Genetic Diversity and Variability in Exotic Winter and Facultative Wheat Germplasm under Semi-Arid Condition

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Magnitude and nature of genetic divergence was assessed in 69 exotic winter and facultative wheat germplasm using non-hierarchical Euclidean cluster analysis for different traits. The accessions were grouped into eight clusters. Cluster V was most divergent as well as early flowering. Cluster I was the best for yield while Cluster VII for test weight. Cluster II and VII were highly diverse from each other while Cluster VI and VIII were closely related. Geographical diversity did not relate to genetic diversity.

Key word: Cluster analysis, Facultative wheat, Genetic divergence, *Triticum aestivum*, Wheat, Winter wheat

Wheat (*Triticum aestivum* L. em. Thell.) is the most important winter cereal crop of India. During 1999-2000, India produced 75.2 mt of wheat and ranked as second largest producer in the world. North western hills of India constitute about 4.2 per cent of wheat area and 2.4 per cent of the total production of India (Jag Shoran *et. al.*, 1995). Around 82 per cent area in this part of the country is under rainfed conditions and productivity of wheat is around 16 q/ha, which is quite low as compared to the national average of 27 q/ha. However, the cool climate and comparatively longer crop season in hills are congenial to harvest high yields with suitable genotype and matching agro-technology. The climatic conditions of North-Western Himalayas of India are ideally suited for growing the winter and facultative wheat, which otherwise cannot be grown in plains owing to their specific vernalization requirement. Winter and facultative group of wheat are considered to possess genes for may desirable attributes and high yield and efforts are on to harness these through hybridisation.

The more diverse the parents within over all limits of fitness, the greater are the chances of obtaining higher amounts of heterotic expression in F1's and broad spectrum of variability in segregating generations. Mahalnobis D^2 statistics has been used for identifying diverse parents for hybridization in spring wheat (Bhatt 1970, Singhal and Upadhyaya 1977, Jatasra and Paroda 1978 and Garg and Gautam 1997) and in winter wheat (Jag Shoran and Tandon 1995 and Kant *et. al.*, 1999). Multivariate analysis based on Mahalnobis D^2 statistics and canonical analysis has the limitations for classifying huge germplasm collections (Arunachalam 1981). However, non-hierarchical Euclidean cluster analysis suggested by Beale (1969) and Sparks (1973) is capable of overcoming the limitations of Mahalnobis D^2 statistics. Utility of this analysis for choosing parents for generating good segregants, though enormous, yet has received very little attention. The present study was undertaken to study the nature and extent of genetic variability and divergence in the 69 germplasm lines under semi-arid conditions and to identify donors for different characters, for their use in developing genotypes which can suit well under rainfed conditions.

Materials and Methods

Sixty six winter and facultative wheat germplasm lines and six checks viz., Bez, Seri, BLL, GRK, ATAY 85 and VL 616 were selected for genetic divergence studies. All winter and facultative wheat lines were of exotic origin and were selected from International nurseries supplied by CIMMYT, Mexico. Total sixty nine germplasm lines including checks were evaluated under semi-arid, low fertility ($N:P_2O_5:K_2O$:: 60:30:0 kg/ha) conditions at Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS) Experimental Farm, Hawalbagh, Almora, India (29^0 36'N and 79^0 30'E and 1250 m) during winter season of (*rabi*) 1997-98.

The experiment was conducted in an augmented block design with 2 replications of checks. The plot size comprised two rows, 3 m long, with inter-and intra-row spacing 0.3 and 0.1 m respectively. The crop received 30 kg/ha N and 30 kg/ha P_2O_5 as basal dose and 30 kg/ha N as top dressing after first irrigation. In additional to a total 414.6 mm rainfall the crop received, one supplemental irrigation (50 mm) was provided. The crop was not protected against leaf rust (*Ustilago nuda tritic*) and powdery mildew (*Erysphi tritici*) as the disease appeared in traces.

Observations were recorded on four quantitative characters namely days to 50 per cent heading, plant height (cm), grain yield (g/plot) and test weight (g). Five competitive plants were randomly selected for recording observation on plant height. Rest of the observations were recorded on plot basis. Genetic divergence was studied using Non-Hierarchical Euclidean cluster analysis (Beale, 1969 and Spark, 1973). The SPAR1 package developed by Indian Agricultural Statistical Research Institute (IASRI), New Delhi, was used for classifying the genotypes.

Results and Discussion

The range of various characters exhibited wide differences (Table 1) in the winter and facultative wheat germplasm, which indicates ample scope for genetic manipulation. Further variability can be incorporated in other characters by hybridization among distant accessions. A number of research workers (Griffing and Lindstrom, 1954; Moll *et al.*, 1962; Arunachalam, 1981) have emphasized classificatory procedures for identifying distant genotypes which can be used as donor parents. Non-Hierarchical Euclidean analysis has been found quite useful for estimating the genetic divergence utilizing unreplicated data in larrge germplasm collection. In this method all the variables are converted to single inde of similarity in the form of principal component. The eigen vectors, roots and associated variances have been given in (Table 2). The maximum variation of 52.73 per cent was explained by first latent vector followed by second vector (25.30%). Thus around 78% of variation was explained by first two vectors and rest by other two.

