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Nidhi Anima Xaxa
PG Scholar, Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh, India

Vikram Singh
Associate Professor, Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh, India

Shruti Grace George
Ph.D., Research Scholar, Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh, India

AC Singh
Associate Professor, Department of Agronomy, Kulbhaskar Ashram PG College, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Nidhi Anima Xaxa
PG Scholar, Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh, India

Performance of rice (*Oryza sativa* L.) hybrids on growth, yield and economics under agro-climatic conditions of Prayagraj, U.P.

Nidhi Anima Xaxa, Vikram Singh, Shruti Grace George and AC Singh

Abstract
The Agronomic investigation entitled — Performance of Rice (*Oryza sativa* L.) hybrids on growth, yield and economics under Agro-climatic conditions of Prayagraj, U.P. was carried out during *Kharif* 2021. The experimental site was located at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) with an aim to study about the growth and yield attributes of rice hybrids and to study the economics of different rice hybrids. The field experiment was carried out in randomized block design (RBD) 10 different varieties as treatments, each of which was replicated thrice totalling to 30 plots. The rice hybrid seeds were provided by Uttar Pradesh Council of Agricultural Research (UPCAR). The findings of the experiment indicated that the growth parameters of rice *viz.* plant height (119.60 cm), tillers/hill (15.93) were higher in UR-7 as well as yield attributes like effective tiller/m2 (310.67), Panicle length (31.52 cm), filled grains/panicle (250.67), grain yield(g)/hill (34.33 g), test weight (25.33 g), grain yield (t/ha) (8.67 t) and biological yield (t/ha) (27.66 t) were recorded higher in UR-7. Hence, it can be concluded that the hybrid rice variety UR-7 was found to be most productive and economical.

Keywords: Economics, growth, hybrid rice, varietal response, yield

Introduction

Rice is a staple cereal food crop of India, occupying about 24% of gross cropped area of the country. It contributes 42% of total food grain production and 45%of total cereal production of the country. Rice is one of the crops that feeds more than half of the world population and has ended up employing millions of people The current global population is 7.55 billion which can be expected to reach 8.1 billion in some years and 9.6 billion by 2050 (DESA, 2018).The population increase will be higher in developing countries of Asia and Africa, because rice is the staple food. Around the world, 159 hectares of area is under rice cultivation, having an average annual production of around 748 million tonnes and productivity of 4.6 tonnes/ha (FAO, 2016- 2017).

In 1986, China put the first hybrid rice combinations into commercial production. Since then, the area under hybrid rice production increased from 2.1 Mha in 1977 to 52.9 Mha in 2009. China successfully commercialized the hybrid rice technology in1970 and in 1989 obtained the first patent, in the United States (Yuan, 1989).

Rice is the most important crop for millions of farmers. In the future, it is imperative that rice production continue to grow at least as rapidly as the population, if not faster. Rice researches develop new technologies for all farmers play a vital role in meeting this need and contributing to global efforts directed at poverty alleviation. Rice provides 21% of global human per capita energy and 15% of per capita protein.

43.79 million hectares of area is under Indian cultivation, making it a major rice growing country in the world, with a production of 112.91 million tonnes and a productivity of 2.57 t/ha (Directorate of Economics and Statistics, 2017-2018).

In Uttar Pradesh, 5.9 million ha area produces 13.27 million tones. It's average productivity is 2447 kg/ha and production is 14.63 million tonnes (Agriculture Statistics, 2016).

Methane from rice fields contribute around 1.5 percent of total global greenhouse gas emissions. Reduction in the emission of methane is a challenge to the global scientific community. The global warming potential of methane is about 28–36 which makes it capable

for trapping heat in the atmosphere and thus, contributing to global warming (Chatterjee *et al.*, 2021) [8].

Consistent water depth shows an improvement in the rice plants' ability to compete against weeds for nutrients and sunlight, reducing the need for herbicides. But, on an average, the estimated evapotranspiration (ET) rate was 5.1 mm/day, seepage and percolation (S & P) rate was 4.2 mm/day in Kharif season. These values depicts that 55% of the applied water is needed for ET and the rest 45% is lost from the field as seepage and percolation (Rashid, 2009) [1].

