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STUDY ON GENETIC VARIABILITY, HERITABILITY, GENETIC ADVANCE AND CHARACTER ASSOCIATION IN TUBEROSE (*Polianthes tuberosa* L .) GENOYPES

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ABSTRACT : The present study consists of twenty one tuberose genotypes to find out the estimates of genetic variability, heritability, genetic advance and character association. The phenotypic coefficient of variation was found to be higher than their corresponding genotypic coefficient of variation for all the characters. The high genotypic coefficient variation (GCV) and phenotypic coefficient variation (PCV) magnitude was observed for yield of bulb per plant (gm), yield of bulb (q/ha), concrete (%), absolute (%) and weight of bulbs (gm). High heritability coupled with high genetic advance as percent of mean was recorded for number of leaves per plant, vase life (days), numbers of bulbs per plant, yield of bulb per plant (gm) and yield of bulb (q/ha), weight of bulb (gm), concrete and absolute indicating that genetic control in the inheritance of these traits and selection pressure could be profitably applied on these characters for yield improvement. Phenotypic correlations were of higher magnitude as compare to their corresponding genotypic correlation in most of the attribute combination which indicated that existence of strong influence of environmental factor for the various characters. Yield of bulb showed significant and positive correlation with days to taken to sprout, plant height, length of longest leaf, days required for visibility of first spike, number of floret per spike, diameter of floret, length of spike, number of bulbs per plant, yield of bulb per plant and diameter of bulb at genotypic level and phenotypic level yield of bulb exhibited positive significant association with days to taken to sprout, plant height, number of floret per spike, length of spike, number of bulbs per plant, yield of bulb per plant and diameter of bulb. Thus, it can be inferred that selection based on any one of these characters either alone or in combination, will result in identifying high yielding strains in tuberose crop.

Kewwords : *Tuberose, genetic advance, genetic variability, heritability, character association.*

Tuberose (*Polianthes tuberosa* L.) is one of the most important tropical ornamental bulbous flowering plants cultivated for production of long lasting flower spikes. It is popularly known as Rajanigandha or Nishigandha. It belongs to the family Amaryllidaceae and is native of Mexico. There are about fifteen species under the genus Polianthes, of which twelve species have been reported from Mexico and Central America. Of these, nine species have white flowers (Rose, 14), one is white tinged with red and two are red. Except *Polianthes tuberosa* L., all the others are found growing wild. On the basis of bearing pattern of petals in the rows; tuberose are classified in four categories namely, Single, Semi-double, Double and Variegated. Tuberose is diploid with chromosome number of 30, of which 5 are large and rest are small (Whitaker, 21). The knowledge about the factors responsible for yield is a difficult problem as yield is a complex character and an interactive effect multiplication of different traits especially in vegetatively propagated crops. Therefore, for achievement of high yield level of bulb and flower yield, the breeder is required to simplify this complex situation. Under these scenarios, the study of correlation between yield and its components is of prime importance in formulating the selection criteria. Selection is generally based on the phenotypic values of a particular trait which partly determined by genotypes which is heritable, and partly by environment which is non-heritable. The characters that are largely influenced by environment are said to have low heritability while those which are less susceptible to environment variation shows high heritability. Paroda and Joshi (10) referred the idea about heritability. Therefore, it is necessary to know the

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various components of yield, their heritable and non-heritable variability and their mutual correlation. The study of genetic advance is equally important as it measures the genetic gain based on selection in a particular character. Genetic advance provide the improvement in performance over the parents as shown by off springs. Therefore, any crop improvement programme through selection, the study of genetic variability and heritability together with genetic advance is necessary (Murthy and Srinivas, 9; Kannan *et al.,* 4; Radhakrishna *et al.,* 11; Vijayalaxmi *et al.,* 20). The heritability of a specific character and intensity of selection are the two important factors behind the entire success due to selection. This is important factor on which breeder rely most. Genetic advance provide the improvement in performance over the parents as shown by off springs. Correlation coefficient provides symmetrical measurement of degree of association between two characters help in understanding the nature and magnitude of association among yield and its components. Under present study heritability, genetic advance and correlation carried out to evaluate the twenty one genotypes of tuberose for advance in breeding programme.

