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Genetic Divergence Studies in Garlic (*Allium sativum* L.) through Morphological Features

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A B S T R A C T

For the assessment of the Genetic diversity among 80 germplasm of Garlic, an experiment was conducted at main experimental station, Narendra Deva University of Agriculture & Technology, Faizabad (U.P.) by using 12 morphological traits. Divergence analysis grouped tested genotypes in the nine distinct non-over lapping clusters. The maximum inter-cluster distance was observed between cluster VII and III (39.852), these two clusters were genetically diverse to each other. However, the minimum inter-cluster D^2 value was recorded in case of cluster I and cluster II, as these two clusters were genetically not diverse to each other. Cluster VII was most important because 03 genotypes in this cluster having the most important diverse characters, because it showed maximum mean values. These clusters could be useful in heterosis breeding to achieve more genetic gain. The percent contribution was found highest for plant height followed by length of leaf, number of cloves per bulb, and total soluble solids for total divergence among the available genotypes of garlic. The current study concluded that on the basis of phenotypic characters, genotypes were highly diverse, which could be exploited for future heterosis breeding program and useful for selection of better recombinant.

Introduction

Garlic (*Allium sativum* L.) a monocotyledonous vegetable especially used as spice and flavoring agent in cuisine (Velisek *et al.,* 1997). Its Center of Origin is Central Asia (Kazakhstan) while China and the Mediterranean area are its secondary centers of diversification (Etoh and Simon, 2002).Garlic bulb is extraordinary medicine for enormous diseases (Mishra *et al.,* 2018). Its consumption reduces the risk of heart disease by cutting down cholesterol level. It has good cure against some stomach disease and sore eyes and cough. Its juice has medicinal properties to cure skin diseases. Garlic contains moisture 62.8%, protein 6.3%, carbohydrate 29%, fiber 0.80%, fat 0.1%, mineral matter 1.00%, calcium 0.03%, phosphorus 0.31%, and iron 0.001% per 100g

fresh peeled garlic cloves. It also contains vitamin A 175 IU, vitamin B_1, 0.68% and vitamin B_2, 0.08% in dehydrated garlic powder.

India is the second largest producer after China with the average productivity of 5.4 tons/ha, which is low in comparison to the other garlic growing countries (Singh *et al.,* 2012). In India, Madhya Pradesh is the leading state in garlic production, its share, 0.06 Million hectare area with 0.27 Million tonnes production. The important garlic growing states are Andhra Pradesh, Gujarat, Maharashtra, Orissa, Rajasthan, Tamil Nadu and Uttar Pradesh. The garlic is grown on a large acreage through clonal propagation, which is main reason for narrowing genetic base, and reducing the genetic variation. Therefore, it become necessary to collect basic information on genetic diversity and other statistical parameters that could help in selection, exploitation of heterosis and obtain superior recombinants for genetic improvements to achieve the more yield of the crop.

Materials and Methods

Eighty (80) diverse genotypes of garlic (*Allium sativum* L.) in Augmented Block Design (Table 1) at Main Experimental Station Department of Vegetable Science, Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.). Each block keeping 30cm distance between the row and the distance of plant to plant was maintained at 10cm. The basal fertilizers were applied at the rate of 30 tonnes FYM, 125:100:65kg NPK per hectare. The recommended agronomic practices were followed to raise a good crop. Observations were recorded on five randomly selected plants for twelve yield characters i.e. plant height (cm), number of leaves per plant, length of leaf (cm), width of leaf (cm), neck thickness of bulb (cm), diameter of bulb (cm), bulb yield per plant (g), number of cloves per bulb, weight of clove (g), length of clove (cm), diameter of clove (cm) and total soluble solids (%). The mean data on twelve characters from the experiment were used for analysis.

