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COMPARATIVE ASSESSMENT OF GROWTH, YIELD AND GRAIN QUALITY OF DIFFERENT HYBRID RICE VARIETIES IN *KHARIF* SEASON

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ABSTRACT

Present research work was carried out in *kharif* season of 2022 at Regional Research Sub-Station, Bidhan Chandra Krishi Viswavidyalaya, Chakdaha, Nadia to compare the growth and yield performance of six hybrid rice varieties and one local high-yielding variety in randomized complete block design with three replications. Growth parameters namely plant height, number of tillers m^{-2}, leaf area index, dry matter accumulation were the highest for the hybrid variety PAN 802. The leaf chlorophyll content was also maximum for this variety. The high yielding variety IET 4786 showed poor growth attributes. Number of panicles m^{-2} (306) and test weight (25.91 g) were highest in case of PAN 802; while the highest filled grains $panicle^{-1}$ (128.90) was recorded in Arize 6444 Gold. The highest grain yield was obtained in PAN 802 (7.55 t ha^{-1}), but the yields recorded in PAN 2423 (7.33 t ha^{-1}), PAN 2140 (7.36 t ha^{-1}), PAN 2150 (7.5 t ha^{-1}) and Arize 6444 Gold (7.4 t ha^{-1}) were statistically at par. Both PAN 802 and PAN 2150 produced 84.15% and 82.92% higher yield respectively over IET 4786. The hybrid variety PAN 802 had the highest grain amylose content (26.51%), closely followed by IET 4786 (26.42%). The highest carbohydrate content (82.35%) was found in PAN 802, while total soluble protein (1.72%) and crude protein (6.44%) content was recorded highest in Arize 6444 Gold and PAN 2150, respectively. Economic benefit in terms of net return (Rs.57,801 ha) and B:C ratio (1.97) was the highest for PAN 802.

Keywords **:** Amylose content, Chlorophyll content, Hybrid rice, Yield

Introduction

With rapidly increasing population and declining resources, India has to increase its rice productivity by any means in order to sustain present food self-sufficiency and meet future requirement. But the productivity of high-yielding varieties of green revolution era has already plateaued. Among many genetic approaches being explored to break the yield barrier in rice, hybrid rice technology appears to be the most feasible and readily adoptable one (Banerjee, 2004). Hybrids can give 20-30% higher yield over best inbred variety grown under similar conditions (Namasharma *et al.*, 2023). Hybrids have ability to perform better under adverse condition of drought and salinity, resistant to several disease and pests, short duration and non-lodging (Banerjee *et al.,* 2018). The suitability of growing hybrid rice in new alluvial zone of West Bengal particularly during rainy season (*kharif*) has already been established by many researchers (Banerjee *et al.,* 2019; Mondal *et al.,* 2022), and there is huge scope also to bring more land under hybrid rice cultivation particularly in *kharif* season. Hence, the assessment of newly released hybrid rice varieties in terms of growth and productivity is urgent needed to assure superiority of hybrids over high-yielding varieties of rice. Moreover,

zone-specific varietal selection for hybrid rice would be the key to achieve higher yield than any other local high-yielding varieties.

The present study aimed to compare the growth and yield performance of the hybrid varieties with the local popular high-yielding variety IET 4786 during *kharif* (rainy) season in the new alluvial zone (NAZ) of West Bengal, India. Another specific objective of the study was to examine the grain quality attributes of tested varieties.

