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Genetic diversity analysis in aromatic lines of rice (*Oryza sativa* L.)

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Abstract
The forty five genotypes of Aromatic Rice were studied for genetic divergence .The observation were recorded on thirteen quantitative and three cooking quality characters. All the characters showed highly significant differences among the genotypes for all the characters, indicated that appreciable amount of diversity was present among the genotypes. The VDNGS-12 for grain yield per plant, straw yield per plant, VDNGS-19 for early flowering , L: B ratio, kernel length after cooking, amylase content, VDNGS-25 for productive tillers per square meter, 1000 grain weight, grain yield per plant, VDNGS-30 for productive tillers per plant, productive tillers per sq.m, 1000 grain weight, grain yield, amylase content, VDNGS-31 for L:B ratio kernel length after cooking, VDNGS-36 for number of seeds per panicle, 1000 grain weight, VDNGS-44 for number of tillers per sq. m., grain yield per plant were found to be superior genotype on the basis of *per se* performance.
The 45 genotypes were grouped into 10 clusters and the clusters I, II, IV, V and VI contained 21, 4 , 2, 8 and 5 genotypes, respectively. While, the clusters III, VII ,VIII, IX and X were monogenotypic. D^2 analysis revealed that there was a wide diversity between the genotypes. Suggesting that the genotypes may provide large source of variation under breeding programme. On the basis of per se performance and divergence classes the following genotypes were suggested for further breeding programme, *viz.*, VDNGS-4, VDNGS-12, VDNGS-19, VDNGS-25, VDNGS- 30, VDNGS-31, VDNGS-20, VDNGS-44, For improvement of yield and yield components in Aromatic Rice.

Keywords: genetic diversity, variability, rice, aromatic rice, *Oryza sativa* L.

Introduction
Oryza sativa L. (2n = 24) is one of the cultivated rice provides food for more than one third of the world's population. 90% of the world's rice is grown in Asia. India stands second in rice production after China producing approx.119 million tonnes per annum. The demand of food grains to feed growing population is increasing every year, and hence to achieve sustainable production in rice, advanced breeding methods and biotechnological tools are required. A Number of rice varieties were developed by the continuous cultivation and selection process over the years, though landraces usage in plant breeding programmes is very limited and so utilization of these diverse genotypes in breeding events may useful in improving the productivity.
The efficiency of selection in the divergent population largely depends on the range of genetic variability present in a population. The phenotypic variation observed in the genotypes is the result of interaction between genotypic and environmental factors (GXE) and genetic factor alone heritable. The current study was carried out to estimate genetic diversity studies among rice genotypes for selection of divergent genotypes and identification of traits rewarding yield improvement in rice.

Material and Methods
The present investigation "Genetic diversity in Aromatic Lines of Rice (Oryza sativa L.)" was conducted at Agricultural Research Station, Vadgaon Maval, Pune during Kharif 2016. For the present study forty five genotypes of rice originating from different geographic regions and showing phenotypic variability for different agronomic and yield characters were used. Sowing of forty five genotypes of rice on nursery seed bed was completed on 16th June, 2016. and transplanting was done on 14th July 2016. The experiment was done by using randomized block design with three replications. All recommended agronomic practices such as weeding, fertilizer application were carried out as and when required. Observations on twelve quantitative characters viz, Days to 50 percent flowering (No.), Days to maturity (No.), Plant height (cm), Productive tillers per plant (No.), Number of tillers per sq. m. (No.), Panicle length (cm), Number of Grains per panicle (No.), , 1000 grain weight (g), Straw yield per plant (g), Length: Breadth ratio of grain, Harvest index (%) and Grain yield per plant (g).

The analysis of variance for the characters were studied as per procedure given by Pance and Sukhatme (1961) [5] and the generalized distance between two population estimated as per procedure given by Mahalanobis (1936) [3] and formation of cluster by Tocher's method described by Rao (1952) [8].

Results and Discussions

Genetic divergence

As per analysis of variance indicated that there was sustainable amount of variability present in the material studied (Table-1). Mahalanobis´s (1936) [3] distance statistic (D^2) is a useful tool for this and is now well established and widely used in plant breeding for classifying the genetic stocks, on the basis of genetic divergence between populations.

