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Growth Rate and Phenology of Rice (*Oryza sativa*) Hybrids under Agro-Climatic Conditions of U.P.

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A B S T R A C T

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 significantly higher plant dry weight was recorded in the treatment KHR-27 (49.91 g/hill) and CGR (35.63 g/m^2/day) and RGR (0.0046 g/g/day) was recorded significantly higher in Rice hybrid KHR-23. And the minimum days to 50% flowering (58.33) and days to maturity (91.33) was recorded significant in Rice hybrid KHR-28. The yield parameters viz. grain yield/hill (28.14 g), grain yield (8.16 t/ha), Harvest index (41.78 %) was recorded significantly higher in Rice hybrid KHR-27.

Introduction

Rice plants have been traced back to 5000 BC, but the practice of rice growing is believed to have originated in areas of china, and southern & eastern Asia, in about 2000 BC. Rice crop needs a hot and humid climate. It is best suited to regions which have high humidity, prolonged sunshine and an assured supply of water. The average temperature throughout the life period of the crop ranges from 21 to 37°C. Maximum temp which the crop can tolerate 40°C to 42°C. The nutrient contents of rice are 80% carbohydrates, 7-8% protein, the amino acid profile shows that it is rich in Glutamic acid and aspartic acid, highest quality cereal protein being rich in lysine (3.8%), 3% fibre, iron 1.0 mg and Zinc 0.5 mg (Juliano *et al.*, 1985). The current global population of 7.55 billion is expected to reach 8.1 billion by 2025 and 9.6 billion by 2050 (Department of Economics and Social Affairs -2018). 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). Hybrid rice was planted in an area of 1.3 million hectares and additional rice production of 1.5 to 2.5 million tonnes was recorded through this technology. Hybrid rice technology has provided farmers with high yields, saved land for agricultural diversification and created rural employment opportunities. Although the technology is still new, many rice-producing countries have expressed their interest in applying it to improve food security. Where yield levels have reached a plateau and further increase yield are not possible through conventional varieties. The higher yield of hybrids can be realized with proper management practices. So, adequate agronomic management is essential to achieve potential yield in hybrid rice. Therefore, Present study has been conducted to assess the actual spreading of these newer varieties in terms of area with simultaneous reduction in the area under older varieties for rice crop and the increases in the average yield/ha. This will help the government to draw a plan for augmenting the spread of the superior newer varieties in place of the age old varieties. Therefore, hybrid rice is practically feasible readily adoptable genetic option to increase rice productivity. Hybrid rice cultivation is recommended in situation. The present investigation was carried out with objective to find out superior growth rate and phenology of 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, Prayagraj (U.P.) which is located at 250 24' 42" N latitude, 810 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. The region receives an average annual rainfall is 981 mm. The total rainfall of 195.2 mm 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 comprising of ten rice hybrids viz. KHR-22, KHR-23, KHR-24, KHR-25, KHR-26, KHR-27, KHR-28, KHR-29, KHR-30, KHR-31 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 top dressings of $1/4^{th}$ 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 up to 100 DAT. Three plants were randomly uprooted without damaging the root from each plot at 20, 40, 60, 80 and 100DAT. The samples were air dried and then kept in oven for 72 hours at 70^0 C, their dry weight was determined and the average dry weight/hill was calculated. It represents dry weight gained by a unit area of crop in a unit time expressed as $g/m^{2/}day$ (Fisher, 1921). The values of plant dry weight at 20, 40, 60, 80 and 100 DAT intervals were used for calculating the CGR. The value of

CGR is expressed in (g/m/day). It was described by Fisher (1921) which indicates the increase in dry weight per unit dry matter over any specific time interval and it was calculated by the following equation. This RGR parameter was calculated for the time intervals, *i.e*., 20, 40, 60, 80 and 100DAT intervals using the data obtained from dry weight of plants. Plants were observed daily for flowering. The day on which 50 per cent of the plants showed flowers in the plot was considered as 50 per cent flowering. The number of days of sowing to flowering was calculated and expressed add days taken for 50per cent flowering. The number of days required from the date of sowing to the physiological maturity in each experimental plot is counted and averaged. Five plant hills were selected randomly from each plot and tagged and the average grain yield (g) of these plant hills was recorded. 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. Harvest index was obtained by dividing the economic yield (grain) by the biological yield (grain + straw). It was calculated for each of the plots and was represented in percentage. 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%.

