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Genetic variability and heritability studies on double tuberose (*Polianthes tuberosa* L.) genotypes

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Abstract
Tuberose (*Polianthes tuberosa* L.) is one of the most crucial tropical ornamental bulbous flowering plant, for economic trade used as cut and loose flower due to its charming and lovely fragrance. In the present study, genetic variability among 16 double type tuberose genotypes was studied using morphological traits. As per mean performance Bidhan Rajni-13 attained highest with respect to Plant Height, Spike length, Rachis length, Spikes per Plot and Weight of spike. Bidhan Rajani 19 performed highest in case of number of leaves, Leaf Width and number of Flowers. Bidhan Rajani 14 showed highest number of tillers. Bidhan Rajani 22 showed highest in flower length. Subhasini Double attained highest in flower breadth. The maximum weight of five flowers was shown in both Calcutta double and Bishan Rajani 23. The maximum GCV was observed in case of number of leaves (29.86%). High heritability and high GA had been found for number of leaves, and Rachis Length for double type genotypes.

Keywords: Double tuberose, GCV, PCV, H (bs), GA

Introduction
Among the ornamental bulbous cut flowers, which are valued for their beauty and fragrance, tuberose (*Polianthes tuberosa* L. Family Agavaceae) occupies a very special position. It is native of Mexico (Trueblood, 1973) [15]. The long flower spikes are excellent as ideal cut flower. The loosen flowers emit a delightful fragrance and are the source of tuberose oil. The genus Tuberosa contains 12 species of which nine have white flower (Sarkar *et al*., 2010) [16]. In India, commercial tuberose cultivation is confined to one species *P. tuberosa*, which is basically a white-flowered type. Double varieties which has more than two rows of perianth are used as cut flowers, 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 and the production of loose and cut flowers is 823MT and 1962MT in 2017-18 respectively. About 4807 ha land of West Bengal (India) 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) [9]. Being narrow genetic base and very few researchers are involved with this crop; there are quite much confusion to distinguish among varieties and land races. It is noticeable that there are too much variability exists in this crop with respect to growth habit, flowering behavior, etc. Even though of such variability, very few are having desirable characters in terms of yield and quality. Therefore, in this present study, to find out the mean performance, genotypic and phenotypic coefficient of variance, heritability and genetic advance of 16 nos. double tuberose germplasm has been done.

Material 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 research station is situated at 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 experimental field was typical gangetic alluvial (entisol) containing sandy loam texture, with pH 6.9. The range of temperature lies between 15°C to 35° C around the year. The annual rainfall received is 900mm. Temperature around the year is between 15°C to 35°C. Complete Tropical humid climate is seen here.
The experiment was carried out by using 16 double tuberose genotypes *viz*. Calcutta Double, Vaibhab, Hyderabad Double, Subhasini Double, Bidhan Rajani 13, Bidhan Rajani 14, Bidhan Rajani 15, Bidhan Rajani 16, Bidhan Rajani 17, Bidhan Rajani 18, Bidhan Rajani 19, Bidhan Rajani 20, Bidhan Rajani 21, Bidhan Rajani 22, Bidhan Rajani 23 and Bidhan Rajani 24.

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.

All the recommended package of practices followed and fertilizers applied according to recommended doses. The data was 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) [12]. Heritability in broad sense was estimated as a ratio of genetic variance to phenotypic variance (Falconer, 1981) [2]. Genetic advance was calculated using the formula given by Johnson *et al*., 1955 [6].

Among all the double tuberose genotypes studied shown significant variation for specific trait, it may be due to diversity in their origin or evolution from a different geographical region. Mean performance of the genotypes studied were tabulated in Table 1. All these parameters are shown diversity for growth parameter for all the genotypes studied. Among the double genotypes Bidhan Rajani-13 attained maximum plant height (77.40 cm) (Kameswari *et al*., 2014) [14] which was followed by Hyderabad Double (58.33cm) and Subhasini Double (58.10cm). Bidhan Rajani-21 recorded lowest plant height (32.23 cm). Bidhan Rajani 19 recorded maximum numbers of leaves (184.33) which was followed by Bidhan Rajani- 23 (177.67) and Bidhan Rajani-17 (174.67), whereas, Bidhan Rajani-21 had lowest mean performance for leaf number (61.00). Bidhan Rajani 14 had highest mean performance for number of tillers (12.00) and which was followed by both Bidhan Rajani 15 and Bidhan Rajani 15 (11.33), whereas Bidhan Rajani-20 attained only 7.33. For leaf width among double types of tuberose genotypes, both Bidhan Rajani-19 and Bidhan Rajani- 23 attain highest mean value (2.10cm) followed by Bidhan Rajani-16 (2.00cm), whereas Bidhan Rajani -20 attained lowest mean (1.03cm).

