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Genetic divergence studies for agro-morphological and yield attributing traits in locally adopted rice varieties of Bihar

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Abstract
Twenty two rice varieties were planted in RBD with 3 replications during 2018-19 at Rice Research farm, RPCAU, Pusa, Samastipur, Bihar to study the genetic divergence for yield and its components. Based on Tocher's clustering, all the 22 varieties were grouped into five clusters. Dular grouped in cluster III exhibited earliness in days to fifty 50% flowering, days to maturity, minimum panicle length of main axis, minimum panicle number per plant, lesser 1000 grain weight, shortest grain length, minimum root volume and minimum grain yield based on cluster mean and *per se* performance. The variety Rajendra Saraswati in cluster V exhibited superiority for panicle length of main axis, width of leaf blade, grain length, decorticated grain length, root volume and grain yield per plant with highest cluster mean and superior *per se* performance. The variety Dhanlaxmi in Cluster II was found superior for panicle number per plant with highest cluster mean and superior *per se* performance. The variety namely Dinesh in cluster IV for higher 1000 grain weight and grain width based on cluster mean and superior *per se* performance. The variety Rajendra Mahsuri was selected from cluster I for dwarfness based on cluster mean and superior *per se* performance. The variety in cluster II and cluster V, due to maximum inter cluster distance between them, exhibited high degree of genetic diversity and thus may be utilized under inter varietal hybridization programme (transgressive breeding) for getting high yielding recombinants. Similar inter varietal crosses may be attempted between varieties in cluster II and IV, cluster III and V, cluster III and IV and cluster I and V for yield. The maximum contribution in the manifestation of genetic divergence was exhibited by length of leaf blade followed by decorticated grain width, grain yield per plant, decorticated grain length, days to 50% flowering, 1000 grain weight, stem thickness, days to maturity, panicle length of main axis and grain length suggesting scope for improvement in these characters. In other words, selection for these characters may be rewarding.

Keywords: adolescents, attitude, parents, parental involvement, everyday life

Introduction
Rice (*Oryza sativa* L.) is one of the most important food crops of the world particularly Asian countries where it is the staple food. The estimated world rice production for the year 2019-20 is 496.67 million metric tons (USDA, 2020) [21]. It may be originated at least 130 million years ago and dispersed all around the world with separation of different continent from the single land mass that existed. It is produced in wide range of locations and under different climatic conditions. As it grows in variable climatic condition and having such an extended geographical distribution throughout the world it is the crop with maximum germplasm diversity. As the consequence of great geographical distribution and extending its boundaries to various climatic conditions it faces several form abiotic stresses occurring in those environment and flooding being of those. Therefore, study of the diversity of rice in low lying flooded area is of prime importance for the development of new varieties, to sustain the rice production and improve the socioeconomic status of people living in these areas. Genetic divergence among the genotypes plays an important role in selection of parents having wider variability for different traits (Nayak *et al*., 2004) [14] and it also helps in the development of superior recombinants (Manonmani and Khan, 2003b) [13]. Genetic diversity analysis is done with help of D2 statistics developed by P. C. Mahalanobis. Genetic divergence analysis evaluates the genetical distance among the selected genotypes and shows the relative contribution of specific traits towards the total divergence (Iftekharuddaulae *et al*., 2002) [8].

Materials and Methods

The present investigation was conducted at Rice Breeding Section, Pusa Farm, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar during kharif 2019. Total of 22 rice (table 1) were investigated, which were sown in RBD fashion at standard spacing of 15 x 20 cm in 3 replications. All the recommended packages of practices were given during the growth period. Observations for fifteen characters were recorded viz., days to 50% flowering, days to maturity, plant height (cm), grain length (mm), grain width (mm), kernel length (mm), root volume (mm3), panicle length of main axis` (cm), leaf length (cm), leaf width (cm), no. of panicle, stem thickness (mm), 1000 grain weight, kernel width(mm), grain yield per plant (g). Various parameters of genetic diversity like clustering pattern of various genotypes, mean intra and inter-cluster distances among the different clusters, cluster mean, contribution of individual character to divergence and dendrogram of the clustering pattern were analysed using the data recorded for the fifteen characters.