Materials and Methods

Field experiment was carried out during *kharif* (rainy) season of 2022 at Regional Research Sub-Station (NAZ), Bidhan Chandra Krishi Viswavidyalaya, Chakdaha, Nadia (23°5.3′N latitude, 83°5.3′E longitude and 9.75 m above mean sea level) under sub-tropical humid climate. Weather data (Figure 1a-b) revealed that average monthly maximum and minimum temperatures fluctuated between 30.06 to 34.76°C, and 13.10 to 26.29°C, respectively during the cropping season (2nd July to 4th November, 2022). Maximum and minimum relative humidity ranged from 89 to 96% and 67.57 to 89.57%, respectively. The total rainfall during the experimental period was 574.5 mm. The weekly total evaporation during the entire cropping period ranged between 1.80 to 48.10 mm. The experimental soil (0-30 cm depth) was sandy clay loam in texture (38.71% sand, 27.67% silt and 33.62% clay), with a pH of 7.2 (Jackson, 1967) and electrical conductivity of soil solution 0.63 dS m^{-1} (Jackson, 1967). It contained 0.68% organic carbon (Jackson, 1967) and available nutrient content of 185.0 kg N ha^{-1} (Jackson, 1967), 16.0 kg P ha^{-1} (Olsen *et al*., 1954) and 126.20 kg K ha^{-1} (Hanway and Heidel, 1952) respectively.

The experiment was arranged in randomized complete block design replicated thrice, with individual gross plot area of 5m × 4m. Six rice hybrids (PAN 2423, PAN 2430, PAN 2140, PAN 2150, PAN 802, and Arize 6444 Gold) and a local HYV (IET 4786) were tested. Salient features of these varieties are given in Table 1. Seedlings of 21 days old were manually transplanted on July 25, at a spacing of 20 × 15 cm with one seedling per hill. The fertilizer dose of 90 kg N ha^{-1}, 45 kg P ha^{-1} and 45 kg K ha^{-1} was applied through urea, single super phosphate (SSP) and muriate of potash (MoP), respectively as per recommendation of Department of Agriculture, Govt. of West Bengal. Half dose of urea was applied as basal and the rest amount in two equal splits at 30 and 45 days after transplanting (DAT). Entire amounts of SSP and MoP were given as basal i.e., at the time of final land preparation. The ponding depth of water in the field was maintained at 2 cm during transplanting and about 5 cm during crop establishment until maturity. Manual weeding was done whenever required. In each plot, third row was marked for destructive sampling as well as for recording different biometric observations. Ten panicles were randomly selected from each plot to determine 1000-grain weight and number of grains per panicle and other yield parameters. The middle two rows were marked for determination of seed yield. Nutritional and cooking quality content of grain was determined by standard biochemical methods as stated by Sadasivam and Manickam (1996).

Data on growth, yield and grain quality of rice hybrids were analysed using analysis of variance (ANOVA) technique to evaluate the differences among treatments; while the means were separated using the critical difference (CD) test at 5% level of significance (Gomez and Gomez, 1984).

Results and Discussion

Growth attributes

Significant variations in different growth parameters were observed amongst different tested varieties (Table 2). Plant height of all the tested rice hybrids was more as compared to HYV (IET 4786). At 75 DAT, plant height was recorded highest in PAN 802 (131 cm) followed by 120.50 cm in Arize 6444 Gold and the lowest was recorded in IET 4786 (107.75 cm). These findings are in line with that of Banerjee and Pal (2012). Number of tillers m^{-2}, being the most important yields determining trait, varied significantly at 75 DAT among tested hybrid rice varieties. This again proved the fact that hybrid rice cultivars have higher tillering ability than conventional varieties (Chandrasekhar *et al*., 2001; Pandey *et al.*, 2001; Maiti *et al.*, 2006), which is usually ruled by the genotypic makeup of rice variety (Swain *et al.*, 2006). Highest numbers of tillers m^{-2} were obtained in PAN 802 (457.14) followed by PAN 2140 (449) and Arize 6444 Gold (441.25); while lowest was observed in IET 4786 (261.75). Increased tiller production in rice hybrids ultimately resulted in higher chlorophyll synthesis, dry matter accumulation (DMA) and leaf area index (LAI). At 75 DAT, the highest DMA and LAI was recorded in PAN 802 (1046.74 g m^{-2} and 3.91) followed by PAN 2140 (1035.54 g m^{-2} and 3.81) which was statistically at par with all other hybrids during 75 DAT. The local high yielding variety IET 4786 exhibited lowest DMA as well as LAI (845.32 g m^{-2} and 2.53). The crop growth rate (CGR) was found to be higher during 25-

