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Estimation of variability and diversity in tuberose (*Polianthes tuberosa*L.) genotypes

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ABSTRACT

Fourteen cultivars of tuberose (Polianthestuberosa L.) were assessed for valuation of different variability parameters and genetic diversity analysis atthe Horticultural Research Station, BCKV, West Bengal.All the traits comprised offlowering, growth and yield attributingcharactershowing the existence of substantial morphological variation and diversity among the genotypes. High heritability value coupled with high GA percentage over mean was observed in maximum character showing additive gene action. Leastchangevalue between PCV and GCVwere recorded forentiretraitssignifying less influence of environment on those characters.The fourteen cultivars could be clustered into five groups. Cluster I and cluster V respectively,comprisedof highest (5) and lowest (1) number of genotypes. Inter-cluster distance was recorded maximum among cluster II and V (676.80) followed by, cluster IV and V (591.21).Lowest inter-cluster distance (32.06) was found between cluster II and IV.Cluster mean performance revealed that cluster IV was the best performing in respect of growth and flowering traits however, cluster II was finest in respect of florets yield. Genotypes of cluster IV and II should be selected for further tuberose improvement programme. Based on the mean values of twelve characters variety Prajwal exhibited best performance in that particular locality.

Keywords:*Cluster,Genetic diversity, Tuberose, Variability, GCV,PCV*

Introduction

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Tuberose (*Polianthes tuberosa* L.),is animportant flowerof family Amaryllidaceae, preferred worldwide due to its attractive long spikes and nearly year-round production in tropical and subtropical climates [1-2].In India among the commercially grown ornamental flowers, tuberose occupies a key position owing to its popularity as a loose flower, cut flower, and usefor perfumery along with its potential as source of secondary metabolites.

The crop exhibited narrow variation in respect of flower type and only two categories of tuberose (Single and Double) cultivated throughout the world. Several varieties of this crop show variation with respect to growth habit, flowering behaviour and yield etc. However, very few have desirable traits in terms of quality and yield. In Indiacultivation of tuberoseis becomingpopular among the commercial farmers and so development of new varieties with elite floral characteristic and high yield is essential for every plant breeding programme. Meanwhile, performance of same varieties varies from one region to other regions of variable climatic conditions [3]. Hence, there is urgent need to assess the performance of genotypes as well asdegree of genetic variability, evaluation for nature and diversity in the gene pool.Study of important yield contributing characters in a crop is crucial[4]. The current experiment was therefore taken up to evaluate the performance of fourteenvarieties of tuberose and select the appropriate genotype(s) in the new alluvial zone of West Bengal based on different variability parameters.

Due to availability of very meagre references on the investigation relating to genetical studies, it is envisagedthat detailed study in this respect will be rewarding. The germplasm of any crop including the floricultural plants is the sinkof genetic diversity thatfrequentlyusage to encounter the erraticneeds for developing new improved varieties. There is paramount importance of the knowledge of genetic diversity which can be achievable through multivariate analysis with the help of D^2 statistics.

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Multivariate analysis is act as an important tool between the biological populations in computing the divergence at genotypic level and to assess the total divergence of different components at both intra and inter cluster levels. Due to very limited knowledge about the application of D^2 statistics in tuberose, the present experiment was therefore conducted for assessing the tuberose cultivars with the help of analysis of variance, GCV, PCV, heritability and multivariate analysis.

Materials and Methods

Present experimental work was undertaken at Horticultural Research Station, Bidhan Chandra Krishi Vishwavidyalaya, W.B., India, during the year 2015-16. The experimental site was geographically located at 23.5^0N latitude and 89^0E longitude with an average altitude of 9.75 m above sea level. This zone falls under the subtropical humid climate where summer and winter both are short and mild/moderate. The experimental materials consisted of fourteen single and double type commercial cultivars of tuberose (*Polianthes tuberosa* L.), which were selected due to their quality and ease in availability. A brief description of different genotype is listed in table 1.

The source of the experimental materials was the AICRP on Floriculture Improvement Project (ICAR) of the BCKV, Nadia (West Bengal). The trial was laid out in Randomised Complete Block Design with three replications. Necessary agronomic package and practices were followed to grow a successful crop [2]. Representative plants were marked in each replication and close observations were noted regularly.