Clusters their distances and mean performances

Clustering of genotypes following the Tocher´s method as described by Rao (1952) [8] led to formation of ten clusters in the present study. This distribution of genotypes into different clusters is presented in Table 2. The cluster I comprised most of the genotypes i.e. 21, while cluster II had 4 genotypes, cluster IV had 2 genotypes, cluster V had 8 genotypes, cluster VI had 5 genotypes and cluster III , VII, VIII, IX and X was monogenotypic. Grouping of genotypes into ten clusters suggested the presence of relatively more amount of genetic diversity in the material under investigation.

Perusal of Table 3 revealed that maximum inter-cluster distance was observed between cluster IV and VI (36.04) suggesting that genotypes included in cluster IV might have entirely different genetical architecture from the genotypes include in the cluster VI. This maximum inter-cluster distance value was followed by cluster VI and cluster VIII (33.70).Cluster VI had 5 genotypes and cluster VIII had 1 genotype , then cluster VIII and IX (29.56) both cluster have 1 genotype then cluster II and cluster VI (26.68), cluster II had 4 genotypes and cluster VI had 5 genotypes then cluster IV and cluster IX (26.42) in that cluster IV had 2 genotype and IX have 1 genotype.

Based on mean performances of clusters for 12 characters (Table 4), it revealed wide range of variability among the clusters for all the characters. The genotypes in cluster IX were early for days to 50 per cent flowering (82.33) and also earliest for days to maturity. For days to maturity, range of cluster means was observed between 116.00 (cluster VII) and 133.17 (cluster II). Plant height showed range of cluster means from 83.67 (cluster IX) to 126.47 cm (cluster IV). Productive tillers per plant ranged for their cluster means between 11.43(cluster VII) and 15.47 (cluster VIII). Number of tillers per square meter ranged for their cluster mean between 381.00 (cluster VII) and 515.67 (cluster VIII). Mean panicle length of clusters ranged between 17.27cm (cluster III) and 24.93 cm (cluster VII). Number of grains per panicle differed in the range of cluster means between 154.10 (cluster VII) and 245.43 (cluster VIII). Length: breadth ratio of grain showed the range of cluster means between 1.85 (cluster V) and 3.89 (cluster IX). The trait, 1000 grain weight exhibited range of variation for cluster means between 10.33 g (cluster VIII) and 29.67g (cluster VI). Seed yield per plant varied from 47.47 g (cluster III) to 67.07 g (cluster VIII) among the clusters. Straw yield per plant exhibited range of cluster mean performance from 56.40 g (cluster II) to 85.80 g (cluster VIII). Harvest index varied from 55 percent (cluster IV) to 91 percent (cluster II). The divergence in quantitative characters were also reported by, Bidhan *et al*. (2002) [1], Nayak *et al*, (2002) [4], Pater *et al* (2014) [6], Prasad *et al* (2009) [7] Sandhyakishore *et al* (2007) [9] and Vennila *et al*. (2011) [10] in rice. Discrepancies in the results might be due to the different sets of material and also due to the role of environmental variability as suggested by Karthikeyan and Anubuselvam (2008) [2].

Genetic divergence and selection of potent parents

The success of crop improvement programme involves selection of the best parents having high potential for the economically important characters. Among the different approaches of selecting parents, selection based on diversity has its own significance as diversity is the basic need of crop improvement. D^2 analysis revealed that there was a wide diversity between the genotypes. Suggesting that genotypes may provide large source of variation under breeding programme. On the basis of per se divergence classes the following genotypes were suggested for further breeding programme - VDNGS-4, VDNGS- 12, VDNGS-19, VDNGS-25, VDNGS-30, VDNGS-31, VDNGS-20 and VDNGS-44.

Table 1: Analysis of variance for 12 characters in rice

Sr. No	Characters	MSS	
		Treatment (d. f.44)	Error (d. f. :88)
1	Days to 50% Flowering (No.)	75.75**	0.90
2	Days to Maturity (No.)	90.53**	1.59
3	Plant height (cm.)	611.35**	4.23
4	Productive tillers/ plant (No.)	20.62**	10.53
5	Number of tillers per Sq. m.	8815.90**	341.18
6	Panicle length (cm.)	7.96**	0.81
7	No. of gains per panicle (No.)	1163.58**	197.65
8	Grain yield per plant (g)	424.53**	8.40
9	1000 Grain weight (g)	77.36**	0.14
10	Straw yield per plant (g)	518.24**	7.74
11	L:B Ratio	1.42**	0.003
12	Harvest Index	0.037**	0.001

