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Studies on variability, heritability and genetic advance in double type genotypes of tuberose (*Agave amica* (Medik.) Syn. *Polianthes tuberosa* L.)

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Abstract
The present study on performance and genetic variability studies in tuberose (*Agave amica* (Medik.) Syn. *Polianthes tuberosa* L.) Double type genotypes was conducted at Botanical Garden, Department of Floriculture and Landscape Architecture, Tamil Nadu Agricultural University during the year 2018-2020. Among five double type genotypes, Suvasini followed by Hyderabad Double and Vaibhav showed better performance in vegetative, flowering and yield parameters with spike yield of 3.38, 3.31 and 3.25 spikes/ plant respectively and bulb yield of 735.00, 654.75 and 540.75 g/ plant respectively. Among different vegetative and flowering parameters recorded, phenotypic coefficient of variation and genotypic coefficient of variation were found to be high for bulb yield and moderate for plant height and rachis length suggesting the scope for selection and improvement of these traits. High estimates of heritability coupled with high genetic advance as percent of mean was recorded for bulb yield implying the additive gene effect whereas high heritability with moderate genetic advance as percent of mean was observed in leaf length, leaf width, spike length, spike diameter, number of florets per spike and number of spikes per plant.

Keywords: Tuberose, double types, variability, heritability and genetic advance

Introduction
In India flowers have historical value and they are part in almost in every cultural, social and religious activities. Among the major flowers which are under cultivation in India tuberose occupies a significant place. It is botanically known as *Agave amica* (Medik.) (Syn. *Polianthes tuberosa* L.), belongs to the family Asparagaceae (Thiede and Govaerts, 2017) [23]. Being a native of Mexico (Bailey, 1919) [1] it grows in tropical and subtropical climates (Benschop, 1993) [2]. Tuberose as one of the major flower crops in India, gained popularity with its elegant white flowers arranged on long spikes in pairs and give lingering delightful fragrance. The florets contain tepals which are undifferentiated petals and sepals. The spikes remain fresh for quite a long time and can stand distance transportation (Desai, 1957; Patil *et al.*, 1999) [6, 18]. It is perennial bulbous plant and gives economical yield up to two years which can be extended to third year also. Tuberose gained importance as cut flower, loose flower and also as concrete yielding plant. It also grows as pot plant and used for garden purpose.
There are mainly two types in tuberose classified based on the number of whorls of tepals. The plant that produces florets with one whorl of petal are said to be single types and the double types have more than three whorls of tepals. Though semi-double type category is also there but the cultivars of that type are not popular. The double types are mostly used for cut flower purpose and produce pleasant white flowers with many tepals which give them elegant look. There are very few varieties and other cultivars available in double type tuberoses which show the need for improvement especially with spike related traits. The performance of any crop or variety largely depends upon its genetic makeup and climatic condition of the region under which they are grown. Hence, it is very much necessary to collect and evaluate all the available genotypes in order to select suitable and high yielding genotypes for a particular region. Considering the potentiality of this crop there is much scope for crop improvement. One important step in any traditional improvement programme is selection.

Selection is generally based on the phenotypic expression of a character which, in general, is collective result of its genetic make-up and the environment in which it is grown. The basic key to bring about genetic improvement to a crop is to utilize the available or created genetic variability. If the variability in the population is largely due to genetic cause with least environmental effect, the probability of isolating superior genotype is possible. The characters that are largely influenced by environment are said to have low heritability which is opposite in the case of traits with low environmental effect (Paroda and Joshi, 1970) [16]. Assessing the genetic advance and heritability will give the information regarding genetic gain in selecting a particular character (Kannan *et al*., 1998) [12]. The characters showing high heritability along with high estimates of genetic advance are more effective for selection (Kalloo, 1985) [11]. Therefore, the present study was undertaken to evaluate the performance of double type genotypes and study the genetic variability.

