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EVALUATION OF WHITE AND PIGMENTED RICE CULTIVARS FOR MORPHO-PHYSIOLOGICAL CHARACTERS AND YIELD

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ABSTRACT

The present investigation was conducted during *kharif* season of 2020-2021 at research farm of ARS Sakoli, Dist. Bhandara (MH) in Randomized Block Design (RBD) with eleven treatments which included five white rice cultivars *viz.*, PDKV Tilak, Sakoli-9, PKV HMT, PDKV Kisan and SKL-3-1-41-8-33-15 and six pigmented rice cultivars viz., SKLRR-1, Kormagreen, Raktashali, Kalibati, Chakhao Poireiton and Black Rice Early and were replicated thrice. White rice cultivar SKL-3-1-41-8-33-15 recorded lower plant height, average number of effective tillers plant^{-1}, higher total dry matter production plant^{-1} and significantly highest grain yield plant^{-1}. White rice cultivar Sakoli-9 and pigmented rice cultivar SKLRR-1 stood second and third respectively in terms of grain yield plant^{-1}.

(Key words: Rice, white, pigmented, morpho-physiological traits, yield)

INTRODUCTION

Rice (*Oryza sativa* L.) is the seed of the monocot plants. It can be a short, medium or long grain size. It can also be waxy (sticky) or non-waxy. Some rice varieties are considered aromatic. Rice also comes in many different colors including white, brown, red, purple and black. India has the world's largest area under rice with 44.5 million ha and it contributes 21% of global rice production. Pigmented glutinous rice in particular has gained a lot of attention as raw materials for production of commercial health food supplements due to its high phenolic, anthocyanin and antioxidant contents.

Throughout the world and in India people prefer white rice for consumption as food. However pigmented rice is not yet known as the primary food and as a herb for people. There are many countries and states diverting production towards pigmented rice over traditional white rice. Eastern Vidharbha Zone in Maharashtra are also diverted to some extent to the production pigmented rice like black, red, green rice which fetches higher market price because of high nutritional content. Various research studies indicated higher nutritional benefits of pigmented rice cultivars as compared to white rice cultivars but they are low grain yielder. Considering the above facts present study was undertaken to evaluate white and pigmented rice cultivars for morpho-physiological traits and yield.

MATERIALS AND METHODS

An experiment was carried out at research farm ARS, Sakoli, Dist. Bhandara (MH) during 2020-21 in RBD with three replications and eleven treatments (cultivars included five white rice cultivars *viz.*, PDKV Tilak, Sakoli-9, PKV-HMT, PDKV Kisan and SKL-3-1-41-8-33-15 and six pigmented rice cultivars *viz.*, SKLRR-1, Kormagreen, Raktashali, Kalibati, Chakhao Poireiton and Black Rice Early). Observations on plant height and total dry matter production were recorded at 60 DAT and at harvest. Leaf area and LAI were recorded at 60 DAT and 90 DAT. Number of effective tillers plant^{-1} was recorded at harvest. Observations on days to 50% flowering and days to maturity and grain yield plant^{-1} were also recorded. Data were statistically analyzed as per method suggested by Panse and Sukhatme (1967).

The plant height of the randomly selected five plants from each treatment and replication were measured at 60 DAT and at harvest in cm from the ground surface to the tip of main panicle by using meter scale. Number of effective tillers (tillers producing panicles) were recorded from the randomly selected plant at harvest. Number of days required from sowing to the days when primary panicles in 50 % plants were in heading were counted and expressed as days to 50% flowering. The number of days to maturity was counted from the date of sowing to the date of physiological maturity of each cultivar of each plot in

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each replication and were averaged. Five plants excluding root at 60 DAT and at harvest from each cultivar and replication were taken and allowed to sun dry. Then dried in an oven at 70 ^{0}C till constant weight was achieved. After this their weight was recorded on electronic balance. Later mean was worked out and presented as mean dry weight plant^{-1} in gram. Five random plants which were selected from each treatment and replication for dry matter production were used for measurement of leaf area before sun drying. Leaves were grouped into large, medium and small and counted and measured leaf length and width in centimeters by use of scale. Leaf area was calculated by using following equation.