Table 2: Number of clusters

Cluster Number	No. of genotypes in the cluster	Genotypes
Cluster I	21	VDNGS-11, VDNGS-22, VDNGS-10, VDNGS-13, VDNGS-35, VDNGS-39, VDNGS-12, VDNGS-14, VDNGS-26, VDNGS-29, VDNGS-28, VDNGS-45, VDNGS-27, VDNGS-40, VDNGS-31, VDNGS-37,

		VDNGS-43, VDNGS-44, VDNGS-34, VDNGS-21, VDNGS-41.
Cluster II	4	VDNGS-1, VDNGS-3, VDNGS-4, VDNGS-5.
Cluster III	1	VDNGS-23
Cluster IV	2	VDNGS-2, VDNGS-6
Cluster V	8	VDNGS-16, VDNGS-17, VDNGS-25, VDNGS-24, VDNGS-9, VDNGS-8, VDNGS-42, VDNGS-18
Cluster VI	5	VDNGS- 20,VDNGS-32, VDNGS-38, VDNGS-30, VDNGS-15.
Cluster VII	1	VDNGS-33
Cluster VIII	1	VDNGS-36
ClusterIX	1	VDNGS-19
ClusterX	1	VDNGS-7

Table 3: Average intra and inter cluster D² values and D (parenthesis) of 45 genotypes of rice

	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI	Cluster VII	Cluster VIII	Cluster IX	Cluster X
Cluster I	86.11 (9.28)	324.36 (18.01)	138.06 (11.75)	543.36 (23.31)	367.49 (19.17)	376.36 (19.40)	169.52 (13.02)	618.02 (24.86)	192.10 (13.86)	192.10 (13.86)
Cluster II		95.06 (9.75)	231.34 (15.21)	303.80 (17.43)	297.56 (17.25)	711.82 (26.68)	424.77 (20.61)	513.93 (22.67)	607.12 (24.64)	176.09 (13.27)
Cluster III			0.00	387.70 (19.69)	198.53 (14.09)	403.21 (20.08)	96.24 (9.81)	374.42 (19.35)	203.63 (14.27)	133.63 (11.56)
Cluster IV				27.56 (5.25)	606.64 (24.63)	1298.88 (36.04)	480.49 (21.92)	474.80 (21.79)	698.02 (26.42)	273.57 (16.54)
Cluster V					179.29 (13.39)	519.38 (22.79)	406.02 (20.15)	298.94 (17.29)	644.14 (25.38)	372.49 (19.30)
Cluster VI						164.09 (12.81)	560.74 (23.68)	1135.69 (33.70)	537.78 (23.19)	549.43 (23.44)
Cluster VII							0.00	485.76 (22.04)	97.61 (9.88)	180.36 (13.43)
Cluster VIII								0.00	873.79 (29.56)	574.56 (23.97)
Cluster IX									0.00	256.32 (16.01)
Cluster X										0.00

Table 4: Mean Performance of clusters in rice

Cluster no.	Days to 50% Flowering (No.)	Days to Maturity (No)	Plant height (cm)	Productive tillers/ plant (No.)	Number of tillers per Sqm.	Panicle length (cm.)	No. of grains per panicle	Grain yield per plant (g.)	1000 Grain Weight (g.)	Straw yield per plant (g.)	L:B Ratio	Harvest Index (%)
ClusterI	96.03	127.71	89.14	14.46	462.22	19.57	154.36	56.77	22.97	73.55	3.30	77
ClusterII	98.83	133.17	125.63	13.38	446.08	20.52	169.97	51.50	17.28	56.40	2.46	91
ClusterIII	87.67	121.00	88.93	11.80	393.67	17.27	156.10	47.47	20.20	64.80	2.70	73
ClusterIV	95.50	130.17	126.47	12.33	411.00	18.93	164.40	34.02	10.88	62.00	3.37	55
ClusterV	94.17	125.42	90.51	13.71	456.79	19.05	163.22	60.84	17.58	74.65	1.85	81
ClusterVI	91.67	122.80	88.96	13.81	460.47	20.24	158.16	55.67	29.67	77.72	2.15	74
ClusterVII	86.00	116.00	85.20	11.43	381.00	24.93	154.10	59.87	21.40	71.00	3.43	84
ClusterVIII	95.00	123.33	83.73	15.47	515.67	22.47	245.43	67.07	10.33	85.80	2.15	78
ClusterIX	82.33	116.67	83.67	14.47	482.33	18.13	156.79	60.47	25.40	71.73	3.89	84
ClusterX	94.00	121.00	123.13	11.87	395.67	19.13	159.90	64.20	19.33	78.07	3.14	80

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