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GENETIC DIVERGENCE ANALYSIS IN TUBEROSE (*POLIANTHES TUBEROSA* L.) GENOTYPES

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ABSTRACT

An experiment was carried out in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2016-17 and 2017-18, to study the genetic diversity in tuberose (*Polianthes tuberosa* L.) genotypes. The experiment was laid out with eighteen tuberose genotypes in Randomized Block Design (RBD) with three replications. Observations were recorded for growth, flower and physiological characters. Based on D^2 values, the genotypes were grouped into seven clusters. Maximum inter cluster distance was observed between cluster 6 (Phule Rajani) and cluster 3 (Subhasini and Vaibhav). Traits *viz.* duration of spike, number of spike per bulb planted and yield per spike had highest contribution towards genetic divergence.

Key words : Tuberose, D^2 analysis, Cluster distance, Genetic divergence.

Introduction

Tuberose (*Polianthes tuberosa* L) is a bulbous fragrant ornamental plant, native to Mexico. In India, tuberose occupies a prime position in the floriculture industry. The major portion of tuberose flowers consumption is in the form of loose flowers and cut flowers. The loose flowers of tuberose have high demand in the market for making garlands and other floral arrangements. The tuberose flowers are valued more because they impart sweet and lingering pleasant fragrance. The highly fragrant single petaled flowers contain 0.08 to 0.14 per cent concrete, which is used in high grade perfumes. There is a good demand for tuberose concrete and absolute in the international market and fetches a good price. It's essential oil is exported at an attractive price to France, Italy and other countries (Sadhu and Bose, 1973). Hence, tuberose is extensively cultivated as a source of raw material for perfume industry (Gandhi, 2017). The performance of any crop or variety largely depends upon its genetic makeup. Further, the performance of these crops depends upon climatic conditions of the region under which they are grown. As a result, genotypes, which perform well in one region, may not perform well in other regions of varying climatic conditions. Hence, it is essential to collect and evaluate all available genotypes in order to select suitable and high yielding genotypes for a particular region (Martolia, 2010). In plant breeding, genetic diversity plays an important role because hybrids between genetically diverse parents manifest greater heterosis than those between closely related parents .The scope for improvement in a crop is dependent on the genetic diversity present in available germplasm. The D^2 technique based on multivariate analysis developed by Mahalanobis (1936) is the most effective method for quantifying the degree of genetic diversity among genotypes, which helps in selecting the parents for hybridization.

Materials and Methods

The present investigation included 18 genotypes of tuberose conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat in two seasons during 2016-17 and 2017-18. The genotypes taken were Arka Nirantara, Vaibhav, Subhasini, Mexican Double, Mexican Single, Prajwal, Jorhat Collection, Guwahati Single, Hajo Locale, Calcutta Single I, Calcutta Single II, Calcutta Double, Sikkim Selection, Bidhan Rajani I, Bidhan Rajani II, Shringar and Phule Rajani. The experiment was laid out in randomized block design with three replications. The soil was brought to a fine tilth by giving deep ploughings. The field was divided into plots for allotment of various treatments. Fifty four plots were laid out to accommodate all the 18 treatments replicated three times. The gross size of an individual plot was 2.5 × 1.5 m in each replication. Medium sized bulbs of 3.0 - 3.5 cm diameter weighing about 25 grams were selected and treated with Bavistin 1.5g/l water for half an hour. The treated bulbs were planted in rows at 30 × 25 cm spacing accommodating 28 plants per plot. All the growth, flower and bulb characters were recorded in five sampled plants in each treatment from each replication. Genetic diversity was studied following Mahalanobi's (1936) generalized distance (D^2) extended by Rao (1952). Clustering of genotypes was done according to Tocher's method (Rao, 1952).

Results and Discussion

Clustering pattern of varieties based on D^2

In the present study, based on D^2 values, all the eighteen genotypes were grouped into seven clusters (Table 1) following the method suggested by Tocher (Rao, 1952). Cluster I was the largest one with 7 genotypes followed by cluster II having 4 genotypes. Cluster III and cluster VII had two genotypes each. Custer IV, V and VI were solitary cluster comprising only one genotype each. Cluster III and Cluster VI comprised of only double genotypes. Clustering of genotypes was not associated with the geographical distribution and mainly grouped due to their morphological differences and breeding history.

Table 1: Clustering pattern of 18 cultivars of Tuberose using morphological traits.

