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Phenotypic Characterization, Genetic Variability and Correlation Studies among Ten *Chakhao* (scented) Rice of Manipur

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A B S T R A C T

An investigation was carried out to know the extent of genetic variability present in ten *Chakhao* rice (scented rice) of Manipur during *kharif* 2017. Ten *Chakhao* landraces namely *Wairi chakhao, Khurkhul chakhao, Khunou chakhao, Chakhao sempak, Pong chakhao, Chetemo, Chakhao angangbi, Heimang chakhao* and two *Chakhao poireiton* samples (from different locations) were taken for the experiment. The characters that were evaluated included days to 50% flowering, days to 80% maturity, plant height at maturity (cm), total number of tillers per plant, effective number of tillers per plant, number of seeds per panicle, panicle length (cm), 100 seeds weight and grain yield per plant. Statistical analysis showed significant differences between the tested landraces. The analysis of variance revealed highly significant differences for all the traits under study indicating adequate for selection. The high estimates for PCV and GCV were obtained for no. of seeds per panicle, panicle length, 100 seed wt. and seed yield per plant revealing that the cultivars have a broad genetic background that will respond positively in selection for improving these traits. All the nine characters under study exhibited high values for broad sense heritability. Correlation analysis showed a significant and positive relationship between seed yield per plantand plant height. The correlation study also showed that seed yield positively associated with no. of seeds per panicle and panicle length. The positive and significant correlation could be effectively exploited in scented rice yield improvement program.

Introduction

Rice (*Oryza sativa* L.) is a member of Gramineae family which belongs to the genus *Oryza*, which includes 23 wild species and two cultivated species. Rice is the most important cereal crop of the world. The primary material for rice breeding is the

genetic resource of rice which makes a great contribution to global wealth and food security (Zhang *et al.,* 2011). Valuable alleles which are not common in modern germplasm are present in the landraces of rice (Perviaz *et al.,* 2010). Modern agriculture practices and extensive used or over exploitation has resulted in the depletion of genetic diversity.

Increasingly landraces are being replaced by modern cultivars to meet the need of sustainable agriculture and agricultural production; this may lead to the extinction of landraces. Many eff ort has put up for collecting, organising, conserving and studying landraces recently. Landraces could be deployed for their improvement for their potential as source of biotic and abiotic stress resistance genes or combination of genes for phytonutrient concentrations which can help alleviate aging-related and chronic diseases and also for nutrient rich source. The study on genetic variation relatedness among the rice landraces would help in the modern crop improvement program. Manipur is a state of India lying on the north-eastern corner of India bordering Myanmar (Burma). Manipur is endowed with several rice germplam with several values including those of biotic and abiotic stress resistant, different phytonutrients and unique cultural values. In Manipur several scented rice known as *Chakhao* rice are available. The colour of *Chakhao* range from dark purple colour (black scented rice) to red and white. They are used in community feast as a delicacy and in rituals ceremonies. The literal meaning of *Chakhao* is delicious rice (*Chak*-rice; *hao*-delicious). *Chakhao* has been used by the traditional medical practitioners of Manipur, also (Asem *et al.,* 2015). *Chakhao Poireiton* and *Chakhao Amubi* have reported to have high anthocyanin, phenolic content and strong antioxidant activity and the main anthocyanin present in *Chakhao Poireiton* and *Chakhao Amubi* are delphinidin 3-galactoside, delphinidin 3-arabinoside, cyanidin 3-galactoside and cyanidin 3-glucoside (Asem *et al.,* 2015). A cross mixture of twenty-six and eleven volatile compounds are found to be responsible for emanating aroma in *Chakhao Poireiton* from *Chakhao Amubi*, respectively where N-hexadecanoic acid, 17-pentatriscontene and 13-octadecenal are the predominant volatile oil components in them (Asem *et al.,* 2017). The dishes prepared from *Chakhao* are one of the highly rated. In the local markets, they are available at a premium rate. *Chakhao* are poor yielding, highly lodging, late maturing and *Chakhao* are poorly studied, they are found only in the state of Manipur in India and other regions of India hardly knows or has only very little knowledge about *Chakhao* (Asem *et al.,* 2015).

The conservation of landraces and their well characterization with genetic different is important for the successful effective application. There are many possibilities for the improvement of the productivity of this crop by varietal improvement and development of hybrids. The most significant importance of studying genetic variability is its utilization in the genetic improvement of a crop. The prior requirement for the planning of effective breeding programmes is the assessment of any trait. Heritability is the measure of the transmission of characters from parents to their offspring. Thus, in the selection process in plant breeding, heritability plays an important role. And the information on expected gain obtains from selection of superior individuals was provided by genetic advance. Henceforth, the two important selection parameters which help in predicting the gain are heritability and genetic advance. The present studies were undertaken assessing the performance of ten *Chakhao* landraces and study the extent of inheritance and their relationship between yield component characters.

