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Field performance of single-petalled tuberose (*Polianthes tuberosa* L.) genotypes for growth, flowering and bulb attributes under foot hills of Himalayas

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Abstract

Tuberose is an important commercial bulbous flower crop grown for cut flower, loose flower concrete and absolute. The present experiment was laid out in RBD with three replications to evaluate sixteen genotypes of single-petalled tuberose for various attributes for two years to screen the suitable genotype. All the genotypes showed significant variation in their growth, flowering and yield behavior. The results indicated that the genotype Arka Nirantara performed better with respect to growth traits followed by Mexican Single and Phule Rajni. The yield of spikes, bulbs and bulblets were found to be highest for Arka Nirantara which was statistically at par with Mexican Single. However, early spike emergence, early floret opening, flowering duration, number of florets, spike length and rachis length were all found to maximum in genotype Kalyani Single. Genotypes Arka Nirantara, Mexican Single and Kalyani Single are found to be superior overall the other genotypes.

Keywords: Tuberose, single-type, bulb, spike yield, vase life

Introduction

Floriculture is fundamentally a science-based industry; hence the most current scientific achievement is inevitably the most intriguing and fascinating. In recent years, there has been a tremendous increase in global demand for floricultural goods, which offers limitless domestic and export prospects but necessitates product diversification. The total area under floriculture in 2019-2020 was 305 thousand ha with the total production of 2301 thousand tons of loose flowers and 762 thousand tons of cut flowers. The total export of floriculture products during the year 2020-2021 was Rs. 575.98 Crores or 77.84 million USD ^[1]. Due to its quick growth rate, rising purchasing power, and increased public awareness, the flower business is developing as the most diversified and prospective component in the horticulture sector at both national and international levels.

Among the wide varieties of cultivated flowers, Tuberose (*Polianthes tuberosa* L.) is one of the important ornamental bulbous flower crops which is valued for its beauty, fragrance and long-lasting flower spikes. This plant being the tuberous hyacinth as distinguished from the bulbous hyacinth, the name thus is 'tuber - ose', not 'tube - rose'. It is extensively cultivated in tropical and sub-tropical parts of the world including India and belongs to the family Amaryllidaceae ^[2, 3] and is a native to Mexico. The flowers of tuberose are used for floral ornamental, decoration, bouquets and in garlands. It is also preferred for table decoration in bowl and vase because its spike remains fresh for long time ^[4]. The flowers of tuberose produce one of the rarest and most valuable aromas with sweet and pleasant fragrance ^[5]. It is commercially grown in many countries including India, and its commercial cultivation is done in Karnataka, Andhra Pradesh, Tamil Nādu, Maharashtra, West Bengal, Assam, Gujarat, Rajasthan, Delhi and Haryana.

However, the performance of any crop or variety largely depends upon its genetic makeup and climatic condition of the region under which they are grown. As a result, cultivars which perform well in one region may not perform well in other regions of varying climatic conditions. As a result, collecting and evaluating all the available genotypes is very crucial in order to identify acceptable and high-yielding genotypes for a given region. Hence, keeping in view the above point the trial was conducted to evaluate the single-petalled tuberose germplasm for growth, flowering and bulb attributes.

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Material and Methods

The present investigation was carried out at Model Floriculture Centre, of the University for Two years and the data have been pooled. Pantnagar is located in the foothills of Himalayas and lies in the *Tarai* region of Uttarakhand which experiences extremely hot summers, cold winters and intense rainfall and the soil at Pantnagar comes under mollisols. The soil of experimental field was sandy-loam with adequate drainage and optimum water holding capacity. The experimental material used for the study consisted of 16 single-petalled tuberose germplasm. The description of the genotypes is given in the Table 1.

The land was brought to fine tilth by ploughing it three times followed by levelling. The plots of 15 m x 35 m were prepared. Well decomposed farm yard manure was applied before the land preparation at the rate of 25 tons per hectare and mixed well into the soil. Besides this, a recommended dose of N: P: K @ 200:200:200 kg /ha were also incorporated into the experimental field, out of which half dose of N and entire dose of P₂O₅ and K₂O were applied as basal dose at the

time of planting of bulbs whereas, the remaining N was applied in two split doses at 30 and 60 days after planting of bulbs. The field was lightly irrigated before planting to optimize moisture. Healthy bulbs of commercial grade (1-1.5 cm diameter) were planted at a spacing of 30 X 30 cm and depth of 5-7 cm on 25th March, 2018. The bulbs were treated with a 0.2 per cent Bavistin solution for half an hour to prevent bulb rot, and then dried in the shade for half an hour before planting. Throughout the crop growing period, uniform cultural operations and crop management procedures were adapted. First weeding was done when the bulbs sprouted which was followed by light irrigation. Depending upon the prevailing weather conditions subsequent irrigation was provided to the crop by flooding. The technique of random sampling was adopted for recording the data for various characters of tuberose.

