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Short communication

Genetic diversity for morphological and biochemical traits in bulb onion

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ABSTRACT

The 43 accessions of bulb onion were analyzed for genetic variability studies based on morphological and biochemical traits. The germplasm under investigation grouped into seven divergent clusters irrespective of their geographical origin based on Mahalanobis D^2 analysis. It was found that cluster-I was largest of all with 12 genotypes while cluster-IV and VI were the smallest with only two genotypes. Observations on cluster distances revealed that the intra-cluster distance were less than inter-clusters. In principal component analysis, first seven principal components explained 78.290% of the total variation and only, quantitative characters contributed significantly towards PC-1, whereas qualitative characters in PC-2.

Key words: Qualitative characters, quantitative characters, Mahalanobis D^2 analysis, Principal component analysis.

The information on genetic divergence is very useful for explorers, geneticists and breeders to conduct studies concerning germplasm collection, genetic erosion and use of accessions in breeding programmes (Dhillon *et al*., 1). Bulb onion crop improvement programme is a challenging job due to its out-crossing behavior and biennial nature. However, cross-pollination has the advantage for creation of high variability in the crop. Therefore, it is important for a breeder to estimate genetic diversity available in the germplasm to determine and organize the available genetic resources aiming at the production of promising cultivars (Palomino *et al*., 3). Various multivariate techniques like cluster, canonical and principal component analysis (PCA) were used in various crop species for determining the genetic divergence (Gupta *et al*., 2; Rathi *et al*., 5; Santos *et al*., 6). Among them, cluster analysis provides an efficient measure of genetic diversity present in the biological populations and PCA for reducing the number of variables to those explaining most of variation in the germplasm. Thus, present investigation was planned to estimate the variability available in the bulb onion germplasm for morphological and biochemical characters using PCA for the first time in India.

The 43 accessions of bulb onion were grown at the Department of Vegetable Science, Punjab Agricultural University, Ludhiana (India) as per recommendations. The germplasm was characterized for leaf colour, leaf girth (cm), leaf length (cm), leaf habit, leaf cross-section, leaf arrangement, bolting (present or absent), bolting % , days to 75% maturity, number of leaves per plant, plant habitat maturity, plant height (cm), stem shape, bulb location, bulb shape, bulb skin colour, bulb size, bulb weight (g), number of scales per bulb, bulb flesh colour, bulb hearting, polar diameter (cm), equatorial diameter (cm), neck to bulb ratio (cm), lachrymatory factor (mg/100 g) as per the procedure given by Tewari and Bandyopadhay (7) and total soluble solids (°Brix) during 2009-2010 and 2010-2011. The data was subjected to computer software window stat 8.0 (www.indostat.com) for D^2 Mahablonis analysis and JMP 9.0 (SAS) for principal component analysis.

The divergence analysis during the present studies grouped fourty three genotypes into seven different clusters (Table; Fig. 1). The cluster-I was

Table 1. Clustering pattern of bulb onion genotypes based on D^2 analysis.

Cluster No.	No. of genotypes	Genotypes
I	12	P-96-B-2, P-96-A-2, PBN, Pb. Selection, PRR, Red Creole, P-4811, P-Kala, PRO-6, 65 A, P-Rose and PKV white
II	3	PEx-0557, Pb.-48 and Pb. White
III	11	RO-597, N-2-4-1, AFLR, P-2665, Proj-545, PBR-4, Selection 338, P-305, Arka Niketan, P-888 and RHRO-5
IV	2	201-A and BKHO-1001
V	7	30-A, JNB-207, ADR, BRBO-1006, Arka Kalyan, Arka Kirtiman and AKHO-1001
VI	2	BKHO-1007 and BKHO-1008
VII	6	BKHO-1002,BRBO-1004,ARBO-1007,S-383, BRBO-1016 and ARBO-1001

