 56" E longitude and 98 m altitude above the meansea level. This area is situated on the right side of the river Yamuna by the side of Allahabad Rewa Road about 5 km away from Allahabad city. The region receives an average annual rainfall is 981 mm. The total rainfall of 195.2mm was received during crop period in *kharif*2019. The maximum temperature ranged in crop seasons was 29ºC to 37.8ºC and minimum temperatures during the same seasons was 21.3ºC to 28.7ºC.The soil of the experiment at site was sandy loam with a pH (7.2), EC 0.38 (ds/m^2), carbon (0.48%), available N (108.0 kg/ha) P_2O_5 (22.5 kg/ha) and K_2O (280.0 kg/ha). The experiment was laid down in randomized block design (RBD) with 10 treatments and 3 replications and to evaluate the hybird rice under agro-climatic condition in prayagraj, variety provided by UPCAR, Lucknow. Twenty two days old seedlings were transplanted to main field conventionally at a spacing of 20 x 10 cm. The crop recommended dose was fertilizer120-60-60 kg N-P-K/ha basal dose of fertilizer was applied just before last puddling on 12 July, 2019, Half dose of nitrogen and full dose of phosphorus and potassium followed by two topdressings of 1/4th dose of nitrogen on 05/08/2019 (23 DAT) & 02/09/2019 (50 DAT), respectively. Irrigation was scheduled at 6-8 days interval; however other normal cultural practices were followed timely as; weeding at 30 DAT &45 DAT.

In the experiment biometric observation were recorded at 20 days interval upto 100 DAT. Plant height of these plants were measured from the ground level up to the collar joint of rice plant and Number of tillers was counted from five random plants per hills of panicle. Moreover, grains from harvest area(1.0 m^2) were dried in sun, cleaned and weighed separately from each plot for calculating the grain yield in tones/ha. Straw from harvest area (1.0 m^2) was dried in sun, bundled, tagged and weighed separately from each plot for calculating the straw yield in tones/ha. Harvest index was calculated by using formula. The data was analyzed by the method of analysis of variance as described by Gomez and Gomez (1984). The level of significance used in "F" test was given at 5%. During the years of experimentation, the crop was transplanted on 13th July 2019 and harvested on 5th November 2019.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (kg/ha)}}{\text{Biological yield (kg/ha)}} \text{ x100}$$

Results and Discussion

Growth attributes

Plant height (cm)

Plant height is not a yield component especially in grain crops but it indicates the influence of various nutrients on plant metabolism. In the present investigation plant height (cm) was increased with crop age it was increased from 20-100 DAT and highest plant height was observed at 100DAT. At 20 DAT the highest plant height was observed in T_2 *i.e.,* KHR-23 (16.46 cm) and the lowest obtained in T_8 *i.e.,* KHR-29 (14.72 cm). And at 40 DAT the highest plant height was observed in T_3 *i.e.,* KHR-24 (31.49 cm) and the lowest obtained in T_5 *i.e.,* KHR-26 (28.31 cm). There is no significant difference among treatments.

At 60 DAT the highest plant height was observed in T_1 *i.e.,* KHR-22 (97.27 cm) which was significantly superior over rest of the treatments except T_3 *i.e.,* KHR-24 (91.48 cm) and T_{10} *i.e.,* KHR-31 (89.36 cm) which are statistically at par. At 80 DAT the highest plant height was observed in T_2 *i.e.,* KHR-23 (122.49 cm) which was significantly superior over rest of the treatments except T_5 *i.e.,* KHR-26 (116.09 cm) and T_9 *i.e.,* KHR-30 (112.51 cm) which are statistically at par. At 100 DAT the highest plant height was observed in T_2 *i.e.,* KHR-23 (123.91 cm) which was significantly superior over rest of the treatments except T_5*i.e.,* KHR-26 (117.77 cm) is statistically at par. The maximum plant height may be due to genetic makeup of the variety. Similar results have also been reported by Haque *et al.* (2015) [4]. Increase in plant height may be due to synchronized availability of essential plants nutrients to the crop especially nitrogen for a longer period during its growth stages. The results
are in conformity with those of Deshpande and Devasenpathy, 2011 [2]. And also reason for maximum plant height might be due to more favorable weather condition associated and was criticized by the higher growing degree days and hydrothermal units gained in these KHR-23 hybrid Bahure *et al.* (2019) [1].

Tillers/hill (No.)

In the present investigation number of tillers was increased from 20-60 DAT and thereafter number of tillers declined slightly from 60-100 DAT and highest number of tillers was observed at 60 DAT (Table 2). At 20 DAT the highest number of tillers was observed in T_6 *i.e.,* KHR-27 (7.87) and the lowest obtained in T_7 *i.e.,* KHR-28 (5.73). There is no significant difference among treatments. At 40 DAT the highest number of tillers was observed in T_3 *i.e.,* KHR-24 (14.13) which was significantly superior over rest of the treatments except T_9 *i.e.,* KHR-31 (13.27), T_1 *i.e.,* KHR-22 (13.07), T_2 *i.e.,*KHR-23 (12.93) and T_7 *i.e.,* KHR-28 (12.07) which are statistically at par. At 60 DAT the highest number of tillers was observed in T_6 *i.e.,* KHR-27 (14.47) which was significantly superior over rest of the treatments.

