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Response of rice (*Oryza sativa* L.) hybrids on growth and yield under agro-climatic conditions of Allahabad Uttar Pradesh

Vishaka Sharma, Rajesh Singh and Prasad Mithare

Abstract
The field experiment was conducted during kharif season of 2016 at Crop Research Farm SHUATS, Allahabad. The experiment was carried out to find the performance of 22 hybrids comparing with check variety (Vikrant 44), which laid out in Randomized Block Design (RBD) & replicated thrice. The experiment finding revealed that the treatment T_{12} (KR15-33) significantly performed better than all other varieties viz; Plant height (112.87 cm), Dry weight (78.73 g), RGR (0.113 g g^{-1} day^{-1}), Number of effective tillers per hill (11.82), Panicle length (25.93 cm), Number of filled grains $plant^{-1}$ (248.89), Grain yield (5.74 t ha^{-1}), Straw yield (11.44 t ha^{-1}), Biological Yield (17.21t ha^{-1}). While the same treatment T_{12} (KR15-33) recorded highest gross return (137600 Rs ha^{-1}), net return (111169 Rs ha^{-1}) and B: C ratio (4.20), however treatment T_{11} (KR 15-32) and T_{13}: (KR 15-34) were statistically at par with treatment T_{12}.

Keywords: conventional, panicle initiation, days after transplanting (DAT), nursery, one quadrate

Introduction
Rice belongs to genus *Oryza* and the family Gramineae (Poaceae). The genus Oryza contains 25 recognized species, of which 23 are wild species and two cultivated (*O.sativa* and *O. glaberrima*). Rice is the most important cereal food crop of the world, providing major source of the food energy for more than half of the human population. Rice is the staple food for more than 60% of the Indian population. It accounts for about 43% of total food grain production and 46% of total cereal production in the country Anonymous, 2006 [1]. More than 90 per cent of the world's rice is produced and consumed in Asia, where it is an integral part of culture and tradition. Rice occupies a pivotal place in Indian agriculture and it is contributes to 15 per cent of annual GDP and provides 43 per cent calorie requirement for more than 70 per cent of Indians Anonymous 2005 [2]. India has 44.14 million hectare area under rice and production of 106.65 million tonnes with an average yield of 2416 kg ha^{-1} during 2013-14, Uttar Pradesh has an area of 5.98 m ha, production of 14.64 million tonnes and productivity of 2.447 t ha^{-1} of rice GOI, 2016 [3]. It is estimated that 5000 liters of water is needed to produce 1 kg of Rice Bouman *et al*., 2009 [4]. Manual transplanting is the most common practice of rice cultivation in south and south-east Asia. In recent years, water table is running down at a very rapid rate throughout the globe, thus sending an alarming threat and limiting the scope for cultivation of high water requiring crops very seriously. Rice production and productivity was significantly enhanced with the introduction and cultivation of semi-dwarf, fertilizer responsive and non-lodging high yielding varieties in the early seventies leading to the "Green Revolution". The yield level of high yielding varieties is plateauing in recent year to meet the demand of increasing population and maintain this self sufficiency the present production level needs to be increased up to 140 million tonnes by 2025 which can be achieved only by increasing the rice production by over 2 million tonnes per year incoming decade. Hybrid rice technology has provided farmers with high yields, saved land for agricultural diversification and created rural employment opportunities.

Materials and Methods
A field experiment was conducted during kharif 2015 at the Crop Research farm, Department of Agronomy, Allahabad School of Agricultural, Sam Higginbottom University of Agriculture Technology and Sciences, Allahabad. The experiment site lies between 25- 27° N latitude, 8.5°E Longitude and 98 meters altitude. The climate is characterized by the alternate hot rainy season from late June to early September with mean temperature of 38°C. The soil was sandy loam in texture having a pH (7.6), EC (0.26 dSm^{-1}), organic carbon (0.38%), available N (237