Table 1: List of genotypes

Sl. No.	Name of Varieties	Sl. No.	Name of Varieties
1.	Rajendra Bhagwati	12.	Saroj
2.	Rajendra Nilam	13.	Gautam
3.	Rajendra Saraswati	14.	Sita
4.	Rajendra Kasturi	15.	Sahbhagi Dhan
5.	Rajendra Suwasini	16.	Pooja
6.	Rajendra Sweta	17.	Swarna sub-1
7.	Rajendra Mahsuri 1	18.	BPT5204
8.	Prabhat	19.	Kalanamak
9.	Richharia	20.	Dinesh
10.	Turanta	21.	Dular
11.	Dhanlaxmi	22.	Sabour Surbhit

Results and Discussion

Genetic diversity is the most important tool in the hands of the plant breeder in choosing the right type of parents for hybridization program. The divergence can be studied by technique using D2 statistics developed by Mahalanobis (1936) [11]. This is considered as the most effective method for qualifying the degree of genetic diversity among the genotypes included in the study. The present investigation aimed to estimate the magnitude of genetic divergence present in the 22 rice varieties and to identify the diverse verieties for future utilization breeding program. In the present investigation, all the twenty two varieties were grouped into five clusters on the basis of D^2 statistics and ward minimum variance. Cluster I comprises largest number of genotypes (18). The cluster II, III, IV and V were solitary (monogenotypic), comprising single genotype. Similar studies based on D^2-statistic was also performed by Chauhan and Singh (2003) [5], Sankar *et al.* (2005) [18], Sood *et al.* (2005) [20], Singh *et al.* (2008) [19], Raut (2009) [16, 17] and Mall *et al.* (2011) [12].

The highest intra cluster distance was observed in cluster I, indicating differences in genotypes within cluster. The genotypes in cluster II and cluster V exhibited high degree of genetic diversity due to maximum inter cluster distance between them and thus may be utilized under inter varietal hybridization programme for getting high yielding recombinants. Similar inter varietal crosses may be attempted between genotypes in cluster II and IV, cluster III and V, cluster III and IV, cluster I and V. The lowest inter cluster distance was observed between cluster II and III showing this cluster was relatively less divergent and crossing between them cannot produce vigorous offspring (F_1 progenies). Similar studies based on D^2 statistic was also performed by that of Chandra *et al.* (2007) [3].

Table 2: Clustering pattern of twenty-two genotypes of rice on the basis of D2 statistics

Clusters	No. of genotypes within cluster	Genotypes in cluster
I	18	Rajendra Nilam, Sahbhagi, Gautam, Rajendra Bhagwati, Pooja, Rajendra Suwashini, Prabhat, Saroj, Sabour Surabhi, Rajendra Kasturi, Sita, Rajendra Mahsuri, Rajendra Shweta, Swarna sub-1, BPT-5204, Richharia, Kalanamak, Turanta
II	1	Dhanlaxmi
III	1	Dular
IV	1	Dinesh
V	1	Rajendra Saraswati

Table 3: Mean intra and inter cluster distance (D2) among six cluster in rice

Clusters	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V
Cluster I	10.33				
Cluster II	13.83	00.00			
Cluster III	13.76	10.51	00.00		
Cluster IV	13.69	21.31	19.91	00.00	
Cluster V	19.76	24.26	20.81	16.77	00.00

Table 4: Cluster mean values of 6 clusters of different quantitative characters in 22 rice cultivars

Cluster/characters	DFF	DM	SL	ST	PL	PP	LLB	WLB	TGW	GL	GW	DGL	DGW	RV	GY/P
Cluster I	93.52	123.76	107.86	6.58	24.98	14.89	37.84	1.12	26.53	8.50	2.38	5.87	1.86	20815.34	25.97
Cluster II	79.67	104.67	118.45	6.24	25.30	21.33	52.11	1.27	29.91	10.52	2.94	6.52	1.36	20000.73	30.77
Cluster III	70.33	101.00	118.89	7.30	23.45	10.67	59.64	1.28	25.70	8.30	2.86	6.46	2.37	17667.34	23.33
Cluster IV	115.33	143.33	119.45	6.49	24.73	12.67	23.78	1.14	37.80	9.44	3.54	6.32	2.21	19667.22	27.83
Cluster V	84.00	118.00	108.25	6.38	27.90	17.33	45.94	1.31	32.84	12.17	2.34	8.55	1.14	20667.06	30.93

