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GENETIC DIVERSITY AND CHARACTER ASSOCIATION STUDIES FOR SOME ECONOMIC TRAITS IN RICE (*ORYZA SATIVA* L.)

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ABSTRACT
An investigation was carried out to assess the nature and magnitude of genetic diversity was in 57 genotypes of rice using Mahalanobis D^2 statistics. They were evaluated for thirteen yield and yield attributing characters and based on D^2 analysis, 57 genotypes were grouped into 13 clusters. Clusters II and IV was the largest cluster containing 14 genotypes each followed by cluster III with 11 genotypes. The pattern of distribution of genotypes within different clusters was random and independent of geographical origin or region of adaptation. The characters like days to maturity (34.21%), days to flowering (27.44), grain length (19.55%) and grain width (12.16%) contributing maximum towards diversity. Hence these characters can be given consideration for selection of genotypes for future breeding programmes. The effective tillers (0.474), spikelet fertility (0.323), biological yield (0.723) and harvest index (0.744) in land races, plant height (0.542), panicle length (0.356), effective tillers (0.436), spikelet fertility (0.317), biological yield (0.766) and harvest index (0.744) in new plant types and panicle length (0.386), spikelets and grains per panicle (0.459, 0.498), biological yield (0.627) and harvest index (0.627)in japonicas were positively associated with grain yield indicating that these are the important characters and can be strategically used to improve the yield of rice.

INTRODUCTION

Rice (Oryza sativa L.) is one of the world's most widely cultivated crop species and is staple food for more than half of the human population in the world and about two third in India. About 785 million tonnes of paddy which is 70 per cent more than the current production will be required to growing demand by 2025 (Manonmani and Khan, 2003a). Being staple food for majority of the population in India, improvement in its productivity has become crucial. The pace and magnitude of genetic improvement generally depend on the amount of genetic diversity present in a population and it is estimated that not even 15% of the potential diversity has utilized till date. Genetic divergence among the genotypes plays an important role in selection of parents having wider variability for different traits (Nayak *et al.*, 2004) and it also helps in the development of superior recombinants (Manonmani and Khan, 2003b). The use of D^2 statistics has been emphasized by many workers (Roy *et al.* 2002, Datt and Mani, 2003 and Kumar *et al.*, 2014).The presence of sufficient diversity and knowledge of the nature of inter-associations among yield and yield attributing characters is basic and fore most endeavor to find out the guidelines for plant selection.

Keeping this in view, the present study was conducted to estimate the diversity among 57 genotypes for selection of diverse genotypes for utilization in future breeding programmes and to know the inter-associations among yield and yield attributing traits.

MATERIALS AND METHODS

The material consisted of fifty seven genotypes involving some land races (*indica* and *japonicas*) & improved varieties of Himachal Pradesh and advanced lines of new plant types obtained from IRRI, Philippines (Table 1). The experiment was conducted at the experimental farms of the Department of Plant Breeding & Genetics, CSK HPKV, Palampur in compact family block design with indica, japonica and new plant types as three different families with 3 replications for two consecutive years. Each entry was sown in a plot of 3 rows of 2.1 meter length with inter and intra-row spacing of 20 cm and 15 cm, respectively.

Data were recorded on five randomly selected plants per plot for grain yield per plant (g), plant height (cm), total tillers per plant, effective tillers per plant, biological yield per plant (g), harvest index (%), 1000-grain weight (g) and on plot basis for days to flowering, days to maturity. Panicle length and spikelet fertility (%) were recorded on five panicles selected plants, the quality characters like grain length (mm) and grain width (mm) after dehulling of paddy based on their dimensions according to Digimatic Caliper (Mitutoyo) Model CD-8//CSX having range of 0-200 mm/0-8 inches.. The statistical analysis was carried out following D^2- statistics (Mahalanobis, 1936) to estimate the genetic diversity for various traits and grouping of genotypes into different clusters was done using Tocher's method as described by Rao (1952). The genotypic and phenotypic correlations among 10 yield and yield attributing traits were calculated following Al-jibouri *et al.* (1958).

