Agro-morphological Characterization and Genetic Diversity in a mini core collection of Aromatic Rice (*Oryza sativa* L.)

ABSTRACT

Aromatic rice is a special kind of rice known in the World. 20 genotypes of aromatic rice were evaluated at the Agricultural Experimental Farm of University of Calcutta situated in Baruipur, West Bengal to characterize and estimate Genetic Diversity in mini core collection of Aromatic Rice (*Oryza sativa* L.). Research work has so far been done mainly on Basmati rices giving less importance to the improvement of small and medium grain indigenous aromatic rice genotypes. West Bengal, is a rich source of small and medium grain aromatic rice germplasms with excellent grain quality parameters including aroma. Therefore, enough scope is there for improve these small and medium grain scented germplasms by bringing them in breeding programme with the varieties having desirable traits especially high yield and aroma. In this study,A close relation was maintained by Phenotypic coefficients of variation (PCV) with Genotypic coefficient of variation(GCV) for all the traits though PCV exhibited a bit higher value, this indicates low G×E interaction. Additive gene action was prominent for the traits like plant height, panicle length, number of filled grains per plant and 1000 grain weight. A correlation study showed that grain yield per plant was positive and significantly correlated with panicles per plant and total number of filled grains per plant, emphasizing on these traits help in increasing the grain yield of aromatic rice. Manhattan cluster analysis revealed two distinct clusters i.e. Cluster I(A and B) and Cluster II(A and B), on the basis of the agro-morphological traits taken. Cluster II has the maximum genotypes i.e., 15 and 5 genotypes in Cluster I. The investigation concludes that the total number of filled grains per plant and panicle length influences grain yield. Path analysis revealed that total number of filled grains per plant , panicles per plant and 1000 grain weight directly effects grain yield per plant.

Key Words: *Agro-morphological traits, Aromatic rice, Cluster, Genetic Diversity.*

1. INTRODUCTION

Rice is the staple food for more than 70% of Indians and more than half the World's population of 8 billion approximately (Worldmeters, 2020). It is grown in almost all states and ecologies of India. India is the fourth exporter of rice in the world due to an enhanced rice production in recent years. In India, West Bengal is known as the rice bowl of India and is the largest producer of rice.

Aromatic rice is a special class of rice having high market value because of its superior grain qualities and pleasant aroma (Singh *et al.,* 2000). The productivity of aromatic rice is low in comparison to other types of rice. This is due to non-availability of aromatic rice varieties with higher productivity.

India is very rich in rice genetic resource, aromatic rice in particular. Aromatic rice constitutes a small and unique group of rice which is highly priced due to its premium quality; it is widely grown in different states of North India like Himachal Pradesh, Jammu and Kashmir, Haryana, Punjab and parts of Uttar Pradesh (Nene, 1998). There is a high demand of aromatic rice in international markets, about two-third of aromatic rice produced by India is exported to different countries and is increasing every year (Siddiq, 1990). Trade-in aromatic rice has not received considerable attention in India even though scented rice varieties have competitive international prices and the country can earn foreign exchange. Demand for aromatic rice has been increased manyfold in the last two decades in national and international markets. The aromatic rice of India is very famous throughout the world. Now, realizing the importance and demand of short grained aromatic rice in the world market, emphasis has been given on collection, characterization and evaluation of the aromatic short grained rice grown in India for its documentation and to find out suitable donors for different traits that are prerequisites for varietal development.

Exploring diversity in the collection of landraces is essential for identifying new genes and further improving the germplasm (Thomson *et al*., 2007). Some small and medium-grained aromatic rice landraces are strongly aromatic and have good quality traits like elongation ratio of cooked rice, taste, etc. and therefore could be excellent sources for improving quality in high-yielding varieties. Genetic study of existing aromatic rice landraces is the prerequisite for the development of new varieties. The present study was done to assess the genetic variation in a mini core collection of 20 aromatic rice genotypes by considering their agro-morphological traits.