Results and Discussion

The studies on genetic divergence among 80 genotypes of garlic were carried out by using Mahalanobis D^2 statistics. Overall, eighty genotypes of garlic were grouped in nine distinct non-over lapping clusters (Table 1). This indicated that presence of considerable diversity in the genotypes. The major clusters in the above mentioned genetic divergence analysis contained frequently the genotypes of heterogeneous origin. Although the genotypes of same origin or geographic region were also found to be grouped together in the same cluster. The instances of grouping of genotypes of different origin or geographic region in same cluster were frequently observed. This suggested that there was no parallelism between genetic and geographic diversity. All genotypes were divided into nine clusters (Table 1). Cluster I (18) had maximum number of genotypes followed by clusters IV (13), cluster II (12), cluster VI (10), cluster VIII (8), cluster V (6), cluster IX (6), and cluster III (4). While, cluster VII (3) had lowest number of genotypes. Similar findings were reported by Khar *et al.,* (2006).

The averages inter and intracluster distance has been mentioned in Table 2. The maximum intra-cluster D^2 value observed in cluster VII (21.881) while minimum was in VI (13.508). The maximum inter-cluster distance was observed between cluster VII and III (39.852), which suggested that members of these two clusters are genetically very diverse to each other. Followed by inter-cluster distance between VI and cluster IX (39.451).

Table.1 Clustering pattern of eighty garlic genotypes on the basis of Non-hierarchical Euclidean Cluster Analysis for 12 characters

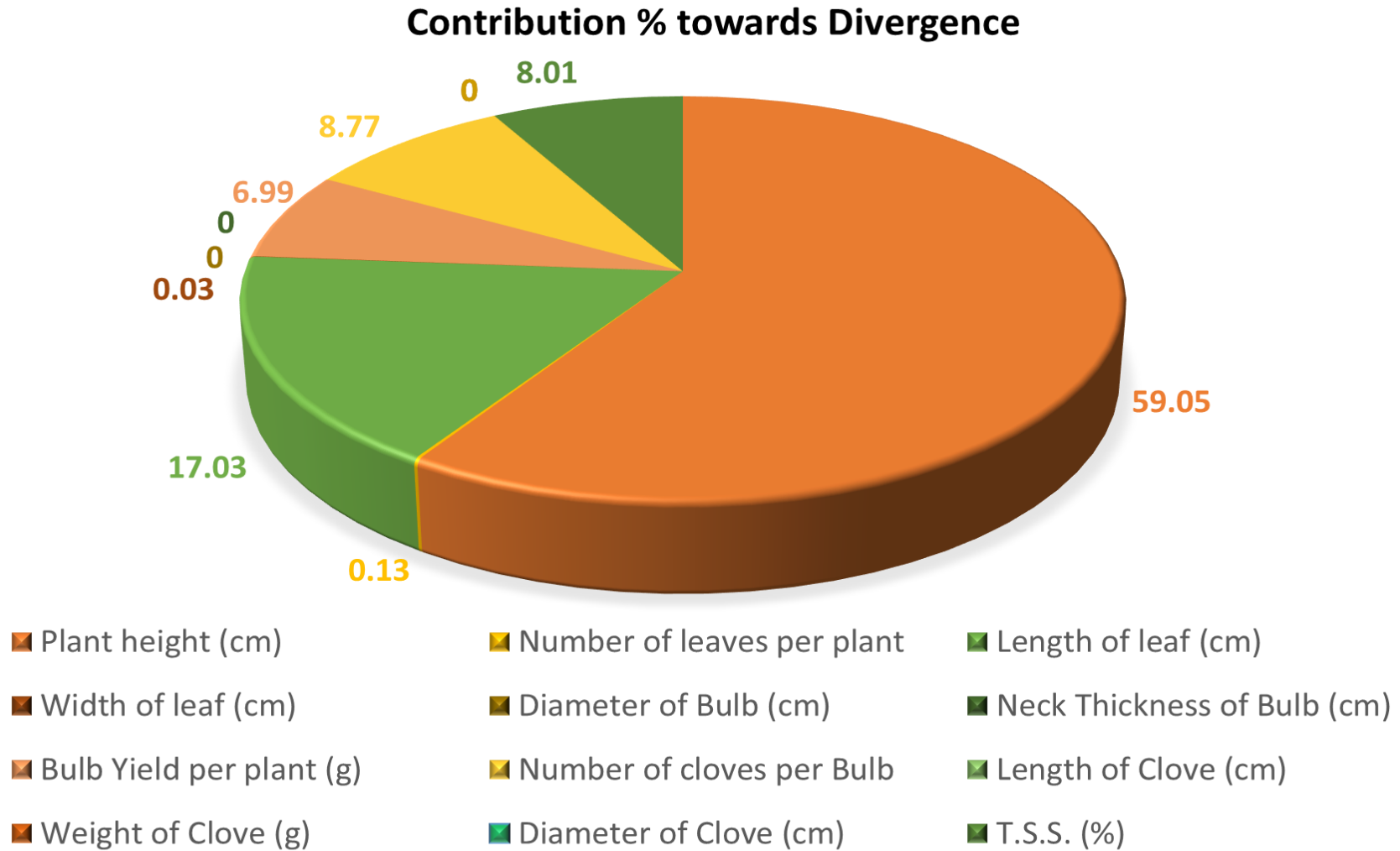| Cluster Number	Number of genotypes	Genotypes
I	18	NDG-2,NDG-22,NDG-21,NDG-71,NDG-10,G-41,NDG-8,NDG-1, NDG-3,NDG-4,G-282,G-50,NDG-70,NDG-73,NDG-12,NDG-15,NDG-23,NDG-55
II	12	NDG-7,NDG-16,NDG-11,NDG-72,NDG-14,NDG-18, NDG-46,NDG-41,NDG-40,NDG-58,NDG-57,NDG-61
III	4	NDG-13,NDG-67,NDG-68,NDG-69
IV	13	NDG-17,NDG-20,NDG-19,NDG-45,NDG-63,NDG-24,NDG-47,NDG-49,NDG-25,NDG-48,NDG-56,NDG-64,NDG-65
V	6	NDG-5,NDG-6,NDG-9,NDG-75,NDG-77,NDG-77
VI	10	NDG-26,NDG-32,NDG-43,NDG-42,NDG-50,NDG-62,NDG-74,NDG-51,NDG-52,NDG-53
VII	3	NDG-29,NDG-30,NDG-27
VIII	8	NDG-31,NDG-44,NDG-54,NDG-36,NDG-66,NDG-59,NDG-60,NDG-28
IX	6	NDG-33,NDG-38,NDG-39,NDG-34,NDG-35,NDG-37

