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Study the estimates of correlation coefficient for genotypic level among different character's and correlation between yield and yield contributing traits in tuberose

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Abstract
In the present investigation, at the Horticultural Research Centre, Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (UP), during the year of 2015-2016 on "Study the estimates of correlation coefficient for genotypic level among different characters between yield and yield contributing traits. All twenty-two genotypes were grown in randomized block design with 3 replications with row to row and plant to plant spacing of 30 cm and 20 cm, respectively during 2015-16. Observations were recorded on various characters viz; days taken to analysis of variance revealed substantial amount of variability among the genotypes for all the characters, under study, indicated wide spectrum of variability among the genotypes. High genotypic and phenotypic coefficient of variation was observed for number of sprouts per bulb and number of bulbs per plant and moderate was observed for number of leaves per plant, length of longest leaf, number of spikes per bulb, length of rachis, number of bulblets per plant, yield of bulb plant, yield of bulbs and bulblets per plant, yield of bulb, While, low GCV and PCV was observed for days taken to sprouting, plant height, width of longest leaf, days required for visibility of first spike, days taken to opening of first flower, numbers of florets per spike, diameter of flower, diameter of spike, length of spike, longevity of spike, vase life, diameter of bulb.

Keywords: genotypic level, yield and yield contributing traits

Introduction
The tuberose (*Polianthes tuberosa* Linn.), is a night-blooming perennial plant, belongs to the family Asparagaceae and thought to be native to Mexico along with every other species of *Polianthes* (Benschop, 1993) [6]. The common name of *Polianthes tuberosa* derives from the Latin *tuberosa*, meaning swollen or tuberous in reference to its root system and *Polianthes* means "many flowers" in Greek language. It consists of about 12 species.

Tuberose is having elongated spikes up to 45 cm long that produce clusters of fragrant waxy white flowers that bloom from the bottom towards the top of the spike. It has long, bright green leaves clustered at the base of the plant and smaller, clasping leaves along the stem. Plant height 60-120 cm long and propagated through bulb like tuberous root stock, covered with broadened bases of fleshy leaves forming arosette,6-9 in number, 3-4.5 cm long and about 1.5 cm wide. It occupies a prime place among the bulbous ornamentals because of its elegant, highly fragrant flowers, which can be used in various ways. (Sheela, 2008) [16].

The area under floriculture production in India was 255.00 thousand hectares with a production of 1,754 thousand metric tons loose flowers and 543 thousand metric tons cut flowers during 2013-14 (Anonymous, 2015) [1]. Floriculture is now commercially cultivated in several states with West Bengal (32%), Karnataka (12%) Maharashtra (10%), having gone ahead of other producing states like Madhya Pradesh, Gujarat, Punjab, Haryana, Andhra Pradesh, Orissa, Jharkhand, Uttar Pradesh and Chhattisgarh. India's total export of floriculture was Rs. 455.90 crores in 2013-14. The major importing countries were United States, Netherlands, Germany, United Kingdom, United Arab Emirates, Japan and Canada.

The flowers of tuberose produce one of the rarest and most valuable aromas with sweet and pleasant fragrance. In the last two decades or so a few new tuberose cultivars have been identified and recommended for commercial cultivation in different regions of our country. Several cultivars had been assessed and evaluated for their performance under different regions of the country taking single petalled and double petalled cultivars together by Bankar and Mukhopadhyay (1980) [5], Bhattacharjee *et al.*, (1981) [7], Pratap and Manohar Rao (2003)

and Singh and Misra (2005) [14] and have revealed that a market demand has increased manifold for want of diverse forms and intense fragrance found in them.

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 character 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 (1970) [11] referred the idea about heritability. Therefore, it is necessary to know the various components of yield, their heritable and non-heritable variability and their mutual correlation.