Data of five plants in each genotype in every replication for twelve characters which includes vegetative parameters like number of shoots/clumps, height of plant,number of leave per plant, flower quality parameters like length of spike, length of rachis, florets length, diameter of florets, weight of individual floret and yield parameters like number of florets/

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spike, spike/clump, weight of cut spike and spike yield/ plot were recorded and computed for drawing conclusions on different genetical parameters.

Table 1: List of tuberose genotypes under study with flower types and key features.

Sl. No.	Genotype	Flower types	Character
1.	Shringar	Single	Cross between Mexican Single x Pearl Double, (developed by IIHR)
2.	Phule Rajani	Single	Single rows of corolla segment
3.	Rajat Rekha	Single-	Gamma ray induced leaf variegated mutant, having silvery white streak along the leaf midrib
4.	Sikkim Selection	Single	Leaves are variegated type; flower buds are greenish in colour
5.	Calcutta Single	Single	Flower buds are greenish in colour and small
6.	Prajwal	Single	Flower buds are slightly pinkish in colour, Cross of Shringar x Mexican Single (developed by IIHR); recommended for both loose as well as cut flower
7.	Hyderabad Single	Single	Unopened florets have pinkish tinge
8.	Hybrid GKTC-4	Single	Flower spike curvature absent
9.	Arka Nirantara	Single	Flower spike curvature present, released by IIHR.
10.	Vaibhav	Semi-double	The flower buds are greenish in colour in contrast to pinkish buds, cross Mexican Single x IIHR-2, (developed by IIHR)
11.	Suvasini	Double	Multi-whorled variety, cross between Single x Double, (developed by IIHR)
12.	Calcutta Double	Double	Used mainly as cut flower
13.	Hyderabad Double	Double	More than three rows of corolla segment.
14.	Swarna Rekha	Double	Gamma ray induced leaf variegated mutant,having golden yellow streak along the margin of leaf blade.

Recorded data were subjected to analyse statistically, and analysis of variance was carried out using the formula suggested by Snedecor [5]. Phenotypic and genotypic coefficients of variation were obtained using the method as per Burton and De-Vane[6]. Heritability (broad sense) and genetic advance (GA) respectively were assessed as the formula described by Lush and Allard [7-8]Estimates of divergence among the 14 genotypes were based on multivariate analysis using Mahalanobi's D^2 statistic [9] and generalized distance (D^2) by Rao [10]. The formation of clusters was done by Toucher's method [10].

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Results and Discussions

TheANOVA (table -2) exhibited very significant differences amongst varieties in respect of all the characters except spike/clump. The result is in conformity with earlier observations [11-13]in tuberose. The variations among the genotypes might be due to its diversified origin, and also evolution of the specific genotype as per morphotype in their particular geographical location. Such enormous variation offers better choice for selecting genotypes with healthier performance under the present agro-climatic condition of West Bengal.

Table 2:ANOVA table for twelve characters of fourteen genotypes of tuberose

Sl. No	Characters	Mean squares	
		Genotypes	**Error**
1	Height of plant (cm)	391.26**	20.23
2	Leaves number per plant	162.68**	122.74
3	Number of shoots/clump	83.89**	8.09
4	Length of spike(cm)	1464.36**	297.89
5	Length of rachis (cm)	263.59**	0.62
6	Number of florets/spike	396.35**	14.91
7	Length of florets (cm)	6.27**	0.002
8	Diameter of florets (cm)	3.99**	0.01
9	Wt. of floret (gm.)	19.33**	0.002
10	Wt. of cut spike/plant (gm.)	4563.66**	2.63
11	Spike/clump	0.74^{NS}	0.04
12	Spike yield/plot	48.98**	0.44

** Significant at 1 per cent level

Mean performance of genotypes for all the parameters revealed the substantial variation among the genotypes (Table 3). The range for plant heightwas recorded from 34.00 cm (Rajat Rekha) to 79.33 cm (Prajwal), for number of leaves/plant from 57.00 (Swarna Rekha) to 245.00 (Calcutta Single), for Number of shoot/clump from 5.00 (Rajat Rekha) to 22.00 (Calcutta Single), for spike length from 43.86 cm (Swarna Rekha) to 137.71 cm (Sikkim Selection), for rachis length from 7.39 cm (Swarna Rekha) to 41.77 cm (Vaibhav), for number of florets/spikefrom 10.11 (Swarna Rekha) to 51.77 (Hyderabad Single), for floret length from 0.82 cm (Swarna Rekha) to 6.36 cm (Prajwal), diameter of floret varies from 0.63 cm (Swarna Rekha) to 4.99 cm (Prajwal), for floret weight from 2.02 g (Swarna Rekha)

