Int.J.Curr.Microbiol.App.Sci (2020) *9*(8): 2522-2527

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 9 Number 8 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.908.289

Genetic Variability and Heritability Studies of Single Tuberose (*Polianthes tuberosa L.*) Genotypes

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Keywords

Tuberose, GCV, PCV, H (bs), GA

Article Info

Accepted:
xx July 2020
Available Online:
xx August 2020

A B S T R A C T

Tuberose (*Polianthes tuberosa* L.) is one of the most important tropical ornamental bulbous flowering plant, commercially used as cut and loose flower due to pleasant fragrance. In the present study, genetic variability among 22 single type tuberose genotypes was studied using morphological traits. As per mean performance Bidhan Rajni-1 attained highest with respect to Plant Height, Rachis length, Flower Length, Flower breadth and Weight of stick. Calcutta Single performed highest in case of number of leaf and number of tiller. Bidhan Rajani-2 gave highest number of flower. The tallest spikes were shown for the Sikkim Selection. Widest leaves were shown for Bidhan Rajani-5. The maximum weight of five flowers was shown in case of Bidhan Rajani-3. The maximum GCV was observed in case of weight of flower (40.47%). High heritability and high GA had been found for number of leaf, height of spike for single type genotypes. Thus it suggests that additive genes may control these characters.

Introduction

Tuberose (*Polianthes tuberosa* L.) is one of the most important tropical ornamental bulbous flowering plant cultivated for production of long lasting flower spikes. It is popularly known as Rajanigandha. It belongs to the family Agavaceae and native of Mexico. Single types of Tuberose genotypes are an important commercial cut flower crop due to pleasant fragrance, longer vase-life of spikes, higher returns and wide adaptability to varied climate and soil. 'Single' varieties are more fragrant than 'Double' type and contain 0.08 to 0.14 percent concrete which is used in high grade perfumes (Singh and Uma, 1995). There is high demand for tuberose concrete and absolute in international markets which fetch a very good price. Flowers of the Single type (single row of perianth) are commonly

used for extraction of essential oil, garden display and interior decoration. As per area and production statistics of National Horticulture Board (2013), the total area under tuberose cultivation in the country is about 7.95 lakh hectare. The production of loose and cut flowers is823MT and 1962MT in 2017-18 respectively(NHB2018). In West Bengal (India) about 4807 ha of land is under tuberose cultivation with the production of 1114.7 million stems per year and productivity 0.23 million stems per ha (Sadhukhan *et al.,* 2013). The genetic base of Tuberose is not wider as other crops but lot of confusion is there to distinguish among varieties and land races because very few researchers are involved with this crop. So, it is very much needed to characterize all the varieties and other genotypes so that further research would be easy for breeding programme. A huge quantum of variability exists in this crop with respect to growth habit, flowering behavior, etc. In spite of such variability, very few are having desirable characters in terms of yield and quality. Considering the fact, there is a need for selection as well as maintenance of good germplasm. Therefore, Present study is an attempt to achieve characterization of the tuberose and to carry out further research and conservation of germplasm.

Materials and Methods

The experiment was conducted at the Horticulture Research Station Farm, Mondouri, B.C.K.V., Nadia during December 2016 to march 2018. The station is situated at the elevation of 9.75m above mean sea level, at approximately 22.43°N latitude and 88.34°E longitude in new alluvial zone of West Bengal. The soil of the field was typical gangetic alluvial (entisol) with sandy loam texture, with pH 6.9. The climate is neither too hot nor to cold. The range of temperature lies between 15°C to 35° C around the year. The average rainfall is 900mm. Overall a typical tropical humid climate is found here.

The experiment was carried out by using 22 single tuberose genotypes viz. Shringar, PhuleRajani, Hyderabad single, GKTC-4, Prajwal, Sikkim Selection, SwarnaRekha, Calcutta single, ArkaNirantara, Bidhan Rajani 1 (Bidhan Snigdha), Bidhan Rajani 2 (Bidhan Ujjwal), Bidhan Rajani 3 (Bidhan Jyoti), Bidhan Rajani 4, Bidhan Rajani 5, Bidhan Rajani 6, Bidhan Rajani 7, Bidhan Rajani 8, Bidhan Rajani 9, Bidhan Rajani 10, Bidhan Rajani 11, and Bidhan Rajani 12. The experiment was laid out in Randomized Block Design (RBD) with 3 replications. Plot size was 180cm X 150cm and both row to row and plant to plant spacing was 30 cm. in a single row 5 plant was planted. Total numbers of plots were66.