50 DAT, and then declined during 50-75 DAT. During 25-50 DAT, the highest CGR was recorded in PAN 802 (22.54 g m^{-2} day^{-1}) followed by PAN 2140 (22.19 g m^{-2} day^{-1}) and Arize 6444 Gold (21.25 g m^{-2} day^{-1}); however they were statistically at par in this regard. During 50-75 DAT, maximum CGR was recorded in PAN 2150 (8.22 g m^{-2} day^{-1}) followed by PAN 2430 (7.21 g m^{-2} day^{-1}) and the variety PAN 2140 showed lowest CGR (4.07 g m^{-2} day^{-1}). The rate of increment of chlorophyll was more in early growth stages than later stages. However, maximum leaf chlorophyll content was determined in PAN 802 at 50 DAT (3.45 mg g^{-1}) and 75 DAT (3.29 mg g^{-1}), which was statistically at par with leaf chlorophyll content of PAN 2430, PAN 2140, PAN 2150 and Arize 6444 Gold. The leaf chlorophyll content was 63.5% and 59.7% higher than HYV (IET 4786) at 50 DAT and 75 DAT, respectively. This indicates that the hybrids had better physiological performance in terms of chlorophyll content, which is important for photosynthesis and overall plant health. Banerjee *et al.* (2019) also expressed similar opinion.

Yield determining traits, Yield and economic benefit

Both panicle length and weight were measured for all tested varieties, as these two contribute to biological yield of hybrid rice (Table 3). The highest (28.49 cm) panicle length was observed in hybrid variety PAN 2150 followed by PAN 802 (28.11cm), while the lowest was recorded in HYV IET 4786 (24.47cm). However, the highest panicle weight (4.24 g) was obtained in hybrid variety PAN 2140, and it was 79.66% higher than the panicle of IET 4786 variety (2.36g). For other yield components namely number of panicles m^{-2}, filled grains $panicle^{-1}$ and test weight, the highest values were recorded with PAN 802 (306.75), Arize 6444 Gold (128.90) and PAN 802 (25.91 g) respectively. But all the tested hybrids were statistically at par with respect to number of panicles m^{-2} and test weight. Same types of results were also recorded by Sardar *et al.* (2018). Both grain yield (7.55 t ha^{-1}) and straw yield (8.14 t ha^{-1}) was found to be the highest in PAN 802. However, grain yields of PAN 802, PAN 2150 (7.50 t ha^{-1}), Arize 6444 Gold (7.40 t ha^{-1}), PAN 2140 (7.36t ha^{-1}) and PAN 2423 (7.33 t ha^{-1}) were statistically at par, and the hybrid variety PAN 2430 was poor performer. As compared to grain yield of high yielding variety IET 4786 (4.10 t ha^{-1}), two hybrids PAN 802 and PAN 2150 produced 84.15% and 82.92% higher grain yield respectively. There was not much difference in harvest index values of tested varieties and hybrid variety PAN 2150 recorded highest HI (49.80) while IET 4786 had lowest HI (40.35). These findings corroborate to that of other investigators (Swain *et al.*, 2006; Mondal *et al.*, 2012). Highest net return (Rs. 57801 ha^{-1}) and B:C ratio (1.97) was obtained with hybrid variety PAN 802. But net returns and B:C ratios obtained for Arize 6444 Gold, PAN 2150, PAN 2140 and PAN 2423 were statistically at par with PAN 802.