This research was conducted with the aim of evaluating the productivity of different rice hybrids in the agro-climatic conditions of Prayagraj, Uttar Pradesh.

Materials and methods

The field experiment was conducted during Kharif of 2021 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). the experiment site is located between 25-27º N latitude, 8.5º E longitude and 98 meters altitude. The climate is characterized by the alternate warm and rainy season from late June to early September with a mean temperature of 38ºC. The soil is sandy loam in texture having pH (7.2), EC (0.14 dSm-1), organic carbon (0.38%), available N (225 kg ha-1), P (19.5 kg ha-1), K (340 kg ha-1), S (16.800 ppm) and Zn (0.51 ppm) during the experimental year. Twenty five days old seedlings were transplanted in the main field conventionally at a spacing of 20 cm x 10 cm. The crop was fertilized with the recommended dose of NPK 120:60:60 kg ha-1. 100% (full dose) phosphorus and potassium whereas 50% of nitrogen was applied at the time of transplanting as the basal dose and the remaining was applied in two equal split doses as top dressings (at tillering and panicle initiation stages respectively). Similarly, ZnSO4 was applied as basal dose at the rate of 25 kg ha-1 for the amendment of zinc and sulphur deficiencies. Irrigation was scheduled at 10-12 days interval as flood; however, other cultural practices were followed time-to-time such as weeding at 30 DAT and 42 DAT. One quadrate was harvested in every plot for the determination of results and data was subjected to statistical analysis separately by using analysis of variance technique. The difference among hybrids means were compared by using least significant difference test at 5% probability level.

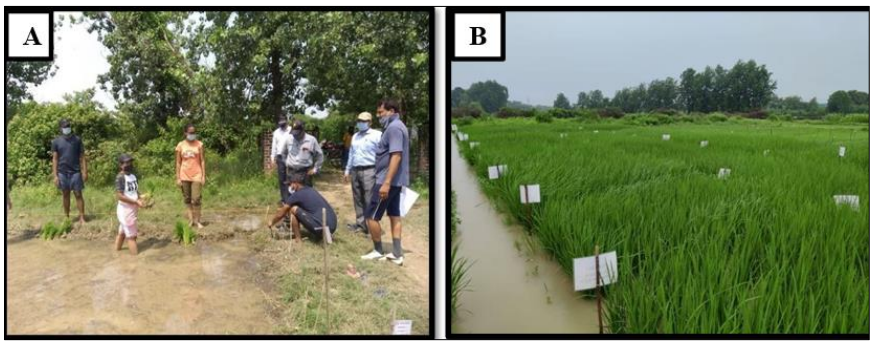

Fig 1: Transplanting of 25 days old seedlings (A); Field view at 30 DAT (B) at the Crop Research Farm, SHUATS, Prayagraj, U.P., India

Growth attributes Plant height (cm)

Significantly taller plant height (119.60 cm) was recorded in UR-7 at 90 DAT. However, UR-10 (118.52 cm) was found to be statistically at par with UR-7. The increase in plant height may be due to the genetic character and genetic disparity of the cultivar. Synchronized availability of the essential plant nutrients may result in increase in plant height, in particular, nitrogen for a longer period during growth stages (Deshpande and Devasenpathy, 2011). Similar findings were also reported by Parihar *et al*. (2005), Kalyani *et al*. (2012), Kumar *et al.* (2015) and Singh *et al*. (2019) [4].

Tillers/hill

Significantly higher number of tillers/hill (15.93) was found in UR-7 at 90 days after transplanting (DAT). However, UR-10 (15.70), UR-6 (15.27), UR 15 (14.90), UR-11 (14.87), UR-8 (14.80), UR-14 (14.66) were observed to be statistically at par with UR-7. The significant differences is because of the fact that high yielding varieties have relatively high tillering capacity Yadav *et al. (*2010). High tiller production was due to better inducement of root growth for anchorage that lead to better nutrient and water uptake and ultimately lead to higher dry matter accumulation and number of tillers Bahure *et al.* (2019) [7].