Cluster	Number of cultivars	Cultivars
1	7	Jorhat Collection Hajo Locale Guwahati Single Calcutta Single II Calcutta Single I Bidhan Rajani I Bidhan Rajani II
2	4	Shringar Maxican Single Prajwal Arka Nirantara
3	2	Subhasini Vaibhav
4	1	Hyderabad Single
5	1	Sikkim Selection
6	1	Phule Rajani
7	2	Maxican Double Calcutta Double

Thus it reflected that geographical isolation is not the sole cause for genetic diversity. Genotypes grouped to the same cluster diverse little from one another as the aggregate of characters measured (Gogoi, 2017)

The magnitudes of diversity among parents determine the inherent potential of a cross and the selection of a parent based on the genetic divergence would be desirable for creating the maximum variability. Therefore, hybridization programme may be initiated involving the genotypes belonging to seven different clusters as they are genetically distinct to develop hybrid varieties because hybrid between two divergent parents gives more heterosis as compared to closely related parents.

Intra and inter-cluster distance

The inter-cluster distance values were greater than intra-cluster distance values (Table 2). Among the seven clusters, the intra- cluster distance varied from 0.00 to

Table 2 : Intra (diagonal) and inter cluster D^2 values for different characters in tuberose cultivars.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
Cluster 1	**604.16**	2368.18	15734.38	808.01	941.62	**1883.67**	9595.88
Cluster 2		**334.55**	8914.93	965.99	1141.90	1756.60	5659.89
Cluster 3			**370.07**	13503.64	12543.48	**16986.68**	1770.83
Cluster 4				**0.00**	727.05	740.87	8604.01
Cluster 5					**0.00**	1838.78	7174.72
Cluster 6						**0.00**	12129.95
Cluster 7							**747.26**

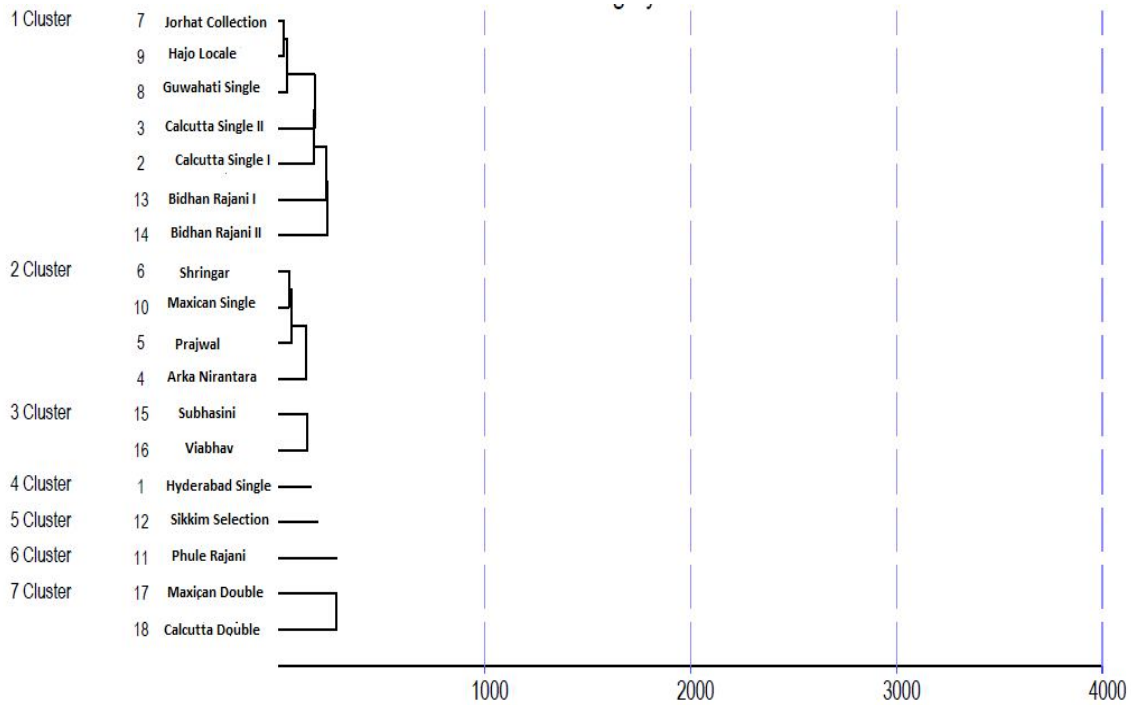

Fig. 1: Clustering pattern by Tocher method of eighteen tuberose cultivars.

747.26. As the cluster IV, V and VI contained only one genotype, the intra cluster distance was found to be 0.00. The highest inter-cluster distance was found between clusters III and VI (16986.68). The inter cluster distance was minimum (727.05) between Cluster IV and Cluster V indicating close relationship among the genotypes of that clusters and similarity for most of the characters. The inter-cluster distance being larger than the intra cluster distance suggested wider genetic diversity among the genotypes at the seven different clusters.