Materials and Methods

The study was carried in the field of All Manipur Medicinal and Aromatic Plants Promoter Consortium (AMAPCON), Manipur at Sawombung, Imphal-East, Manipur during *kharif* season, 2017. Ten *Chakhao* landraces namely *Wairi Chakhao, Khurkhul Chakhao, Khunou Chakhao, Chakhao Sempak, Pong Chakhao, Chetemo, Chakhao Angangbi, Heimang Chakhao* and two *Chakhao Poireiton* samples (from different locations) were taken for the experiment (Table 1). The experiments were laid out in Randomized Complete Block Design (RCBD) in 5 row plots of 4 m long with three replications. Row to row spacing was kept at 20 cm and plant to plant at 10 cm. At the appropriate growth stage of rice plant, following the standard evaluation system of IRRI (IRRI, 2002), morphological data under study were collected. The observations were recorded from five randomly selected plants in each plot in each replication on plant height at maturity (cm), total number of tillers per plant, effective number of tillers per plant, number of seeds per panicle, panicle length (cm), 100 seeds weight and grain yield per plant. On whole plot basis, data on days to 50 % flowering and days to maturity was taken and recorded. Using the method by Burton (1952), estimation of the genotypic and phenotypic coefficients of variation (GCV and PCV) was done. Calculation of heritability (broad sense) and genetic advance were done based on the method given by Johnson *et al.*, (1955). According to the method explained by Singh and Chaudhary (1985), correlation coefficients were calculated.

Results and Discussion

Table 2 represents the mean sum of squares of various characters showing differences for the 10 *Chakhao* rice for the characters, 50% flowering, days to 80% maturity, plant height at maturity (cm), total number of tillers per plant, effective number of tillers per plant, number of seeds per panicle, panicle length (cm), 100 seeds weight and grain yield per plant. The extent of variability measured in terms of range, grand mean, phenotypic coefficients of variation (PCV), genotypic coefficients of variation (GCV), heritability (broad sense), genetic advance (GA) are presented in table 3. The partitioning of variance components showed moderate and high heritability estimates in the broad sense for the characters (Table 3).

Table.1 Pericarp color of 10 *Chakhao* rice genotypes collected from Manipur

Sl.No.	Cultivar Name	Pericarp Color	Collection Source	District
1.	*Chakhao Poireiton*	Purple	Farmers	Bishnupur
2.	*Chakhao Poireiton*	Purple	Farmers	Imphal East
3.	*Wairi Chakhao*	Purple	Farmers	Imphal East
4.	*Khurkhul Chakhao*	Purple	Farmers	Imphal West
5.	*Pong Chakhao*	Purple	Farmers	Chandel
6.	*Chakhao Sempak*	Purple	Farmers	Bishnupur
7.	*Khunou Chakhao*	Purple	Farmers	Tengnoupal
8.	*Chetemo*	Purple	Farmers	Imphal West
9.	*Chakhao Angangbi*	Red	Farmers	Kangpokpi
10.	*Heimang Chakhao*	White	Farmers	Imphal East

Table.2 Variance mean squares of 10 aromatic rice genotypes for nine characters

Source of variance	d. f.	Days to 50% flowering	Days to 80% Maturity	Plant Height (cm)	Total no. of tillers per plant	No. of effective tillers per plant	No. of seeds per panicle	Panicle length (cm)	100 seed weight (g)	Seed yield per plant (g)
Replication	2	9.30	17.03	27.08	6.10	0.93	749.20	26.64*	0.09	11.47
Treatments	9	203.09*	269.85*	2653.05*	23.71*	11.04*	2144.55*	17.55*	0.40*	106.80*
Error	18	3.81	7.47	39.49	9.40	2.45	225.27	4.88	0.08	37.90

* = Significant at P<0.05 levels

Table.3 Estimates of genetic parameters for nine characters in 10 aromatic rice genotypes under Manipur condition

Characters	Mean	Range		PCV (%)	GCV (%)	H^2 (%) (Broad sense)	Genetic Advance
		Min	Max				
Days to 50% flowering	68.60	61.33	83.67	20.90	20.71	0.98	28.99
Days to 80% Maturity	129.23	122.33	154.33	12.83	12.65	0.97	33.22
Plant Height(cm)	133.38	68.27	178.80	38.81	38.52	0.99	105.06
Total no. of tillers per plant	8.90	4.67	13.67	61.51	50.97	0.69	7.74
No. of effective tillers per plant	6.23	3.33	10.00	57.15	51.32	0.81	5.92
No of seeds per panicle	105.70	65.00	146.33	45.32	43.04	0.90	88.99
Panicle length (cm)	20.30	17.60	23.98	22.47	19.66	0.77	7.19
100 seed weight (g)	2.83	2.47	3.70	23.88	21.69	0.82	1.15
Seed yield per plant (g)	18.51	8.87	26.74	62.08	52.43	0.71	16.88

Table.4 Genotypic and phenotypic correlation coefficients among 10 Chakhao rice genotypes of Manipur