MATERIALS AND METHODS

The experiment was conducted at Horticultural Research Centre, SVPUA&T, Meerut U.P. in the year 2013-14 with 21 genotypes of tuberose. Experiment was laid out in randomized block designed (RBD) with three replications. All the recommended cultural practices were followed under irrigated conditions. The observations were recorded on five randomly selected plants of each genotype in all replications at various stages of growth on statistically twenty important quantitative characters namely, days taken to sprout, plant height (cm), number of leaves per plant, length of longest leaf (cm), width of longest leaf (cm), days required for visibility of first spike, number of florets (cm), numbers of spikes per clump, length of spike (cm), length of rachis (cm), longevity of spike (days), vase life (days), numbers of bulbs per plant, diameter of bulb (cm), yield of bulb (q/ha), weight of bulb (gm), concrete (%) and absolute (%). Collected data were subjected to analyze statistically and analysis of variance was carried out using the formula suggested by Snedecor and Cochran, (18). Phenotypic and genotypic coefficients of variation were obtained using the method suggested by Burton and DeVane (3). Heritability (broad sense) and genetic advance (GA) were estimated as per the formula described by Lush, (7) and Allard, (2), respectively. Correlation coefficients were calculated as per the methods suggested by Searle, (15).

RESULTS AND DISCUSSION:

Analysis of variance was found highly significant differences among genotypes for all the twenty characters namely, days taken to sprout, plant height,

Table 1 : Analysis of variance (ANOVA) for twenty characters of tuberose.

Source of Variation	D F	Days taken to sprout	Plant Height (cm)	No.of leaves / plant	Length of longest leaf (cm)	Width of the longest leaf (cm)	Days required for visibility of first spike	No. of florets/ spike	Diameter of floret (cm)	No. of spikes / clump	Length of spike (cm)
Replication	2	0.24	11.41	10.53	4.26	0.01	9.54	8.45	0.026	0.04	3.05
Treatment	20	2.12**	65.62**	131.02**	70.16**	0.05**	62.74**	43.86**	0.17**	0.12**	38.56**
Error	40	0.74	8.03	9.19	9.50	0.01	16.48	7.34	0.06	0.01	14.89

Source of Variation	D F	Length of rachis (cm)	Longevity of spike (days)	Vase life (days)	No. of bulbs per plant	Yield of bulb per plant (gm)	Diameter of bulb (cm)	Yield of bulb (q/ha)	Weight of bulb (gm)	Concrete%	Absolute%
Replication	2	4.88	1.58	1.73	3.56	2905.16	0.13	4660.28	20.39	0.0005	0.0000
Treatment	20	12.93**	5.25**	2.98**	21.37**	35836.18**	0.21**	46668.47**	139.84**	0.0065**	0.0004**
Error	40	3.05	1.32	0.27	1.02	605.86	0.03	1013.95	2.49	0.0001	0.0000