2. MATERIAL AND METHODS

Seeds of 20 aromatic rice accessions (Table No.1) were sown in the nursery bed. Twenty-five (25) days old seedlings were transplanted in the field during Kharif season (June to December) 2019 at the Baruipur Agricultural Farm of University of Calcutta located in South 24 Parganas District of West Bengal. The farm is situated at an elevation of 10 meter above sea level (latitude 22º87' and longitude 88º76'). Baruipur has an average soil (pH): 6.80. Average rainfall (in cm) ranges from 40.23-35.126, temeparture is in between 36.2^{O}C-20.2^{O}C and relative humidity is close to 67%. The design used for transplanting was an RBD - randomized block design with three replications. The spacing was 15 x 20 cm. Each genotype was sown in three lines per replication. In our study, the fertilizer dose of N:P:K used was 60:30:30 kg/ha. Agro-morphological characters for randomly selected five plants in each replication were recorded at different crop growth stages and the data were statistically analyzed with the help of SPSS 20. The quantitative characters like Days to flowering, Days to maturity, Plant height (in cms), Tillers per plant, Panicles per plant, Panicle length (in cms), Total number of filled grains per plant, 1000 grain/seed weight (in gms) and Total grain yield per plant (in gms) etc. were recorded.

3. RESULT AND DISCUSSIONS

3.1. Genetic Variation Estimation

The analysis of variance (ANOVA) revealed significant differences between the genotypes for all the traits in the experiment (Table No. 2). In the present study, the Phenotypic Coefficient of Variation (PCV) was higher than Genotypic Coefficient Variation (GCV) for all the traits that imply the environment's role. The same findings were reported earlier (Bhadru *et al.,* 2012). The PCV and GCV were high for the characters-panicle length, total number of filled grains per plant, 1000 grain weight and total grain yield per plant, indicating more significant variability in respect of these attributes. Moderate to moderately high PCV and GCV were estimated for the traits plant height and tillers per plant (Table No.3). PCV and GCV showing a narrow difference indicates minimum influence of the environment in the expression of the traits. All characters/traits except days to 50% flowering, days to maturity and grain yield per plant showed less influence of the environment (Sarawag*i et al.,* 2000). The present study showed high heritability coupled with moderate to high genetic advances for the traits total number of filled grains per plant and grain yield per plant, suggesting that these traits were primarily under additive genetic control and selection of such traits can be achieved through their phenotypic performance.

3.2. Correlation between Quantitative traits

Correlations identifies the measurement of intensity of association between the different traits considered for studying. It also helps the breeder to understand the mutual component characters on the basis of which selection can be done for genetic improvement. In the present investigation, the association analysis (Table No.4) demonstrated that the trait grain yield per plant was positive and significantly correlated with panicles per plant and total no. of filled grains per plant indicating the importance of these characters for yield improvement in this population. Similar kinds of associations were reported earlier by various researchers like Krishna *et al. (*2008) for panicle number. Associations with other characters should be considered simultaneously when characters having direct effect on yield are selected, as this will indirectly affect yield. Therefore, a judicious selection programme might be formulated for simultaneous improvement of such important developmental and component characters under any situation. The results of correlation coefficients implied that plant height, panicle numbers per plant and number of filled grains per plant might be considered for selection for yield improvement. Correlation analysis thus revealed that panicles per plant and total number of filled grains per plant played a vital role in increasing grain yield per plant. Enhancing these traits may hopefully help to obtain a high grain yield. An effective means of untangling direct and indirect causes of association should be provided for a closer view of association between traits which would allow a critical examination of the specific forces producing a given correlation.

3.3. Path Analysis

Path coefficient analysis has helped to find out the direct effect of each causal factor component and its indirect effect via another factor component on grain yield per plant (Wright, 1934). This method is useful in plant selection and breeding depending upon one or more causal factor (Dewey and Lu, 1959). A path coefficient is a standardized partial regression coefficient and measures the direct influence of a predictor variable on the response variable (Li, 1975). Here in the study, path coefficient analysis reveals that number of filled grains per plant exhibited highest positive direct effect on grain yield per plant (Table No.5). Other traits which contributed positive direct effects were panicles per plant and 1000 grain weight. We have observed in our study that days to maturity had negative correlation. Thus, it appeared that the traits-panicles per plant, filled grains per plant and 1000 grain weight were important yield components. Plant breeders are always interested to carry out selection in the field with minimum number of traits. Inter-relationship study exhibited plant height was positively correlated with panicles per plant and 1000 grain weight. So, selection for improvement with plant height would like to improve panicles per plant and 1000 grain weight through correlated response. More over improving plant height would have positive correlated response in some other traits also like tillers per plant and panicle length etc. Naturally, plant height would have obvious choice rather than tillers per plant which exhibited negative interrelation with 1000 grain weight. So, restructuring plant ideotype in aromatic rice with following traits would like to produce desirable lines in future- 1) plant with more grains per plant 2) plant with taller height.