kg ha^{-1}), P (19.60 kg ha^{-1}), K (313 kg ha^{-1}), S (17.70 ppm), and Zn (0.50 ppm) during the experimental year. The experiment was laid down in randomized block design (RBD) with 23 treatments and 3 replications. Twenty one days old seedlings were transplanted to main field on 28-07-2015 conventionally at a spacing of 20 x 15 cm. The crop was fertilized with recommended dose of NPK 150:60:60 kg ha^{-1} was applied. The (100%) full dose phosphorus and potassium whereas (50%) of Nitrogen was applied at the time of planting as basal dose and the remaining Nitrogen was applied in two equal split doses as top dressing at active (Tillering & Panicle Initiation stage) respectively. Irrigation was scheduled at 5-6 days interval during vegetative growth; however other normal cultural practices were followed timely as; weeding at 30 DAT & 45 DAT. One quadrate (1 m^2) 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 treatment means was compared by using least significant difference test at 5% probability levels. The treatment consisted of Hybrids T_1: KR 15-22, T_2: 20 KR 15-23, T_3: KR 15-24, T_4: KR 15-25, T_5: KR 15-26, T_6: KR 15-27, T_7: KR 15-28, T_8: KR 15-29, T_9: KR 15-30, T_{10}: KR 15-31,T_{11}: KR 15-32, T_{12}: 20 KR 15-33, T_{13}: KR 15-34, T_{14}: KR 15-35, T_{15}: KR 15-36, T_{16}: KR 15-37, T_{17}: KR 15-38, T_{18}: KR 15-39, T_{19}: KR 15-40, T_{20}: KR 15-41,T_{21}: KR 15-42, T_{22}: KR 15-43, T_{23}: Vikrant (Check).

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. Significantly maximum plant height (108.20 cm) & (112.87 cm) were recorded in treatment T_{12} at 60 DAT and 90 DAT, however treatment T_{11} and T_{13} were statistically at par with treatment T_{12} respectively (Table 1) and (Fig 1).The increase in plant height might be due to the genetic makeup of the variety. 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 Deshpande and Devasenpathy 2011 [5]. Similar finding was also reported by Parihar *et al.*, 2005 [6], Kalyani *et al.*, 2012 [7] and Kumar *et al*., 2015 [8].

Plant dry weight (g)

The observations regarding plant dry weight are being presented in the (Table) was observed significant difference between the treatments at different intervals. Maximum plant dry weight (36.67 g) was observed in treatment T_{14} where as treatment T_{12} and T_{16} were found statistically at par with treatment T_{14}, while minimum plant dry weight (23.00 g) was recorded in treatment T_{22} at 60 DAT. Similarly maximum plant dry weight (51.00 g) was observed in treatment T_{12} where as treatment T_8 and T_{10} were found statistically at par with treatment T_{12} while minimum plant dry weight (40.89 g) was recorded in treatment T_{22} at 90 DAT (Table 1) and (Fig 1). The increase in plant dry weight (g) might be due to more assimilatory surface leading to higher dry matter production coupled with effective translocation and distribution of photosynthates from source to sink. These results are confirmed by Singh and Khan 2003 [9]. Similar finding was also reported by Kalyani *et al.*, 2012 [7].

Crop growth rate (g m^{-2} day^{-1}) and Relative growth rate (g g^{-1} day^{-1})

Maximum CGR (32.61) and RGR (0.113) were recorded in treatment T_{12} at 30-60 DAT. However treatment T_{14} was statistically at par as compared to $T_{12,}$ while minimum CGR (16.42) and RGR (0.086) was recorded in treatment T_{11} (Table 1) and (Fig 1). The percentage increase in CGR is due to prevelance of low temperature coupled with less humidity at the reproductive stage or at flag leaf stage which might be reduced in yield as compare to earlier planting. The availability of ample supply of nutrients especially nitrogen through foliar feeding may be the reason for the better performance with regard to CGR & RGR. Similar results have been reported by Yadav *et al.,* 2004 [10].

Yield attributes

The yield attributes of hybrid rice, viz., number of effective tillers hill^{-1}, number of grains panicle^{-1}, length of panicle (cm), number of filled grains plant^{-1} were significantly influenced by genetic potential of the variety and also may be due to synchronized availability of essential plants nutrients to the crop especially NPK for a longer period during its growth & reproductive stages. Treatment T_{12} (KR 15-33) recorded the highest number of effective tillers hill^{-1} (11.82), Panicle length (25.93 cm), number of grains panicle^{-1} (51.11), number filled grains plant^{-1} (248.89), where as lowest yield attributes was recorded in Treatment T_{22} (KR 15-43). However, treatment T_{11} (KR 15-32) and T_{13} (KR 15-34) were statistically at par with treatment T_{12} (Table 2) and (Fig 2). 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 number of effective tillers production at all the growth stages was significant, the number increased till 77 DAT followed by a decline to harvest due to death of some undeveloped tillers, thus tillers development was found to be more in hybrid varieties apart from local variety reported by Akram *et al.*, 2007 [11]. The higher grains panicle^{-1} might be due to optimum utilization of the nutrient. The another reason of the high grains panicle^{-1} of variety is due to better growth attribute resulting to produce higher grains panicle^{-1} reported by Ranjitha *et al.*, (2013). According to Gulzar *et al.*, 2012 [13] demonstrated that grains panicle^{-1} of had maximum positive correlation coefficient with grain yield. According to Neelam *et al.*, 2009 [14] hybrid rice have longer panicles and more spikelets panicle^{-1} and thus in the study had significantly produced the longest panicle among the hybrid experiment.