Bidhan Rajani 13 had the highest mean performance (155.77cm) for spike length followed by Hyderabad Double (133.00cm) and Subhasini Double (118.50), whereas Bidhan Rajani-18 attained lowest mean value (72.17cm) among double types of tuberose genotypes. Bidhan Rajani-13 attained highest mean value for rachis length (68.83cm), where Bidhan Rajani-18 had lowest mean value (25.33cm) for rachis length. Among double genotypes Bidhan Rajani-22 attained highest mean value (6.30cm) for flower length and followed by Subhasini Double (5.83cm) and the lowest one is Bidhan Rajani-18 (4.63cm). Subhasini Double shown highest flower breadth (6.47cm) Bidhan Rajani 13 produce lowest flower breadth (3.87) among double tuberose genotypes.

Bidhan Rajani-13 shown highest mean value for spikes per plot (12.33) followed by Subhasini Double (11.67) and Hyderabad Double (11.33) produces lowest mean value for spikes per plot among double tuberose genotypes. Bidhan Rajani-13 recorded highest (153.83g) for weight of spike among double tuberose genotypes and Vaibhab recorded lowest (66.67g) value. Among double tuberose genotypes, Calcutta double attained highest mean value (23.50g) for weight of five flowers, whereas Bidhan Rajani-18 attained lowest mean value (15.83g) for weight of five flowers. Number of flowers is highest in Bidhan Rajani-19 (54.00) and followed by Subhasini Double (53.33), whereas lowest flower producing genotype is Bidhan Rajani-18 (35.00).

Genetic variability studies

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 double tuberose genotypes, a wider range of variability was found for the character of number of leaves (123.33) and followed by weight of stick 87.17 and poorest range was 1.07 for leaf width. Phenotypic variance was higher than genotypic variance for all the traits studied. The maximum PCV and GCV was observed in case of number of leaves (30.14%, 29.86%) (Vanlalruati *et al.*, 2013) [13] and second highest PCV was scored for spike per plot (28.20%) and second highest GCV was scored for Rachis length (25.54%) (Ranchana P. *et al*., 2013) [8]. The lowest PCV and GCV were recorded for flower length 8.61 and 7.77 respectively (Ranchana *et al*., 2013) [8]. This result indicates the presence of considerable variability in these traits and scope of selection and improvement (Sathappan *et al*., 2018) [10]. The minimum difference between GCV and PCV were observed for weight of stick, spike length, number of leaf, rachis length and plant height respectively which indicates a little influence of environmental effect on the phenotypic expression of those respective characters.

Heritability in broad sense was estimated highest for spike length (98.65%) followed by weight of spike (98.35%), number of leaves (98.12%), Rachis Length (96.33%), plant height (94.83%), number of flowers (82.13%), flower length (81.40%). However, genetic advance expressed as percent of mean was found to be highest in case of number of leaf (60.92%) followed by rachis length (51.63%), plant height (49.19%), spike length (46.19%), spike per plot (40.54%), weight of spike (37.24%), leaf width (26.63%), weight of five flower (22.01%) and number of flowers (21.63%). These traits *viz*. spike length, weight of spike, no of leaf, rachis length, plant height and number of flower shows the action of additive genes in their inheritance pattern as lesser influence of environment in the expression of the particular traits observed. This result was almost similar with Vanlalruati *et al.*, 2013 [13], Gaidhani *et al*., 2016 [3] and Ranchana *et al*., 2013 [8]. Flower length exhibited high heritability associated with moderate genetic advance, indicating the presence of non- additive gene action and similar result also reported by Gaidhani *et al*., 2016 [3] and Ranchana *et al*., 2013 [8]. Selection based on these traits will be useful in crop improvement. The traits like spike per plot, leaf width, and weight of five flowers showed low heritability and high genetic advance which reveals the traits were highly influenced by environment but governed by additive genes. Other traits like number of tiller and flower breadth exhibited low heritability and moderate or low genetic advance as percentage of mean which indicates the traits were highly influenced by environment and concerned genes governed by non-additive genes and similar genetic behavior has been reported by Panse (1957) [7], Sheikh *et al*., 1995 [11], Gangadharappa *et al*., 2008 [4], Gaidhani *et al*., 2016 [3] and Chaudhary *et al*., 2018 [1]. A general interpretation can be drawn in this context as GCV alone is not sufficient for determination of extent of variation that continue from one generation to the next. GCV along with heritability would give a better understanding of extent of advance that can be made through selection.

Table 1: Mean performance of different quantitative traits of double tuberose genotypes.

