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Study of Phenotypic and Genotypic Variance and Coefficient of Variance, Heritability, Phenotypic and Genotypic Correlation Coefficient Among Different Character's in Tuberose

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A B S T R A C T

The investigation was carried out at the Vegetable research farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh from May 2018 to March 2019 with twenty cultivars of tuberose. The experiment was carried out by using Randomised Block Design with three replications. Every individual plant is selected from each treatment and average was calculated for statistical computation. Phenotypic and genotypic variance and coefficient of variation were estimated. Heritability in broad sense was estimated as a ratio of genetic variance to phenotypic variance. Correlation coefficient was estimated to know the degree and direction of association between the variables. Both genotypic correlation coefficient and phenotypic correlation coefficient were estimated from the variance and covariance components.

Introduction

The various top most cut flowers like tuberose, rose, gladiolus, chrysanthemum etc. are commercially grown on various agro climatic zones of India which have great potential both for domestic and international market. Among various top cut flowers tuberose (*Polianthes tuberosa*) is commonly grown for its high demand (loose and cut flower purpose). It belongs to the family Amaryllidaceae. The genus *Polianthes* contains three types of flowers i.e., Single, double and semi-double. Single flower type have the basic chromosome number n = x = 30 and 2n = 60, which is used as female parent in breeding programme and in perfumery industry, semi-double and double type of flower have the basic chromosome number of 2n = 50 which are grown for cut flower (Biswas *et al.,* 2002). The height of the plant ranges from 60-120 cm with 35-45 cm long and 1.5 cm wide leaves which are 6-9 in number. It bears a spike length of 45 cm which produce clusters of white, fragrant and waxy flowers that blooms acropetally (base to top) (Sheela, 2008). In any plant species the phenotypic expression is determined by two major prime factors that is Genetic factor and environmental factor. The

genotypic expression is further controlled by additive gene effect which is heritable, non-additive gene effect or dominance which is non-heritable and epistasis which is non- allelic interaction. Assigning of the phenotypic variability into its heritable and its non-heritable components with suitable genetic parameters such as genotypic and phenotypic co-efficient of variations and correlation analysis is necessary (Murthy and Srinivas, 1997; Kannan *et al.,* 1998; Radhakrishna *et al.,* 2004; Vijayalaxmi *et al.,* 2012).

Materials and Methods

The investigation was conducted at the Vegetable research farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh from May 2018 to March 2019 with twenty cultivars of tuberose under alluvial loam with adequate drainage and optimum water holding capacity. Twenty tuberose varieties according to layout design are given below.

Table.1

Mexican Single	**Kalyani Single**
Pearl	Hyderabad Single
Phule Rajani	Hyderabad Double
Prajwal	GKTC-4
Suvasini	Double
Shringar	Calcutta Double
Single	Bidhan Snigdha
STR-505	Bidhan Ujjwal
Swarna Rekha	Arka Nirantara
Sikkim Selection	
Vaibhav	

The experiment was conducted by using Randomised Block Design with three replications. Important cultural operation was followed to grow a successful crop. Every individual plant is selected from each treatment and average was calculated for statistical computation. Phenotypic and genotypic variance and coefficient of variation were estimated as suggested by Singh and Choudhary (1979). Heritability in broad sense was estimated as a ratio of genetic variance to phenotypic variance (Falconer, 1981). Genetic advance was calculated using the formula given by Johnson *et al.,* (1955). Correlation coefficient was estimated to know the degree and direction of association between the variables. Both genotypic correlation coefficient and phenotypic correlation coefficient were estimated from the variance and covariance components as given by Aljibouri *et al.,* (1958).

Results and Discussion

Phenotypic and genotypic variance

The maximum phenotypic variance was observed for weight of big bulb (1292.84) followed by weight of spike (347.01), spike length (224.04), plant height (163.49) and diameter of big bulb (109.77). The moderate value of phenotypic variance was recorded for length of big bulb (84.89), florets per plant (68.05), weight of small bulb (53.46), rachis length (48.03) and length of small bulb (38.89). The low value of PCV was observed for the traits like width of longest leaf (0.07), spikes per plant (0.18), floret length (0.19), floret diameter (0.31), internodal length of spike (1.10), days taken to bulb sprout (3.35), vase life of floret (4.58) and diameter of small bulb (15.07).