Leaf area (dm^2) = leaf length x leaf width x 0.75

0.75 is correction factor given by Yoshida (1981).

Leaf area index represent the ratio of leaf area to the land provided to a plant expressed in the same unit. Leaf area indices were worked out from the data of leaf area plant^{-1} recorded at 20 cm X15 cm at 60 and 90 DAT as per formula given by Watson (1947).

$$LAI = \frac{\text{Leaf area plant}^{-1}}{\text{Land area plant}^{-1}}$$

Grain yield plant^{-1} was recorded from five randomly selected plant from each cultivar and from each replication. Then clean produced were dried for 2-3 days in sun and weighed separately on electronic balance.

RESULTS AND DISCUSSION

Plant height (cm)

The data are presented in Table 1 indicates that three pigmented rice cultivars recorded significantly higher plant height than the mean plant height of all the cultivars (105.73 cm). Significantly highest plant height was recorded in rice cultivar Chakhao Poireiton (134.95 cm) followed by Kormagreen (124.03 cm) and Kalibati (120.34 cm), while three white rice cultivars and one pigmented rice cultivar recorded significantly lower plant height. Significantly lowest plant height was recorded in PDKV Tilak (85.73 cm) followed by SKLRR-1 (91.05 cm), PKV-HMT (91.41 cm) and PDKV Kisan (92.02 cm). Remaining all the rice cultivars were found at par with the general mean.

As per the data presented in Table 1 it is observed that three pigmented rice cultivars recorded significantly higher plant height than the mean plant height of all the cultivars (125.57 cm). Kalibati (175.48 cm) recorded the highest plant height followed by Chakhao Poireiton (169.26 cm) and Kormagreen (161.90). Whereas, two white rice cultivars *viz.*, SKL-3-1-41-8-33-15 (103.78 cm) and PKV-HMT (105.44 cm) and three pigmented rice cultivars namely, SKLRR -1 (106.77 cm), Black Rice Early (107.63 cm) and Raktashali (107.97 cm) recorded significantly lower plant height. Remaining all the rice cultivars were found at par with the general mean.

The variation in plant height was observed due to the genetic makeup of the rice cultivars. The plant height at harvest ranged from 103.78 cm to 175.48 cm. Such variation in plant height was also observed by Padole *et al.* (2018). They reported variation in plant height from 115 cm to 160 cm. Yaqoob *et al.* (2012) also reported significant differences in plant height of rice genotypes ranging from 86.67 to 114.67 cm.

Number of effective tillers plant^{-1} at harvest

The data are presented in Table 1 indicates that mean number of effective tillers plant^{-1} of rice cultivars at harvest was 6.78. Numerically highest number of effective tillers was recorded in white rice cultivar PDKV Tilak (7.88) and pigmented rice cultivar Black Rice Early (7.88) followed by white rice cultivar PDKV Kisan (7.86). Significantly lower number of effective tillers was noted in two pigmented rice cultivars *viz.*, Chakhao Poireiton (4.95) and Kalibati (5.02).Rest of the rice cultivars were found at par with the general mean (6.78).

Mean number of tillers plant^{-1} progressively increased from 30 days after transplanting (8.22) to 60 days after transplanting (10.96), however effective tillers plant^{-1} were reduced to 6.78 at harvest might be due to mortality of late form tillers. Differences in effective tillers in rice cultivars ranged from 4.95 to 7.88 plant^{-1}. The present results are also in accordance with results reported by Padole *et al.* (2018). They reported that MTU-1010, RTN-5, KJT-4, PKV-Ganesh and SYE-5 recorded highest productive tillers plant^{-1} (11) and mid late duration rice cultivar DRR Dhan-45 (6) recorded lowest productive tillers plant^{-1} with a general mean of 9.

Days to 50% flowering

The data are presented in Table 1 indicates that mean days to 50% flowering of rice cultivars was 97.67. Significant differences were found in rice cultivars for days to 50% flowering. Three white rice cultivars and four pigmented rice cultivars recorded significantly higher days to 50% flowering among which significantly highest days to 50% flowering was required by pigmented rice cultivar Kalibati (121.67) followed by Kormagreen (116.67). However, significantly lowest days to 50% flowering was recorded in pigmented rice cultivars Black Rice Early (64) followed by Raktashali (71) and white rice cultivar SKL-3-1-41-8-33-15 (82.33).