Plant dry weight (g)

Significantly higher plant dry weight (54.89 g) was recorded in UR-7 at 90 DAT. However, UR- 10 (53.80 g) was found to be statistically at par with UR-7. High dry matter accumulation is due to the significant increase in morphological parameters that is responsible for the photosynthetic capacity of the plant thereby increasing the straw yield Bozorgi *et al.* (2011) [2].

Crop growth rate (g/m2/day) and Relative growth rate (g/m2/day)

Significantly higher crop growth rate (37.36 g/m2/day) was recorded in UR-7 at 45-60 DAT. However, UR-10 (36.86 g/m2/day), UR-6 (36.43 g/m2/day), UR-9 (35.99 g/m2/day), UR-12(35.59 g/m2/day), UR-11 (34.80 g/m2/day) and UR-15 (34.09 g/m2/day) were found to be statistically at par with UR-7. Relative growth rate in UR-7 with a value of 0.038 g/g/day was found to be significantly superior. The percentage increase in CGR is due to prevalence of low temperature along with less humidity at the reproductive stage or flag leaf stage which might lead to reduced yield as compared to early planting. The availability of ample supply of nutrients essentially nitrogen through foliar feeding can be the reason for the better performance with regard to CGR & RGR. Similar results have been reported by Yadav *et al*. (2004).

Days to 50% flowering and days to maturity

At the stage of 50% flowering, early flowering was seen in

UR-11 at 63.33 days and significantly more time was taken for 50% flowering by UR-7 (79.67 days). This might be due to the inherent characteristics of the cultivar to take minimum days for 50% flowering. Heritability can be defined as a measure of phenotypic variations that is caused by the action of genes. In this experimental study, high heritability was observed for traits *viz* days to 50% flowering and days to maturity Haque *et al*. (2015) [3]. Significantly lesser number of days to maturity (91.67 days) was recorded by UR-9 and to attain full maturity significantly more time was recorded by UR-7 (116 days). With regard to number of days to maturity, prevalence of low temperature along with less humidity at flag leaf stage may be reduced in availability of ample supply of nutrients especially nitrogen through foliar feeding may be the reason for the better performance Singh *et al.* (2019) [4].

Yield attributes

The yield attributes of hybrid rice such as effective tillers/m2 (310.67), panicle length (31.52 cm), filled grains/panicle (250.67), test weight (25.33 g), grain yield (8.67 t/ha) and straw yield
(18.99 t/ha) were recorded significantly higher in rice hybrid UR-7. The yield attributes are significantly influenced by genetic potential of the variety and also may be due to synchronized availability of essential plant nutrients to the crop especially NPK for a longer period during its growth and reproductive stages. Increased number of effective tillers hill-1 may have helped in increasing the photosynthetic area for photosynthesis in plant. In several rice cultivars, the effect on effective tillers production at all the growth stages was significant, the figures increased till 75 DAT followed by a decline at harvest due to death of some undeveloped tillers. Thus, development of tillers was found to be more in hybrid varieties apart from local varieties, reported by Akram *et al*. (2007). Higher number of grains per panicle may be due to the optimum utilization of nutrients. The other reason for higher number of grains per panicle of varieties is due to better growth attribute and this lead to higher grain yield. Similar findings were reported by Ranjitha *et al*. (2013) [5]. Adoption of 20cm x 10 cm spacing for rice transplanting resulted in healthier grains, heavier filled and higher test weight. Similar results have been also reported by Haqueet *et al.* (2015) [3]. Grain yield per plant depicted significantly higher positive correlation with healthier grains, plant height, harvest index, grain yield per plot, grain yield /meter2 and grain yield /hectare. These results are confirmed with the findings of Rahman *et al.* (2013) [6]. Increase in straw yield may be due to high dry matter accumulation that is due to the significant increase in morphological parameters that are responsible for the photosynthetic capacity of the plant. The result was confirmed with Bozorgi *et al.* (2011) [2].