The maximum genotype variance also showed the same result with highest value of (711.63), spike length (174.14), leaves per plant (58.32), number of floret (41.26) and length of big bulb (32.63). The moderate value of genotype variance was observed for diameter of big bulb (22.41), plant spread (21.73) length of longest leaves (21.0), weight of small bulb (19.75), plant height (18.85), rachis length (18.72) and diameter of small bulb (10.95). Lower value of genotype variance was recorded for traits like length of small bulb (19.45), days taken to bulb sprout (1.42), internodal length (0.77), floret diameter (0.18), spikes per plant (0.17), floret length (0.11) and width of longest leaf (0.06).

Phenotypic and genotypic coefficient of variation

The highest value of PCV was observed for weight of spike (33.10%) followed by weight of small bulb (31.9%), weight of big bulb (28.06%), leaves per plant (24.49%), diameter of small bulb (24.48%), rachis length (23%), internodal length of spike (21.98), florets per plant (20.36), plant spread (18.86) and width of longest leaf (18.27). The less value of PCV was observed for floret length (7.63), plant height (10.71), length of longest leaf (11.16) and vase life of floret (12.00).

The highest value of GCV was observed for weight of spike (29.58) followed by spike per plant (21.09), diameter of small bulb (20.84) and weight of big bulb

(20.82). Moderate value of GCV was observed for weight of small bulb (19.38), internodal length of spike (18.35), width of longest leaf (16.56), florets per spike (15.85) and leaves per plant (14.63). Lower value of GCV was recorded for the trait like rachis length (14.36), days taken to bulb sprout (10.56), floret diameter (10.43), length of longest leaf (9.51) and plant height (8.77).

Heritability in broad sense (h^2) %, Genetic advance and Genetic advance as % of mean

Heritability in broad sense is proportion of genotypic variance to phenotypic variance and it indicates the probability of selection. The ranged for heritability was 3.09 to 96.32%. Highest heritability was recorded for spikes per plant (96.32) followed by width of largest leaf (81.11), spike weight (79.82), spike Internodal length and diameter of small bulb (72.69), plant height (67.14) and florets per spike (60.64). The moderate value of heritability was also found for floret length (57.97) followed by floret diameter (56.76), big bulb weight (55.04), plant spread (51.45), big bulb length (43.15), days taken to bulb sprout (42.33), rachis length (38.97), small bulb weight (36.94) and leaves per plant (35.67). The least value of heritability was found for length of small bulb (24.29) followed by diameter of big bulb (20.42), spike length (17.13) and vase life of floret (3.01). It was seen that most of the traits are come under the moderate heritability. The results showed similar heritability estimate for most of traits as per Chaudhary *et al.,* (2018) in tuberose and Pattanaik *et al.,* (2015); and Ranchana *et al.,* (2013) in gladiolus.

High value of heritability coupled high genetic advance as percent of mean was observed for the traits, width of longest leaf, internodal length of spike, number of spikes/plants, weight of spike, number of florets/plant and diameter of small bulb. It is indicated that importance of additive gene effect for governing their inheritance and phenotypic selection.

The similar results are in consonance with the findings of Chaudhary *et al.,* (2018) and Sirohi *et al.,* (2017) in tuberose and Pattanaik *et al.,* (2015); Naresh *et al.,* (2015) and Ranchana *et al.,* (2013) in gladiolus.

High heritability along with less to medium genetic advance as percent of mean was noted for plant height and length of longest leaf which indicate that it is controlled by non-additive genes. But other side, most of the traits showing moderate heritability with high genetic advance as percent of means (NLPP, RL and WSB).

The genetic advance as % of mean ranged from 0.76 to 54.43. It was highest recorded for the trait spike weight (54.43) and minimum for vase life of floret (0.76 days). The other traits like, spike per plant (42.64), diameter of small bulb (36.66), weight of big bulb (31.81), internodal length of spike (31.27), width of longest leaf (30.54), spike length (29.25), florets per spike (25.43), weight of small bulb (24.27) and rachis length (18.46) were also exhibited high value genetic advance as % of mean.