Grain quality

The highest quantity of brown rice (79.80%) and milled rice (60.53%) was obtained with PAN 2423, whereas the lowest values (74.30% and 53.53% respectively) were noted in IET 4786 (Table 4). Milling percentage of hybrid rice ranged between 54.81% in PAN 802 to 60.53% in PAN 2423. In terms of cooking quality parameter, the amylose content was highest in PAN 802 (26.51%), which was very close to grain amylose content of IET 4786 (26.42%). Among different tested hybrid rice varieties, the lowest amylose content was found in Arize 6444 Gold (22.48%) and highest in PAN 802 (26.51%). Based on scoring value, it can be inferred that these tested hybrids have intermediate to high amylose content. Similar observation was found in the study of Rekha *et al*. (2020) and they noted wide variation in amylose content (17.21 to 26.78%) of 40 tested hybrids. Among nutritional quality parameters, maximum carbohydrate content was found in case of PAN 802 (82.35%), and it was closely followed by grain carbohydrate content of high yielding variety IET 4786 (80.68%). Both the total soluble protein and crude protein content was found to be the highest in Arize 6444 Gold (1.72%) and PAN 2150 (6.13%) varieties respectively.

Conclusion

Based on various results obtained in the present study, the best performing variety was PAN 802. Additionally, the performance of hybrid rice varieties like PAN 802, Arize 6444 Gold, PAN 2150, PAN 2140 and PAN 2423 was much better than conventionally grown local HYV (IET 4786) with respect to growth, yield and grain quality. Hence, these rice hybrids can be considered for cultivation during *kharif* season in new alluvial zone (NAZ) of West Bengal under sub-tropical humid climate.

Table 1: Details of rice varieties.

Variety	Nature	Duration (days)	Grain type	Special features	Disease/pest tolerance	Produced by
PAN 2423	Hybrid variety	110-115	Long bold	Non-lodging, high test weight, suitable for pressed rice and wet rice preparation.	Tolerant to stem borer and leaf folder. Moderately resistance to sheath blight and BLB (bacterial leaf blight).	PAN Seeds Pvt. Ltd.
PAN 2430	Hybrid variety	105-110	Medium bold	Ideal for growth in both semi-medium lands and uplands, optimal test weight, very good cooking quality.	Tolerant to blast and BLB.	PAN Seeds Pvt. Ltd.
PAN 2140	Hybrid variety	128-133	Long slender	Has non-lodging and non-shattering properties, quality assured and tested for top-notch productivity.	Tolerant to leaf blast, BLB and BPH (brown plant hopper)	PAN Seeds Pvt. Ltd.
PAN 2150	Hybrid variety	118-123	Long slender	Ideal for improved cooking quality, non-lodging and non-shattering nature.	Tolerant to leaf blast, BLB and BPH	PAN Seeds Pvt. Ltd.
PAN 802	Hybrid variety	120-125	Extra-long slender	With top-notch germination assurance, these grains have excellent resistance against discolouration. Best seeds for the best yields.	Tolerant to stem borer and leaf folder. Resistant to sheath rot.	PAN Seeds Pvt. Ltd.
Arize 6444 Gold	Hybrid variety	112-115	Long slender	Have good cooking quality, India's highest selling hybrid rice	Resistant to BLB	Bayer Bio-Science Pvt. Ltd.
IET 4786	High yielding variety	110-120	Fine long slender	Suitable for upland and medium upland	Resistance to blast, sheath blight, sheath rot	ICAR-National Rice Research Institute, Cuttack, Odisha