*,** significant at 5% and 1% level, respectively

Table 2 : Estimates of variability parameters for twenty characters in Tuberose

Characters	Heritability (%)	Genetic Advance	Genetic Advance value (% mean)	GCV (%)	PCV (%)
Days taken to sprout	38.25	0.86	6.87	5.39	8.71
Plant Height (cm)	70.50	7.58	15.13	8.75	10.42
Number of leaves per plant	81.54	11.85	23.70	12.74	14.11
Length of longest leaf (cm)	68.03	7.64	16.10	9.48	11.49
Width of the longest leaf (cm)	57.85	0.19	10.83	6.91	9.09
Days required for visibility of first spike	48.34	5.62	8.99	6.28	9.03
Number of florets / spike	62.40	5.68	12.53	7.70	9.75
Diameter of floret (cm)	40.17	0.25	6.84	5.24	8.27
Number of spikes / clump	72.27	0.34	18.11	10.34	12.16
Length of spike (cm)	34.65	3.41	4.70	3.88	6.58
Length of rachis (cm)	51.95	2.70	10.04	6.76	9.38
Longevity of spike (days)	49.89	1.67	9.07	6.23	8.82
Vase life (days)	77.28	1.72	21.46	11.85	13.48
Number of bulbs per plant	86.96	5.00	32.36	16.85	18.07
Yield of bulb per plant (gm)	95.09	217.69	56.46	28.11	28.82
Diameter of bulb (cm)	64.27	0.40	14.39	8.72	10.87
Yield of bulb (q/ha)	93.75	246.06	53.59	26.87	27.75
Weight of bulb (gm)	94.83	13.57	55.44	27.64	28.38
Concrete%	98.21	0.09	92.77	45.44	45.85
Absolute%	97.23	0.02	99.48	48.97	49.66

number of leaves per plant, length of longest leaf, width of longest leaf, days required for visibility of first spike, number of florets, numbers of spikes per clump, length of spike, length of rachis, longevity of spike, vase life, numbers of bulbs per plant, diameter of bulb, yield of bulb, weight of bulb, concrete and absolute, indicating wide spectrum of variation among the genotypes (Table 1). High amount of genetic variability for many of these traits has also been reported earlier by (Singh *et al.,* 17). High GCV and PCV (>20 %) was observed for yield of bulb per plant (28.11 and 28.82), yield of bulb (26.87 and 27.75), weight of bulbs (27.64 and 28.38), concrete (45.44 and 45.85) and absolute (48.97 and 49.66) While low values (<10 %) of phenotypic and genotypic coefficient variation was recorded for length of spike (3.88 and 6.58), diameter of floret (5.24 and 8.27), days taken to sprout (5.39 and 8.71), longevity of spike (6.23 and 8.82), days required for visibility of first spike (6.28 and 9.03), length of rachis (6.76 and 9.38), width of longest leaf (6.91 and 9.09), numbers of florets per spike (7.70 and 9.75), diameter of bulb (8.27 and 10.87) and plant height (8.75 and 10.42). The high values of genotypic and phenotypic coefficient of variation for these traits, suggested that there was a possibility of improvement yield of bulb in tuberose through direct selection. In general estimates of phenotypic coefficient of variation (PCV) were higher comparable with genotypic coefficient of variation (GCV) for all traits (Table-2), indicating that all these traits were influenced by environment. These findings are similar in agreement with earlier reported by Kumar *et al,* (5), Ranchana *et al.* (12) in tuberose, Misra *et al.* (8) in dahlia and Sheela *et al.* (16) in heliconia. High heritability (>60%) in broad sense (Table 1) was recorded for plant height (70.50), number of leaves per plant (81.54), length of longest leaf (68.03), number of florets per spike (62.40), number of spikes per clump (72.27), vase life (77.28), number of bulbs per plant (86.96), yield of bulb per plant (95.09), yield of bulb (93.75), weight of bulb (94.83), concrete (97.23) and absolute (97.23). High heritability estimates for most of the traits studied have also been reported earlier also by Vanlalruati *et al.* (19). The high heritability denotes high proportion of genetic effects in the determination of these characters and can be adopted directly for improving the bulb yield. Genetic advance as perceimum (20%) for number of leaves per plant (23.70), vase life (21.46), number of bulbs per plant (32.36), yield of bulb per plant (56.46), yield of bulb (53.59), weight of bulb (55.44), concrete (92.77) and absolute (99.48) whereas, it was minimum for length of spike (4.70). High heritability coupled with high genetic advance as percent of mean was observed for number

Table 3 : Estimates of correlation coefficient for genotypic level among different characters in Tuberose.