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to 10.71 g (Prajwal), for weight of cut spike from 11.63 g (Swarna Rekha) to 163.44 g (Prajwal), number of spike/clumprange from 0.22 (Swarna Rekha) to 2.04 (Calcutta Single) and spike yield/plotranged from 2.19 (Swarna Rekha) to 16.92 (Calcutta Single).Based on the mean values of twelve yield contributing characters of fourteen cultivars of tuberose, Prajwal exhibited the best performance as compared to other cultivars in the present agro-climatic condition of new alluvial zones of West Bengal (table 3). Similar finding [14] is in agreement with present work.

The valuation of non-heritable and heritable parameters in the entire variability is essential for adopting appropriate plant breeding programme. It is reported from previous finding that genetic variability and diversity are prime requisite for any breeding programme on which selection cab be made to evolve elite genotype. Consequently, higher the amount of variation present for the numerous traits in gene pool, selection will be more effective for that characters.

Observed variation was heritable portion ascertained by estimating the components of variation like heritability, GCV, PCV and predicted Genetic Advance (table 4). High GCV and PCV were experiential for all the growth and yield attributes except plant height (18.11 and 19.62). The high values of phenotypic and genotypic coefficient of variation for these traits, suggested that there was a possibility of improvement yield in tuberose through direct selection. Table 4 shown that estimates of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for entirely traits, signifying there is impact of environment on all these traits.

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Table 3: Mean performance of fourteen tuberose genotypes for twelve characters.

Genotypes	Plant ht. (cm)	No. of leaves/ plant	No. of shoots/ clump	Spike Length (cm)	Rachis Length (cm)	No. of florets/ spike	Length of Florets (cm)	Diameter of Florets (cm)	Wt. of Floret (g)	Wt. of cut spike/plant (g)	Spike/ clump	Spike yield/ plot
Shringar	50.00	111.33	9.33	89.70	33.66	45.63	5.65	4.19	7.87	83.57	1.38	11.21
Phule Rajani	52.00	152.67	14.67	89.92	34.49	44.97	5.43	4.65	8.13	88.64	1.35	7.56
Calcutta Double	52.33	163.00	10.33	91.43	34.74	41.62	5.08	4.56	10.12	116.82	1.94	8.44
Rajat Rekha	34.00	76.67	5.00	61.26	17.93	26.02	3.25	2.29	3.40	30.72	0.69	6.56
Prajwal	79.33	181.33	10.00	120.93	39.01	46.13	6.36	4.99	10.71	163.44	1.61	11.88
Vaibhav	63.00	161.33	11.00	86.38	41.77	49.08	5.37	4.40	8.45	78.02	1.40	9.60
Subhasini	65.00	198.67	11.00	95.23	38.44	50.48	5.80	4.80	10.52	125.57	1.19	7.54
Calcutta Single	61.00	245.00	22.00	88.08	27.34	33.86	5.95	4.01	6.53	65.24	2.04	16.92
Swarna Rekha	57.67	57.00	6.00	43.86	7.39	10.11	0.82	0.63	2.02	11.63	0.20	2.19
Sikkim Selection	74.00	190.00	18.67	137.71	39.58	40.65	5.83	4.05	7.09	88.95	1.46	12.69
Hyderabad Single	62.33	218.67	21.00	90.72	32.13	51.77	5.53	4.10	7.76	84.76	1.69	14.06
Hybrid GKTC-4	45.33	208.67	14.00	85.65	30.94	47.52	5.63	4.47	7.95	88.68	1.76	13.67
Hyderabad Double	61.67	231.33	18.00	98.86	37.79	51.56	4.90	4.21	10.43	110.75	1.89	15.31
Arka Nirantara	57.00	111.67	10.33	95.42	36.81	42.90	6.14	4.44	8.23	128.51	1.25	7.15
MEAN	58.19	164.81	12.952	91.081	32.288	41.593	5.125	3.985	7.8	90.38	1.416	10.342
SE(m)	2.59	6.39	1.64	9.96	0.45	2.22	0.03	0.05	0.03	0.93	0.11	0.38
CD at 5 %	7.55	18.59	4.78	28.97	1.32	6.48	0.08	0.13	0.08	2.72	0.32	1.12

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Meanwhile, the minimum influence of environment on these traits was justified due to observation of insignificant difference between GCV and PCV. Similar results were observed in tuberose [14-16] and in gladiolus [17-18].