Yield

Rice hybrids had a significant effect on the yield parameters. Significant and highest grain yield (5.74 t ha^{-1}), straw yield (11.44 t ha^{-1}) and biological yield (17.21 t ha^{-1}) was recorded in treatment T_{12} (KR 15-33), while lowest grain yield (1.45 t ha^{-1}), straw yield (3.35 t ha^{-1}) and biological yield (4.72 t ha^{-1}) was recorded in treatment T_{21} however T_{18} (KR 15-39) and T_{20} (KR 15-41) were statistically at par with treatment T_{12} (Table 3) and (Fig 3).. This might be due to genetic ability of the plant attributed to higher biomass accumulation coupled with effective translocation and distribution of photosynthates from source to sink, which in turn resulted into elevated stature of yield attributes, which of course was due to favourable weather conditions such as rainfall distribution, evaporation and relative humidity prevailed during the crop growth period. Such varietal differences were also reported by

Singh and Khan 2003 [9], Parihar *et al*., 2005 [6] and Kalyani *et al*, 2012 [7].

Economics

The highest gross return (137600 ₹ ha^{-1}), net return (111169 ₹ ha^{-1}) and B:C ratio (4.20) was observed in treatment T_{12} (KR 15-33), while lowest gross return (35700 ₹ ha^{-1}), net return (9269 ₹ ha^{-1}) and B:C ratio (0.35) was observed in treatment T_{21} however T_{18} and T_{20} were statistically at par with treatment T_{12} (Table 3) and (Fig 4). Maximum B: C ratio (4.20) was recorded in the treatment T_{12} (KR15-33).

Table 1: Response of Rice (*Oryza sativa* L.) Hybrids on Growth Attributes viz, Plant height (cm), Plant dry weight (g), Crop growth rate (g m^{-2} day^{-1}) and Relative growth rate (g g^{-1} day^{-1}).

Treatments	Hybrid	Plant height (cm)		Plant dry weight (g)		Crop growth rate (g m^{-2} day^{-1})	Relative growth rate (g g^{-1} day^{-1})
		60 DAT	90 DAT	60 DAT	90 DAT	30-60 DAT	30-60 DAT
T_1	KR 15-22	104.60	112.60	24.89	44.44	18.76	0.094
T_2	KR 15-23	86.80	101.13	27.00	44.89	19.75	0.094
T_3	KR 15-24	88.27	97.73	26.89	46.44	21.11	0.098
T_4	KR 15-25	88.93	100.93	27.89	46.00	21.11	0.098
T_5	KR 15-26	89.33	107.53	28.22	47.67	22.22	0.100
T_6	KR 15-27	88.67	90.94	24.56	43.56	17.53	0.092
T_7	KR 15-28	99.06	112.37	25.56	46.00	18.64	0.094
T_8	KR 15-29	96.80	113.07	25.33	48.11	16.79	0.090
T_9	KR 15-30	98.60	101.00	23.22	46.11	14.69	0.086
T_{10}	KR 15-31	101.67	111.00	31.33	48.44	22.22	0.100
T_{11}	KR 15-32	97.59	108.60	26.78	42.89	16.42	0.090
T_{12}	KR 15-33	108.20	112.87	36.33	51.00	32.61	0.113
T_{13}	KR 15-34	97.80	104.40	26.44	43.89	20.37	0.097
T_{14}	KR 15-35	105.00	106.73	36.67	40.89	30.49	0.110
T_{15}	KR 15-36	89.65	100.67	29.33	44.44	22.34	0.100
T_{16}	KR 15-37	95.07	97.73	33.22	45.00	24.32	0.103
T_{17}	KR 15-38	79.39	96.83	26.89	48.33	21.11	0.098
T_{18}	KR 15-39	92.87	94.37	31.89	46.22	24.69	0.103
T_{19}	KR 15-40	86.40	92.73	29.78	46.33	23.82	0.101
T_{20}	KR 15-41	82.93	102.73	27.00	47.33	22.84	0.101
T_{21}	KR 15-42	78.81	93.36	32.00	45.56	26.29	0.105
T_{22}	KR 15-43	89.73	94.87	23.00	42.44	28.27	0.108
T_{23}	Vikrant 44	91.53	98.67	30.00	43.44	23.70	0.102
F-test		S	S	S	S	S	S
SEd(±)		6.03	7.32	2.59	2.26	5.96	0.004
CD (P=0.05)		11..73	8.83	5.23	4.56	2.96	0.009

