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EVALUATION OF GENETIC DIVERGENCE IN BERSEEM (*TRIFOLIUM ALEXANDRINUM* L.) GERMPLASMS

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ABSTRACT
Forty germplasms of berseem were assessed for the nature and magnitude of genetic divergence based on ten different traits of economic importance including green forage yield per plant following Mahalanobis's D^2 statistics. The germplasms were grouped into seven clusters. The grouping showed one mono-genotypic cluster (Cluster II), while others comprised of two (Cluster IV), three (Cluster III), four (Cluster V), five (Cluster VII), nine (Cluster I) and sixteen germplasms (Cluster VI). The maximum inter-cluster distance was observed between Cluster II and IV (D^2 = 51.898) and minimum between Cluster I and VI (D^2 = 5.523). The maximum intra-cluster average D^2 value was observed for Cluster VII (D^2 = 7.354) and minimum for Cluster II (D^2 = 0.000). For green and dry forage yield per plant, the maximum intra-cluster group mean was found for Cluster III (D^2 = 12.65) and Cluster V (D^2 = 2.41) respectively. Green forage yield per plant contributed maximum (21.45 %) and minimum contribution was through leaf: stem ratio (2.19 %) towards the total genetic divergence.

INTRODUCTION

Berseem or Egyptian clover (*Trifolium alexandrinum* L., 2n = 16) is an important winter forage crop being quite nutritive and succulent. It has 20 % crude protein and 70 % dry matter digestibility and also rich in calcium and phosphorus. The prerequisite of any breeding programme is the evaluation of existing genetic stock. The success of a systematic breeding programme depends mainly on judicious selection of promising parents from the gene pool. The variability accomplished with genetic distance among different accessions of a species is known as genetic diversity or genetic divergence. Genetic diversity plays an important role in plant breeding because a hybrid between lines of diverse origin generally displays a greater heterosis than those between closely related accessions (Ram and Panwar, 1970). The maximum heterosis however, occurs at an optimal or intermediate level of diversity. The D^2 technique (Mahalanobis, 1936) has been used in assessing the variability present in crops like maize, sorghum, pearl millet, wheat, linseed, cotton, tobacco, alfalfa, berseem and *Brasssica* (Moll and Stuber, 1974). In addition to the selection of divergent parents for hybridization, D^2 statistics also measures the degree of diversification and relative contribution of each component character towards the total divergence.

The knowledge of genetic diversity helps the breeders in deciding the appropriate breeding procedures to increase the genetic potentialities as well as to surpass the yield barrier. Chaudhary *et al.* (1991) concluded that higher fodder yields in berseem varieties could not be attributed to the stimulation of any particular yield component but was due to positive contribution of a combination of yield components like number of tillers and number of leaves per plant along with plant height. Yadav and Shukla (2006) studied genetic divergence for fourteen quantitative traits and germplasms were found stable for forage yield and quality and these may be preferred in breeding programmes. Avtar *et al.* (2007) evaluated ten different traits in berseem; plant height, tillers per plant and leaves per plant were observed to be main components of green fodder yield which should be taken into account in berseem breeding programmes aimed at achieving higher yields. Therefore, looking towards the importance of berseem as a forage crop, the present study was undertaken to assess the genetic divergence for yield and its component traits.

MATERIALS AND METHODS

The experimental material comprised forty genotypes of berseem including checks *viz.*, Wardan, Bundel Berseem-3 and Mescavi commonly grown for forage crop which include elite lines and land races. These genotypes have wide spectrum of variability for various agronomic and morphological characters. All these genotypes are grown for multi cut forage crop. All the forty genotypes were grown during *Rabi*, 2008-09 at Genetics and Plant Breeding Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) in RBD with three

Table 1: Clustering pattern of 40 germplasms on the basis of Mahalanobis's D^2 statistic in Berseem

Cluster number	Number of germplasms	Germplasms
I	9	NB-1, NB-7, NB-9, NB-46, NB-51, NB-66, NB-67, Bundel berseem-3, Wardan
II	1	Mescavi
III	3	NB-4, NB-64, JHB08-2
IV	2	NB-2, NB-3
V	4	NB-6, HFB5-15, JB03-11, JHB08-1
VI	16	NB-8, NB-10, NB-11, NB-12, NB-32, NB-33, NB-44, NB-47, NB-48, NB-49, NB-50, NB-53, NB-56, NB-57, NB-61, HFB4-14
VII	5	NB-5, NB-45, NB-62, NB-63, NB-65