The data were subjected to Statistical analysis using randomized block design (RBD) as given by Panse and Sukhatme [6].

Table 1: List of Tuberose genotypes with their characteristics

Sl. No	Genotypes	Characteristics
01.	Bidhan Snigdha-1	It is released from BCKV, Kalyani and is cross between Arka Nirantara x Prajwal and shows photo-thermo-insensitive behaviour.
02.	Bidhan Ujjawal	It is released from BCKV, Kalyani, is cross between Sikkim Selection x Phule Rajni, shows tolerance to lodging, and is highly fragrant.
03.	Arka Shringar	Released from IIHR, Bangalore. It is a cross between Single x Double and bears fragrant flowers on strong, sturdy medium spikes.
04.	Sikkim Selection 1	Flowers are single but leaves are of variegated types
05.	GKTC-4	Released from MPKV, Rahuri. It bears single row of petals and the flower spike curvature is absent.
06.	Kalyani Single	Released from BCKV, Kalyani and bears long single flowers and petals with creamy colour.
07.	Mexican Single	It bears florets on 2-3 rows of corolla segments on straight spikes
08.	Phule Rajni	Released from MPKV, Rahuri in 2005 and bears sparkling white florets on tall spikes
09.	Hyderabad Single	Bears single row of florets.
10.	Single	Bears one row of corolla segments on medium to tall spikes.
11.	Arka Prajwal	Released from IIHR, is a cross between Shringar' x Mexican Single and the buds are slightly pinkish in colour,
12.	Arka Nirantara	Released from IIHR and has white, single flowers with prolonged blooming
13.	Shyadari Vaman	Released from DFR, Pune and is a dwarf variety developed through hybridization generally suitable as pot plants or for gardening
14.	Pratap Rajni	Released from MPUAT, Udaipur and bears white colour florets on long spikes.
15.	Coloured Tuberose-1	It bears pink coloured single type florets.
16.	Coloured Tuberose-2	It bears yellow coloured single type florets.

Result and Discussions

The pooled mean data of all the varieties observed for different characters are presented in Table 2 and 3. Analysis of variance revealed significant differences among the varieties in terms of various morphological traits.

Growth attributes: The data pertaining to growth characters are furnished in the Table 2. Significant variation was observed among the various vegetative traits and it was revealed that the genotype Arka Nirantara produced significantly taller plants (75.50 cm) which was statistically at par with Phule Rajni (74.25 cm) but significantly taller than rest of the varieties whereas, plants with shortest height (58.07 cm) was produced by Shyadari Vaman. This variation in plant height might be due to the genotypic differences which resulted in the phenotypic expression of the traits and

could have been further influenced by the agro-climatic conditions. Similar findings have been reported by Singh *et al.* [7] under Pune conditions and Gogoi and Talukdar, [8] under Assam conditions. The highest number of leaves per plant was recorded in Arka Nirantara (80.47) which was at par with Kalyani Single (77.52 cm) and Mexican Single (77.17) but significantly higher than rest of the treatments while the lowest number of leaves were exhibited by Sikkim Selection (53.50). These variations observed among the genotypes for the number of leaves may be due to the heredity traits, also due to variations of stored food material in mother bulbs as expressed by their sizes and the prevailing environmental conditions. This result is in conformity with the findings of Martolia and Srivastava [9] and Dimri *et al.* [10].

Table 2: Growth and Floral attributes in single-type tuberose genotypes under foot hills of Himalayas (Two years pooled data)