G.L.= Grain Length, GW= Grain Width, DGL= Decorticated Grain Length, DFF= Days TO 50% Flowering, RV= Root Volume, PL= Panicle Length of Main Axis, WLB= Width OF Leaf Blade, PL= Panicles PER Plant, DM= Days TO Maturity, ST= Stem Thickness, TGW=1000 Grain Weight, DGW =Decorticated Grain Width, LLB= Length OF Leaf Blade, GY/P= Grain Yield Per Plant

Table 5: Ranking and contribution of character towards divergence

Sl No.	characters	Time rank 1	Percentage Contribution
1.	Days to 50% flowering(days)	17	7.36
2.	Days to maturity(days)	10	4.33
3.	Stem length (cm)	3	1.30
4.	Stem thickness(mm)	11	4.76
5.	Panicle length of main axis(cm)	7	3.03
6.	Panicle number per plant(no.)	0	0.00
7.	Length of leaf blade(cm)	59	25.54
8.	Width of leaf blade(cm)	1	0.43
9.	1000 grain weight(gm)	13	5.63
10.	Grain length(mm)	6	2.60
11.	Grain width(mm)	2	0.87
12.	Decorticated grain length(mm)	30	12.99
13.	Decorticated grain width(mm)	39	16.88
14.	Root volume(mm^3)	0	0.00
15.	Grain yield per plant (gm)	33	14.29

Table 6: Diverse Rice genotypes based on genetic distance and superior *per se* performance for the traits under investigation

Sl No.	Characters		Cluster	Suitable Genotype in Cluster	Per se Performance
1	DFF	Early	III	Dular	70.33
		Late	IV	Dinesh	115.33
2	DM	Early	III	Dular	101.00
		Late	IV	Dinesh	143.33
3	SL	Dwarf	I	Rajendra Mahsuri	107.42
		Tall	IV	Dinesh	119.45
4	ST	Max	II	Dhanlaxmi	6.24
		Min	III	Dular	7.30
5	PL	Max	V	Rajendra Saraswati	27.90
		Min	III	Dular	23.45
6	pp	Max	II	Dhanlaxmi	21.33
		Min	III	Dular	10.67
7	LLB	Max	III	Dular	59.64
		Min	IV	Dinesh	23.78
8	WLB	Max	V	Rajendra Saraswati	1.31
		Min	I	Rajendra Shweta	1.13
9	TGW	Min	III	Dular	25.70
		Max	IV	Dinesh	37.80
10	GL	Min	III	Dular	8.30
		Max	V	Rajendra Saraswati	12.17
11	GW	Max	IV	Dinesh	3.54
		Min	V	Rajendra Saraswati	2.34
12	DGL	Max	V	Rajendra Saraswati	8.55
		Min	I	Rajendra Nilam	5.87
13	DGW	Max	III	Dular	2.37
		Min	V	Rajendra Saraswati	1.14
14	RV	Max	V	Rajendra Saraswati	20667.06
		Min	III	Dular	17667.34
15	GY/P	Max	V	Rajendra Saraswati	30.93
		Min	III	Dular	23.33