Results and Discussion

Plant dry weight (g/hill)

The results presented in Table 1 about the analysis of variance indicated that the dry weight was significantly ($P<0.05$) affected by different hybrids. In the present investigation dry weight was increased with crop age it was increased from 20-100 DAT and dry weight was observed at 100DAT. At 20 DAT the highest dry weight was observed in KHR-27 (1.43 g). There is no significant difference among treatments. At 40 DAT the highest number of tillers was observed in KHR-27 (11.92) which was significantly superior over rest of the treatments. At 60 DAT the highest dry weight was observed in KHR-27 (24.02 g) which was significantly superior over rest of the treatments except KHR-23 (22.67 g) and KHR-31 (21.32 g) which are statistically at par. At 80 DAT the highest dry weight was observed in KHR-27 (38.02 g) which was significantly superior over rest of the treatments except KHR-23 (36.92 g) and KHR-31 (34.15 g), which are statistically at par.

At 100 DAT the highest dry weight was observed in KHR-27 (49.91 g) which was significantly superior over rest of the treatments except KHR-23 (49.33 g) and KHR-24 (43.73 g) which are statistically at par. In the present study the dry weight was significantly higher in KHR-27 (49.91 g). The propable reason of high dry matter accumulation in might be due to the significant increase in morphological parameters which responsible for the photosynthetic capacity of the plant thereby increasing the straw yield. The result conformed with Bozorgi *et al.,* (2011).

Crop growth rate (g/m²/day)

In the present investigation crop growth rate was increased from 20-80 DAT and thereafter declined slightly. At 20-40 DAT the highest crop growth rate was observed in KHR-27 (26.23 g/m2/day), where KHR-27 was found significantly superior over all other treatments. At 40-60 DAT the highest crop growth rate was observed in KHR-23 (33.97 g/m^2/day) which was significantly superior over rest of the treatments except KHR-22 (28.65 g/m^2/day), KHR-24 (29.17 g/m^2/day), KHR-26 (29.30 g/m^2/day), KHR-27 (30.26 g/m^2/day) and KHR-31 (29.45 g/m^2/day), which are statistically at par. At 60-80 DAT

the highest crop growth rate was observed in KHR-23 (35.63 g/m^2/day) which was significantly superior over rest of the treatments except KHR-24 (31.75 g/m^2/day) KHR-27 (35.01 g/m^2/day) and KHR-31 (32.08 g/m^2/day) which are statistically at par.

At 80-100 DAT the highest crop growth rate was observed in KHR-23 (31.03 g/m^2/day) which was significantly superior over rest of the treatments except KHR-22 (24.51 g/m^2/day), KHR-24 (25.74 g/m^2/day) and KHR-27 (29.72 g/m^2/day) which are statistically at par. In the present study the crop growth rate was significantly higher in KHR-23 (35.63 g/m^2/day). The propable reason for maximum crop growth rate may be the availability of ample supply of nutrients especially nitrogen through foliar feeding may be the reason for the better performance with regard to CGR. Similar results have also been reported by Yadav *et al.,* (2004)

Relative growth rate (g/g/day)

In the present investigation relative growth rate was decreasing from 20-100 DAT. At 20-40 DAT the highest relative growth rate was observed in KHR-27 (0.106 g/g/day) and the lowest obtained in KHR-30 (0.096 g/g/day). There is no significant difference among treatments. At 40-60 DAT the highest relative growth rate was observed in KHR-23 (0.046 g/g/day) which was significantly superior over rest of the treatments except KHR-24 (0.042 g/g/day), KHR-26 (0.041 g/g/day) and KHR-31 (0.040 g/g/day) which are statistically at par. At 60-80 DAT the highest relative growth rate was observed in KHR-23 (0.025 g/g/day) and the lowest obtained in KHR-30 (0.021 g/g/day). There is no significant difference among treatments.