Table 2: Response of Rice (*Oryza sativa* L.) Hybrids on Yield Attributes viz., Number of effective tillers $hill^{-1}$, Panicle length, Number of grains $panicle^{-1}$, Number of filled grains $plant^{-1}$.

Treatments	Hybrid	No. of effective tillers $hill^{-1}$	Panicle length (cm)	No. of grains $panicle^{-1}$	No. of filled grains $plant^{-1}$
T_1	KR 15-22	9.22	24.93	46.22	228.89
T_2	KR 15-23	8.44	24.47	41.44	189.67
T_3	KR 15-24	7.04	23.53	48.11	233.67
T_4	KR 15-25	6.59	21.67	42.78	231.56
T_5	KR 15-26	8.47	24.47	42.11	246.11
T_6	KR 15-27	7.87	21.73	46.78	210.44
T_7	KR 15-28	8.50	24.20	43.22	177.56
T_8	KR 15-29	8.30	25.00	46.33	215.56
T_9	KR 15-30	8.00	24.87	45.78	222.00
T_{10}	KR 15-31	7.27	24.27	47.67	233.33
T_{11}	KR 15-32	11.04	25.67	44.89	213.78
T_{12}	KR 15-33	11.82	25.93	51.11	248.89
T_{13}	KR 15-34	9.83	24.47	41.56	208.11
T_{14}	KR 15-35	8.30	22.33	49.78	195.44
T_{15}	KR 15-36	8.20	22.60	51.00	215.78
T_{16}	KR 15-37	7.27	24.73	47.22	214.22
T_{17}	KR 15-38	7.19	21.93	44.11	210.78
T_{18}	KR 15-39	6.60	23.33	38.56	204.44
T_{19}	KR 15-40	8.93	22.13	41.89	199.44
T_{20}	KR 15-41	7.67	24.80	49.56	175.33
T_{21}	KR 15-42	7.49	23.20	45.00	207.00
T_{22}	KR 15-43	6.23	15.73	26.89	196.44
T_{23}	Vikrant 44	8.13	23.60	49.22	219.00
F-test		S	NS	NS	NS
SEd(±)		1.20	2.60	7.53	21.25

CD (P=0.05)	2.41	-	-	-

Table 3: Response of Rice (*Oryza sativa* L.) Hybrids on Grain yield, Straw yield, Biological yield, Gross return, Net return and B: C ratio

Treatments	Hybrid	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1	KR 15-22	4.65	9.31	14.01	111420.00	84989.00	3.21
T_2	KR 15-23	2.41	5.08	7.61	58340.00	31909.00	1.20
T_3	KR 15-24	5.45	9.98	15.43	128760.00	102329.00	3.87
T_4	KR 15-25	4.08	9.15	13.30	99900.00	73469.00	2.79
T_5	KR 15-26	5.46	10.59	16.08	130200.00	103769.00	3.92
T_6	KR 15-27	4.21	9.11	13.41	102420.00	75989.00	2.87
T_7	KR 15-28	3.50	6.77	10.38	83540.00	57109.00	2.16
T_8	KR 15-29	2.37	4.90	7.38	57000.00	30569.00	1.15
T_9	KR 15-30	3.73	8.73	12.51	92060.00	65629.00	2.48
T_{10}	KR 15-31	3.40	7.67	11.20	84120.00	57689.00	2.18
T_{11}	KR 15-32	4.90	10.04	14.95	119340.00	92909.00	3.51
T_{12}	KR 15-33	5.74	11.44	17.21	137600.00	111169.00	4.20
T_{13}	KR 15-34	5.22	10.44	15.64	125680.00	99249.00	3.75
T_{14}	KR 15-35	5.30	10.53	15.90	106150.60	79719.99	3.01
T_{15}	KR 15-36	4.24	8.81	13.25	102420.00	75989.00	2.87
T_{16}	KR 15-37	2.80	6.47	9.27	69540.00	43109.00	1.63
T_{17}	KR 15-38	1.79	5.91	8.09	47620.00	21189.00	0.84
T_{18}	KR 15-39	5.73	10.99	16.72	136380.00	109949.00	4.15
T_{19}	KR 15-40	2.41	6.25	8.51	60680.00	34249.00	1.29
T_{20}	KR 15-41	5.66	11.06	16.53	135100.00	108669.99	4.11
T_{21}	KR 15-42	1.45	3.35	4.72	35700.00	9269.00	0.35
T_{22}	KR 15-43	2.45	6.05	8.47	61100.00	34669.00	1.31
T_{23}	Vikrant 44	4.78	10.01	14.89	115420.00	88989.00	3.36
F-test		S	S	S	--	--	--
SEd(±)		0.17	0.39	0.46	--	--	--
CD (P=0.05)		0.36	0.80	0.93	--	--	--