RESULTS AND DISCUSSION

The analysis of variance showed significant difference among all the characters studied which indicated the existence of

Table 1: List of genotypes used in the study

Sr. No.	Designation	Source/Parentage
Land races		
1.	Ram Jawain-100	Kangra
2.	LC Samloti-3	Kangra
3.	LC Rajiana-3	Kangra
4.	LC Yol-1	Kangra
5.	LC Serathana-1	Kangra
6.	KLC-6	Kangra
7.	LG-11	Kangra
8.	LG-15	Kangra
9.	LG-16	Kangra
10.	Kijun	Chamba
11.	Kalizhini	Kangra
12.	Lal Nakanda 41	Kangra
13.	TotuDhan	Kangra
14.	RJ-100	Kangra
15.	Japani	Chamba
16.	KrishanDhan	Kangra
17.	KalooDhan	Kangra
18.	Lal Zheeni	Kangra
19.	Zheeni	Kangra
20.	ChittiZheeni	Kangra
21.	Mukti	Kullu
22.	Chinna 988	China
New Plant Types		
23.	IR 68544 -29-2-1-3-1-1	IRRI
24.	IR 68544 -29-2-1-3-1-Y_n 1	IRRI/Myanmar
25.	IR 69353-70-3-1-1-3- Y_n1-4	IRRI/Myanmar
26.	IR 70749-45-2-3- Y_n1-2	IRRI/Myanmar
27.	IR 70544 -10-3-1-3- Y_n1-1	IRRI/Myanmar
28.	IR 71204 -78-3-3-Y_n1-1	IRRI/Myanmar
29.	IR 69853-70-3-1-1	IRRI
30.	IR 69137-34 -1-3-1	IRRI
31.	IR 65564 – 44 -5-1	IRRI
32.	IR 65600-87-2-2-3	IRRI
33.	IR 64683-87-2-2-3-3	IRRI
34.	IR 68450-36-3-2-2-3	IRRI
35.	IR 71146-40-7-2-1-2-1	IRRI
36.	IR 72870-21-2-1-2	IRRI
37.	IR 65600-27-1-2-2	IRRI
38.	IR 72780-120-1-2-2	IRRI
39.	IR 66159-189-5-5	IRRI
40.	IR 72884 -181-3-2-1	IRRI
41.	RP 2421	DRR
Japonicas		
42.	Koshihikari	Japan
43.	Hinohikari	Japan
44.	BhriguDhan	Chucheng/Deval-R//Matali
45.	Matali	Naggar (Kullu)
46.	Jattoo	Naggar (Kullu)
47.	TeejuDhan	Chamba
48.	TiyunDhan	Chamba
49.	Desi Dhan	Chamba
50.	Kunjan - 4	-
51.	Yunlen - 18	China
52.	Deval - W	Naggar (Kullu)
53.	Deval - R	Naggar (Kullu)
54.	Hexi - 4	China
55.	Fukunishiki	Japan
56.	Won - 124	-
57.	NaggarDhan	China

ample variability among the genotypes. On the basis of D^2 values, 57 genotypes were grouped into 9 distinct overlapping clusters (Fig. 1 and Table 2). Among the nine clusters, cluster II and IV accommodated maximum 14 genotypes each, followed by cluster III of 11 genotypes, cluster I of 9 genotypes and cluster V of 5 genotypes. The remaining cluster *i.e.* VI, VII, VIII and IX accommodated single genotype. The grouping of genotypes into so many clusters suggested the presence of high degree of diversity in the material evaluated. Earlier workers have also reported presence of substantial genetic diversity in rice (Kumar *et al.*, 2014, Ahamed *et al.*, 2014 and Sandhya *et al.*, 2015).