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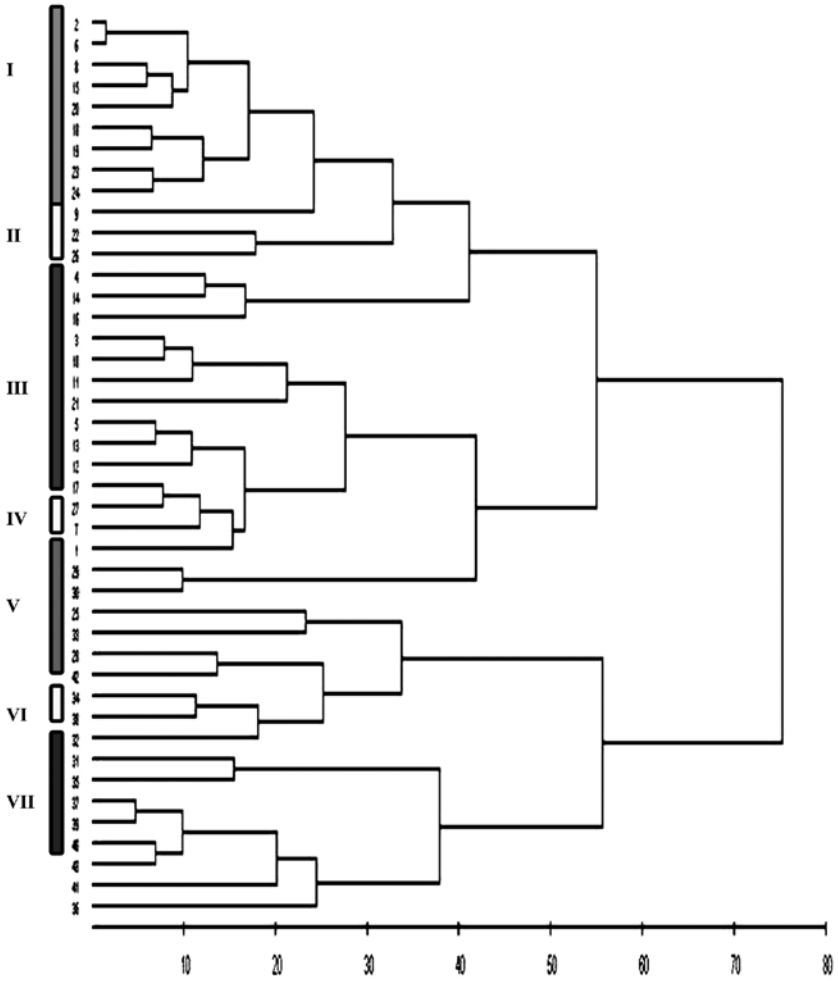

Fig. 1. Dendogram representing different clusters based on D^2 analysis in bulb onion accessions.

the biggest having twelve genotypes (Light orange bar) and lowest number of accessions were in cluster IV and VI (Yellow bar). The clustering pattern of the genotypes was independent of geographical sources, as in cluster I cultivar PKV White from Maharashtra, 65-A from Karnataka and PBN from Punjab clustered together and similar trend was observed in other clusters. The inter-cluster distances were higher than intra-cluster distances. Maximum inter-cluster distances was found between cluster I and VI (64.261) followed by cluster II and VI (62.069), cluster III and VI (56.477) and cluster II and V (54.728). The minimum intra-cluster distance was 9.887 for the cluster number IV and maximum 23.128 for V as indicated in Fig. 2. It indicates that accessions grouped in one cluster were differing from the others. The germplasm was grouped into seven clusters irrespective of their geographical origin indicated the role of genetic drift, germplasm exchange, natural

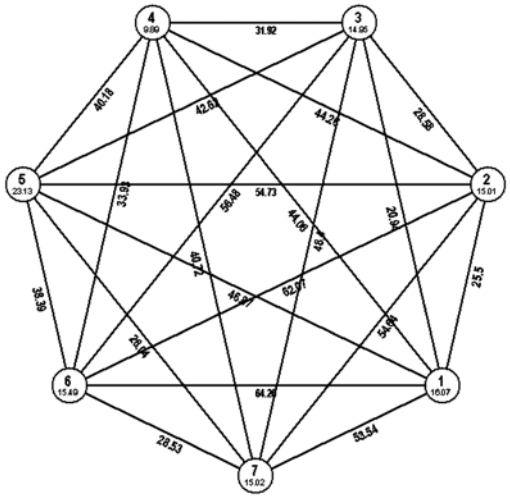

Fig. 2. Inter- and intra-cluster distances between different clusters.

and artificial selections in creation of variation in the bulb onion germplasm. Prasad *et al*. (4) have also reported grouping of 115 landraces of bulb onion into 10 clusters independence of their geographical origin. The intra-cluster distances were less than inter cluster distances and implies that genotypes of one cluster are sufficiently homogeneous among them and differ greatly from the genotypes grouped into other clusters. It provides an opportunity to breeders for selection of diverse accessions to utilize in their breeding programmes.

In principal component analysis first seven components explained 78.29% of total variation based upon eigen values (Table 2). PC-1 had eigen value of 6.95 and accounted for 28.97% of total variance. This component consists of only, quantitative characters like number of leaves per plant, bolting (%), bulb weight, polar diameter, equatorial diameter and number of scales per bulb were contributed significantly towards the variability in the germplasm. PC-2 comprised of qualitative traits namely bulb shape, bulb location and stem shape and described 17.33% of total variation. In PC 3, Lachrymatory factor, bulb size and leaf girth contributed 8.37% of total variation. Whereas, PC 4 has stem shape, bulb flesh colour, leaf girth and neck to bulb ratio while, PC 5 includes bulb skin

Table 2. Contribution of each character towards major principal components for qualitative and quantitative characters.