Variation in days required to 50% flowering in rice cultivars was due to their genetic makeup. The range found to be 64 to 121.67 days. Padole *et al.* (2018) also observed range of 74 to 114 days in 50% flowering in white and red rice cultivars. Asem *et al.* (2019) recorded range of 61.33-83.67 days to 50% flowering in Chakhao rice cultivars.

Days to maturity

The data are presented in Table 1 shows that mean days to maturity of rice cultivars was 127.88. Significant differences were found in rice cultivars for days to maturity. Three white rice cultivars and four pigmented rice cultivars

recorded significantly higher days to maturity. Significantly highest days to maturity was required by pigmented rice cultivars Kalibati (151.67) followed by Kormagreen (146) and white rice cultivar PDKV Tilak (142.67). However, significantly lowest days to maturity was recorded in pigmented rice cultivar Black Rice Early (94.33) followed by Raktashali (100.33) and white rice cultivar SKL-3-1-41-8-33-15 (115).

Variation in days required to maturity in rice cultivars was due to their genetic makeup. The range found to be 94.33 to 151.67 days. Different researchers reported different maturity in different rice varieties tested under different conditions. Rajesh *et al.* (2017) reported significant differences for days to maturity which ranged from 97- 140. Asem *et al.* (2019) recorded range of 122.33-154.33 days to maturity in Chakhao rice cultivars. Sarif *et al.* (2020) studied 32 pigmented rice accessions and reported range of 104-146 for days to maturity.

Total dry matter production (g plant^{-1})

The data are presented in Table 1 shows that mean total dry matter production (g plant^{-1}) of rice cultivars was 16.06 g. Significant differences were found in rice cultivars for total dry matter production. Significantly higher total dry matter production was recorded in two pigmented rice cultivars *viz.*, Black Rice Early (22.18 g) and Raktashali (19.52 g), while lowest total dry matter production was recorded in pigmented rice cultivar SKLRR-1 (12.35 g). However, rest of all other rice cultivars were found at par with the general mean.

The data are presented in Table 1 indicates that mean total dry matter production (g plant^{-1}) of rice cultivars was 27.22 g. Significant differences were found in rice cultivars for total dry matter production. Significantly highest total dry matter production was recorded in pigmented rice cultivar Kalibati (33.14 g). However, numerically higher total dry matter production was recorded in Chakhao Poireiton (30.29 g), Kormagreen (29.85 g), SKL-3-1-41-8-33-15 (28.68 g) and Sakoli-9 (28.58 g). Significantly lowest total dry matter production was recorded by pigmented rice cultivar Raktashali (21.12 g). However, rest of all other rice cultivars were found at par with the general mean.

Dry matter production is the result of balance between photosynthetic activity and respiration loss of plant. The total dry matter production often indicates the potentiality of crop plants for yield, but its mobilization towards grain development is important for grain yield.

From the results, it is observed that total dry matter production (g plant^{-1}) progressively increased from 30 DAT to harvest. At harvest total dry matter production (g plant^{-1}) of rice cultivars was in the range of 21.12 to 33.14 g. In present study high yielding white rice varieties SKL-3-1-41-8-33-15 and Sakoli-9 recorded 28.56 g and 28.58 g total dry matter plant^{-1} respectively. The findings are in conformity with the results observed by Kumar *et al.* (2014). They recorded total dry matter production in the range of 24.9 g plant^{-1} to 28.6 g, plant^{-1}.

Leaf area (dm^2)

The data are presented in Table 1 indicates that mean leaf area (dm^2 plant^{-1}) of rice cultivars was 9.13 dm^2. Significant differences were found in rice cultivars for leaf area (dm^2 plant^{-1}). Two pigmented rice cultivars *viz.*, Chakhao Poireiton (11.47 dm^2), Kalibati (11.35 dm^2) and white rice cultivar Sakoli-9 (10.55 dm^2) recorded significantly higher leaf area (dm^2 plant^{-1}). The pigmented rice cultivar Raktashali (2.68 dm^2) recorded significantly lowest leaf area (dm^2 plant^{-1}). Remaining all rice cultivars were found at par with the general mean.