At 80 DAT and100 DAT the highest number of tillers was observed in T_6 *i.e.,* KHR-27 which was significantly superior over rest of the treatments except T_3 KHR-24, T_{10} KHR-31, T_5 KHR-26 and T_1 KHR-22 which are statistically at par. In the present study the number of tillers was significantly higher in T_6 *i.e.,* KHR-27 (14.47) at 60 DAT. The significant differences could due to the variation in genetic make-up of the high yielding varieties (variety KHR-27) that might be influenced by heredity. This was consistent with Chowdhery *et al.* (1993). The number of tillers/hill of rice increased linearly up to 60 DAT and thereafter it was declined slightly which might be due to self-thinning mechanism, resource constraint or intra plant competition. The results are in conformity with those of Harish *et al.* (2011) [5].

Yield

Grain yield (t/ha)

During the period of investigation the data showed (table 3) the highest grain yield/ha was observed in T_6 *i.e.,* KHR-27 (8.16 t/ha) which was significantly superior over rest of the treatments except T_3 *i.e.,* KHR-24 (8.03 t/ha) which are statistically at par. The increased yield attributes might be due to increased growth and development parameters which ultimately resulted in increased grain. These results in the conformity with the work done by Vishwakarma (2015) [8]

Stover yield (t/ha)

And the highest straw yield/ha was observed in T_6 *i.e.,* KHR-27 (11.37 t/ha) which was significantly superior over rest of the treatments except T_1 *i.e.,* KHR-22 (11.13 t/ha), T_2 *i.e.,* KHR-23 (11.23 t/ha), T_3 *i.e.,* KHR-24 (11.26 t/ha) and T_{10} *i.e.,* KHR-31 (11.03 t/ha) which are statistically at par. According to the findings by (Padmavathi, 1997) [7] shows that the capability of hybrid rice to utilize more nitrogen through the expression of better growth brought by the beneficial effect on nutrient uptake and physiological growth increase the straw yield.

Harvest index (%)

The data showed that harvest index (%) was observed in T_6 *i.e.,* KHR-27 (41.78%) which was significantly superior over rest of the treatments except T_2 *i.e.,* KHR-23 (40.92%), T_3 *i.e.,* KHR-24 (41.63T_5 *i.e.,* KHR-26 (40.91%), T_8 *i.e.,* KHR-29 (40.91%) %) and T_{10} *i.e.,* KHR-31 (41.66%), which are statistically at par. The increase in harvest index might be due to higher rate of translocation of photosynthates to grains at grain filling stage. Harvest index reflects the physiological capacity of a crop variety to mobilize and translocate the photosynthates to the sink. Similar results have reported by (Marri *et al.,* 2005) [6].

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Table 1: Studies of Rice hybrids on plant height at different growth intervals

Treatment No.	Hybrids	Plant height (cm)				
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT
T_1	KHR-22	15.48	30.83	97.27	102.61	104.15
T_2	KHR-23	16.46	30.83	80.76	122.49	123.91
T_3	KHR-24	15.67	31.49	91.48	99.77	101.14
T_4	KHR-25	15.30	30.74	85.43	111.38	112.93
T_5	KHR-26	15.92	28.31	84.64	116.09	117.77
T_6	KHR-27	15.61	30.53	83.23	112.09	113.60
T_7	KHR-28	16.41	31.15	78.07	90.76	92.37
T_8	KHR-29	14.72	30.63	88.38	110.34	111.58
T_9	KHR-30	15.75	30.03	84.15	112.51	113.84
T_{10}	KHR-31	15.71	29.39	89.36	105.29	107.63
SEm±		0.60	1.18	2.66	3.44	3.36
CD (P=0.05)		NS	NS	7.91	10.24	9.98

Table 2: Studies of rice hybrids on number of tillers /hillat different growth intervals

Treatment No.	Hybrids	Tillers/hill (No.)				
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT
T_1	KHR-22	6.53	13.07	10.80	10.60	10.33
T_2	KHR-23	6.80	12.93	10.13	9.73	9.47
T_3	KHR-24	7.47	14.13	11.67	11.40	11.00
T_4	KHR-25	6.33	8.40	8.67	8.53	8.27
T_5	KHR-26	6.53	10.53	11.47	10.67	10.33
T_6	KHR-27	7.87	11.13	14.47	11.47	11.07
T_7	KHR-28	5.73	12.07	9.53	9.40	9.07
T_8	KHR-29	6.40	8.80	9.87	9.73	9.40
T_9	KHR-30	6.20	8.10	9.47	9.47	9.20
T_{10}	KHR-31	6.73	13.27	11.87	11.20	10.87
SEm±		0.85	0.95	0.64	0.42	0.41
CD (P=0.05)		NS	2.84	1.91	1.26	1.23

Table 3: Studies of rice hybrids on grain yield, straw yield and harvest index.

Treatment No.	Hybrids	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
T1	KHR-22	7.44	11.13	40.06
T2	KHR-23	7.78	11.23	40.92
T3	KHR-24	8.03	11.26	41.63
T4	KHR-25	6.15	10.90	36.07
T5	KHR-26	6.81	9.83	40.91
T6	KHR-27	8.16	11.37	41.78
T7	KHR-28	6.30	10.76	36.93
T8	KHR-29	6.95	10.03	40.91
T9	KHR-30	6.48	9.93	39.47
T10	KHR-31	7.88	11.03	41.66
SEm±		0.09	0.12	0.44
CD (P = 0.05)		0.27	0.36	1.33

Conclusion

It may be concluded that variety T_6*i.e.*, KHR-27 was found to be the best for obtaining higher growth attributes and yield, tillers/hill, yield (8.16 t/ha), straw (11.37 t/ha), harvest index (41.78%) in hybrid rice. Since the finding is based on the research done in one season further trials are needed to confirm the results.

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