Table 2: Growth attributes of rice varieties as recorded in *kharif* 2022

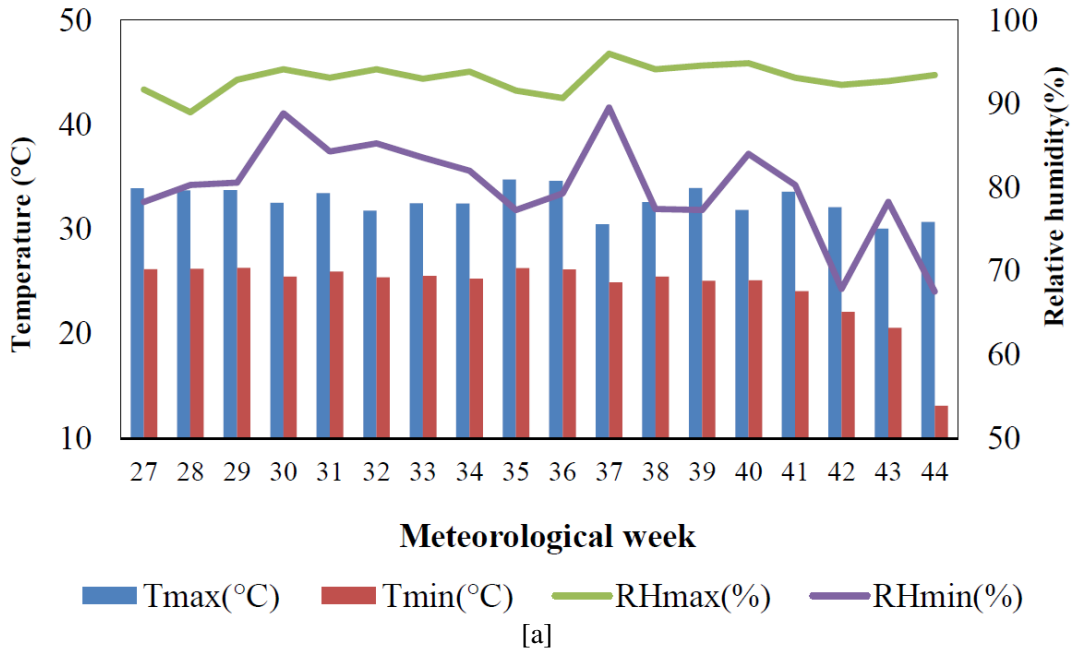
Treatment (variety)	Plant height (cm) at 75 DAT	Number of tillers m^{-2} at 75 DAT	DMA (g m^{-2}) at 75 DAT	CGR (g m^{-2} day^{-1})		LAI at 75 DAT	Chlorophyll content (mg g^{-1})	
				25-50 DAT	50-75 DAT		50 DAT	75 DAT
PAN 2423	109.38	396.50	927.40	17.51	7.15	3.27	2.31	2.28
PAN 2430	113.25	394.25	960.80	18.43	7.21	3.59	3.12	3.00
PAN 2140	118.50	449.00	1035.54	22.19	4.07	3.81	2.97	2.95
PAN 2150	115.88	426.00	966.30	17.70	8.22	3.22	3.12	3.05
PAN 802	131.00	457.14	1046.74	22.54	4.36	3.91	3.45	3.29
Arize 6444 Gold	120.50	441.25	995.01	21.25	4.81	3.00	3.22	3.10
IET 4786	107.75	261.75	845.32	16.96	5.33	2.53	2.11	2.06
S.Em±	4.241	28.091	39.352	1.158	0.741	0.581	0.274	0.219
CD (P=0.05)	13.068	87.882	121.256	3.568	2.283	NS	0.844	0.675

Table 3: Yield associated characters, yield and economics of rice varieties as recorded in *kharif* 2022