All the agronomic package of practices followed and as per the recommend doses fertilizers applied. The data were recorded from randomly chosen five plants from the each replicated plot of each genotype. The characters were Plant Height (cm), Number of Leaves per Clump, Number of Tillers, Leaf Width (cm), Spike (or stick) Length (cm), rachis Length (cm), Number of Flowers, Flower Length (cm), Flower Breadth (cm), Spikes (or stick) per plot, Weight of Spike (g). 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.

Results and Discussion

Among all the genotypes studied they showed significant variation for particular trait, it may be due to their diverse origin, evolution from

a different geographical region. Mean performance of the genotypes for growth parameter reflects the variation among the genotypes (Table 1). Among thesingle genotypes Bidhan Rajani-1 attained maximum plant height (68.37 cm) which was followed by Bidhan Rajani-10 (65.93cm) and Bidhan Rajani-11 (65.17cm). Bidhan Rajani-6 recorded lowest plant height (29.67 cm). Calcutta Single recorded maximum numbers of leaves (281.33) which was followed by BidhanRajani- 11 (208.83) and BidhanRajani-9 (205.67), whereas, Bidhan Rajani-3 had lowest mean performance for leaf number (72.33). Calcutta Single had highest mean performance for number of tillers (16.67) and which was followed by Hyderabad Single (16.33) and Hybrid GKTC-4 (15.00) whereas Bidhan Rajani-3 attained only 6.33. For leaf width among single types of tuberose genotypes, Bidhan Rajani-5 attain highest mean value (2.50cm) followed by Bidhan Rajani-11 (2.43cm) and Bidhan Rajani-12 (2.27cm) whereas RajatRekha attained lowest mean (1.37cm).

Sikkim Selection had the highest mean performance (153.00cm) for spike length and followed by Bidhan Rajani-10 (130.50cm) and Bidhan rajani-8 attained lowest mean value (77.10cm) among single types of tuberose genotypes.

Bidhan Rajani-1 attained highest mean value for rachis length (51.33cm) where RajatRekha had lowest mean value (23.43cm) for rachis length. Among single genotypes Bidhan Rajani-1attained highest mean value (7.70cm) for flower length and followed by Bidhan Rajani-9 (6.60cm) and the lowest one is Bidhan Rajani-10 (5.50cm). Bidhan Rajani-1 shown highest flower breadth (6.47cm) and both RajatRekha and Calcutta Single produce lowest flower breadth among single tuberose genotypes.

Calcutta Single shown highest mean value for spikes per plot (11.67) followed by RajatRekha (11.33) and Swarnarekha produces lowest mean value for spikes per plot among single tuberose genotypes. Bidhan Rajani-1 recorded highest (184.00g) for weight of stick among single tuberose genotypes and RajatRekha recorded lowest (59.67g) value. Among single tuberose genotypes, Swarnarekha attained highest mean value (20.33g) for weight of five flowers whereas Bidhan Rajani-3 attained lowest mean value (4.60g) for weight of five flowers. Number of flowers is highest in Bidhan Rajani-2 (67.00) and followed by Bidhan Rajani-4 (59.67) whereas lowest flower producing genotype is RajatRekha (23.33).

Studies of genetic variability

The genetic variability parameters showing phenotypic and genotypic variance, co-efficient of variation, heritability in broad sense and genetic advance as a percentage over mean along with their mean values and range are presented in Table 2.