Phenotypic and genotypic correlation coefficients

In present study, phenotypic and genotypic correlation coefficients extracted from twenty genotypes for twenty-one traits of tuberose. Correlation coefficient data showed that the value of genotypic correlation coefficient was higher than their phenotypic correlation coefficient for all the traits taken under study (Sirohi *et al.,* 2017). So, it is clearly marking the less impact of environment expression of genetic relationship of traits in phenotype.

DTBS was negative and significantly correlated with plant height (-0.266), LLL (-0.385), WLL (-0.324), WS (-0.332) and FD (-0.318). PH was positive and significantly related with LLL (0.829), WLL (0.527), WS (0.425), LBB (0.359), PS (0.279) and INLS (0.276). Length of longest leaf was positive and significantly correlated to the width of longest leaf (0.577), weight of spike (0.438), length of big bulb (0.347), plant spread (0.330), weight of big bulb (0.302) and length of spike (0.257). Width of longest leaf was positive and significantly correlated to the weight of spike (0.457), Internodal length of spike (0.393), weight of big bulb (0.375) and length of big bulb (0.373). Internodal length of spike shows positive and significant correlation with rachis length (0.517), length of spike (0.497), weight of spike (0.311), weight of small bulb (0.272). Length of spike was positive and significantly correlated to the rachis length (0.429) and vase life of florets (0.290). Weight of spike was positive and significantly correlated to the weight of big bulb (0.523), length of florets (0.473), length of big bulb (0.443), diameter of florets (0.428), length of small bulb (0.380) and diameter of big bulb (0.354). Rachis length was positive correlated with vase life of flower (0.265), diameter of big bulb (0.226), diameter of florets (0.226), weight of big bulb (0.182) and length of big bulb (0.136).

Table.2 Phenotypic correlation coefficients among number of spikes/plant and its components in tuberose

Sl. No	Characters	DTBS	PH	NL/P	LLL	WLL	INLS	PS	SL	WS	RL	NF/P	FL	FD	VLF	LBB	DBB	WBB	LSB	DSB	WSB	NS/P
1.	DTBS	1.000	-0.266*	-0.1236	-0.3845**	-0.3241*	0.0119	-0.0941	0.1141	-0.3323**	-0.0522	-0.11031	-0.1282	-0.3176*	0.0918	-0.13163	-0.0638	-0.1279	-0.0869	0.0565	0.1372	**-0.2743**
2.	PH		1.000	-0.0076	0.8294**	0.5266**	0.2759*	0.2801*	0.2332	0.4253**	0.1471	-0.2581*	0.1989	0.2440	-0.22078	0.3587**	0.1610	0.3196*	0.0003	-0.1016	0.0478	**-0.0678**
3.	NL/P			1.000	-0.0446	-0.2794*	-0.1948	0.0955	-0.0279	-0.1988	-0.1524	-0.0436	-0.1875	-0.1245	0.0163	-0.0212	0.1624	0.0515	0.2051	-0.1225	-0.0346	**0.0357**
4.	LLL				1.000	0.5773**	0.2107	0.3297*	0.2565*	0.4378**	0.1674	-0.0583	0.3470	0.2656	-0.0994	0.3465**	0.1588	0.3021*	0.0512	-0.1365	0.0298	**0.0489**
5.	WLL					1.000	0.3931**	0.0952	0.0041	0.4572**	0.1461	0.0012	0.2419	0.1146	-0.0471	0.3725**	0.2359	0.3748**	0.0440	0.0372	0.2161	**0.0840**
6.	INLS						1.000	-0.5301	0.4972**	0.3111*	0.5174**	0.0184	0.1010	0.0350	0.1753	0.2008	0.1900	0.1944	0.0761	0.1835	0.2717*	**-0.4821**
7.	PS							1.000	-0.4095	-0.0666	-0.3784**	0.0794	0.0775	0.0444	-0.2345	0.2385	-0.0677	0.0778	-0.2435	-0.2373	-0.0983	**0.4189**
8.	SL								1.000	0.2188	0.4293**	0.2054	0.1942	-0.0872	0.2896*	-0.1800	0.0664	0.0143	0.2405	0.2365	0.1832	**-0.37**
9.	WS									1.000	0.23	0.0514	0.4730**	0.4281**	0.0470	0.4433***	0.3540**	0.5234**	0.3804**	0.1882	0.2009	**-0.0512**
10.	RL										1.000	0.0406	0.0056	0.2215	0.2647	0.1362	0.2261	0.1822	0.0097	-0.0688	0.1274	**0.0786**
11.	NF/P											1.000	01069	-0.1579	0.2530	-0.1660	-0.0044	-0.0423	0.1265	0.0787	-0.0669	**0.0534**
12.	FL												1.000	0.2682	-0.0743	0.1107	0.0694	0.1638	0.2913*	0.0151	0.2397	**-0.0646**
13.	FD													1.000	-0.2592*	0.3721**	0.2812*	0.3301*	0.0475	-0.1938	-0.1692	**0.3156**
14.	VLF														1.000	0.0679	0.0244	0.0338	0.0614	0.0870	0.0061	**-0.0978**