Table 1. Range, mean, check mean and coefficient of variation for different in winter and facultative wheat germplasm

Character	Days to 50% flowering	Plant height (cm)	Grain yield (g/plot)	Test weight (g)
Mean	154.30	115.64	699.71	35.93
Range	116-190	90-150	410-1200	25.1-46.5
Best check mean	122	98	880	46.5
CV	10.42%	10.51%	22.16%	12.85%

Table 2. Eigen root vector, eigen roots and associated variances for various components in winter and facultative wheat germplasm

	Eigen root vector			
Characters	1	2	3	4
Days to 50% heading	0.619	-0.0091	-0.540	-0.563
Plant height (cm)	0.149	0.988	0.032	-0.027
Grain yield (g/plot)	-0.058	0.051	-0.755	0.651
Test weight (g)	0.769	-0.114	0.371	0.508
Eigen roots	2.109	1.001	0.606	0.284
% variation	52.73	25.03	15.14	7.10

Non-Hierarchical Euclidean analysis proved useful for estimating the genetic divergence in 69 winter and facultative wheat genotypes, which were grouped in to 8 different non-overlapping clusters (Table 3). The grouping indicated considerable amount of genetic diversity in the germplasm. The appropriate cluster arrangement as determined by F test revealed that the 8 clusters were most suited. Genotypes from 9 different origins were accommodated in the same cluster (III, VI and VII) and thus indicated their close affinity. On the other hand, genotypes developed from the same area were distributed to different clusters. These results indicate that geographical diversity may not necessarily be related to genetic diversity. These findings are in general agreement with the results obtained by Murty and Arunachalam (1966), Bhatt (1970) and Tewari (1970) in different crops. Cluster I is the smallest containing only four accessions which had highest values for grain yield (1045 g/plot). Cluster VIII consisted maximum number of accessions (17) and had highest value for days to 50 per cent heading (168.18). Cluster II contained 8 accessions, which had lowest values for plant height (100 cm), grain yield (566.25 g/plot) and test weight (30.45 g). Cluster V and VII both consisted of 6 accessions each which had lowest value for days to 50% heading (126.67) and highest value for test (43.21 g) respectively. Cluster III consisted of 7 accessions, which had highest value for plant height (137.86). All clusters have exotic strains suggesting wide spectrum of genetic diversity among the germplasm.

The average inter- and intra-cluster distance are presented in Table 4, which provide an index of genetic diversity among and within the cluster. The generalized

Table 3. Characters mean in different clusters in facultative and winter wheat germplasm

Characters	I(4)	II(8)	III(7)	IV(11)	V(6)	VI(10)	VII(6)	VIII(17)
Days to 50% heading	133.00	166.62	153.57	149.45	128.67	164.20	133.00	168.18
Plant height (cm)	111.25	100.00	137.86	114.09	102.17	115.00	125.00	117.71
Grain yield (g/plot)	1045.00	566.25	785.00	811.82	768.33	573.00	827.50	603.53
Test weight (g)	37.60	30.45	35.87	36.22	41.47	38.57	43.21	31.88

Figures in parenthesis indicate the number of accessions

Table 4. Average inter-cluster and intra-cluster distance D. values among 9 clusters in winter and facultative wheat germplasm

	1	2	3	4	5	6	7	8
1	0.921							
2	4.111	1.049						
3	3.290	3.561	1.039					
4	1.858	2.534	2.051	0.982				
5	2.125	3.564	3.544	2.001	1.164			
6	3.629	2.150	2.296	1.865	2.825	0.841		
7	2.180	4.346	2.399	2.047	1.974	2.858	0.976	
8	3.836	1.516	2.221	2.033	3.621	1.580	3.649	0.959

intra-cluster distance value ranged from 0.841 (Cluster VI) to 1.164 (Cluster V). Therefore, broadly it can be concluded that relatively less genetic divergence exists in Cluster VI while individuals in Cluster V were genetically more divergent. Maximum inter-cluster distance (4.346) were found between Clusters II and VII suggesting wide diversity between the groups. The crosses between the genotypes from these clusters may give putative transgressive segregants. In contrast minimum distance occurred between Clusters VI and VIII (1.500) indicating close relationship. The genetic diversity among the parents to be included in crop hybridization programme has been greatly emphasized, therefore the inter-cluster distance must be taken into consideration while selecting the parents. The situation also reflected the relative divergence of clusters which allows a convenient selection of group of genotypes for any hybridization progrmme, facilitating better exploitation of germplasm resources. Thus intercrossing between the genotypes of Cluster II and VII may be helpful in developing heterotic combinations to drive desirable recombinants.

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Table 5. Minimum and maximum values for various traits in winter and facultative wheat germplasm

Character	Minimum			Maximum		
	Name	Value	Group	Name	Value	Group
Days to 50% heading	494J6.11/TRAP//1/BOW	116	V	UT 1545.80/ID 13.1 MLT	190	VIII
Plant height (cm)	TAST/SPRW/IT 176.73/7/SOTY/SUT/LER/4/2*/RFN/	90	II	SA 1684/*MOLOPO61	150	III
	3/FR//KAD/GB/5/TMP 64 BLL/F7223/3/TLLA/2*FR/KAD11					
	KC 5550 B/GRATSIYAB		V			
Grain yield (g/plot)	MAYA 74/ON//1160/147/3/BB/GLL/4/CHAT /5/ID 13.1/MLT	410	II	MANCH/ITX71A374.4/TAXY1 A 10.39, VI/3/74/CB 462/TRAPPER//VONA	1200	I
Test weight (g)	TX71A1039.V 1*3/ANI/1 SDY/OK 78047/3/CTY	25.1	II	SERI	46.5	II

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