The pattern of distribution of genotypes from diverse geographical region into different clusters was random. It showed that genotypes collected from same geographic region got distributed in different clusters and vice versa, thereby indicating non-relationship between geographical and genetic diversity. Thus indicating that the parents chosen on the basis of geographical diversity may not be rewarding rather should be chosen on the basis of genetic diversity. The lack of relationship between geographical and genetic diversity has also been reported earlier by Kumar (2008), Raut *et al.* (2009) and Ahamed *et al.* (2014).

The average inter cluster distances among the nine clusters are presented in Table 3. The inter cluster distances were higher than intra cluster distances indicating wider genetic divergence among the genotypes. The inter cluster distance ranged from 9.340 (cluster III) to 11.661 (cluster I), while inter cluster distance was maximum between cluster VII and VIII (34.876) followed by cluster III and IX (34.273) and cluster I and III (33.821). This indicated that the genotypes in these clusters are having broad spectrum of genetic diversity and could very well be used in hybridization programme. Similar results were reported by Yadav *et al.* (2011) and Sandhya *et al.* (2015).

Cluster mean values showed high variation for all the characters under study (Table 4), except total tillers per plant and effective tillers per plant. Cluster VII had maximum grain yield per plant, while genotypes in cluster I was early in maturity with minimum plant height and maximum biological yield per plant. Genotypes in cluster V were having longest panicles with maximum spikelet fertility, highest harvest index, grain width, total and effective tillers per plant, while cluster III genotypes were early in flowering but late in maturity.

The contribution of different characters towards genetic diversity is given in Table 5. Days to maturity (34.21%) contributed maximum followed by days to flowering (27.44%), grain length (19.55%) and grain width (12.16%). Earlier, Roy *et al.* (2002), Datt and Mani (2003) Banumathi *et al.* (2011) and Kumar *et al.* (2014)also reported these characters to be responsible for diversity.

The inter-cluster distance was highest between cluster VIII and VIII followed by cluster III and IX and cluster I and III suggesting that crosses involving parents belonging to these clusters would provide wide range of variability in the segregating generations. Thus, hybridization of the genotypes belonging to clusters separated by high inter cluster distance and differing for characters having high contribution towards genetic divergence would be effective in isolation of superior genotypes in the segregating generations.

The genotypic and phenotypic correlations between yield and

Table 2: Distribution of 57 genotypes of rice in IX clusters

Cluster	No. of genotypes	Genotypes
I	9	Ram Jawain-100, RJ-100, LC Yol-1, KLC-6, LG-16, LG-15, KalooDhan, Japani, ChittiZheeni
II	14	LC Samloti-3, LG-11, Lal Zheeni, TotuDhan, Lal Nakanda 41, LC Rajiana-3, KrishanDhan, Kalizhini, Zheeni, RP 2421, Mukti, Jattoo, Kijun, China 988
III	11	IR 69353-70-3-1-1-3- Y_n1-4, IR 70544 -10-3-1-3- Y_n1-1, IR 69853-70-3-1-1, IR 69137-34 -1-3-1, IR 70749-45-2-3- Y_n1-2, IR 65564 – 44 -5-1, IR 65600-87-2-2-3, IR 71204 -78-3-3-Y_n1-1, IR 68544 -29-2-1-3-1-1, IR 6854 4 -29-2-1-3-1-Y_n 1, IR 66159-189-5-5
IV	14	Hinohikari, TeejuDhan, TiyunDhan, Desi Dhan, BhriguDhan, Yunlen – 18 , NaggarDhan, Fukunishiki, Deval – R, Kunjan – 4, Matali, Hexi – 4 , Won – 124, Koshihikari
V	5	IR 64683-87-2-2-3-3, IR 71146-40-7-2-1-2-1, IR 68450-36-3-2-2-3, IR 72870-21-2-1-2, IR 72780-120-1-2-2
VI	1	Deval – W
VII	1	LC Serathana-1
VIII	1	IR 65600-27-1-2-2
IX	1	IR 72884 -181-3-2-1