The data are presented in Table 1 shows that mean leaf area (dm^2 plant^{-1}) of rice cultivars was 6.22 dm^2. Significant differences were found in rice cultivars for leaf area (dm^2 plant^{-1}). Three pigmented rice cultivars recorded significantly higher leaf area (dm^2 plant^{-1}) as compared to general mean *viz.*, Kalibati (8.33 dm^2), Kormagreen (7.98 dm^2) and Chakhao Poireiton (7.33 dm^2). Four white rice cultivars recorded significantly lower leaf area. However, PDKV Tilak (4.37 dm^2) recorded significantly lowest leaf area followed by PKV-HMT (4.68 dm^2), Sakoli-9 (4.89 dm^2) and PDKV Kisan (5.50 dm^2). All the remaining rice cultivars were found to be at par with the general mean. Three early duration varieties *viz.*, SKL-3-1-41-8-33-15, Raktashali and Black Rice Early were harvested before 90 DAT, hence data is nil.

From the results, it is observed that leaf area (dm^2 plant^{-1}) of rice cultivars was progressively increased from 30 DAT to 60 DAT and later on decreased at 90 DAT due to senescence of leaves. The pigmented rice cultivar Chakhao Poireiton recorded significantly highest leaf area (11.47 dm^2) at 60 DAT. Present findings are in accordance with the results reported by Ashrafuzzaman *et al.* (2008). They evaluated six aromatic rice varieties and reported range of 2.51-3.54 dm^2 flag leaf area. Sarif *et al.* (2020) studied 32 coloured rice accessions and reported range of 1.89- 5.89 dm^2 for leaf area.

Leaf area index

The data are presented in Table 1 shows that mean leaf area index of rice cultivars at 60 DAT was 3.05. Two pigmented and one white rice cultivar exhibited significantly higher leaf area index. Significantly highest leaf area index was recorded in pigmented rice cultivar Chakhao Poireiton (3.82) followed by Kalibati (3.80) and white rice cultivar Sakoli-9 (3.51). Whereas, significantly lowest leaf area index was recorded in pigmented rice cultivar Raktashali (0.89).

The data are presented in Table 1 indicates that mean leaf area index of rice cultivars at 90 DAT was 2.05. Three pigmented rice cultivars recorded significantly higher leaf area index as compared to general mean *viz.*, Kalibati (2.77), Kormagreen (2.66) and Chakhao Poireiton (2.44). Four white rice cultivars recorded significantly lower leaf area index. However, PDKV Tilak (1.38) recorded the significantly

Table 1. Plant height (cm), effective tillers plant^{-1}, days to 50% flowering, days to maturity, total dry matter production (g), leaf area (dm^2) and leaf area index and grain yield of white and pigmented rice cultivars

Genotypes	Plant height (cm)		Effective tillers	Days to 50%	Days to	Dry matter production (g)		Leaf area (dm^2)		LAI		Grain yield
	60 DAT	Harvest	plant^{-1} at harvest	flowering	maturity	60 DAT	Harvest	60 DAT	90 DAT	60 DAT	90 DAT	plant^{-1} (g)
PDKV Tilak	85.73	113.42	7.88	110.67	142.67	13.71	27.19	9.97	4.37	3.32	1.45	10.88
Sakoli-9	104.11	119.44	7.16	99.00	129.00	15.72	28.58	10.55	4.89	3.51	1.63	12.42
PKV HMT	91.41	105.44	6.85	102.00	131.33	13.57	25.56	8.97	4.68	2.99	1.56	9.96
PDKV Kisan	92.02	110.16	7.86	101.33	130.67	15.74	26.57	10.04	5.50	3.34	1.83	11.32
SKL-3-1-41-8-33-15	103.78	103.78	6.44	82.33	115.00	18.47	28.68	8.30	-	2.76	-	13.79
SKLRR-1	91.05	106.77	7.64	102.67	132.33	12.35	25.36	9.15	6.67	3.05	2.22	11.56
Kormagreen	124.03	161.90	6.21	116.67	146.00	15.69	29.85	8.80	7.98	2.93	2.66	9.21
Rakthashali	107.97	107.97	6.66	71.00	100.33	19.52	21.12	2.68	-	0.89	-	8.06
Kalibati	120.34	175.48	5.02	121.67	151.67	14.66	33.14	11.35	8.33	3.78	2.77	10.14
Chakhao Poireiton	134.95	169.26	4.95	103.00	133.33	15.00	30.29	11.47	7.33	3.82	2.44	8.83
Black Rice Early	107.63	107.63	7.88	64.00	94.33	22.19	23.11	-	-	-	-	8.94
Mean	105.73	125.57	6.78	97.67	94.33	16.06	27.22	9.13	6.22	3.05	2.05	10.47
SE (m) ±	3.79	5.71	0.49	0.72	0.82	0.93	1.86	0.31	0.36	0.15	0.11	0.68
CD at 5%	11.21	16.85	1.46	2.13	2.44	2.75	5.49	0.92	1.05	0.43	0.32	2.02