Heritability plays important role to plant breederas it stipulates the opportunity and degree to which enhancement is potential through selection. Superior heritability only is not appropriate to put together competent selection in the higher generation unless attended by extensive amount of genetic advance. Henceforth,maximum heritability combined with high genetic advance valueoffer better scope for progressive improvement in succeeding generation. Heritability estimates for all the characters except diameter of florets (53.66%)were observed maximum. However, higher heritability along with higherGA as % of mean was noticed for spike length (63.80%, 23.56), rachis length (92.00%, 39.52), number of florets/spike(90.54%, 52.83), weight of florets (96.20%, 49.31), weight of cut spike (91.36%, 38.27), spike/clump(86.00%, 45.46) and spike yield/plot(97.43%, 59.04) which shown that these characters are governed by additive gene action. The outcomes further proposed thatthese traits are feweraffected by environmental expression sothrough selection of all attributes could be in effect and profitable for yield enhancement and in developing a better tuberose variety. Similar observation reported in tuberose[15] for number of spikes/m^2, number of florets/spike, rachis length and yield of florets per plot are in accordance with present findings.

The genotypes were significantly diverse from each other with their vegetative, morphological and yield parameters. Based on the degree of divergence fourteen cultivars of tuberose were grouped into five clusters (table 5) indicating wide genetic diversity in the present material.

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Table 4:Genetic components of different traits of tuberose.

Character	Mean	Range	GCV	PCV	Hert (%)	GA (%) of Mean
Plant ht. (cm)	58.19	34.00-79.33	18.11	19.62	86.20	15.25
Leave number per plant	164.81	57.00-245.00	34.67	37.31	74.84	10.35
Number of shoots/clump	12.95	5.00-22.00	38.81	44.59	76.45	18.55
Length of spike (cm)	91.08	43.86-137.71	21.65	28.77	63.8	23.56
Length of rachis (cm)	32.28	7.39-41.77	29.00	30.10	92.00	39.52
Number of florets/spike	41.59	10.11-51.77	27.11	28.66	90.54	52.83
Length of florets (cm)	5.12	0.82-6.36	28.21	28.23	67.73	19.15
Diameter of florets (cm)	3.98	0.62-4.99	28.94	29.01	53.66	12.65
Wt. of floret (g)	7.80	2.02-10.71	32.54	34.54	96.20	49.31
Wt. of cut spike (g)	90.38	11.63-163.44	31.14	33.18	91.36	38.27
Spike/clump	1.42	0.20-2.04	34.18	36.76	86.00	45.46
Spike yield/plot	10.34	2.18-16.91	38.89	39.42	97.43	59.04

Twenty-one single and double type tuberose genotypes were grouped into six clusters including twenty characters [19] and 28 gladiolus genotypes based on twelve characters were assembled into eight clusters [20]which are in agreement of present work. Maximum five genotypes were included into cluster I whereas, cluster V confined with only one entry. Cluster II, III and IV werecomprised with 2, 3 and 3 genotypes respectively.Genotypes within thecluster indicates thatpossess narrow genetic divergent between themselves. The likeness in the base plant population, from which had been developed, might be the reason of genetic homogeneousness. Present finding has been supported by the earlier result[21] in double type tuberose using morphological marker and in single type tuberose using molecular markers [22].

Table 5:Pattern of cluster in tuberosecultivars

Cluster Number	No. of cultivars	Cultivars
Cluster-I	5	Shringar, PhuleRajani, Calcutta Double, Hyderabad Single, Hybrid GKTC-4
Cluster-II	2	Subhasini, Hyderabad Double
Cluster-III	3	RajatRekha, Calcutta Single, Sikkim Selection
Cluster-IV	3	Prajwal, Vaibhav, Arka Nirantara
Cluster-V	1	Swarna Rekha

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Inter and Intra cluster distances are shown in Table 6. Inter-cluster distances were greater than the intra-cluster distance signifying the incidence of wider diversity among genotypes of distance groups. Maximum differences among the genotypes within the same cluster were observed in cluster III (26.72) followed by cluster IV (19.67), cluster I (13.65), and cluster II (6.73). While, maximum inter cluster value (676.80) wasobserved between cluster II and V followed by (591.21) in cluster IV and V and minimum cluster value (32.06) was observed between cluster II and IV.The cluster II and V produced the highest inter-cluster distances signifying wide diversity of the genotypes between the groups and thesecultivars could be utilized as parents in breeding program for accomplishmentof transgressive segregants. The minimum inter cluster distance was recorded between cluster II and IV (32.06) and cluster I and IV (30.73) suggesting that genotypes of these clusters were genetically closed and hence, may not be emphasized upon to be used in hybridization programme.