Characters	Level	Days to 50% flowering	Days to 80% Maturity	Plant Height (cm)	Total No. of tillers per plant	No. of effective tillers per plant	No of seeds per panicle	Panicle length (cm)	100 seed weight (g)	Seed yield per plant (g)
Days to 50% flowering	G	1.000	0.85*	0.09	-0.50	-0.44*	0.49*	0.55*	0.38*	0.04
	P	1.000	0.85*	0.08	-0.20	-0.31	0.40*	0.36	0.30	0.02
Days to 80% Maturity			1.000	0.00	-0.28	-0.18	0.23	0.45*	-0.06	-0.21
	P		1.000	-0.01	-0.07	-0.11	0.19	0.27	-0.05	-0.10
Plant Height (cm)	G			1.000	0.43*	0.32	0.70*	0.74*	-0.18	1.00*
	P			1.000	0.26	0.28	0.65*	0.60*	-0.18	0.65*
Total No. of tillers per plant	G				1.000	0.80*	-0.14	0.47*	-1.08	-0.11
	P				1.000	0.76*	-0.06	0.17	-0.27	0.40
No. of effective tillers per plant	G					1.000	-0.26	0.26	-1.02	-0.07
	P					1.000	-0.11	0.20	-0.46*	0.44
No of seeds per panicle	G						1.00	0.93*	0.45*	0.48*
	P						1.00	0.75*	0.22	0.33
Panicle length (cm)	G							1.00	0.12	0.52*
	P							1.00	-0.16	0.27
100 seed weight (g)	G								1.00	-0.34
	P								1.00	0.00
Seed yield per plant (g)	G									1.00
	P									1.00

* = Significant at P<0.05 levels

Significant differences among the 10 *Chakhao* rice cultivars of Manipur, *Wairi Chakhao, Khurkhul Chakhao, Khunou Chakhao, Chakhao Sempak, Pong Chakhao, Chetemo, Chakhao Angangbi, Heimang Chakhao and two Chakhao Poireiton* for all the characters under study were resulted by the study. Significant variability for yield and its components in rice was also observed by Singh *et al.,* (2006) which showed consistent with our present findings. For the character, days to 50 per cent flowering, the study revealed that, a range of 61.33-83.67 days was obtained among the genotypes while a range of 122.33-154.33 days was obtained for maturity. The study revealed that plant height had a range of 68.27- 178.80cm. Total no. of tillers per plant and effective no. of tillers per plant among the genotypes varies from 4.67 - 13.67and 3.33 - 10.00 respectively. Data on number of seeds per panicle, Panicle length and 100 seed weight among the genotypes varied from 65.00 - 146.33, 17.60 cm - 23.98 cm and 2.47 g - 3.70 g. A highest yield of 26.74 g per plant was obtained for *Chakhao Anganbi* and lowest 8.87 g per plant was recorded for *Chetemo*. Ganapati *et al.,* 2014 and Shiva Prasad *et al.,* 2013 reported similar findings. The narrow differences between phenotypic and genotypic coefficients of variation were observed for all the characters, thus, it indicated there is less influence of environment on expression of characters for all the characters studied except for seed yield per plant. Additive mode of gene action was indicated as the result of the study showed high heritability for all the characters.

Heritability plays a vital role in deciding the suitability and adopting breeding strategy for improvement of a particular character. All the nine characters under study exhibited high values for broad sense heritability ranging from 98% (days to 50% flowering) to 69% (total number of tillers per plant). But for the characters, total no. of tillers per plant, no. of effective tillers per plant, panicle length, 100 seed weight and seed yield per plant, high heritability and low genetic advance were observed which indicated the involvement of non-additive genes. Therefore, for the improvement of these characters, heterosis breeding involving population improvement may be used.

Plant height and no. of seeds per panicle showed high heritability and high genetic advance which indicated additive gene effects. Sheikh *et al.,* 2017; Ketan and Sarkar, 2014; Rajpoot *et al.,* 2017 reported similar results. Significant and positive relationship was resulted between seed yield per plantand plant height by correlation analysis. From the correlation study, it was also observed that seed yield was positively associated with no. of seeds per panicle and panicle length. Seed weight and no. of effective tillers per plant was negatively correlated. Between days to 50% flowering and days to maturity, between plant height and no. of seeds per panicle and panicle length, a positive and significant correlation was found. Conservation and maintenance of the rice landraces are important for further in-cooperation of their valuables traits for sustainable agriculture (Table 4). Complete knowledge on interrelationship of plant character like grain yield with other characters is of supreme importance. This knowledge would be of immense help in the improvement of rice for complex quantitative character like grain yield as direct selection is not much effective for grain yield. Therefore, association analysis was conducted for the determination of the direction of selection and number of characters to be considered in improving grain yield. Based on findings, it can be concluded that, the studied landraces can be further exploited in yield improvement program for developing high yielding scented rice genotypes.

In conclusion, the present study shows immense phenotypic diversity of the *Chakhao* rice. All the morphological characters under the study have overall variability indicating that farmers could select for diverse cultural and local ecological needs and could also be utilized effective breeding program. Genetic variability analysis in crops is important as the variability

would be helpful to breeders for the improvement of crops in developing new varieties and hybrids. The present study highlights positive and significant correlation between seed yield per plantand plant height and also observed that seed yield is positively associated with no. of seeds per panicle and panicle length, henceforth, it could be concluded that all these traits could be considered during breeding program for the improvement of *Chakhao* for higher yield.

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