Table.2 Estimates of average intra and inter-cluster distances for 9 clusters in garlic

Clusters	I	II	III	IV	V	VI	VII	VIII	IX
I	**14.428**	18.386	23.204	20.519	22.817	22.775	36.222	26.513	31.702
II		**14.395**	23.531	20.694	21.535	21.762	31.946	23.983	31.881
III			**14.033**	25.117	30.494	33.757	39.852	34.122	38.154
IV				**14.754**	30.458	24.017	36.969	24.380	39.451
V					**13.657**	22.050	32.154	27.508	26.312
VI						**13.508**	35.455	20.409	29.675
VII							**21.881**	26.194	32.304
VIII								**14.346**	23.480
IX									**18.995**

Table.3 Cluster means for 12 characters in Garlic

Cluster/ Characters	Plant height (cm)	Number of leaves per plant	Length of leaf (cm)	Width of leaf (cm)	Diameter of Bulb (cm)	Neck Thickness of Bulb (cm)	Bulb Yield per plant (g)	Number of cloves per Bulb	Length of Clove (cm)	Weight of Clove (g)	Diameter of Clove (cm)	T.S.S. (%)
I	64.522	7.959	35.954	1.982	4.044	1.4462	24.467	22.785	2.366	1.568	1.503	33.812
II	61.844	8.274	33.108	1.695	4.029	1.397	23.560	21.151	2.378	1.328	1.498	32.356
III	62.842	8.418	35.540	1.885	3.793	1.635	22.749	20.230	2.417	1.212	1.432	38.174
IV	42.533	6.762	28.148	1.641	3.244	1.529	19.741	17.197	2.302	1.320	1.515	34.644
V	51.592	7.956	29.327	1.659	3.652	1.443	22.525	19.992	2.201	1.203	1.438	35.234
VI	68.222	8.200	36.789	2.001	4.048	1.605	22.670	22.233	2.465	1.236	1.292	37.180
VII	69.974	8.663	39.927	1.173	4.529	1.219	26.824	27.228	2.579	1.247	1.413	36.305
VIII	59.867	7.743	31.852	1.779	3.661	1.583	22.423	20.844	2.260	1.151	1.221	36.766
IX	52.523	7.639	30.610	1.228	3.574	1.366	25.400	23.534	2.331	1.415	1.508	32.997

Figure.1 Percent contribution of 12 characters towards total genetic divergence in garlic

Contribution % towards Divergence

Legend:
- Plant height (cm)
- Number of leaves per plant
- Length of leaf (cm)
- Width of leaf (cm)
- Diameter of Bulb (cm)
- Neck Thickness of Bulb (cm)
- Bulb Yield per plant (g)
- Number of cloves per Bulb
- Length of Clove (cm)
- Weight of Clove (g)
- Diameter of Clove (cm)
- T.S.S. (%)

Inter cluster distance between 15 clusters were obtained >30. The minimum inter-cluster D^2 value was recorded in case of cluster I and cluster II (18.386) followed by cluster VI and cluster VII (20.409). The higher inter-cluster distance indicated greater genetic divergence between the genotypes of these clusters, while, lower inter cluster values between the clusters suggested that the genotypes of the clusters were not much genetically diverse from each other. This was supported by Khar *et al.,* (2006) and Kumar *et al.,* (2011)in same and other crop, respectively.Saxesena*et al.,* (2013)also stated that genotypes belonging to the cluster with maximum inter cluster distance are genetically more divergent. Therefore, favorable broad spectrum genetic variability for bulb yield improvement may be achieve by adopting the selection of genotypes based on large cluster distances from all the clusters. Hybrids between genotypes belonging to the same cluster never be expected to have desirable segregants, because they are less divergent. Consequently, hybridization between genetically diverse parents from different distant cluster always bring together diverse nature of genes in one pool or genotype. Complementary interaction of divergent genes in parents always yield-promising hybrids.

Cluster VII showed maximum mean values 69.974 for the plant height, number of leaves per plant (8.663), length of leaf (39.927), diameter of bulb (4.529), bulb yield per plant (26.824), number of clove per bulb (27.228) and length of clove (2.579) (Table 3). Cluster VI showed highest mean for width of leaf (2.001). Cluster III showed highest mean for neck thickness of bulb (1.635), and total soluble solids (38.174). Cluster I showed highest mean for weight of clove (1.568). Cluster IV showed highest mean for diameter of clove (1.515). Singh *et al.,* (2012) also reported similar results. Cluster VII was most

important because three genotypes in this cluster having the most important diverse characters, which might be used for the several traits. Albeit, as these clusters are comparatively more diverse, these clusters could be exploited for the breeding to achieve more genetic gain. The present findings were in accordance with the findings of (Kaushik *et al.,* 2016). The maximum D^2 values of any character may be greater decisive factor to choose the cluster toaim of further selection.

A perusal of percent contribution showed that plant height was found for highest 59.05 contribution followed by length of leaf (17.03), number of cloves per bulb (8.77) and total soluble solids (8.01) for total divergence among the available genotypes of garlic (Figure 1). While number of leaves per plant, bulb yield per plant, diameter of bulb, contributed very low towards the divergence. Similar results were reported by Kaushik *et al.,* (2016) and Shashidhar and Dharmatti (2005).

Acknowledgment

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