At 80-100 DAT the highest relative growth rate was observed in KHR-23 (0.014 g/g/day) and the lowest obtained in KHR-30 (0.010 g/g/day). There is no significant difference among treatments. In the present study the relative growth rate was significantly higher in KHR-27 (0.106 g/g/day). The propable reason for the percentage decrease RGR in various hybrids and showing non-significant difference among the treatment is due to prevalence of low temperature coupled with less humidity at the growth and reproductive stage especially during flag leaf stage. Similar findings are also reported by Singh *et al.,* (2019).

Grain yield/hill (g)

The data showed the highest grain yield/hill was observed in KHR-27 (28.14 g) which was significantly superior over rest of the treatments except KHR-23 (23.43 g), KHR-24 (27.25 g), KHR-29 (23.45 g) and KHR-31 (26.85 g), which are statistically at par. The higher grain yield/hill under variety (KHR-27) might be due to the optimum utilization of nutrient. The hybrids of short duration high yielding have the potential to give the maximum grain yield then rest of the varieties.

The another reason of the high yield of variety (KHR-27) is due to the better growth attribute resulting to produce higher grain yield. Similar findings were reported by Ranjitha *et al.,* (2013)

Grain yield (t/ha)

During the period of investigation the data showed (table 3) the highest grain yield/ha was observed in KHR-27 (8.16 t/ha) which was significantly superior over rest of the treatments except 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).

Table.1 Field evaluation of rice hybrids on plant dry weight at different growth intervals.

Treatments	Dry weight (g/hill)				
	20 DAT	40 DAT	60 DAT	80 DAT	100 DAT
T1-KHR-22	1.21	9.45	20.91	33.11	42.91
T2-KHR-23	1.23	9.08	22.67	36.92	49.33
T3-KHR-24	1.19	9.07	20.74	33.44	43.73
T4-KHR-25	1.10	7.85	16.64	25.82	33.78
T5-KHR-26	1.18	8.86	20.58	32.78	41.91
T6-KHR-27	1.43	11.92	24.02	38.02	49.91
T7-KHR-28	1.12	8.27	16.65	26.25	34.10
T8-KHR-29	1.36	9.47	19.67	30.97	39.67
T9-KHR-30	1.33	9.11	19.05	29.88	36.83
T10-KHR-31	1.17	9.54	21.32	34.15	42.87
SEm±	0.07	0.30	0.92	1.53	2.27
CD (P=0.05)	-	0.89	2.74	4.55	6.76

Table.2 Field evaluation of crop growth rate and relative growth rate of rice hybrids at different intervals.

Treatments	CGR (g/m2/day)		RGR (g/g/day)	
	40-60 DAT	60-80 DAT	40-60 DAT	60-80 DAT
T1-KHR-22	28.65	30.50	0.040	0.023
T2-KHR-23	33.97	35.63	0.046	0.025
T3-KHR-24	29.17	31.75	0.041	0.024
T4-KHR-25	21.96	22.95	0.038	0.022
T5-KHR-26	29.30	30.50	0.042	0.023
T6-KHR-27	30.26	35.01	0.035	0.023
T7-KHR-28	20.95	24.00	0.035	0.023
T8-KHR-29	25.49	28.25	0.036	0.023
T9-KHR-30	24.86	27.06	0.037	0.021
T10-KHR-31	29.45	32.08	0.040	0.024
SEm±	2.13	1.71	0.002	0.0006
CD (P=0.05)	6.33	5.08	0.006	-

Table.3 Field evaluation of rice hybrids on Phenology and yield parameters.