Table 3: Intra and inter cluster average D^2 values of IX clusters

Cluster	I	II	III	IV	V	VI	VII	VIII	IX
I	11.661	16.488	33.821	25.384	26.571	17.178	16.975	31.469	23.829
II		11.109	27.362	18.831	27.655	16.099	14.906	28.929	29.183
III			9.340	25.736	23.506	32.446	32.290	14.065	34.273
IV				11.248	30.133	14.715	26.881	26.588	32.250
V					10.849	29.607	26.851	19.667	16.472
VI						0.000	22.779	30.456	26.845
VII							0.000	34.876	26.349
VIII								0.000	29.620
IX									0.000

Table 4: Cluster means of 13 yield and yield attributing traits under study

Cluster No.	No. of genotypes	Grain yield/ plant (g)	Days to flowering	Days to maturity	Plant height (cm)	Panicle length (cm)	Total tillers/ plant
I	9	11.03	104.25	135.98	115.74	24.03	6.98
II	14	8.96	104.4	139.63	108.02	22.68	6.12
III	11	6.8	119.37	158.86	72.79	20.93	5.05
IV	14	8.75	99.46	149.41	78.06	18.96	7.88
V	5	8.09	115.56	156.5	69.26	21.91	6.27
VI	1	8.46	95.33	143	103.1	19.65	6.9
VII	1	11.86	105.33	138.33	113.65	26.16	7.43
VIII	1	4.81	118.83	158	66.58	19.88	5.8
IX	1	9.55	105.83	154.16	82.88	24.66	6.3
Mean		8.63	107.55	148.06	90.22	22.18	6.51
Range	Max.	11.86	119.37	158.86	115.74	26.16	7.88
	Min.	4.81	95.33	135.98	66.58	18.96	5.05

Table 4: Cont.....

Cluster No.	Effective tillers/ plant	Spikelet fertility (%)	Biological yield/plant (g)	Harvest index (%)	Grain length (mm)	Grain width (mm)	1000-grain weight (g)
I	6.29	82.49	27.12	40.83	7.1	2.35	27.31
II	5.51	83.62	22.94	39.19	5.75	2.49	23.71
III	5.02	73.1	20.24	33.57	5.43	2.88	24.33
IV	7.31	88.08	18.32	47.41	5.52	3.09	27.65
V	6.72	72.29	19.89	40.49	7.41	2.14	24.26
VI	6.6	88.02	18.33	46.15	6.42	2.77	30.31
VII	6.2	82.15	26.85	44.09	6.04	1.87	16.32
VIII	5.8	67.4	16.73	29.1	6.5	2.91	32.03
IX	6.2	78.45	25.53	37.32	8.34	2.05	23.93
Mean	6.18	79.19	21.8	39.51	6.57	2.5	25.29
Range	7.31	88.08	27.12	47.41	8.34	3.09	32.03
	5.02	67.4	16.73	29.1	5.43	1.87	16.32

yield attributing traits computed separately for land races, new plant types and japonicas and are presented in table 6, 7 and 8. Grain yield is a complex character and is the end-product of various traits. Therefore, knowledge regarding the correlation of grain yield with other component characters is valuable for understanding the correlated response to selection for yield. The genotypic correlations in general were higher than the corresponding phenotypic values.

In the land races, grain yield per plant had positive and significant associations with total tillers per plant (0.392), effective tillers per plant (0.474), spikelet fertility (0.323), biological yield per plant (0.723) and harvest index (0.744). Meenakshi *et al.* (1999) and Yadav *et al.* (2011) reported similar type of correlations in yield and yield attributing traits.