Among single tuberose genotypes, the widest range of variability has found for the character of number of leaf 209.0 and followed by weight of stick 124.3 and poorest range was 1.1 for leaf width. This will provide scope for selection of best genotypes. For all the traits studied shown higher phenotypic variance than genotypic variance. The maximum PCV and GCV was observed in case of weight of flower (40.99%, 40.47%) followed by number of leaves (32.8%, 32.59%) and weight of spike (29.61%, 29.44%) that indicates the presence of considerable variability in these traits and scope of selection and improvement (Rachana *et al.*, 2013, Vanlalruati *et al.*, 2013, Sathappan *et al*., 2018).

Table.1 Mean performance of different quantitative traits of single tuberose genotypes

Characters → Genotypes ↓	Plant height	no of leaves	No of tillers	Leaf width	Spike length	Rachis length	Flower length	Flower breadth	Spike/plot	Weight of spike	Weight of five flowers	No of flowers
Shringar	55.67	146.67	12.00	1.67	97.50	40.00	6.03	4.47	10.00	85.33	7.90	52.00
PhuleRajani	51.00	147.67	12.00	1.63	94.67	34.33	5.77	5.07	8.67	79.00	7.77	34.33
RajatRekha	46.00	133.67	10.67	1.37	88.33	23.43	5.97	3.47	**11.33**	59.67	5.87	23.33
Prajwal	58.00	123.67	11.33	1.97	129.00	39.33	6.43	5.37	10.00	124.67	13.48	39.33
Calcutta Single	64.17	**281.33**	**16.67**	1.47	114.67	33.00	6.10	3.47	11.67	65.47	6.83	33.67
SwarnaRekha	45.83	89.33	9.67	1.73	97.07	40.67	5.87	5.43	4.00	94.50	20.33	42.33
Sikkim selection	48.33	76.67	9.67	1.63	**153.00**	45.83	5.97	4.43	9.67	152.87	5.67	53.33
Hyderabad single	46.33	172.33	16.33	1.63	97.20	35.33	5.90	4.47	8.67	84.33	7.87	53.33
Hybrid GKTC-4	47.67	155.67	15.00	1.73	92.00	33.67	5.73	5.07	8.33	77.67	7.83	51.33
ArkaNirantara	59.67	161.33	14.33	1.63	110.33	38.00	6.00	5.50	9.00	79.43	7.87	52.00
Bidhan Rajani-1	**68.37**	142.33	12.67	2.03	114.00	**51.33**	**7.70**	**6.47**	9.00	**184.00**	12.87	55.67
Bidhan Rajani-2	51.03	162.33	14.67	1.50	93.00	35.10	5.97	4.30	10.33	82.67	7.22	**67.00**
Bidhan Rajani-3	49.00	72.33	6.33	1.60	127.33	35.07	6.10	4.73	7.33	113.33	**4.60**	44.67
Bidhan Rajani-4	57.00	191.00	14.33	1.80	87.50	36.27	6.17	4.63	6.67	92.33	7.40	59.67
Bidhan Rajani-5	53.33	109.67	11.33	**2.50**	87.73	35.00	6.07	4.70	7.67	87.00	7.20	56.67
Bidhan Rajani-6	29.67	114.83	11.00	1.40	82.33	34.77	5.60	4.13	8.00	84.67	7.43	48.33
BidhanRajani-7	46.00	169.33	12.67	2.17	83.50	27.27	5.63	3.53	7.33	85.67	7.60	50.00
Bidhan Rajani-8	34.67	109.67	10.33	2.07	77.10	34.37	5.53	3.67	7.33	87.67	7.37	58.67
Bidhan Rajani-9	53.00	205.67	11.00	2.03	90.27	35.33	6.60	4.07	7.67	85.67	7.03	52.67
Bidhan Rajani-10	65.93	171.67	11.33	1.57	130.50	35.40	5.50	4.47	7.00	109.00	6.83	51.00
Bidhan Rajani-11	65.17	208.83	13.33	2.43	109.83	31.13	6.27	4.20	7.33	87.67	7.27	49.67
Bidhan Rajani-12	54.83	112.00	9.67	2.27	81.17	33.17	6.03	4.57	8.33	87.00	6.73	53.33
CD	3.56	9.233	1.364	0.157	4.622	3.54	0.20	0.36	1.667	4.907	0.893	3.271
SE (d)	1.243	3.224	0.476	0.055	1.614	1.236	0.07	0.13	0.582	1.713	0.312	1.142
SE (m)	1.758	4.559	0.673	0.078	2.282	1.748	0.1	0.18	0.823	2.423	0.441	1.615
CV(%)	4.116	3.771	6.814	5.249	2.748	5.978	2.04	4.83	11.97	3.124	6.562	4.021