It is desirable to select genotypes from clusters showing high inter cluster distance with high yield as parents in recombination breeding programmes for obtaining desirable segregants. This type of hybridization would be useful for obtaining highest number of valuable segregants along with maximized vigour. The results are in conformity with the findings of Ranchana *et al*. (2015), Sirohi *et al.* (2016) and Gandhi (2017).

Cluster means for different characters

The cluster means for each of 31 characters is presented in the Table 3. Cluster I possessed lowest mean values for fresh weight of spike (47.36g), number of spikes per bulb planted (1.47), bulb weight per clump (15.92g), moisture content (36.06%) and chlorophyll content (0.68mg/g). Cluster II had highest mean values for plant height (98.83cm) and weight of clump (416.89g). Cluster III recorded highest mean values for leaf length (47.28cm), minimum days to spike emergence (75.66), minimum days to opening of first pair of floret from spike emergence (16.50), spike length (82.41cm), rachis length (58.00 cm), number of florets per spike (37.49), length of florets (6.43cm), diameter of stalk (0.99cm), weight of florets (4.20g), fresh weight of spike (103.34g), diameter of rachis (0.86cm), number of spikes per bulb planted (2.41), duration of single flower (7.50 days), duration of spike (29.83 days), vase life of florets (5.83 days), vase life of spike (16.58 days), number of economic bulb produced per bulb planted (10.17), size of bulb (3.91cm), moisture content (66.81%), yield of florets per spike (156.92g), yield of florets per m^2 (1255.32g) and yield of florets per ha (12553.20kg). The highest mean values for minimum days to bulb sprouting (12.50) and chlorophyll content (0.76mg/g) and lowest mean values for leaf length (38.83cm), spike length (70.50cm), rachis length (41.00cm), and duration of single flower (4.67days) were observed in Cluster IV. Cluster V exhibited lowest mean values for leaves per plant (42.00), leaf breadth (1.56cm), leaf area index (104.51), maximum days to bulb sprouting (16.00), maximum days to spike emergence (81.00), maximum days to opening of first pair of floret from spike emergence (25.00), number of florets per spike (23.66), diameter of stalk (0.76cm), weight of floret (0.75g), diameter of rachis (0.69cm), duration of spike (18.50 days), vase life of florets (2.33 days), vase life of spike (8.00 days), number of economic bulb produced per bulb planted (7.50), weight of clump(264.50g), size of bulb (2.80cm), yield of florets per spike (17.38g), yield of florets per m^2

Table 3 : Cluster mean for different characters in tuberose cultivars.

Cluster	Plant height (cm)	Leaves per plant	Leaf length (cm)	Leaf breadth (cm)	Leaf area index	Number of shoots per bulb planted	Days to bulb sprouting	Days to spike emergence
Cluster I	83.94	57.38	40.58	1.80	148.54	6.28	15.57	79.31
Cluster II	98.83**	56.12	45.87	2.38	216.77	5.41	13.41	77.20
Cluster III	96.16	57.16	47.28**	2.28	236.05	5.08	13.08	75.66**
Cluster IV	74.00	55.33	38.83*	1.72	139.96	6.17	12.50**	76.17
Cluster V	94.83	42.00*	46.10	1.56*	104.51*	5.50	16.00*	81.00*
Cluster VI	69.99*	54.50	45.50	2.51**	249.57**	6.50**	14.16	80.16
Cluster VII	81.16	61.58**	45.94	1.93	215.15	3.41*	15.91	80.08

Cluster	Days to opening of first pair of floret from spike emergence	Spike length (cm)	Rachis length (cm)	Number of florets per spike	Length of floret (cm)	Diameter of stalk (cm)	Weight of floret (g)
Cluster I	21.49	71.47	41.40	32.28	5.78	0.78	0.91
Cluster II	19.45	81.75	55.12	36.24	5.83	0.96	1.31
Cluster III	16.50**	82.41**	58.00**	37.49**	6.43**	0.99**	4.20**
Cluster IV	18.00	70.50*	41.00*	33.83	5.30	0.89	0.91
Cluster V	25.00*	72.83	49.50	23.66*	5.83	0.76*	0.75*
Cluster VI	20.83	81.83	45.17	33.00	4.95*	0.82	0.95
Cluster VII	22.58	71.91	45.33	27.25	6.13	0.98	3.24

Cluster	Fresh weight of spike (g)	Diameter of rachis (cm)	Number of spikes per bulb planted	Duration of single flower (days)	Duration of spike(days)	Vase life of florets (days)	Vase life of spike (days)
Cluster I	47.36*	0.74	1.47*	5.04	20.57	2.99	10.02
Cluster II	82.38	0.83	1.75	6.58	24.58	3.79	12.37
Cluster III	103.34**	0.86**	2.41**	7.50**	29.83**	5.83**	16.58**
Cluster IV	66.36	0.79	1.83	4.67*	23.83	3.50	11.67
Cluster V	47.47	0.69*	1.50	5.17	18.50*	2.33*	8.00*
Cluster VI	90.71	0.82	1.83	6.17	26.00	3.67	10.00
Cluster VII	97.77	0.85	1.92	6.91	29.67	5.50	15.66