"-" = Cultivar harvested till observation stage

lowest leaf area index followed by PKV-HMT (1.56), Sakoli-9 (1.63) and PDKV Kisan (1.83). All the remaining rice cultivars were found to be at par with the general mean. Three early duration varieties *viz.*, SKL-3-1-41-8-33-15, Raktashali and Black Rice Early were harvested before 90 DAT, hence LAI data is nil.

From the results, it is observed that leaf area index of rice cultivars was progressively increased from 30 DAT to 60 DAT and lateron decreased at 90 DAT due to senescence of leaves at 90 DAT. The pigmented rice cultivar Chakhao Poireiton recorded significantly highest leaf area index (3.82) at 60 DAT. Present findings are in accordance with the results reported by Mondal *et al.* (2012). They reported maximum LAI at 60 DAT and ranged from 3.90 to 5.29. Present findings are also supported by Singh *et al.* (2020). They carried out an investigation consisting of 10 varieties of paddy and showed LAI in the range of 3.39-3.68 at 90 DAT.

Grain yield plant^{-1} (g)

The data in respect to grain yield plant^{-1} (g) of white and pigmented rice cultivars are presented in Table 1 indicates that mean grain yield plant^{-1} of rice cultivars was (10.47 g). Significant differences were observed in respect to grain yield plant^{-1} of white and pigmented rice cultivars under study. Significantly highest grain yield plant^{-1} was recorded in white rice cultivar SKL-3-1-41-8-33-15 (13.79 g). White rice cultivar Sakoli-9 (12.42 g) and pigmented rice cultivar SKLRR-1 (11.56 g) stood second and third respectively in terms of grain yield plant^{-1}. However, significantly lowest grain yield plant^{-1} was recorded in pigmented rice cultivar Raktashali (8.06 g). While, rest of the rice cultivars were at par with the general mean.

In present investigation grain yield plant^{-1} (g) of rice cultivars was ranged from 8.06 g in low yielding pigmented rice cultivar Raktashali to 13.79 g in top yielding white rice cultivar SKL-3-1-41-8-33-15. The highest grain yield of early duration white rice cultivar SKL-3-1-41-8-33-15 might be due to average number of effective tillers plant^{-1} (6.44), higher total dry matter production plant^{-1} (28.68 g). While, white rice cultivar Sakoli-9 ranked second in grain yield plant^{-1} (12.42 g) might be due to optimum number of effective tillers plant^{-1} (7.16), optimum total dry matter production plant^{-1} (28.58 g) as well as optimum leaf area (10.55 dm^2) at 60 DAT. Likewise pigmented red rice cultivar SKLRR-1 stood third in grain yield plant^{-1} (11.56 g) which might be due to optimum number of effective tillers plant^{-1} (7.64). The results obtained in present study are in agreement with the results reported by Padole *et al.* (2018). They reported grain yield plant^{-1} (g) of rice cultivars in the range of 11.20 g to 25.25 g. Whereas, Asem *et al.* (2019) observed grain yield plant^{-1} (g) in the range of 8.87 g to 26.74 g in 10 Chakhao rice.

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