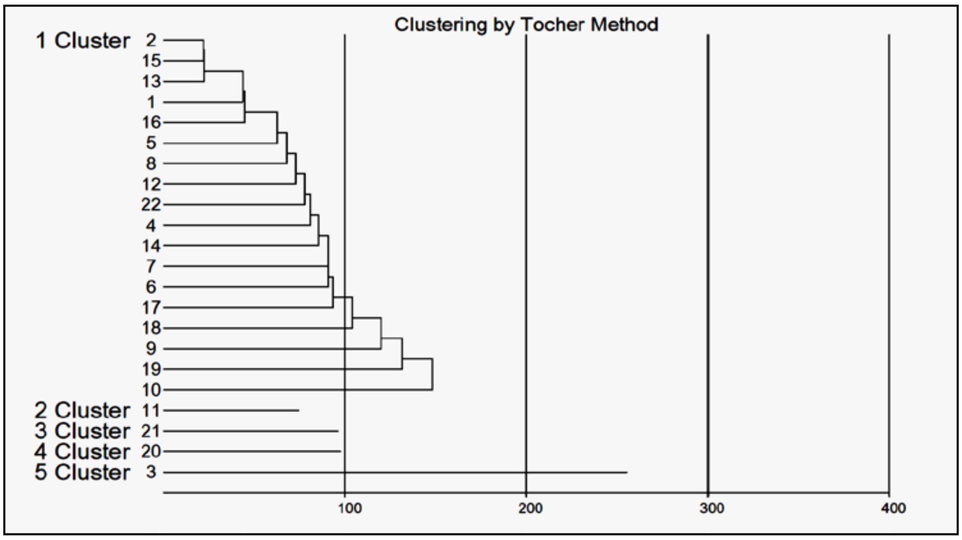

Fig 1: Clustering pattern of 22 rice cultivars on the basis of D2 statistics by Tocher's method

Cluster mean analysis

Different clusters comprises unique feature for different characters under investigation. On the basis of cluster mean values, cluster IV was found late in terms of days to fifty per cent flowering, days to maturity, stem length excluding panicle and maximum for 1000 grain weight and grain width but less for length of leaf blade. Cluster II have maximum panicle number per plant and minimum for stem thickness and decorticated grain width. Cluster III may be selected as maximum for stem thickness, length of leaf blade but less for days to 50% flowering, day to maturity, panicle length of main axis, panicle number per plant, 1000 grain weight, grain length, root volume and grain yield per plant. Cluster I was minimum for stem length excluding panicle, width of leaf blade and decorticated grain length, none of the characters showed maximum value in this cluster. Cluster V was suitable for panicle length of main axis, width of leaf blade, grain length, decorticated grain length, decorticated grain width and root volume whereas minimum value for grain width. Therefore, this cluster may be selected for transferring the traits with high mean values through hybridization programme. Selection of genotypes based on cluster mean for the better exploitation of genetic potential has earlier been reported by kumar S. (2008) [15], Kumar *et al.* (2009) [10], Ramya and Arivoli *et al.* (2009) [2], Raut *et al.* (2009) [16, 17], Gahalain *et al.* (2010), Abarshahr, *et al.* (2011) [1] and Chaturvedi, *et al.* (2011) [4].

Percent contribution of character towards total genetic diversity

The selection and choice of parents mainly depends upon contribution of characters towards divergence. The maximum contribution in the manifestation of genetic divergence was exhibited by length of leaf blade followed by decorticated grain width, grain yield per plant, decorticated grain length, days to 50% flowering, 1000 grain weight, stem thickness, days to maturity, panicle length of main axis and grain length suggesting scope for improvement in these characters. In other words, selection for these characters may be rewarding. The contribution of remaining traits in manifestation of genetic divergence was low. Similar observations were recorded by Hegde and Patil (2000) [7], Kumar *et al.* (2009) [15] and Chandra *et al.* (2007) [3], for character contribution towards total divergence.

Choice of suitable genotypes for future breeding programme

In the present study, 22 diverse genotypes were grouped into various cluster and suitable diverse genotypes were selected based on their cluster mean superiority and per se performance for different characters as presented in table 6.

Dular in cluster III exhibited earliness in days to fifty 50%flowering, days to maturity, minimum panicle length of main axis, minimum panicle number per plant, minimum 1000 grain weight, minimum grain length, minimum root volume and minimum grain yield whereas Rajendra Saraswati in cluster V exhibited superiority for panicle length of main axis, width of leaf blade, grain length, decorticated grain length, root volume and grain yield per plant with highest cluster mean and superior *per se* performance. The genotype Dhanlaxmi in Cluster II showed superior performance for panicle number per plant while Dinesh in cluster IV for maximum 1000 grain weight and grain width based on cluster mean and superior *per se* performance. The genotype Rajendra Mahsuri was selected from cluster I for dwarfness based on cluster mean and superior *per se* performance. Similar pattern were observed by Ramya and Arivoli *et al.* (2009) [2] and Raut *et al.* (2009) [16, 17].

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