15.	LBB															1.000	0.6472 **	0.6595 **	0.0339	-0.1391	0.0311	**0.0290**
16.	DBB																1.000	0.7351 **	0.2008	-0.0305	-0.0900	**-0.0460**
17.	WBB																	1.000	0.1129	-0.1356	-0.0071	**0.1535**
18.	LSB																		1.000	0.4460 **	0.1516	**-0.1408**
19.	DSB																			1.000	0.3021 *	**-0.1640**
20.	SB																				1.000	**0.0006**
21.	**NS/P**																					**1.000**

Table.3 Genotypic correlation coefficients among number of spikes/plant and its components in tuberose

Sl. No.	Characters	DTBS	PH	NL/P	LLL	WLL	INLS	PS	SL	WS	RL	NF/P	FL	FD	VLF	LBB	DBB	WBB	LSB	DSB	WSB	NS/P
1.	DTBS	1.000	-0.6784	-0.1635	-0.6890	-0.5105	0.1573	-0.4164	0.1202	-0.6028	-0.1708	0.0487	-0.2256	-0.8375	-0.6482	-0.3337	-0.2478	-2900	-0.4380	-0.0020	0.4423	**-0.4619**
2.	PH		1.000	-0.3570	-0.9430	0.7447	0.5525	0.1015	0.3158	0.5594	0.3121	-0.2258	0.3287	0.2877	0.4370	0.5222	0.4340	0.4748	-0.1223	-0.1797	-0.1251	**-0.1207**
3.	NL/P			1.000	-2921	-0.3844	-0.2442	-0.0461	-0.1015	-0.3058	-0.3160	0.2507	-0.2712	-0.1123	-0.4763	-0.4701	-0.2205	-0.1514	0.8139	-0.2396	0.7951	**0.0450**
4.	LLL				1.000	0.7276	0.4313	0.1614	0.3341	0.5769	0.3436	-0.0920	0.5029	0.4386	1.0767	0.4990	0.4071	0.4250	-0.0630	-0.1655	-0.0538	**0.0449**
5.	WLL					1.000	0.5384	0.1775	0.0281	0.6071	0.3437	-0.0573	0.3894	0.2386	0.1926	0.7078	0.6318	0.5786	-0.1918	-.0392	0.3417	**0.0772**
6.	INLS						1.000	-0.6758	0.5558	0.4250	0.4539	-0.1445	0.0800	0.0136	-0.7633	0.3540	0.5557	0.2979	0.3055	0.2451	0.4225	**-0.5768**
7.	PS							1.000	-0.7966	-0.1537	-0.7623	-0.1520	0.2252	0.1025	2.6955	0.1375	-0.4320	0.0890	-0.6414	-0.3785	-0.1798	**0.5875**
8.	SL								1.000	0.2922	0.4960	0.2873	0.2304	-0.1069	-1.3202	-0.3697	-0.0285	0.0172	0.6474	0.2859	0.3223	**-0.3983**
9.	WS									1.000	0.4375	-0.0700	0.6887	0.5668	-0.0131	-0.7866	0.8065	0.7298	0.7440	0.1899	0.3249	**-0.0692**
10.	RL										1.000	0.0892	-0.1266	0.3792	-0.2432	0.1165	0.7038	0.3879	0.3035	-0.1306	0.0640	**0.0733**
11.	NF/P											1.000	0.3409	-0.1468	-0.2859	-0.3204	-0.1113	-0.1855	0.3918	0.0954	0.0286	**0.1281**
12.	FL												1.000	0.3576	0.1688	-0.4000	0.2774	0.3839	0.5944	0.0648	0.0442 1	**-0.0937**
13.	FD													1.000	0.5442	-0.6006	0.6229	0.6840	0.2136	-0.2815	-0.1249	**0.4180**
14.	VLF														1.000	1.3503	0.2364	0.2307	-1.8500	-0.9678	-1.4875	**0.5212**