Materials and Methods

The detail of experiment is given below

Experimental design	-	Randomized Block Design
Number of treatments	-	22
Number of replications	-	3
Spacing	-	30 cm x 20 cm
Plot size	-	10 m^2
Total number of plots	-	66
Total area of experimental field	-	1188 m^2
Main irrigation channel	-	1
Sub irrigation channel	-	2
Date of sowing	-	April, 22th 2015

Field preparation

1. The land of experimental field was prepared by ploughing before planting of bulbs. At last ploughing well-rotten FYM @400q/ha was applied. Besides of FYM, a recommended doses of N: P: K @ 120:150:150 kg /ha were also added into the experiment, out of which 60 kg N and entire dose of P_2O_5 and K_2O are applied as basal dose. The remaining N was applied in two split doses (30 +30 kg), 30 and 60 days after planting.

Planting

Tuberose bulbs were planted on April 22, 2015, at 30x20 cm spacing and 4.0 cm depth.

Aftercare

After planting, irrigation was applied at 7-8 day interval and weeding with a gap of 15-20 days is required during the crop period. Weeding was done, manually, by hand hoe.

Estimation of Correlation coefficient

Correlation was estimated the association between various character-pairs. The correlations at genotypic, phenotypic and environmental levels were estimated from the analysis of variance and covariance as suggested by Searle (1961).

1. Phenotypic correlation between character x and y

$$r_{xy}(p) = \frac{Cov_{xy}(p)}{\sqrt{Var_x(p) \times Var_y(p)}}$$

Where,

Cov_{xy} (p) = Phenotypic covariance between two characters x and y.

Var_x (p) = Phenotypic variance for characters x.

Var_y (p) = Phenotypic variance for characters y.

Statistical analysis

The following statistical procedures were followed in the present investigation:

Analysis of variance, Heritability and genetic advance, Correlation, Path coefficient analysis and Genetic divergence

The data collected from the experiments during the year 2015-16 were subjected to statistical analysis. The statistical methods used to obtain various values are described below:

Analysis of variance

The mean values of genotypes in each replication were used for statistical analysis. The data were analyzed for a randomized block design to test the significance of differences between the genotypes for various characters. The analysis of the data was as described by Panse and Sukhatme (1969) [10].

The following mathematical model was used in the analysis

Yij = μ + ti + bj + eij

Where, i= 1, 2, 3, 4,……t, number of treatments (t)

J = 1, 2, 3, 4,……r, number of replications (r)

Yij = Performance of ith genotype in jth replication

μ = general mean of the population

ti = effect of ithtreatment

bj = effect of jth replication

eij = random error associated with ith treatment and jth block

The partitioning of total variance, due to block, treatments and error and Them expectationis in the Table 3.2:

Source of variance	df	Mean square	F value
Replication	r-1	MSr	
Genotypes	t-1	MSt	MSt/MSe
Error	(r-1)(t-1)	MSe	
Total	(rt-1)		

Where,

r = number of replications

t = number of genotypes

df = degree of freedom

MSr = Mean square for replication

MSt = Mean square for treatment

MSe = Mean square for error

Genotypic variance ($\sigma^2 g$) = (MSt/MSe)/r

Phenotypic variance ($\sigma^2 p$) = $\sigma^2 g + \sigma^2 e$

Error variance ($\sigma^2 e$) = MSe

The significance of differences among treatment means was tested by 'F' test at 5% or1% level of significance. Whenever, the 'F' value was found to be significant, critical difference was calculated to test the significance of difference between treatment means as follows:

CD = SEd × t (5%) at error d.f.

Where,

T = table value of't' at error d.f.

SEd = standard error of difference between two treatment means

$$SEd = \sqrt{2\,MSe\ / r}$$

Where,

MSe = Mean sum square of error

r = Number of replications

Result

Estimation of variability, heritability and expected genetic advance

The estimation of variability parameters viz. grand mean, range of variation, phenotypic coefficient of variation, genotypic coefficient of variation, heritability in broad sense and expected genetic advance expressed as percentage of mean for different characters studied below in some heads.