Table 2: Average intra and inter-cluster D^2 and D value (parenthesis) among Berseem germplasm

Cluster	I	II	III	IV	V	VI	VII
I	3.176(1.782)						
II	19.184(4.380)	0.000(0.000)					
III	9.505(3.083)	43.204(6.573)	5.494(2.344)				
IV	24.068(4.906)	51.898(7.204)	25.462(5.046)	5.108(2.260)			
V	8.009(2.830)	28.026(5.294)	16.064(4.008)	20.775(4.558)	4.644(2.155)		
VI	5.523(2.350)	21.576(4.645)	17.665(4.203)	21.604(4.648)	11.903(3.450)	4.137(2.034)	
VII	10.106(3.179)	28.452(5.334)	15.023(3.876)	40.768(6.385)	22.829(4.778)	17.372(4.168)	7.354(2.712)

Table 3: Clusters mean values for ten characters in Berseem germplasms

Characters	Days to 50% flowering	No. of branches per plant	Leaf : stem ratio	Plant height (cm)	Green forage yield per plant (g)
I	129.56	6.37	0.89	44.15	9.40
II	131.67	5.80	0.85	34.13	9.93
III	131.89	7.24	0.93	51.00	12.65
IV	138.83	5.67	0.87	43.83	9.19
V	131.08	6.12	0.90	40.43	8.55
VI	130.04	5.91	0.97	39.08	10.84
VII	130.67	6.64	1.00	42.92	12.20

replications. Each accession was raised as a single row of 3 m length each at spacing of 30 X 10cm. The recommended cultural practices were carried out to raise good crop. Data recorded on five random plants from each line for days to 50% flowering, green forage yield per plant (g), leaf: stem ratio, dry forage yield per plant (g), number of branches per plant, plant height (cm), days to maturity, number of capsules per plant, number of seeds per capsule and seed yield per plant (g). The experimental data of the experiment was compiled by taking mean over randomly selected plants from each replication. The mean data pooled over the cuts were then subjected to D^2 analysis (Mahalanobis 1936, Rao 1952).

RESULTS AND DISCUSSION

Multivariate analysis is a useful tool to discriminate a heterogeneous population into different groups having somewhat similar genetic constitution. Most diverse individuals are more useful in hybridization programme than those having close affinities at the genetic level (Singh *et al.*, 1980). The varieties of similar origin if grouped into different clusters indicate that geographical diversity is not related with genetic diversity. Forty germplasms were grouped into seven clusters thus indicating the presence of a wide genetic diversity in the material under study. The composition of different cluster varied, containing single to sixteen germplasms depending upon the similarity in the expression of their genetic divergence. Cluster VI had the largest number of sixteen germplasms followed by Clusters I, VII and V which consisted nine, five and four germplasms, respectively (Table 1).

It means the overall genetic similarly was found in the germplasms, which were present within the cluster. Only one germplasm *i.e.,* Mescavi formed a separate cluster. Similarly, forty germplasms were dispersed in seven clusters. The possible reason for grouping of genotypes of different places in one cluster could be the free exchange of germplasm among the breeders of different regions or unidirectional selection practiced by breeder in tailoring the promising cultivars for different regions (Verma and Mehta, 1976). Genetic drift and selection in different environments could be the other important factors contributing towards the divergence. The results agree with the previous findings of Murty and Arunachalam (1966); Arunachalam and Ram (1967) in sorghum; Singh and Bains (1968) in cotton; Somayajulu *et al.* (1970) in wheat; Arunchalam (1981) and Mehndiratta *et al.* (1971) in forage sorghum reported that the geographic diversity was not always related to genetic diversity.

The intra and inter-cluster value showed that the intra cluster distance was lesser than inter-cluster distance suggesting that the cluster were homogenous within themselves and heterogeneous among themselves (Table 2).