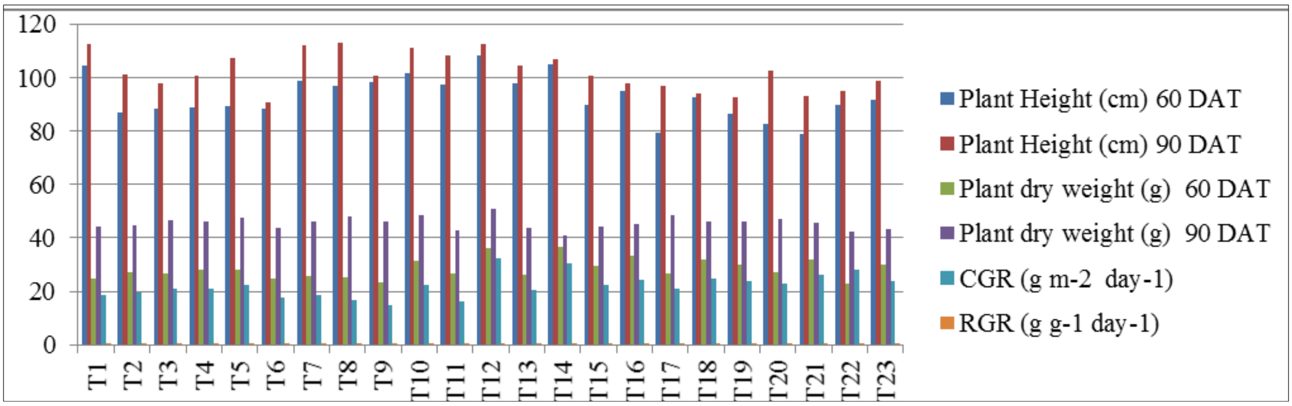

Fig 1: Response of Rice (*Oryza sativa* L.) Hybrids on Growth Attributes viz, Plant height (cm), Plant dry weight (g), Crop growth rate (g m^{-1} day^{-1}) and Relative growth rate (g g^{-1} day^{-1})

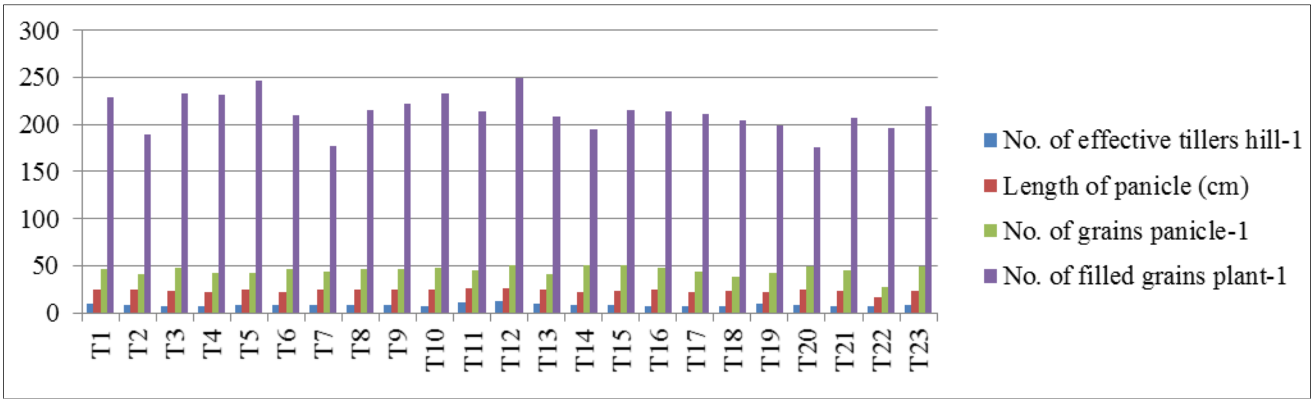

Fig 2: Response of Rice (*Oryza sativa* L.) Hybrids on Yield Attributes viz., Number of effective tillers hill^{-1}, Panicle length, Number of grains panicle^{-1}, Number of filled grains plant^{-1}