15.	LBB															1.000	0.6628	0.8981	-0.1765	-0.3287	0.0789	**0.0764**
16.	DBB																1.000	0.9814	0.3735	-0.3437	-0.4467	**-0.1007**
17.	WBB																	1.000	0.2655	-0.3542	-0.1195	**0.2199**
18.	LSB																		1.000	0.4865	0.0199	**-0.3151**
19.	DSB																			1.000	0.3246	**-0.2050**
20.	SB																				1.000	**-0.0834**
21.	**NS/P**																					**1.000**

Where, DTBS-Days taken to bulb sprout (days), PH- Plant height at 120 days (cm); - NL/P-Number of leaves/plant at 120 days; LLL-length of longest leaf at 120 days (cm), WLL- Width of largest leaf at 120 days (cm); INLS-Internodal length of spike (cm); PS- Plant spread at 120 days (cm); NS/P-Number of spikes / plant; SL-Spike length (cm); WS-Weight of spike (g); RL-Rachis length (cm); NF/P-Number of florets/plant; FL-Floret length (cm); Floret diameter (cm); VLF- Vase life of floret (days); LBB-Length of big bulb (mm); DBB- Diameter of big bulb (mm); WBB-Weight of big bulb (g); LSB-Length of small bulb (mm); DSB- Diameter of small bulb (mm); WSB-Weight of small bulb (g).

Number of florets per plant was positively correlated to the vase life of flower (0.253). The length of floret was positive and significantly correlated with the length of small bulb (0.291). Diameter of florets was positive and significantly correlated to the length of big bulb (0.372), weight of big bulb (0.330), diameter of big bulb (0.381) and spikes per plant (0.316). Length of big bulb was positive and significantly correlated to weight of big bulb (0.660), diameter of big bulb (0.647). Diameter of big bulb was positive and significantly correlated with weight of big bulb (0.735).

Length of small bulb was positive and significantly correlated with diameter of small bulb (0.446). Diameter of small bulb was positive and significantly correlated with the weight of small bulb. Similar results were also obtained by Vanlalrauti *et al.,* (2013) and Sirohi *et al.,* (2017).

In conclusion, this study examined various traits in 20 different types of tuberose plants to understand their genetic and physical characteristics. The study found significant differences in traits such as bulb weight, spike length, and plant height. These differences are important for selecting and breeding better tuberose plants.

High variation was noticed in the weight of big bulbs, spike weight, and plant height, indicating these traits are influenced by genetic factors. Traits like floret length and plant height showed less variation, suggesting they are more stable and less affected by genetic changes.

Heritability, which measures how much of a trait is passed from parent to offspring, was high for traits like spikes per plant, spike weight, and plant height. This means these traits are largely controlled by genes and can be improved through selective breeding.

Traits with low heritability, like spike length and vase life of floret, are more influenced by the environment and harder to improve through breeding alone.

The study also found strong genetic correlations among certain traits. For example, plant height was positively correlated with the length and width of leaves, spike weight, and bulb length, meaning these traits often increase together.

However, the time it takes for bulbs to sprout was negatively correlated with plant height and spike weight, suggesting that plants with taller spikes and heavier bulbs take longer to sprout.

Overall, this research provides valuable information for tuberose breeders and farmers. By understanding the genetic basis of important traits, they can make well decisions to improve tuberose plants for better yield and quality.

Author Contributions

Yougesh Gautam: Investigation, formal analysis, writing—original draft.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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