Treatment	Days to 50% flowering	Days to maturity	Yield/hill (g)	Grain yield t/ha	Harvest index (%)
T1-KHR-22	59.00	93.67	23.11	7.44	40.06
T2-KHR-23	69.33	107.67	23.43	7.78	40.92
T3-KHR-24	62.00	97.33	27.25	8.03	41.63
T4-KHR-25	70.33	97.00	18.48	6.15	36.07
T5-KHR-26	76.67	113.67	23.22	6.81	40.91
T6-KHR-27	79.00	115.00	28.14	8.16	41.78
T7-KHR-28	58.33	91.33	20.38	6.30	36.93
T8-KHR-29	74.67	108.67	23.45	6.95	40.91
T9-KHR-30	74.00	108.33	21.14	6.48	39.47
T10-KHR-31	61.33	97.00	26.85	7.88	41.66
SEm±	0.87	0.92	1.59	0.09	0.44
CD (P = 0.05)	2.60	2.74	4.72	0.27	1.33

Fig.1 Field evaluation of rice hybrids on plant dry weight at different growth intervals.

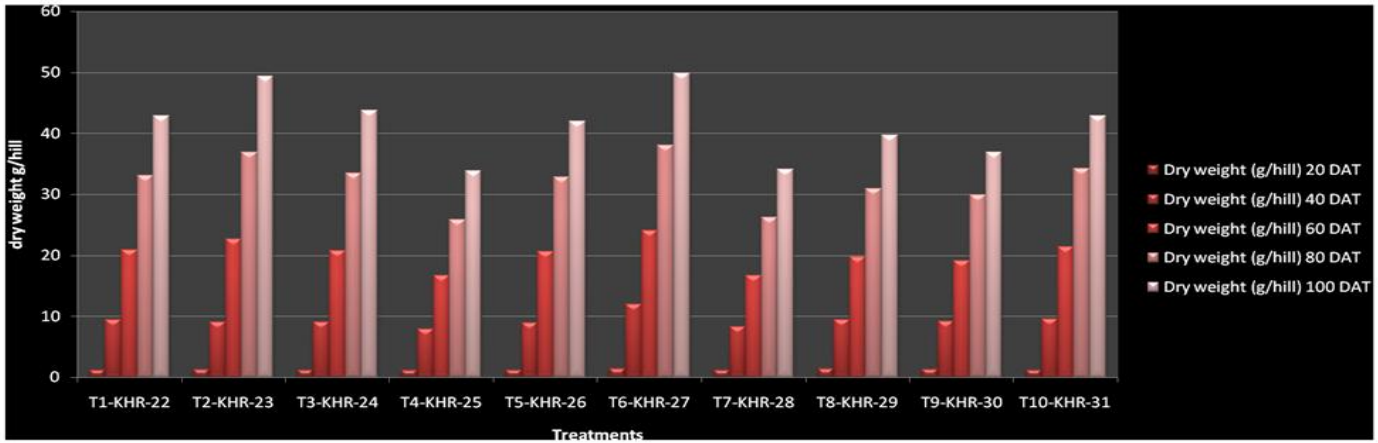


Fig.2 Field evaluation of crop growth rate and relative growth rate of rice hybrids at different intervals.