3.4. Cluster Analysis

SPSS 20 further analyzed all 20 aromatic rice genotypes for grouping. Based on Manhattan clustering, two distinct clusters were found. Cluster I was further divided into Sub Cluster I A and I B, similarly Cluster II was divided into Sub Cluster II A and Sub Cluster II B (Fig. No. 1). Maximum 15 genotypes were grouped into Cluster II consisting of two genotypes in Sub Cluster II A and 13 genotypes in Sub Cluster II B. Whereas, 5 genotypes were grouped into Cluster I with 4 genotypes in Sub Cluster I B and a single genotype in Sub Cluster I A.

Investigating the cluster composition revealed that genotypes of different geographic origins are present in the same cluster, indicating that genotypes genetic divergence is independent of geographic origin. Similarly, Hossain (2009) and Nascimento *et al.* (2011) found in rice. The highest genetic distance has been observed in Paramanya and Dehradun Basmati, Gobindobhog and Gandeswari and Gobindobhog and Paramanya. (Table No.5). Desirable segregates are expected to produce a crossing between these pair of genotypes with a high dissimilarities coefficient.

4. CONCLUSION

The 20 aromatic rice genotypes showed genetic variability and divergence. The additive gene action was prominent for the traits-plant height, panicle length, number of filled grains per plant and 1000 grain weight. Correlation study at phenotypic level revealed that grain yield per plant was positive and significantly correlated with total number of panicles per plant and total number of filled grains per plant, so the selection of genotypes with higher panicles per plant, number of filled grains per panicle and total number of filled grains per plant will result in higher yield. Path analysis reveals that panicles per plant and 1000 grain weight are positively related to higher grain yield. The cluster analysis groups the genotypes into different clusters with specific character traits can help select parental lines in future breeding programmes. The highest genetic distance has been observed in Paramanya and Dehradun Basmati, Gobindobhog and Gandeswari and Gobindobhog and Paramanya. If crossing consists of diverse parents then the F1 generation express considerable amount of heterosis also providing a wide spectrum of recombinants in segregating generations. In the present investigation it is observed that grouping of genotypes based on multivariate analysis was not completely dependent on origin of cultivars. The conventional breeding technique, to select genotypes belonging to different geographical origins to maximize the diversity available to a breeding project does not follow in aromatic rice.

Table 1: List of 20 genotypes.

SERIAL NO.	ENTRY NAME	SERIAL NO.	ENTRY NAME
1	GOBINDOBHOG	11	DEHDRADUN BASMATI
2	PARAMANYA	12	SEETASHAL
3	PUSA BASMATI-I	13	TULAIPANJI
4	KALO NUNIA	14	DADHSAL
5	GANDESWARI	15	KAMAL DHAN
6	RADHUNIPAGOL	16	LAGHU DHAN
7	CHINISHAKKAR	17	JAMAI NADU
8	GOBINDOBHOG (SELECTION)	18	SEETABHOG
9	DANAGURI	19	GOPALBHOG
10	KANAKCHUR	20	KATARIBHOG

Table 2: ANOVA for the yield and yield attributing traits.

*Significant at 5% probability level. **Significant at 1% probability level at 0.01%
DF-Degrees of Freedom

Source	DF	DAYS TO 50% FLOWERING	DAYS TO MATURITY	PLANT HEIGHT	TILLERS PER PLANT	PANICLES PER PLANT	TOTAL NO. OF FILLED GRAINS PER PLANT	1000 GRAIN WEIGHT	YIELD PER PLANT
Replications	2	1.26	2.066	14.82**	49.82**	0.216	673.35**	0.13	24.32**
Treatments	19	16.61**	16.93**	591.96**	18.65**	47.293**	7904.03**	44.72**	1096.73**
Error	38	0.58	0.557	22.24**	5.82*	6.199**	595.93**	0.33	50.553**

Table 3: Estimates of Genetic Parameters.

	CD	C.V.	G.C.V (%)	P.C.V (%)	H (%)	GA
DAYS TO 50% FLOWERING	1.2338	0.743	2.25	2.37	90.17	4.2927
DAYS TO MATURITY	1.2675	0.5857	1.83	1.92	90.72	4.3658
PLANT HEIGHT	7.6236	3.8039	11.12	11.75	89.52	25.4125
TILLERS PER PLANT	3.899	14.949	12.82	19.69	42.37	1.80489
PANICLES PER PLANT	4.025	15.9773	23.75	28.62	68.84	5.2489
TOTAL NO. OF FILLED GRAINS PER PLANT	39.465	14.948	30.22	33.72	80.35	81.689
1000 GRAIN WEIGHT	0.9306	3.5974	24.04	24.31	97.81	7.75027
GRAIN YIELD PER PLANT	11.494	17.469	45.88	49.10	87.34	33.598

Table 4: Phenotypic correlation coefficients among yield and its components.