Economics

The highest gross return (1, 94,040.00 INR/ha), net return (1, 43,073.50 INR/ha) and benefit cost ratio (2.81) was obtained from rice hybrid UR-7.

Conclusion

In conclusion, from the data pertaining to different rice hybrids it may be that among the rice hybrids, UR-7 recorded higher values in majority of growth and yield parameters and it was found to be more productive and economically viable. These findings are based on one season; therefore, further trails may be required for confirmation.

Table 1: Performance of rice (*Oryza sativa* L.) hybrids on growth attributes.

Treatments	Hybrids	AT Harvest			45-60 DAS		50% flowering	Days to maturity
		Plant height (cm)	Number of tillers/hill (no.)	Plant dry weight (g)	CGR 2 (g/m /day)	RGR (g/g/day)		
1	UR -6	117.69	15.27	51.86	46.29	0.037	77.00	111.67
2	UR -7	119.60	15.93	54.89	55.40	0.039	79.67	116.00
3	UR -8	114.38	14.80	45.93	32.00	0.034	74.00	105.00
4	UR -9	116.15	14.53	43.90	33.36	0.027	61.33	91.67
5	UR -10	118.52	15.70	53.80	49.73	0.028	79.00	114.00
6	UR -11	106.14	14.87	47.14	43.84	0.038	63.33	108.33
7	UR -12	105.33	13.43	50.64	47.31	0.041	71.33	94.33
8	UR -13	115.78	14.60	45.31	31.72	0.035	75.33	102.33
9	UR -14	110.46	14.66	47.00	49.48	0.043	67.33	92.33
10	UR -15	109.20	14.90	48.18	44.26	0.027	64.33	95.33
F test		S	S	S	S	S	S	S
SE(m)±		0.55	0.43	0.39	1.78	0.002	0.64	0.47
CD		1.64	1.28	1.17	5.30	0.007	1.91	1.40
(P=0.05)								

Table 2: Performance of rice (*Oryza sativa* L.) hybrids on yield attributes at harvest

Treatments	Hybrids	Effective tillers/meter (no.)	Panicle length (cm)	Filled grain/panicle (no.)	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
1	UR -6	305.00	30.96	237.27	23.33	8.00	16.77
2	UR -7	310.67	31.52	250.67	25.33	8.67	18.99
3	UR -8	273.67	28.47	196.53	20.00	7.37	16.00
4	UR -9	272.67	29.05	219.13	22.00	7.52	15.57
5	UR -10	306.33	31.26	246.27	23.67	8.33	18.45
6	UR -11	261.33	29.87	232.73	22.33	6.60	14.17
7	UR -12	303.43	30.46	210.27	22.00	7.85	15.78
8	UR -13	297.00	29.41	178.00	19.33	6.78	15.19
9	UR -14	276.67	28.19	143.60	22.00	7.49	14.86

10	UR -15	270.67	25.63	211.47	21.00	6.70	14.81
F test		S	S	S	S	S	S
SE(m)±		2.41	0.40	9.65	0.63	0.26	0.34
CD (P=0.05)		7.15	1.18	28.6	1.88	0.77	1.00