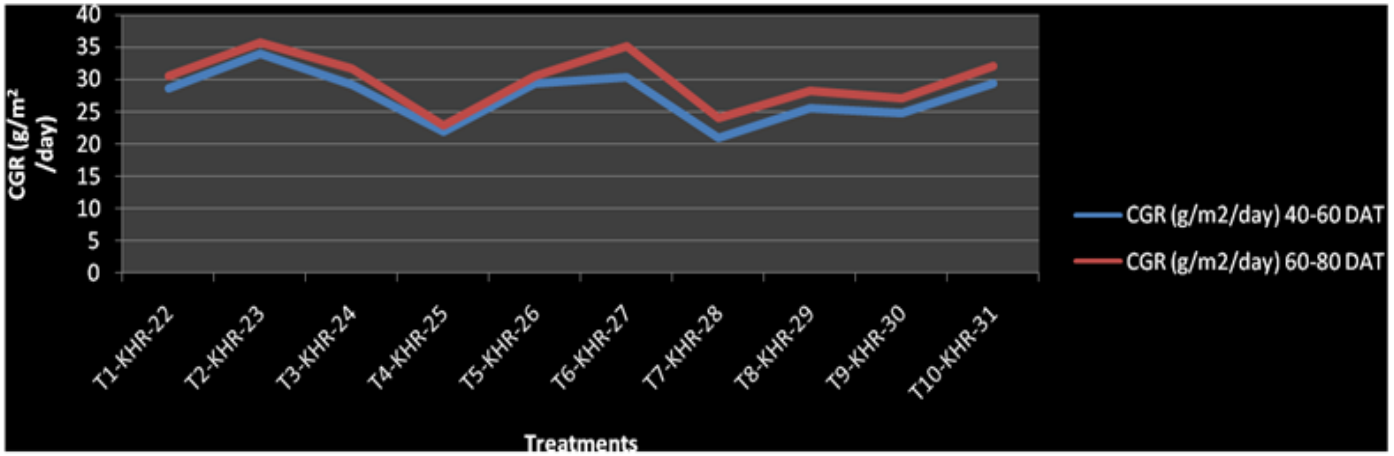


Fig.3 Field evaluation of crop growth rate and relative growth rate of rice hybrids at different intervals.

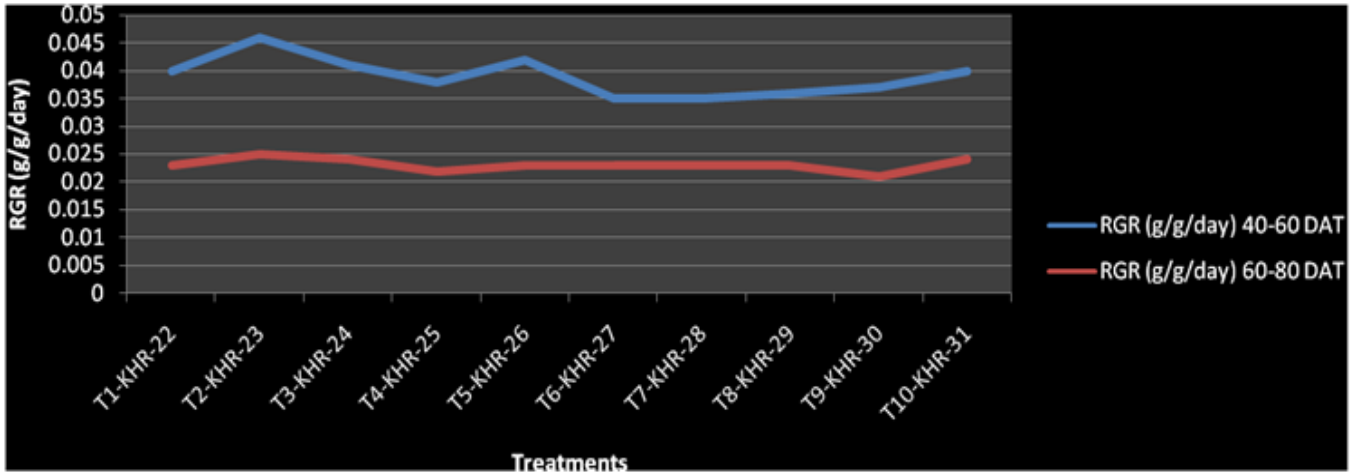


Fig.4 Field evaluation of Phenology parameters of rice hybrids.