The average intra and inter-cluster distance (D^2) values revealed that the highest intra cluster distance of 7.354 was observed in Cluster VII followed by Cluster II (0.000). It is evident from inter-cluster distance that the most divergent clusters were II and IV (D^2 = 51.898) followed by Clusters II and III (D^2 = 43.204) and Clusters IV and VII (D^2 = 40.768) suggesting wide diversity between them and the germplasms in these clusters could be used as parents in hybridization programme since hybridization between divergent parents is likely to produce wide variability and transgressive segregants with high heterotic effects (Rama, 1992). Such recommendations were also made by Murthy and Arunachalam (1966). Many workers in different crops have also reported that selection of parents for hybridization should be done from two clusters having wider inter-cluster distances to get maximum variability in the segregating generations. Heterosis is generally attributed

Table 3 Continued......

Characters	Dry forage yield per plant (g)	Number of capsules per plant	Number of seeds per capsule	Seed yield per plant(g)	Days to maturity
I	1.70	7.30	14.87	1.09	171.30
II	1.80	7.60	15.07	1.15	161.00
III	2.00	7.42	14.40	1.06	174.44
IV	1.74	6.30	13.33	0.84	178.17
V	2.41	6.23	16.58	1.04	173.83
VI	1.53	6.32	13.75	0.87	171.65
VII	1.42	8.88	17.04	1.43	171.47

Table 4: Per cent contribution of ten characters towards total genetic divergence in Berseem germplasms

Characters	Contribution (%)
Green forage yield per plant (g)	21.45
Days to maturity	13.87
Number of seeds per capsule	12.90
Dry forage yield per plant (g)	12.86
Number of capsules per plant	12.59
Days to 50% flowering	10.70
Plant height (cm)	5.92
Number of branches per plant	4.86
Seed yield per plant (g)	2.66
Leaf: stem ratio	2.19

to genetic divergence among the parental lines involved in the crosses. Nevertheless, the genetic divergence for the maximum expression of the heterotic effect has a limit (Moll *et al.*, 1965 and Arunachalam and Bandyopadhyay, 1984).

The study showed that cultivars belonging to the same group were highly valuable since they belonged to different clusters. Table 3 showed that Cluster III had highest mean values for green forage yield per plant, number of branches per plant and plant height. Cluster IV had highest mean values for days to 50% flowering and days to maturity.

Cluster VII had highest mean values for leaf: stem ratio, number of capsules per plant, number of seeds per capsule and seed yield per plant. The Cluster II showed lowest mean values for leaf: stem ratio, plant height and days to maturity. Cluster V had lowest mean values for green forage yield per plant and number of capsules per plant. Cluster IV showed lowest mean values for number of branches per plant, number of seeds per capsule and seed yield per plant. Cluster VI did not show high or low mean value for the character (s) which showed that clusters, which had highest mean value for one trait or more than one trait, will produce desirable segregants when crossed with other varieties. Yadav and Shukla (2006), Avtar *et al.* (2007) and Singh *et al.* (2007) reported that hybridization in berseem between the germplasms of different clusters can give high amount of hybrid vigour or better recombinants because of wider variations which accomplish the basic requirement of hybridization programmes *i.e.* contrasting parents which can achieve heterosis or better combining ability. The per cent contribution of ten characters towards total genetic divergence is listed in Table 4.

The highest contribution in manifestation of genetic divergence was exhibited by green forage yield per plant (21.45) followed by days to maturity (13.87), number of seeds per capsule (12.90), dry forage yield per plant (12.86) and number of capsules per plant (12.59) also played a considerable role in governing the genetic divergence. The lowest contribution towards genetic divergence was exhibited by leaf: stem ratio (2.19). Rest of the characters, *viz.*, days to 50% flowering (10.70), plant height (5.92), number of branches per plant (4.86) and seed yield per plant (2.66) also contributed less towards the expression of total genetic divergence.

Thus, it is evident from the present finding that substantial genetic divergence was envisaged in the genetic stock of berseem. The varieties of same geographic region clustered with the varieties of other geographic region due to selection pressure and genetic drift. This indicates that there is no parallelism between genetic diversity and geographical origin except in some cases. Hybridization between the genotypes of different clusters can give high amount of hybrid vigour and good recombinants. Green forage yield per plant, days to maturity, number of seeds per capsule, dry forage yield per plant and seed yield per plant were important components and these should be taken into account while breeding in berseem.

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