Table 5: Contribution of individual characters to the divergence among genotypes

Characters	No. of times ranked first	Contribution (%)
Grain yield/ plant (g)	8	0.50
Days to flowering	438	27.44
Days to maturity	546	34.21
Plant height (cm)	8	0.50
Panicle length (cm)	14	0.88
Total tillers/plant	5	0.31
Effective tillers/plant	0	0.00
Spikelet fertility (%)	7	0.44
Biological yield	14	0.88
Harvest index (%)	0	0.00
Grain length (mm)	312	19.55
Grain width (mm)	194	12.16
1000-grain weight (g)	50	3.13

Total tillers per plant had positive and significant correlations with effective tillers per plant (0.866) and harvest index (0.361) and effective tillers per plant had significant positive correlation with harvest index (0.462). This infers that, selection for effective tillers would be effective for increasing grain yield because of its positive and significant association with harvest index and these characters in turn are significantly associated with yield.

In new plant types, grain yield per plant showed significant positive correlations with plant height (0.542), panicle length (0.356), total and effective tillers (0.449 and 0.436), spikelet fertility (0.317), biological yield per plant (0.766) and harvest index (0.744). Selvarani and Rengaswamy (1998) and Meenakshi *et al.* (1999) obtained similar type of correlations between yield and yield attributing traits. Among characters, plant height had significant positive correlations with panicle length (0.588), biological yield per plant (0.481) and harvest index (0.353), while spikelets per panicle had positive and significant association with grains per panicle (0.828). Thus indicating that, although biological yield per plant had the highest correlation with grain yield per plant yet selection for plant height and grains per panicle would be effective for increasing the grain yield per plant in new plant types. The results obtained in the present study are on line with the concept on which new plant types have been bred i.e. high biological yield and harvest index and main yield components conceptualized in these plant types were spikelets/grains per panicle and few *i.e.* 7-8 tillers per plant.

In japonica types, at phenotypic level, significant positive correlations of grain yield per plant with panicle length (0.386), spikelets per panicle (0.459), grains per panicle (0.498), biological yield per plant (0.904) and harvest index (0.627)

Table 6: Phenotypic (P) and genotypic (G) correlation coefficients among various yield and yield attributing traits in land races

Character		Grain yield / plant(g) 1	Days to flowering 2	Days to maturity 3	Plant height (cm) 4	Panicle length (cm) 5	Total tiller/ plant 6	Effective tillers/ plant 7	Spikelets /panicle 8	Grains/ panicle 9	Spikelet fertility (%) 10	Biological yield/ plant(g) 11
Days to flowering	P	0.027										
	G	0.049										
Days to maturity	P	**-0.408**	0.271									
	G	-0.488	0.327									
Plant height (cm)	P	0.039	0.175	0.136								
	G	-0.007	0.216	0.317								
Panicle length (cm)	P	0.221	0.167	-0.053	**0.331**							
	G	0.228	0.225	-0.043	0.351							
Total tillers/plant	P	**0.392**	0.091	**-0.444**	**-0.393**	0.022						
	G	0.547	0.052	-0.599	-0.594	-0.004						
Effective tillers/plant	P	**0.474**	-0.001	**-0.419**	**-0.489**	0.066	**0.866**					
	G	0.604	-0.093	-0.560	-0.711	0.020	0.960					
Spikelets/panicle	P	0.039	-0.271	0.151	0.146	-0.083	-0.226	-0.131				
	G	-0.067	-0.338	0.201	0.162	-0.128	-0.363	-0.238				
Grains/panicle	P	0.187	-0.213	0.018	0.153	-0.087	-0.140	-0.075	**0.903**			
	G	0.116	-0.274	0.028	0.194	-0.135	-0.237	-0.166	0.975			
Spikelet fertility (%)	P	**0.323**	0.171	-0.285	-0.102	0.003	0.257	0.197	-0.278	0.147		
	G	0.335	0.213	-0.337	-0.120	0.006	0.379	0.268	-0.528	-0.062		
Biological yield/plant (g)	P	**0.723**	0.151	-0.052	0.297	0.061	0.258	0.258	0.165	**0.311**	0.285	
	G	0.685	0.201	-0.077	0.322	0.078	0.329	0.290	0.082	0.282	0.289	
Harvest index (%)	P	**0.744**	-0.086	-0.547	-0.244	0.271	**0.361**	0.462	-0.129	-0.038	0.235	0.093
	G	0.779	-0.074	-0.618	-0.310	0.329	0.500	0.594	-0.186	-0.089	0.253	0.084

Bold values are significant at 5 per cent level.