Table.2 Estimates of variability and genetic parameters of single tuberose genotypes

Parameters → / Characters ↓	MEAN	RANGE	SE(±M)	GV	PV	ECV	GCV	PCV	H(BS)	GA	GA (%)
Plant height	52.30	38.7	2.03	89.40	94.04	8.86	18.1	18.5	95.1	18.99	36.31
Number of leaves	148.09	209.0	10.31	2328.8	2360	3.77	32.6	32.8	**98.68**	98.75	**66.68**
Number of tillers	12.11	10.3	0.52	5.79	6.47	5.62	19.87	21.01	89.48	4.69	38.72
Leaf width	1.81	1.1	0.07	0.10	0.11	0.50	17.74	18.50	91.95	0.63	35.04
Spike length	101.73	75.9	4.17	380.3	388.13	7.68	19.17	19.37	97.99	39.77	39.09
Rachis length	35.81	27.9	1.21	30.63	35.21	12.80	15.45	16.57	86.99	10.63	29.69
Number of Flowers	49.20	43.7	2.08	0.21	0.22	7.96	19.69	20.10	96.00	19.55	39.75
Flower length	6.04	2.2	0.10	0.53	0.58	0.25	7.52	7.79	93.18	0.90	14.96
Flower breadth	4.55	3.0	0.16	2.55	3.57	1.06	15.94	16.66	91.58	1.43	31.42
Spike/plot	8.42	7.7	0.36	782.04	790.85	12.07	18.96	22.42	71.51	2.78	33.03
Weight of spike	94.98	124.3	5.97	11.08	11.37	9.27	29.44	29.61	**98.89**	57.29	**60.31**
Weight of flower	8.23	15.7	0.71	93.86	97.77	3.54	40.47	40.99	**97.44**	6.77	**82.29**

The minimum difference between GCV and PCV were observed for weight of stick, number of leaf, flower length respectively which indicates a little influence of environmental effect on the phenotypic expression of those respective characters.

Heritability in broad sense was estimated highest (98.89%) for weight of stick, 98.68% for number of leaf and 97.44% for weight of flower. However, genetic advance expressed as percent of mean was found to be highest in case of weight of flower (82.29%) followed by number of leaves (66.68%) and weight of stick (60.31%). This shows the action of additive genes in their inheritance pattern as lesser influence of environment in the expression of the particular traits observed. The other traits exhibited high heritability associated with moderate and low genetic advance, indicating the presence of non-additive gene action. Similar genetic behavior has been reported by Panse (1957), Sheikh *et al*., (1995), Gangadharappa *et al*., (2008) Gaidhani *et al*., (2016) and Chaudhary *et al*., (2018).In this context, a general interpretation can be drawn as GCV alone is not sufficient for determination of extent of variation that perpetuate from one generation to the next. GCV together with heritability estimates would give a better picture of extent of advance that can be made through selection.

In this present study most of the character showed higher heritability. It is interesting to note that the characters showing high genetic advance as percentage of mean had high heritability also. The characters like weight of

flower, number of leaf, weight of spike attained all the above three conditions. A character with high heritability and high genetic advance may positive due to the action of additive genes. The characters without such combination appear generally because of the non-additive gen action. In this present study, weight of flower, number of leaf and weight of spike are likely to be expressed by additive genes while flower length, rachis length are governed by non-additive genes. The selection of traits with these gene actions will be useful for crop improvement.

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How to cite this article:

Samim Ahammed, Sk., Raghunath Sadhukhan and Rashad Khan. 2020. Genetic Variability and Heritability Studies of Single Tuberose (*Polianthes tuberosa* L.) Genotypes. *Int.J.Curr.Microbiol.App.Sci.* 9(08): 2522-2527. doi: https://doi.org/10.20546/ijcmas.2020.908.289