Phenotypic (PCV) and genotypic (GCV) co-efficient variation

It is revealed from the table 1 that highest GCV and PCV (>20 %) was observed in number of sprouts per bulb (25.46 and 33.002) and number of bulbs per plant (21.29 and 21.69) whereas moderate (10-20 %) GCV and PCV values were recorded for number of leaves per plant (13.71 and 16.07), length of longest leaf (10.08 and 10.39), number of spikes per bulb(17.70 and 18.71), length of rachis (10.54 and 11.51), number of bulblets per plant (19.84 and 20.57), yield of bulb plant (17.42 and 18.49), yield of bulbs and bulblets per plant (17.10 and 18.11), yield of bulb (17.83 and 18.49) respectively while low (<10 %) phenotypic and genotypic coefficient variation was observed for days taken to sprouting (2.08 and 3.68), plant height (9.92 and 10.22), width of longest leaf (7.58 and 9.50), days required for visibility of first spike (5.32 and 5.45), days taken to opening of first flower (4.3 and 4.79), numbers of florets per spike (9.82 and 10.66), diameter of flower (6.48 and 7.21), diameter of spike (2.61 and 3.44), length of spike (7.41 and 7.52), longevity of spike (2.65 and 3.35), vase life (3.27 and 4.6), diameter of bulb (7.52 and 11.70) recorded respectively.

Heritability (h^2)

Heritability in broad sense ranged from 31.90– 97.13% as depicted by perusal of data presented in table 1 the values of heritability in broad sense for all the characters were studied. High heritability (>90%) was found in plant height (94.26%), length of longest leaf (94.05%), days required for visibility of first spike (95.18%), length of spike (97.13%), number of bulbs per plant (96.30%), number of bulblets per plant (93.09%) respectively. Moderate heritability (60-90%) was observed for the number of leaves per plant (72.79%), width of longest leaf (63.69%), days taking to opening of first flower (80.29%), number of florets per spike (84.89%), diameter of flower (80.66%), number of spikes per bulb (89.48%), length of rachis (83.78%), longevity of spike (62.69%), yield of bulb per plant (88.85%), yield of bulbs and bulblets per plant (89.13%), yield of bulb (88.81%) while, low heritability (<60%) observed in days taken to sprouting(31.90%) number of sprouts per bulb (59.51%), diameter of spike (57.78%), diameter of bulb (41.10%), vase life (49.02%).

Genetic advance (%)

Genetic advance (GA) and percentage of mean for various quantitative characters exhibited in table 1 the data reveal that, expected genetic advance expressed as percentage of mean and it was observed high (>20%) for number of leaves per plant (24.10%), length of longest leaf (20.14%), number of sprouts per bulb (40.46%), number of bulbs per plant (43.04%), number of spikes per bulb (34.5%), number of bulblets per plant (39.44%), yield of bulb per plant (33.84%), yield of bulb and bulblets per plant (33.26%) and yield of bulb (33.84%), whereas, moderate values (10-20%) showed in character like plant height (19.85%), width of longest leaf (12.47%), days required for visibility of first spike (10.69%), number of florets per spike (18.65%), diameter of flower (11.99%), length of spike (15.05%), length of rachis (19.88%), while low value of genetic advance showed (<10%) in characters like days taken to sprouting (2.42%), days taking to opening of first flower (7.93%), diameter of spike (4.09%), longevity of spike (4.3%), vase life (4.7%), diameter of bulb (9.90%) respectively.

Discussion

Heritability and genetic advance

The information on the heritability estimates is useful in studying the inheritance of quantitative characters as well as for planning breeding programmes with desired degree of expected genetic progress. The heritable variation can be found with the help of heritability estimates and genetic gain.

High heritability (>90%) in broad sense was recorded for plant height, length of longest leaf, days required for visibility of first spike, length of spike, number of bulbs per plant, number of bulblets per plant. Moderate heritability (60-90%) was observed for number of leaves per plant, width of longest leaf, days taking to opening of first flower, number of florets per spike, diameter of flower, number of spikes per bulb, length of rachis, longetivity of spike, yield of bulb per plant, yield of bulbs and bulblets per plant, yield of bulb. Whereas low heritability (<60%) was observed in days taken to sprouting, number of sprouts per bulb, diameter of spike, diameter of bulb, vase life. High or moderate heritability estimates for most of the traits studied have been reported earlier also by Vanlalruati *et al.*, 2013 [17]. The high heritability denotes high proportion of genetic effects in the determination of these characters and can be adopted for improving the bulb yield.