Table 6:Intra (diagonal) and inter cluster distances for twelve characters.

	Cluster I	**Cluster II**	**Cluster III**	**Cluster IV**	**Cluster V**
Cluster I	13.65	34.69	86.82	30.73	474.08
Cluster II		6.73	181.04	32.06	676.80
Cluster III			26.72	137.73	275.97
Cluster IV				19.67	591.21
Cluster V					00.00

The means of cluster in case of twelve character and completetrait wise across the five clusters are shown in table 7. The average cluster mean of twelve characters revealed that not any of the clusters have genotype with entirely the desirable characters and so recombinant plant breeding between genotypes of diverse clusters would bedesirable.The diverse cluster mean value for all characters showed that diverse clusters have higher mean values for different characters indicates that rare clusters contained genotypes with most of the desirable characters. Highest cluster mean for spike/clump (1.62) and lowest cluster mean for plant height (52.40 cm) were recorded in cluster I.

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The genotypes in cluster II showed highest cluster mean for number of leaves/plant (215.00), number of florets/spike (51.02) and weight of florets (10.47gm.). Cluster III possessed high mean value for number of shoots/clump (15.22) and spike yield/plot (12.06). The genotypes of the cluster IV comprised highest mean values for maximum characters namely, plant height (66.44 cm), spike length (100.91 cm), rachis length (39.20 cm), length of florets (5.96 cm), diameters of florets (4.61 cm) and weight of cut spike/plant (123.32 gm.) whereas, all the characters except plant height in cluster V recorded with lowest cluster mean value. Therefore, as per D^2 analysis, it has been understood that desirable traits of plant should give more weightage while choosing parents for crop improvement [23-24].

Conclusion

In the currentinvestigation, maximum number of the traits which showed high to reasonable heritability and desirable genetic advance had extreme positive effect on yield. Therefore, selection based on these traits would be fruitful. The genotypes having varied performances were grouped into five clusters with the help of Tocher's method. Genotypes from wide divergence cluster can be used as parent for the future plant breeding programmelikely to produce potential hybrids. As present,crop strictly vegetative propagated hence any desirable hybrids can obtained, could be maintained and reproduced through asexual mean for commercial use. Based on cluster mean performance cluster IV was the best performing with respect to growth and flowering traits.However, cluster II was finest in respect of florets yield. Genotypes were abundant in use with above-mentioned traits in cluster II and IV would offer a greaterpossibility for the improvement of this crop and rational selection through hybridization programme. Based on the mean performance and genetic divergence the genotypes Prajwal have been identified as best performing cultivar in that particular region for commercial cultivation.

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Table 7: Cluster means for twelve characters of *Polianthes* genotypes

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
Cluster I	52.4	170.87	13.87	89.48	33.19	46.30	5.47	4.39	8.37	92.49	1.62	10.99
Cluster II	63.33	215.00	14.50	97.04	38.12	51.02	5.35	4.51	10.47	118.16	1.54	11.43
Cluster III	56.33	170.56	15.22	95.68	28.28	33.51	5.01	3.45	5.67	61.64	1.40	12.06
Cluster IV	66.44	151.44	10.44	100.91	39.2	46.04	5.96	4.61	9.13	123.32	1.42	9.54
Cluster V	57.67	57.00	6.00	43.86	7.39	10.11	0.82	0.627	2.02	11.63	0.20	2.19

X1= Plant height (cm), X2= No.of leaves/plant, X3= No.of shoots/clump,X4= Spike Length (cm), X5= Rachis Length (cm), X6= No.of florets/spike, X7= Length of florets (cm), X8= Diameter of florets (cm), X9= Wt.of floret (g), X10= Wt.of cut spike/plant (g), X11= Spike/clump, X12 = Spike yield/plo

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