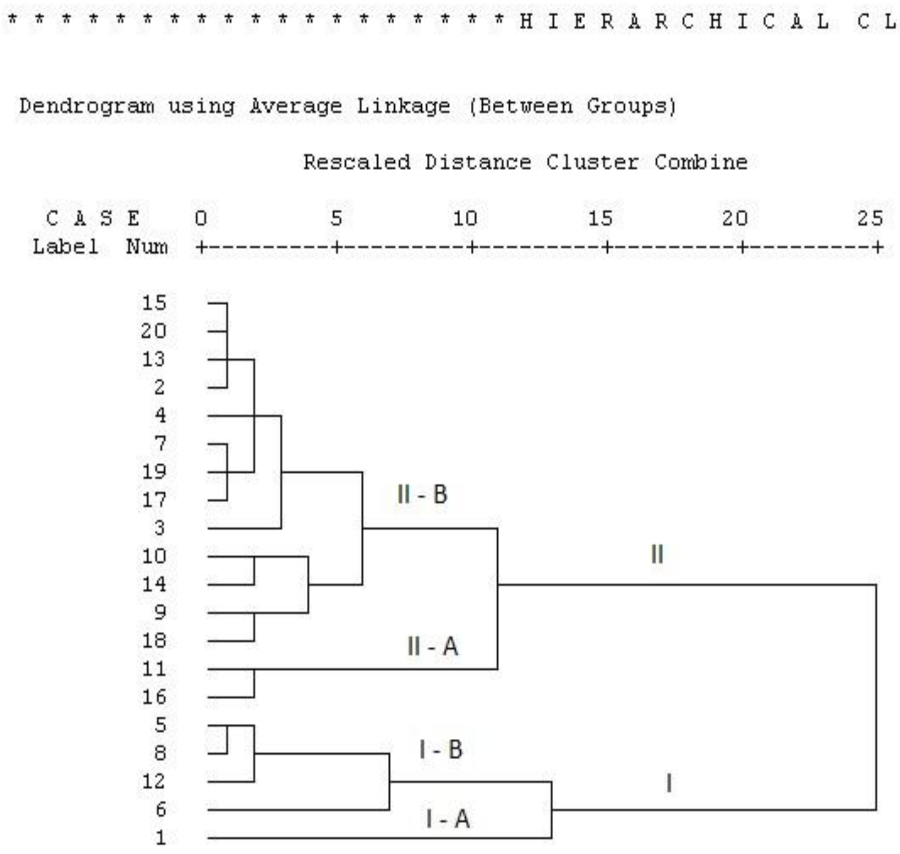
	DF	DM	PH	TP	PP	PL	FGP	GW	GYP
DF	1								
DM	0.87**	1							
PH	.492*	.492*	1						
TP	.266	.266	.262	1					
PP	.333	.333	.318	.585**	1				
PL	-.227	-.227	.017	.144	.266	1			
FGP	.006	.006	-.096	.198	.450*	.398	1		
GW	-.011	-.011	.084	-.137	-.157	-.076	-.439		
GYP	.181	.181	.190	.434	.799**	.437	.716**	.081	1

**.Correlation is significant at 0.01 level (2-tailed). *.Correlation is significant at 0.05 level (2-tailed).

Table 5: Path Analysis.

	DF	DM	PH	PP	TP	FGP	GW
DF	**0.0991**	0.1019	0.0525	0.0325	0.0251	-0.0072	0.0017
DM	-0.1341	**-0.1305**	-0.0659	-0.423	-0.0316	0.0046	-0.0056
PH	0.0182	0.0173	**0.0343**	0.0124	0.0120	-0.0037	0.0029
PP	0.1696	0.1674	0.1861	**0.5163**	0.4000	0.2641	-0.0910
TP	0.0157	0.0150	0.0217	0.0479	**0.0619**	0.0139	-0.0071
FGP	-0.0491	-0.0239	-0.0730	0.3473	0.1520	**0.6791**	-0.3154
GW	0.0087	0.0209	0.0413	-0.0866	-0.0563	-0.2281	**0.4911**

Residual Value:- 0.1092



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Dendrogram using Average Linkage (Between Groups)

                          Rescaled Distance Cluster Combine
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Refer to Table 1 for name of genotypes.