For an effective selection, the knowledge alone on the estimates of heritability is not sufficient and genetic advance if studied along with heritability will be more useful. In the present study, high (>20%) number of leaves per plant, length of longest leaf, number of sprouts per bulb, number of bulbs per plant, number of spikes per bulb, number of bulblets per plant, yield of bulb per plant, yield of bulb and bulblets per plant and yield of bulb, while moderate (10-20%) showed plant height, width of longest leaf, days required for visibility of first spike, number of florets per spike, diameter of flower, length of spike, length of rachis and low (<10%) estimates of genetic advance has been observed in days taken to sprouting, days taking to opening of first flower, diameter of spike, longevity of spike, vase life, diameter of bulb respectively.

In the present investigation, high heritability coupled with high genetic advance observed for length of longest leaf, number of bulbs per plant and number of bulblets per plant. High heritability coupled with high genetic advance for some of these characters have also have been reported earlier by Ranchana *et al.*, 2013 [12] and Vanlalruati *et al.*, 2013 [17].

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 length of longest leaf, number of bulbs per plant and number of bulblets per plant may be useful for further development of high yielding Tuberose varieties.

Positive correlation of bulb yield with number of florets per spike was in agreements with the findings, Positive correlation of bulb yield with number of spikes per bulb is in confirmation of earlier works, Positive association of bulb yield with number of bulbs per plant is similar to findings, Positive association of bulb yield with number of bulblets per

plant is similar to findings, Positive correlation of bulb yield with yield of bulb per plant was consonance with the findings, Positive association of bulb yield with yield of bulb and bulblets per plant is similar to findings and Selection for these characters could definitely be yielded towards productivity as they exhibited correlated response with seed yield with the Vanlaruati *et al.,* 2013, Anuradha *et al.,* 2002 [4], Singh *et al.,* 2013 [15] and Ranchana *et al.,* 2015. Vanlaruati *et al.,* 2013, Rashmi *et al.*, 2012 [13] Kannan *et al.*, 1998 [9].

Table 1: Estimates of variability parameters for twenty-two characters in tuberose.

Character	Heritability (%)	Genetic Advance	Genetic Advance value(% mean)	GCV (%)	PCV (%)
Days taken to sprouting	31.904	0.326	2.422	2.081	3.685
Plant height (cm)	94.263	8.778	19.858	9.929	10.227
No. of leaves per plant	72.791	8.016	24.103	13.714	16.074
Length of longest leaf (cm)	94.057	8.721	20.145	10.083	10.397
Width of longest leaf (cm)	63.699	0.199	12.472	7.586	9.504
No. of sprouts per bulb	59.516	1.928	40.461	25.46	33.002
Days required for visibility of first spike	95.181	7.039	10.698	5.323	5.456
Days taken to opening of first flower	80.299	5.986	7.937	4.3	4.798
No. of florets per spike	84.891	7.086	18.652	9.827	10.666
Diameter of flower (cm)	80.665	0.428	11.994	6.482	7.218
No. of spikes per bulb	89.483	7.425	34.5	17.705	18.716
Diameter of spike (mm)	57.784	0.228	4.097	2.616	3.442
Length of spike (cm)	97.132	10.012	15.056	7.416	7.524
Length of rachis (cm)	83.783	5.172	19.881	10.544	11.519
Longevity of spike	62.693	0.668	4.327	2.653	3.351
Vase life	49.092	0.309	4.729	3.277	4.676
No. of bulbs per plant	96.301	14.161	43.046	21.294	21.699
No. of bulblets per plant	93.094	2.383	39.448	19.847	20.57
Yield of bulb per plant(gm)	88.853	100.427	33.843	17.429	18.49
Diameter of bulb(mm)	41.102	0.15	9.908	7.502	11.702
Yield of bulb and bulblets per plant (q/ha)	89.139	179.256	33.267	17.105	18.117
Yield of bulb (q/ha)	88.816	167.359	33.842	17.432	18.497

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