Table 7: Phenotypic (P) and genotypic (G) correlation coefficients among various yield and yield attributing traits in new plant types

Character		Grain yield / plant (g) 1	Days to flowering 2	Days to maturity 3	Plant height (cm) 4	Panicle length (cm) 5	Total tiller/ plant 6	Effective tillers/ plant 7	Spikelets /panicle 8	Grains /panicle 9	Spikelet fertility (%) 10	Biological yield/ plant (g) 11
Days to flowering	P	**-0.327**										
	G	-0.363										
Days to maturity	P	-0.187	**0.685**									
	G	-0.248	0.718									
Plant height (cm)	P	**0.542**	**-0.366**	-0.050								
	G	0.614	-0.373	-0.058								
Panicle length (cm)	P	**0.356**	-0.208	0.065	**0.588**							
	G	0.489	-0.238	0.078	0.666							
Total tillers/ plant	P	**0.449**	**-0.376**	**-0.399**	-0.122	0.010						
	G	0.517	-0.429	-0.568	-0.182	-0.007						
Effective tillers/ plant	P	**0.436**	**-0.331**	**-0.353**	-0.160	0.007	**0.994**					
	G	0.496	-0.374	-0.517	-0.227	-0.016	0.998					
Spikelets /panicle	P	-0.305	**0.444**	**0.337**	0.149	0.281	**-0.415**	**-0.407**				
	G	-0.275	0.484	0.399	0.174	0.365	-0.531	-0.516				
Grains/panicle	P	-0.169	0.290	0.249	**0.326**	0.227	**-0.400**	**-0.408**	**0.828**			
	G	-0.079	0.346	0.316	0.394	0.340	-0.544	-0.542	0.879			
Spikelet fertility (%)	P	**0.317**	**-0.406**	-0.279	**0.335**	-0.083	0.060	0.023	**-0.415**	0.148		
	G	0.493	-0.534	-0.403	0.435	-0.101	0.131	0.088	-0.522	-0.069		
Biological yield/ plant (g)	P	**0.766**	-0.098	0.073	**0.481**	0.301	0.281	0.279	-0.109	-0.006	0.190	
	G	0.748	-0.098	0.085	0.587	0.466	0.238	0.229	-0.030	0.156	0.335	
Harvest index (%)	P	**0.744**	**-0.392**	**-0.339**	**0.353**	0.268	**0.381**	**0.362**	-0.306	-0.217	0.264	0.156
	G	0.837	-0.457	-0.418	0.417	0.351	0.547	0.523	-0.322	-0.193	0.418	0.272

Bold values are significant at 5 per cent level

Table 8: Phenotypic (P) and genotypic (G) correlation coefficients among various yield and yield attributing traits in japonicas