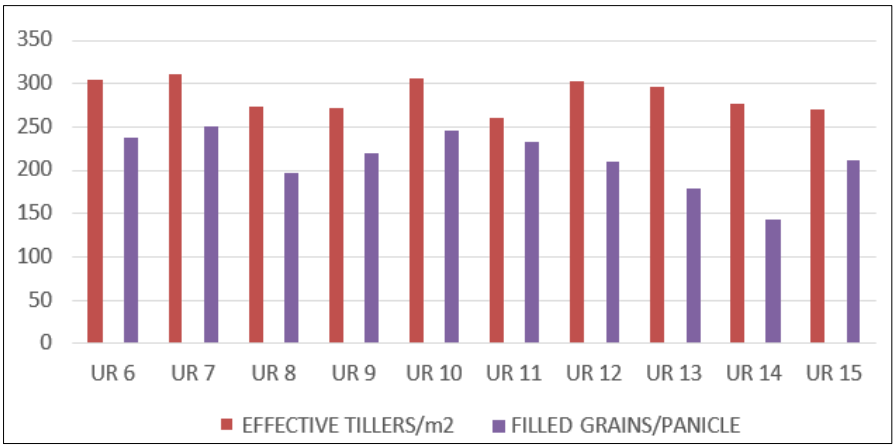

Fig 2: Effective Tillers & Filled Grains/Panicle

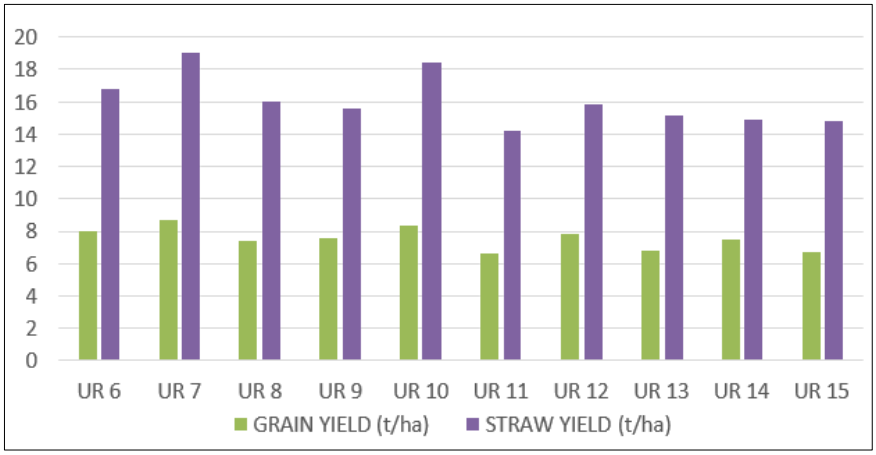

Fig 3: Grain Yield & Straw Yield

Table 3: Performance of rice (*Oryza sativa L.*) hybrids on economics at harvest

Treatments	Hybrids	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B: C ratio
1	UR -6	50,966.50	104770.00	53803.31	2.055656
2	UR -7	50,966.50	114360.00	63393.31	2.243818
3	UR -8	50,966.50	97070.00	46103.31	1.904577
4	UR -9	50,966.50	98290.00	47323.31	1.928514
5	UR -10	50,966.50	110080.00	59113.31	2.159842
6	UR -11	50,966.50	86770.00	35803.31	1.702485
7	UR -12	50,966.50	102130.00	51163.31	2.003858
8	UR -13	50,966.50	89770.00	38803.31	1.761346
9	UR -14	50,966.50	97250.00	46283.31	1.908109
10	UR -15	50,966.50	88510.00	37543.31	1.736624

*Economics not subjected to statistical analysis

Conclusion

The results revealed that rice hybrid UR-7 was best for obtaining maximum plant height (119.60 cm), number of tillers/hill (15.93), plant dry weight (54.89 g/plant), crop growth rate (39.61 g/m2/day), relative growth rate (0.043 g/g/day), 50% flowering (79.67%), days to maturity (116 DAT), effective tillers/m2 (310.67), filled grains/panicle (250.67), test weight (25.33 g), grain yield (8.67 t/ha) and straw yield (18.99 t/ha) were recorded significantly higher in treatment 2 (RICE HYBRID UR-7).

At the same time, higher gross returns (1, 94,040.00 INR/ha), net return (1,43,073.50 INR/ha) and benefit cost ratio (2.81) was obtained from treatment 2 (RICE HYBRID UR-7).

Hence, it is concluded, that among the rice hybrids, UR-7 recorded higher values in majority of growth and yield parameters and it was found to be more productive and economically viable. These findings are based on one season; therefore, further trails may be required for confirmation.

Fig 4: Rice hybrid UR-7

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