Characters	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	-0.085	0.209	-0.104	-0.074	-0.509**	0.107	0.007	-0.158	0.087	-0.422**	0.126	-0.396**	0.650**	0.331**	-0.018	0.443**	-0.183	-0.458**	-0.367**
2		-0.189	1.087**	0.233	0.797**	0.291*	0.264*	0.183	0.975**	0.764**	0.065	0.033	-0.122	0.368**	0.249*	0.326**	0.245*	0.116	0.243
3			-0.129	-0.101	-0.490**	0.337**	-0.135	0.581**	0.002	0.010	0.643**	0.060	0.526**	-0.184	-0.475**	-0.193	-0.554**	-0.164	-0.092
4				0.211	0.683**	0.415**	0.250*	0.126	1.059**	0.660**	0.197	0.089	-0.155	0.358**	0.158	0.324**	0.267*	0.160	0.256*
5					0.232	0.537**	-0.069	0.231	-0.370**	0.059	-0.065	0.058	-0.177	0.053	0.397**	0.059	0.311*	0.323**	0.250*
6						0.373**	0.349**	-0.180	0.476**	0.073	-0.004	-0.313*	-0.443**	0.384**	0.629**	0.349**	0.803**	0.124	0.143
7							0.227	0.142	0.234	0.420**	0.010	-0.243	0.204	0.447**	0.541**	0.367**	0.361**	0.095	0.046
8								0.212	0.588**	0.009	0.557**	-0.367**	0.044	0.493**	0.383**	0.464**	0.275*	-0.256*	-0.171
9									0.814**	0.219	0.693**	0.281*	-0.050	-0.225	-0.498**	-0.280*	-0.480**	0.408**	0.493**
10										0.802**	0.243	0.001	0.415**	0.541**	-0.033	0.545**	-0.093	0.246*	0.434**
11											0.327**	0.112	-0.212	-0.052	-0.327**	-0.031	0.005	0.348**	0.391**
12												0.830**	-0.020	-0.317**	-0.282*	-0.437**	-0.278*	0.090	0.126
13													-0.006	-0.368**	-0.536**	-0.371**	-0.424**	0.219	0.184
14														0.476**	-0.193	0.509**	-0.377**	-0.363**	-0.332**
15															0.709**	0.996**	0.561**	-0.093	-0.101
16																0.684**	1.034**	-0.062	-0.108
17																	0.529**	-0.151	-0.159
18																		-0.005	-0.080
19																			0.956**
20																			1.000

1 : Days taken to sprout
2 : Plant Height (cm)
3 : Number of leaves / plant
4 : Length of longest leaf (cm)
5 : Width of the longest leaf (cm)
6 : Days required for visibility of first spike
7 : Number of florets / spike
8 : Diameter of floret (cm)
9 : Number of spikes / clump
10 : Length of spike (cm)
11 : Length of rachis (cm)
12 : Longevity of spike (days)
13 : Vase life (days)
14 : Number of bulbs per plant
15 : Yield of bulb per plant (gm)
16 : Diameter of bulb (cm)
17 : Yield of bulb (q/ha)
18 : Weight of bulb (gm)
19 : Concrete%
20 : Absolute%

of leaves per plant, vase life, numbers of bulbs per plant, yield of bulb per plant and yield of bulb, weight of bulb, concrete and absolute which indicated that these traits are governed by additive gene action. Direct selection of these attributes will be effective and profitably for yield improvement. The findings are in line of Ranchana *et al.* (13) and Vanlalruati *et al.* (19) who observed high heritability coupled with high genetic advance for some of these characters. On the basis of heritability and expected genetic advance as percent of mean for different characters studied in the present investigation, selection criteria based on yield

Table 4 : Estimates of correlation coefficient for phenotypic level among different characters in Tuberose