Character		Grain yield /plant(g) 1	Days to flowering 2	Days to maturity 3	Plant height (cm) 4	Panicle length (cm) 5	Total tiller/ plant 6	Effective tillers/ plant 7	Spikelets /panicle 8	Grains/ panicle 9	Spikelet fertility (%) 10	Biological yield/ plant(g) 11
Days to flowering	P	-0.086										
	G	-0.119										
Days to maturity	P	-0.145	**0.595**									
	G	-0.168	0.619									
Plant height(cm)	P	0.022	0.143	**-0.397**								
	G	0.146	0.194	-0.574								
Panicle length (cm)	P	**0.386**	0.272	0.038	**0.399**							
	G	0.562	0.303	0.016	0.592							
Total tillers/ plant	P	-0.200	0.076	0.106	-0.043	**-0.331**						
	G	-0.384	0.099	0.230	-0.141	-0.301						
Effective tillers/ plant	P	-0.239	0.065	0.092	-0.063	**-0.357**	**0.940**					
	G	-0.488	0.078	0.259	-0.187	-0.366	1.204					
Spikelets /panicle	P	**0.459**	0.260	0.247	0.153	**0.518**	**-0.436**	**-0.464**				
	G	0.616	0.292	0.247	0.231	0.628	-0.667	-0.737				
Grains/panicle	P	**0.498**	0.241	0.237	0.157	**0.479**	**-0.399**	**-0.435**	**0.960**			
	G	0.647	0.284	0.243	0.191	0.597	-0.651	-0.722	0.980			
Spikelet fertility (%)	P	0.171	-0.026	0.007	-0.038	-0.135	0.106	0.055	-0.046	0.220		
	G	0.120	-0.021	-0.003	-0.282	-0.305	0.163	0.165	-0.110	0.070		
Biological yield/ plant (g)	P	**0.904**	0.110	-0.064	0.048	**0.367**	-0.103	-0.139	**0.371**	**0.390**	0.102	
	G	0.877	0.168	-0.060	0.300	0.605	-0.289	-0.397	0.581	0.577	-0.042	
Harvest index (%)	P	**0.627**	**-0.432**	-0.231	-0.035	0.193	-0.242	-0.275	**0.348**	**0.395**	0.197	0.242
	G	0.785	-0.487	-0.279	-0.099	0.286	-0.306	-0.364	0.403	0.463	0.268	0.393

Bold values are significant at 5 per cent level.

was observed. These correlations are in accordance with those obtained by Rajeshwari and Nadarajan (1996), Manonmani *et al*. (1999) and Nayak *et al*. (2001). Among the yield contributing traits, panicle length was showed significant positive correlation with spikelets per panicle (0.518), grains per panicle (0.479) and biological yield (0.367); spikelets per panicle with grains per panicle (0.960), biological yield per plant (0.371) and harvest index (0.348) and grains per panicle with biological yield per plant (0.390) and harvest index (0.395). This indicated that for improvement in japonica types, in addition to biological yield per plant and harvest index, spikelets per panicle, grains per panicle and panicle length

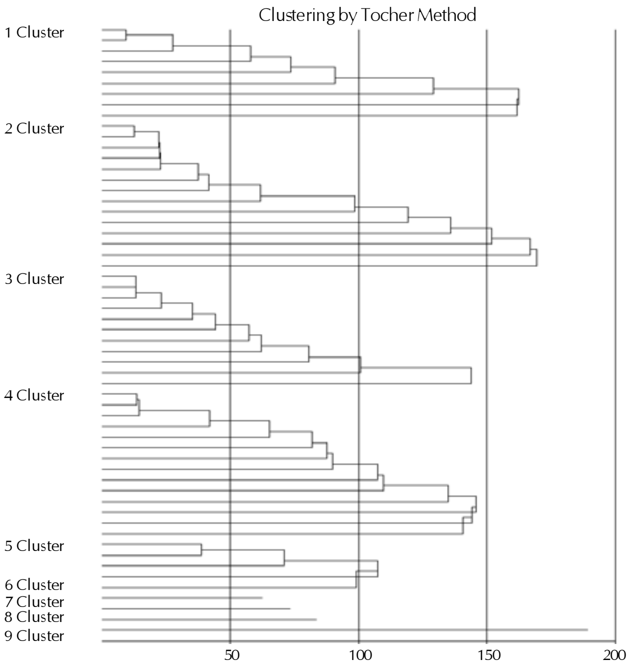

Figure 1: Clustering of the genotypes by Tocher's method

are the three important traits.

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