Character / Genotype	Plant height	No. of Leaves	No. of tillers	Leaf Width	spike length	Rachis length	Flower (length)	Flower (breadth)	Spike /plot	Wt of spike	Wt of 5Flowers	No of flowers
Calcutta Double	53.33	123.67	11.33	1.37	117.00	32.53	4.90	4.87	10.33	127.33	23.50	48.67
Vaibhab	51.33	125.67	11.67	1.87	97.67	35.10	5.03	4.93	5.67	66.67	19.67	50.67
Hyderabad Double	58.33	135.67	11.67	1.93	118.50	40.00	5.67	5.43	11.33	123.33	22.73	50.67
Subhasini Double	58.10	121.00	11.33	1.90	133.00	41.00	6.10	5.83	11.67	153.33	23.40	53.33
Bidhan Rajani-13	77.50	154.00	10.67	1.83	155.77	68.83	5.63	3.87	12.33	153.83	18.50	49.67
Bidhan Rajani-14	41.20	174.33	12.00	1.80	74.63	35.70	5.63	5.00	9.33	120.17	18.17	46.00
Bidhan Rajani-15	53.17	92.00	8.00	1.87	92.17	36.00	5.67	4.60	9.00	117.83	21.27	44.67
Bidhan Rajani-16	37.33	146.33	8.67	2.00	98.50	34.77	5.87	5.20	8.00	121.83	16.17	42.00
Bidhan Rajani-17	44.17	174.67	10.00	1.93	102.50	44.17	5.43	4.43	7.67	120.23	19.83	52.33
Bidhan Rajani-18	33.67	72.33	9.00	1.80	72.17	25.33	4.63	4.27	8.00	78.00	16.17	35.00
Bidhan Rajani-19	42.50	184.33	11.33	2.10	72.87	31.67	5.30	4.53	7.33	117.83	22.33	54.00
Bidhan Rajani-20	33.50	74.33	7.33	1.03	99.50	36.50	6.00	4.37	7.00	111.53	17.33	42.33
Bidhan Rajani-21	32.33	61.00	9.00	1.70	82.83	33.37	5.20	4.80	6.00	113.93	19.33	37.67
Bidhan Rajani-22	42.67	141.67	11.00	1.57	99.83	34.50	6.30	4.20	7.00	118.83	16.67	44.67
Bidhan Rajani-23	52.83	177.67	11.33	2.10	101.83	44.83	5.97	4.33	6.33	122.50	22.50	51.67
Bidhan Rajani-24	48.00	155.33	9.67	1.53	81.67	29.60	5.73	4.50	6.67	113.17	15.83	44.67
C.D.	4.466	9.108	1.887	0.259	4.434	3.151	0.346	0.492	2.187	4.644	2.933	4.221
SE(m)	1.539	3.138	0.65	0.089	1.528	1.086	0.119	0.17	0.754	1.6	1.011	1.454
SE(d)	2.176	4.438	0.919	0.126	2.161	1.535	0.169	0.24	1.066	2.263	1.429	2.057
C.V.	5.612	4.114	10.986	8.715	2.645	4.982	3.709	6.25	15.626	2.358	8.937	5.388

Table 2: Estimates of variability and genetic parameters of double tuberose genotypes.

Parameters / characters	Mean	range	SE(±M)	GV	PV	ECV	GCV	PCV	HS	GA	GA(%)
PH	47.50	45.17	2.93	135.63	143.03	15.57	24.52	25.18	0.9483	23.36	49.19
No. of Leaves	132.13	123.33	9.90	1555.99	1585.77	22.54	29.86	30.14	0.9812	80.49	60.92
No. of tillers	10.25	4.67	0.37	1.66	2.93	12.39	12.58	16.71	0.5671	2.00	19.52
Leaf Width	1.77	1.07	0.07	0.07	0.09	1.34	14.95	17.30	0.7473	0.47	26.63
Spike length	100.03	83.60	5.66	509.87	516.84	6.97	22.57	22.73	0.9865	46.20	46.19
Rachis length	37.74	43.50	2.43	92.90	96.44	9.38	25.54	26.02	0.9633	19.49	51.63
Flower length	5.57	1.67	0.11	0.19	0.23	0.77	7.77	8.61	0.8140	0.80	14.43
Flower breadth	4.70	1.97	0.13	0.22	0.31	1.85	10.02	11.83	0.7183	0.82	17.50
Spike plot	8.35	6.67	0.52	3.87	5.55	20.08	23.56	28.20	0.6978	3.39	40.54
Wt of stick	117.52	87.17	5.40	459.00	466.67	6.53	18.23	18.38	0.9835	43.77	37.24
Wt of 5 Flower	19.59	7.67	0.69	6.45	9.51	15.62	12.97	15.75	0.6784	4.31	22.01
No. of flowers	46.75	19.00	1.40	29.34	35.73	13.65	11.59	12.79	0.8213	10.11	21.63

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