Characters	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	-0.187	0.093	-0.201	-0.291*	0.106	-0.140	0.337**	-0.215	-0.075	0.052	-0.192	0.039	0.235	0.181	0.055	0.267*	-0.022	-0.292*	-0.252*
2		-0.167	0.858**	0.046	0.277*	0.370**	0.044	0.275*	0.391**	0.329**	0.172	-0.033	0.004	0.265*	0.060	0.248*	0.222	0.116	0.205
3			-0.160	-0.035	-0.450**	0.147	0.042	0.395**	0.227	-0.140	0.351**	0.103	0.423**	-0.128	-0.463**	-0.180	-0.496**	-0.125	-0.056
4				0.046	0.408**	0.259*	-0.083	0.341**	0.248*	0.470**	0.065	-0.071	0.034	0.241	0.179	0.194	0.212	0.135	0.264*
5					0.005	0.357**	-0.179	0.012	0.125	-0.086	0.116	-0.088	-0.181	0.116	0.241	0.108	0.131	0.241	0.159
6						0.057	0.195	-0.131	-0.072	0.464**	-0.238	-0.146	-0.358**	0.216	0.588**	0.241	0.546**	0.060	0.075
7							-0.036	0.132	0.064	0.059	0.364**	-0.251*	0.177	0.324**	0.190	0.333**	0.286*	0.070	0.005
8								-0.088	0.324**	-0.037	0.022	0.139	-0.083	0.279*	0.166	0.236	0.276*	-0.152	-0.136
9									0.176	0.140	0.409**	0.091	0.123	-0.233	-0.343**	-0.281*	-0.397**	0.362**	0.464**
10										0.031	0.115	0.031	0.126	0.439**	-0.167	0.331**	-0.099	0.155	0.242
11											-0.080	0.066	-0.188	-0.085	0.100	-0.015	-0.013	0.234	0.259*
12												0.402**	-0.010	-0.218	-0.371**	-0.199	-0.220	0.046	0.064
13													-0.088	-0.328**	-0.431**	-0.338**	-0.296*	0.190	0.146
14														0.400**	-0.113	0.409**	-0.338**	-0.327**	-0.276*
15															0.520**	0.951**	0.518**	-0.092	-0.095
16																0.488**	0.806**	-0.068	-0.103
17																	0.472**	-0.144	-0.172
18																		-0.013	-0.075
19																			0.933**
20																			1.000

*,** significant at 5% and 1% level, respectively

of bulb per plant (gm), yield of bulb (q/ha), weight of bulb (gm) may be useful for further development of high yielding tuberose varieties. Correlation coefficients were estimated among twenty characters at phenotypic and genotypic levels are presented in Table 3 and Table 4. Genotypic and phenotypic correlation coefficients worked out among twenty characters revealed that in general, phenotypic correlation coefficient was higher than the genotypic correlation coefficient which may be a result of modifying effect of environments on the association of the characters. In some cases the genotypic correlation coefficient was slightly higher than the phenotypic correlation coefficients indicating a strong inherent association between various traits. The results are in agreement with the findings of Kannan *et al.,* (4), Singh *et al.,* (17), Vanlaruati *et al.* (19), Kumar *et al.,* (6) and Ranchana *et al.* (13). At genotypic level, yield of bulb exhibited positive and significant correlation with days taken to sprout (0.443), plant height (0.326), length of longest leaf (0.324), days required for visibility of first spike (0.349), number of floret per spike (0.367), diameter of floret (0.0.464), length of spike (0.545), number of bulbs per plant (0.509), yield of bulb per plant (0.996) and diameter of bulb (0.684) at genotypic level and phenotypic level yield of bulb exhibited positive significant association with days to taken to sprout (0.267), plant height (0.248), number of floret per spike (0.333), length of spike (0.331), number of bulbs per plant 0.409), yield of bulb per plant (0.951) and diameter of bulb (0.488). The present results were also supported by Kannan *et al.* (4), Singh and Shamasundaran (17) and Ranchana *et al.* (13) in tuberose. Based on the estimates of genotypic and

phenotypic correlations, the breeder would be able to decide the method of breeding, to be followed so that the useful correlation could be exploited and the undesirable ones could be modified by generating fresh variability to obtain new recombinants. According to AlJibouri *et al.* (1), if negative association between characters is due to pleiotropic effects, it would be very difficult to obtain the desired recombinants, while if linkage is involved; special breeding programme is needed to break these linkages.

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