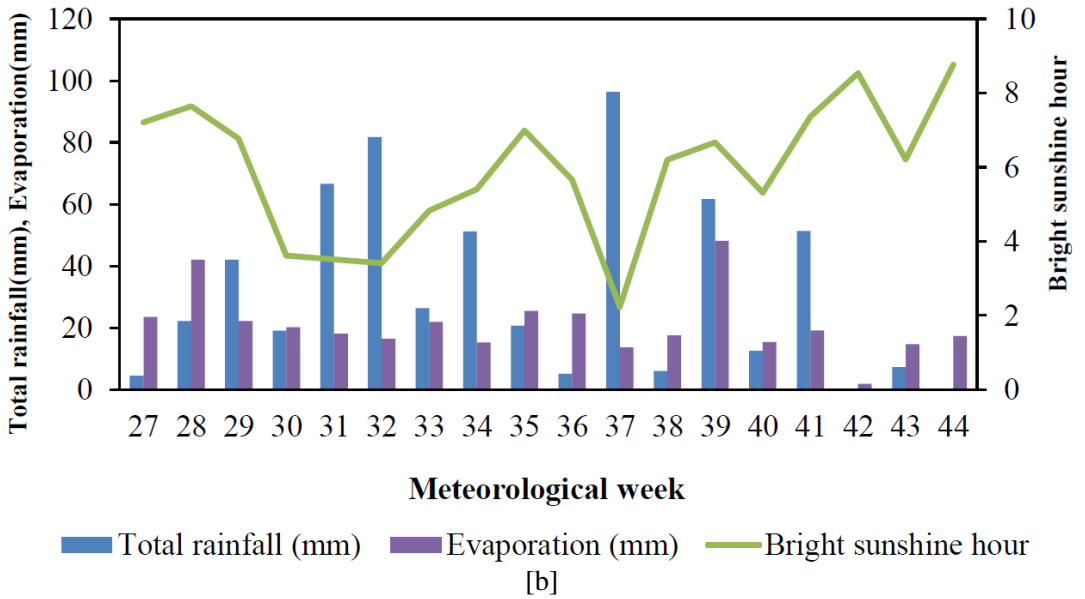
Treatment (Variety)	Panicle length (cm)	Panicle weight (g)	No. of panicles m^{-2}	Filled grains $panicle^{-1}$ (Nos.)	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest Index (%)	Net return (Rs. ha^{-1})	B:C Ratio
PAN 2423	27.60	4.15	286.25	125.7	25.37	7.33	7.50	49.42	53825	1.91
PAN 2430	26.43	3.97	280.00	114.5	24.75	6.20	7.06	46.76	37389	1.63
PAN 2140	25.91	4.24	295.00	120.3	25.89	7.36	8.05	47.76	55015	1.93
PAN 2150	28.49	4.07	302.22	121.5	25.14	7.50	7.56	49.80	56289	1.95
PAN 802	28.11	4.10	306.75	127.8	25.91	7.55	8.14	48.12	57801	1.97
Arize 6444 Gold	27.74	3.16	299.00	128.9	23.44	7.40	7.61	49.30	54959	1.93
IET 4786	24.47	2.36	201.65	118.5	19.35	4.10	6.06	40.35	19829	1.37
S.Em±	0.800	0.357	19.763	2.995	1.146	0.654	0.235	0.861	3605.639	0.079
CD (P=0.05)	2.465	1.100	60.896	9.229	3.531	2.015	0.623	2.681	11191.385	0.231

Table 4: Grain quality attributes of rice varieties

Treatment (Variety)	Brown rice %	Milled rice %	Carbohydrate (%)	Total soluble protein (%)	Crude protein (%)	Amylose content (%)
PAN 2423	79.80	60.53	75.18	1.59	5.80	24.25
PAN 2430	77.51	54.82	73.27	1.45	5.96	23.59
PAN 2140	78.40	56.28	75.77	1.58	5.30	26.20
PAN 2150	79.51	57.45	76.85	1.60	6.13	25.51
PAN 802	78.97	54.81	82.35	1.40	4.63	26.51
Arize 6444 Gold	79.31	60.09	72.93	1.72	5.13	22.48
IET 4786	74.30	53.53	80.68	1.50	5.46	26.42
SEm±	0.937	1.437	1. 775	0.055	0.263	0.792
CD (P=0.05)	2.887	4.428	5.469	0.169	0.810	2.440



[a]



[b]

Figure 1 [a-b]: Weather indicators as recorded during *kharif* 2022.

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