Materials and methods

The present study was conducted with five double type tuberose genotypes, namely, Suvasini, Vaibhav, Hyderabad Double, Calcutta Double and Pearl Double with four replications. The experimental plot was laid out in randomized block design at Botanical Gardens, Department of Floriculture and Landscape Architecture, Tamil Nadu Agricultural University, Coimbatore during the year 2017-2018. The geographical location of the experimental site is at about 11° 02" N latitude and 76° 57" E longitude with an average altitude of 426.76 above mean sea level. The field was prepared with ridges and furrows in plots of 3 m x 3 m and the planting was done with the spacing of 45× 30 cm.

The observations were recorded on different vegetative and floral characters *viz*., plant height (cm), leaf length (cm), leaf breadth (cm), number of leaves per plant, spike length (cm), spike diameter (mm), rachis length (cm), number of florets per spike, number of spikes per plant and bulb yield per plant. The observations were taken from five randomly selected plants in each genotype and replication and the mean was computed.

The statistical analysis was carried out as suggested by Panse and Sukhatme (1967) [15] for the mean performance of genotypes. The phenotypic and genotypic coefficient of variation were worked out as per the methods suggested by Burton (1952) [4] and were classified as low, medium and high as suggested by Sivasubramanian and Menon (1973) [22]. Heritability in the broad sense (h^2) was derived based on the method proposed by Lush (1940) [13] and expressed in percentage (%). Genetic advance as per cent of mean was calculated and classified according to Johnson and Bernard (1962) [10].

Results and discussion

Vegetative parameters

The observations on vegetative parameters showed that overall performance in all the parameters was recorded best in Suvasini followed by Hyderabad Double and Vaibhav. Suvasini recorded highest plant height of 65.11 cm, leaf length of 55.26 cm, leaf width of 1.87 cm and 115.64 leaves per plant whereas Hyderabad Double recorded 59.54 cm, 53.98 cm, 1.71 cm and 111.35 respectively. The genotype Calcutta Double recorded least plant height (50.12 cm), leaf length (44.17 cm), leaf width (1.50 cm) and number of leaves (96.20) and it was followed by Pearl Double. The superior performance of Suvasini was also reported by Ranchana *et al.,* (2015b) [20] which may be due to genetic makeup of the genotype and favourable environmental conditions for its growth and development.

Flowering parameters

The observations on flowering parameters differed significantly among the genotypes (table 1). Floral characters like length of spike, diameter of spike, rachis length and spike weight were found to be highest in Suvasini which recorded 79.80 cm, 0.60 cm, 33.03 cm and 75.20 g. It was followed by Hyderabad Double which recorded 77.25 cm spike length, 0.56 cm spike diameter, 30.20 cm rachis length and 69.51 g spike weight. The number of florets per spike was recorded highest in Hyderabad Double (54.44) which was followed by Suvasini (53.97). The least performance in floral characters was observed in Calcutta Double with 64.04 cm spike length, 0.50 cm spike diameter, 24.06 cm rachis length, 46.06 florets per spike and 60.26 g. It was followed by Pearl Double. The better vegetative growth of the plant might have play role in good source and sink relationships which may be the reason for better performance of Suvasini and Hyderabad Double in floral traits. The similar results were also reported by Ranchana *et al.,* (2015b) [20], Patil *et al.,* (1987) [17] and Meenakshi and Niranjanmurthy (1997) [14].

Yield parameters

Yield parameters were recorded in terms of spikes per plant and bulb yield per plant (g). Flower yield as spikes per plant was recorded highest in Suvasini (3.38) followed by Hyderabad Double (3.31) and Vaibhav (3.25) whereas Calcutta Double followed by Pearl Double recorded low flower yield of 2.79 and 3.01 spikes per plant respectively. In case of bulb yield it was observed that Suvasini recorded highest bulb yield of 735.00 g/plant followed by Hyderabad Double (654.75 g/plant) and Vaibhav (540.75 g/plant). The lowest bulb yield was recorded in Calcutta Double (409.75 g/plant) followed by Pearl Double (458.00 g/plant). It can be observed from the reported results that the genotypes with better performance in vegetative and other flower parameters, also showed good performance in flower yield. The better vegetative growth may also helped in supplying more food material to the underground parts which improved the bulb growth and enhanced the bulb yield. These findings are in line with the findings of Gupta *et al.,* (2004) [9], Ranchana *et al.,* (2015b) [20] and Bindiya *et al.* (2018) [3] in tuberose.