Character	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Early seedling vigour	**-0.3095**	0.1549	-0.0428	0.0101	0.1026	-0.1433	-0.0747
Leaf colour	0.0433	-0.1572	-0.1884	-0.0823	0.1271	-0.2406	**-0.6295**
Leaf habit	-0.000	0.0000	0.0000	0.0000	0.0000	-0.0000	0.0000
Leaf cross-section	0.0951	-0.1794	**-0.3490**	-0.0834	0.2415	-0.1905	0.2218
Leaf arrangement	-0.000	0.0000	0.0000	0.0000	0.0000	-0.0000	0.0000
Bolting	0.0920	-0.1169	0.0917	**-0.3698**	**-0.3757**	-0.0300	0.1170
Plant habit at maturity	0.000	-0.0000	-0.0000	-0.0000	-0.0000	0.0000	-0.0000
Stem shape	-0.0447	**0.2524**	-0.0816	**0.4349**	-0.1439	0.2139	-0.1725
Bulb location	-0.0404	**0.3206**	**-0.2813**	-0.1328	-0.1734	0.1736	0.0232
Bulb shape	-0.0216	**0.3911**	-0.1079	0.1671	0.0056	0.1743	-0.0638
Bulb skin colour	0.03085	-0.1813	-0.2025	0.1959	**0.3461**	-0.256	**0.4241**
Bulb size	-0.0791	0.0084	**0.3851**	0.0527	**-0.4318**	-0.127	**0.2502**
Bulb flesh colour	-0.0996	**-0.2810**	0.1498	**0.2786**	0.0510	0.2063	-0.2096
Bulb hearting	-0.0186	-0.0901	0.0576	-0.3134	**0.2741**	**0.6052**	-0.0961
Leaf girth (cm)	-0.0275	0.1134	**0.4448**	**0.2690**	**0.2784**	-0.192	-0.0610
No. of leaves per plant	**0.3207**	0.1770	0.0615	-0.0364	0.1691	0.0582	-0.0000
Leaf length (cm)	**-0.2583**	0.2313	0.1974	**-0.2520**	0.1690	-0.050	0.0922
Plant height (cm)	**-0.2546**	0.2354	0.1743	**-0.2664**	0.1762	-0.071	0.1235
Bolting (%)	**0.2672**	-0.1423	0.0173	-0.0985	-0.0199	**0.3100**	0.1976
Days to 75% maturity	-0.2842	0.1790	-0.1042	-0.1264	-0.0356	-0.134	-0.0944
Bulb wt. (g)	**0.3087**	0.2218	0.0749	-0.0717	0.1201	-0.036	-0.0606
No. of scales/ bulb	**0.3133**	0.2057	0.0273	-0.0589	0.1890	0.0394	0.0341
Polar dia. (cm)	**0.3112**	0.1317	0.2450	-0.0211	0.0435	-0.067	-0.0750
Equatorial dia. (cm)	**0.2983**	0.1610	0.1894	0.0200	0.0739	-0.181	-0.0201
Neck to bulb ratio (cm)	-0.1751	0.0592	-0.0041	**0.3096**	0.1844	**0.2838**	**0.3208**
Lachrymatory factor (mg/100 g)	-0.0599	**-0.3436**	**0.3435**	0.0519	0.0529	0.0893	-0.0981
TSS (°Brix)	0.2498	0.0569	-0.1450	0.2442	**-0.2780**	-0.0559	0.04667
Eigen value	6.9518	4.1593	2.0085	1.7773	1.4909	1.3200	1.0819
% Variation explained	28.966	17.330	8.369	7.405	6.212	5.500	4.508
% Cumulative variance	28.966	46.296	54.665	62.070	68.282	73.782	78.290

colour, bulb hearting and leaf girth with share of 7.41 and 6.21% of the total variation, respectively. Bolting (%), bulb hearting and leaf girth explained 5.50% and bulb skin colour described 4.51% of total variation for PC-6 and PC-7, respectively. In principal component analysis only, quantitative and qualitative characters contributed positively in PC-1 and PC-2, while the remaining five principal components both qualitative and quantitative traits contributed jointly. It indicates that breeder should give equal consideration to qualitative and quantitative characters in various breeding programmes.

This study implies a wide range of variability for various characters and indicates that Indian region is an important centre of diversity of cultivated bulb onion. This report helps the breeders to select various characters responsible for the most of variation for development of better cultivars to fulfill the needs of producers and consumers. In future, it is worth to evaluate more germplasm over the locations and years for more precise estimation of genetic potential of onion germplasm.

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