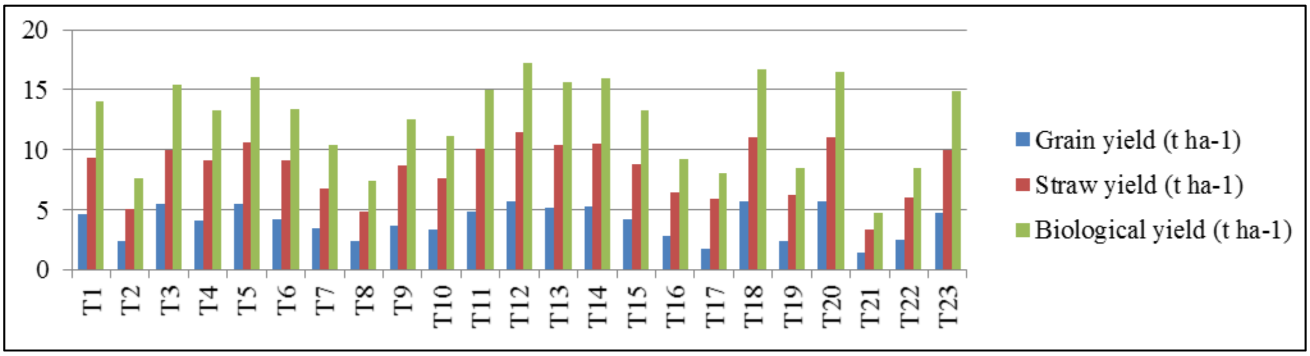

Fig 3: Response of Rice (*Oryza sativa* L.) Hybrids on Grain yield, Straw yield & Biological yield

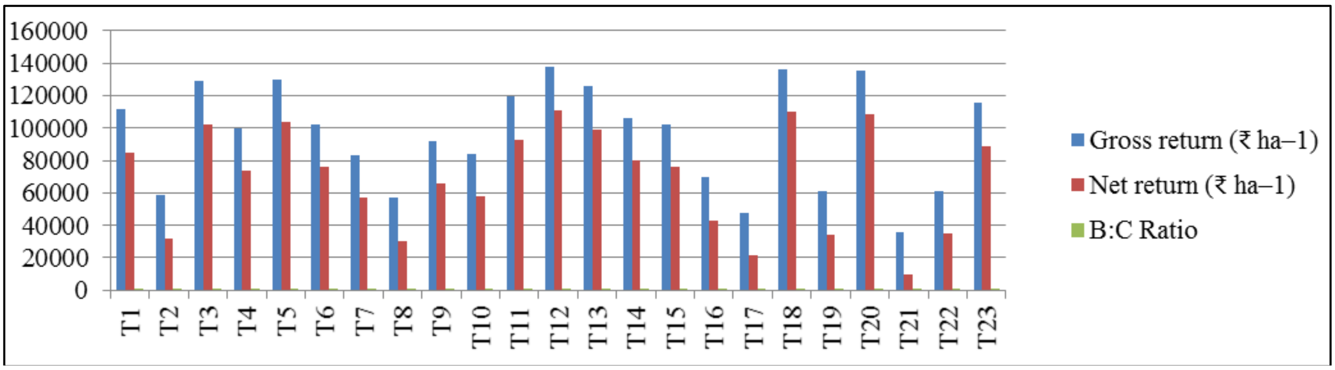

Fig 4: Response of Rice (*Oryza sativa* L.) Hybrids on Gross return (₹ ha^{-1}), Net return (₹ ha^{-1}) and B: C ratio

Conclusion
In conclusion, from the data pertaining to the different treatments, it may be indicated that by using hybrid (KR 15-33), higher grain yield and monetary benefits can be realized over local cultivars. Hybrid (KR 15-33) was found to be the best for obtaining highest Seed yield, Stover yield and benefit cost ratio. Since the findings are based on the research done in one season it may be repeated for conformation.

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