Variability, heritability and genetic advance (%)

From the data presented in table 2, it can be observed that in all the characters under study the phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) which indicates that traits were influenced more by environment. Among vegetative parameters phenotypic coefficient of variation and genotypic coefficient of variation were found to be high for bulb yield and moderate for plant height and rachis length which implies that these traits contain considerable variability and scope of selection and improvement. These results are in line with the findings of Vanlalruati *et al.* (2013) [24], Gaidhani *et al.* (2016) [7] and Sathappan (2018) [21]. The remaining parameters showed low estimates of GCV.

High estimates of heritability coupled with high genetic advance (%) was recorded in bulb yield implying the additive gene effect whereas high heritability with moderate genetic advance as percent of mean was observed in traits like leaf length, leaf width, spike length, spike diameter, number of

florets per spike and number of spikes per plant. This suggests the presence of both additive and non-additive gene actions that selection based on these traits may be profitable for the crop improvement. These findings are in line with the reports of Chaudhary *et al.* (2018) [5], Gangadharappa *et al*. (2008) [8] and Ranchana *et al*. (2015a) [19].

Table 1: Mean performance of tuberose genotypes (double types) based on vegetative and flowering parameters

Genotype	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	No. of leaves/ plant	Spike length (cm)	Rachis length (cm)	Spike diameter (mm)	Florets per spike	Spike weight (g)	Number of spikes per plant	Bulb yield (g/plant)
Vaibhav	54.53	52.37	1.57	104.23	75.56	28.41	0.55	53.03	65.40	3.25	540.75
Suvasini	65.11	55.26	1.87	115.64	79.80	33.03	0.60	53.97	75.20	3.38	735.00
Pearl Double	50.57	51.24	1.54	101.89	66.03	27.28	0.52	48.91	63.51	3.01	458.00
Calcutta Double	50.12	44.17	1.50	96.20	64.04	24.06	0.50	46.06	60.26	2.79	409.75
Hyderabad Double	59.54	53.98	1.71	111.35	77.25	30.20	0.56	54.44	69.51	3.31	654.75
Mean	55.98	51.40	1.64	105.86	72.53	28.59	0.54	51.28	66.78	3.15	559.65
S.E.	2.82	0.76	0.05	4.01	2.35	1.40	0.01	0.87	3.35	0.09	34.02
C.D.(5%)	8.70	2.33	0.15	12.35	7.24	4.33	0.03	2.69	10.34	0.27	104.89
CV(%)	10.08	2.94	6.08	7.57	6.48	9.82	3.90	3.40	10.04	5.56	12.16

Table 2: Variability, heritability and genetic advance in tuberose single type genotypes

S. No.	Character	PCV	GCV	h^2	GA	GA (%)
1.	Plant height	14.33	10.18	50.50	8.34	14.91
2.	Leaf length	8.79	8.29	88.81	8.27	16.08
3.	Leaf width	10.61	8.69	67.14	0.24	14.67
4.	No of leaves	9.80	6.22	40.29	8.61	8.13
5.	Spike length	11.22	9.16	66.68	11.18	15.42
6.	Rachis length	14.44	10.59	53.76	4.57	15.99
7.	Spike diameter	7.72	6.66	74.41	0.06	11.83
8.	Florets/spike	15.57	12.52	7.69	6.90	80.46
9.	Spike weight	12.27	7.04	32.95	5.56	8.33
10.	Number of spikes per plant	0.08	0.05	9.15	7.27	63.08
11.	Bulb yield (g/plant)	26.33	23.35	78.67	238.80	42.67

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