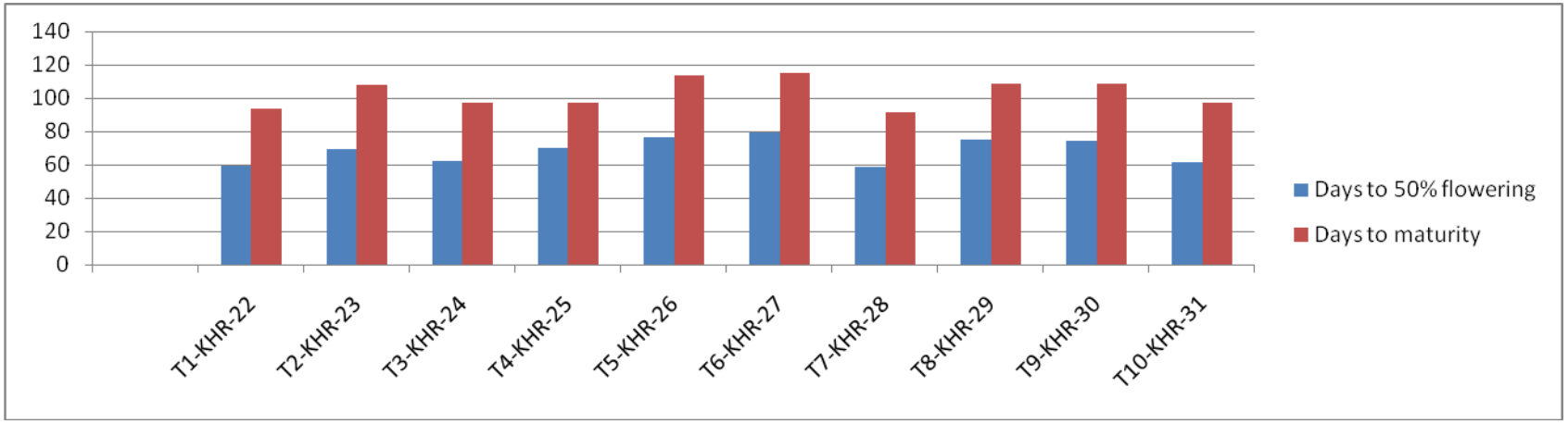
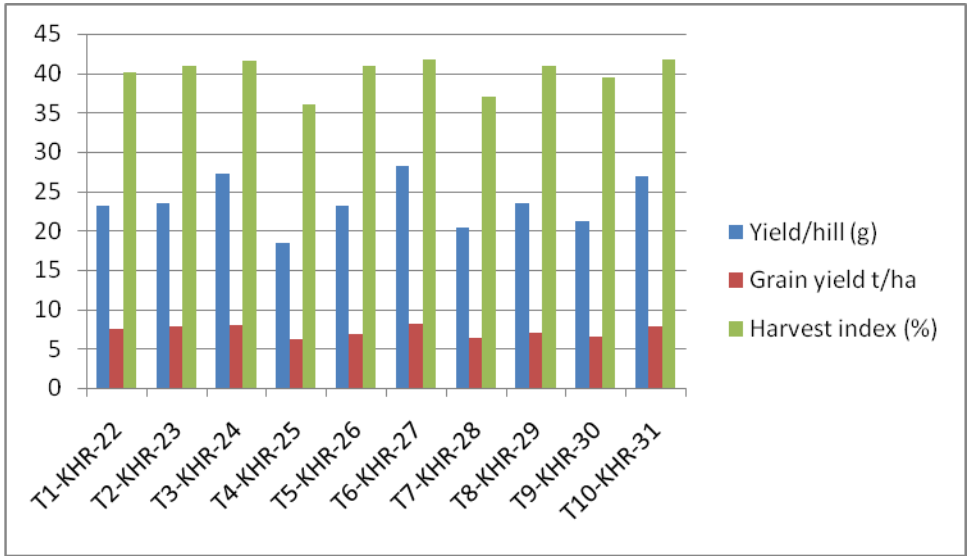


Fig.5 Field evaluation of yield parameters of rice hybrids.



Harvest index

The data showed the harvest index (%) was observed in KHR-27 (41.78 %) which was significantly superior over rest of the treatments except KHR-23 (40.92), KHR-24 (41.63 %), KHR-26 (40.91 %), KHR-29 (40.91 %) and 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.

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The hybrid KHR-27 was found to be the best for obtaining maximum dry weight (49.91 g/hill) as well as higher grain yield (8.16 t/ha) as compared to all other hybrids. And phenology parameters of Days to 50% flowering and Days to maturity minimum days was recorded in hybrid KHR-28.Since the finding is based on the research done in one season further trials are needed to confirm the results.

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