Figure 1 shows Dendrogram of 20 aromatic rice genotypes based on agro- morphological data.

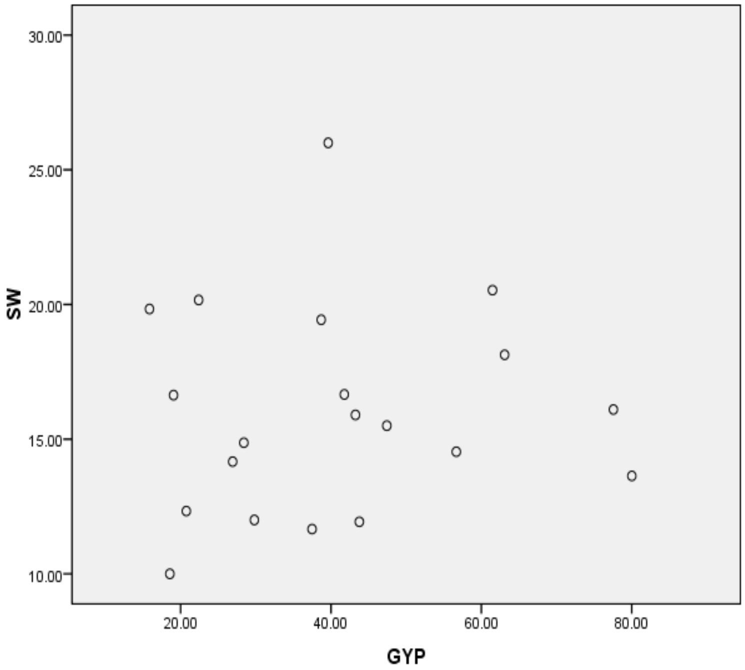

Figure 2 : Plot showing association between Seed Weight and Grain Yield per Plant.

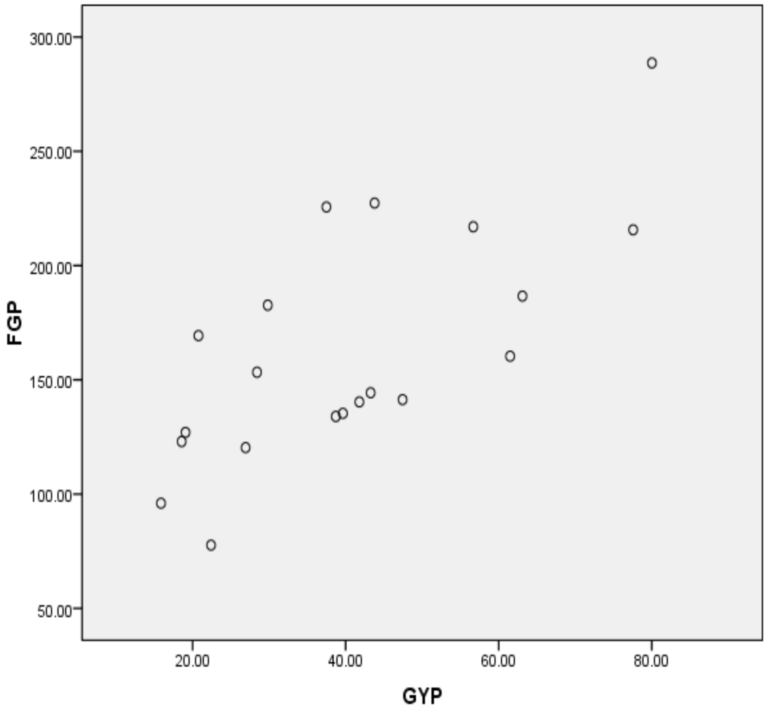

Figure 3: Plot showing association between Filled Grain per Plant and Grain Yield per Plant.

ACKNOWLEDGEMENT

The authors are grateful to DST-INSPIRE for providing the financial support to accomplish this research programme in Aromatic rice.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS'CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABBREVIATIONS

G.C.V- Genetic Coefficient of Variability.

P.C.V-Phenotypic Coefficient of Variability.

H-Heritability.

GA-Genetic Advance.

DF- Days to Flowering

DM- Days to Maturity.

PH-Plant Height.

TP-Tillers per Plant.

PP-Panicles per Plant.

FGP- Filled Grains per Plant.

SW-Seed (Grain) Weight.

GYP- Grain Yield per Plant.