Cluster	Number of economic bulb produced per bulb planted	Bulb weight per clump (g)	Weight of clump (g)	Size of bulb (cm)	Moisture content (%)	Chlorophyll content (mg/g)	Yield of florets per spike (g)
Cluster I	7.52	15.92*	334.50	2.98	36.06*	0.68*	29.62
Cluster II	9.41	19.77	416.89**	3.66	45.20	0.72	46.42
Cluster III	10.17**	28.00	371.16	3.91**	66.81**	0.73	156.92**
Cluster IV	9.83	27.17	335.67	3.60	40.98	0.76**	30.67
Cluster V	7.50*	21.66	264.50*	2.80*	41.78	0.71	17.38*
Cluster VI	7.83	18.25	339.33	3.52	45.87	0.73	31.22
Cluster VII	9.50	29.33**	341.08	3.03	65.20	0.70	88.44

Cluster	Yield of florets per m^2	Yield of florets per ha(kg)
Cluster I	238.13	2381.30
Cluster II	371.39	3713.90
Cluster III	1255.32**	12553.20**
Cluster IV	246.31	2463.10
Cluster V	139.00*	1390.00*
Cluster VI	249.78	2497.73
Cluster VII	707.50	7075.00

(139.00g) and yield of florets per ha (1390.00kg). Likewise Cluster VI exhibited highest mean values for leaf breadth (2.51cm), leaf area index (249.57) and number of shoots per bulb planted (6.50). This cluster recorded lowest mean values for plant height (69.99cm) and length of the florets (4.95cm). Cluster VII exhibited highest mean values for leaves per plant (61.58) , bulb weight per clump (29.33g) and lowest mean values for

Table 4 : Contribution of different characters towards divergence.

Character	Contribution
Vase life of floret	9.15 %
Fresh weight of spike	1.96 %
Rachis Diameter	1.31 %
Spike per bulb planted	20.92 %
Duration of spike	50.98 %
Yield per spike	15.69 %

number of shoots per bulb planted (3.41).

Among the seven clusters, cluster III has got high genetic divergence and could be useful in breeding programme. The genotypes from this cluster showed highest leaf length (47.28cm), leaf area index (236.05), minimum days to spike emergence (75.66), minimum days to opening of first pair of floret from spike emergence (16.50), spike length (82.41cm), rachis length (58.00 cm), number of florets per spike (37.49), length of florets (6.43cm), diameter of stalk (0.99cm), weight of florets (4.20g), fresh weight of spike (103.34g), diameter of rachis (0.86cm), number of spikes per bulb planted (2.41), duration of single flower (7.50 days), duration of spike (29.83 days), vase life of florets (5.83 days), vase life of spike (16.58days), number of economic bulb produced per bulb planted (10.17), size of bulb (3.91cm), moisture content (66.81%), yield of florets per spike (156.92g), yield of florets per m^2 (1255.32g) and yield of florets per ha (12553.20kg). This could be utilized in breeding for a short duration crop and for high yield. Similar such findings were reported by Ranchana *et al*. (2015) and Gandhi (2017) in tuberose.

Contribution of different characters towards divergence

Contribution of different characters towards divergence is presented in Table 4. Out of 31 characters duration of spike was the main contributor towards divergence (50.98% contribution). This was followed by spike per bulb planted (20.92 %), yield per spike (15.69%) and vase life of floret (9.15%). This is in consonance with the findings of Ranchana *et al*. (2015).

Conclusion

Therefore from the experiment it can be concluded that among the seven clusters, cluster III has got high genetic divergence. The cultivars from this cluster showed highest mean value for leaf length, minimum days to spike emergence, minimum days to opening of first pair of floret from spike emergence, spike length, rachis length, number of florets per spike, length of florets, diameter of stalk, weight of florets, fresh weight of spike, diameter of rachis, number of spikes per bulb planted, duration of single flower, duration of spike, vase life of florets, vase life of spike, number of economic bulb produced per bulb planted, size of bulb, moisture content, yield of florets per spike, yield of florets per m^2 and yield of florets per ha .Based on the clustering pattern, cluster distance and cluster mean cultivars Suvasini and Vaibhav could be useful for exploration of hybrid vigour and for getting good recombinant. Duration of spike, spike per bulb planted, yield per spike and Vase life offloret showed high contribution towards genetic divergence.

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