Sl. No	Name of the genotypes	Plant height (cm)	No. of leaves	Days to spike emergence	Days to 1 st floret opening	Days to withering of basal floret	Duration of flowering	No. of florets / spike	Diameter of basal floret (cm)	Length of basal floret (cm)	Weight of Ind. floret (g)	Spike length (cm)	Rachis length (cm)
01.	Bidhan Snigdha-1	62.35	67.33	125.25	27.22	4.07	14.42	30.83	3.80	6.59	1.73	63.06	18.44
02.	Bidhan Ujjwal	63.42	71.67	124.44	27.72	3.87	16.44	35.67	4.05	5.41	1.62	66.60	23.92
03.	Arka Shringar	61.92	65.32	124.85	26.27	4.13	19.80	42.33	3.98	5.94	2.32	84.67	30.07
04.	Sikkim Selection	61.92	53.50	124.28	23.90	3.83	23.25	44.33	4.17	4.43	2.80	91.95	31.70
05.	GKTC-4	70.93	63.12	121.21	30.23	3.41	24.43	39.50	3.88	6.22	1.87	82.29	28.15
06.	Kalyani Single	63.72	77.52	115.69	24.34	4.75	26.38	46.17	3.67	4.73	0.90	106.35	32.88
07.	Mexican Single	69.58	77.17	129.40	27.63	3.96	16.61	35.67	3.52	4.48	0.77	75.90	24.45
08.	Phule Rajni	74.25	72.48	124.17	30.36	4.59	22.62	39.83	3.83	4.77	0.58	61.80	27.43
09.	Hyderabad Single	67.87	62.40	127.62	29.02	4.78	22.31	43.17	3.83	4.68	0.68	79.82	30.82
10.	Single	63.38	70.15	128.12	27.64	3.73	15.49	35.67	3.88	4.31	1.65	85.67	24.04
11.	Arka Prajwal	66.28	63.78	125.97	27.30	3.33	25.11	45.00	3.77	5.53	1.87	108.97	32.51
12.	Arka Nirantara	75.50	80.47	120.43	29.52	3.96	24.07	40.00	3.82	5.94	2.33	75.00	27.84
13.	Shyadari Vaman	58.07	71.93	123.41	27.86	4.02	20.06	36.67	3.75	4.81	1.77	63.58	25.14
14.	Pratap Rajni	65.97	65.50	125.48	29.58	4.03	20.21	34.50	3.87	4.83	0.93	77.43	22.73
15.	Coloured Tuberose-1	61.52	61.62	124.24	27.06	4.01	19.98	34.50	3.60	4.66	1.10	71.00	21.70
16.	Coloured Tuberose-2	64.13	63.72	123.39	28.21	4.15	18.66	35.83	3.65	4.63	1.15	74.77	24.27
	C.D at 5%	4.121	5.553	1.983	1.731	0.554	1.564	2.396	0.170	0.260	0.165	3.189	1.595
	SE (m)	1.463	1.971	0.704	0.614	0.197	0.555	0.850	0.060	0.092	0.059	1.132	0.566

Floral attributes

An inquisition of data presented in Table 2 and 3 indicated that all the genotypes varied significantly with respect to various floral attributes. Early spike emergence (115.69 days) was recorded in Kalyani Single which was significantly quicker than rest of the varieties while late spike emergence (129.40 days) was found in Mexican Single. Sikkim Selection (23.90 days) took least days to 1st floret opening which was statistically at par with Kalyani Single (24.34 days). Moreover, Hyderabad Single (4.78 days) took maximum days for withering of the basal floret which was at par with Phule Rajni (4.59 days) but significantly higher than rest of the treatments and minimum was observed in Arka Prajwal (3.33 days). These differences in spike emergence, 1st floret opening and basal floret withering may be due to the characteristics of the genes responsible for these character as well as the agro-climatic conditions prevailing in a particular area. Similar findings have also been reported by Martolia and Srivastava [9], Dimri *et al.* [10], Madhumati *et al.* [11], Dogra *et al.* [12] and Sivakumar *et al.* [13] in tuberose. The genotypes under study varied significantly for duration of flowering which ranged from 26.38 days in Kalyani Single which was statistically at par with Prajwal (25.11 days) and significantly higher than other treatments to minimum in Bidhan Snigdha-1 (14.73 days). The results are in close conformations with the findings of Chaturvedi *et al.* [14] and Chawla *et al.* [15]. In tuberose. This variation in duration of flowering were attributed to the number of florets per spike, also depends on the carbohydrate reserves of the plant whereas the variation among the genotype might be due to the genetic makeup of the plant.

In the present study longer, spikes were attained by Arka Prajwal (108.97 cm) and Kalyani Single (106.35 cm) which were statistically at par but significantly higher than all the other varieties whereas, the shorter spikes were recorded for Bidhan Snigdha-1 (63.06 cm). The variation in spike length have also been reported by Bindiya *et al.* [16] and Gogoi and Talukdar [8] in tuberose. The variation in all the genotype might be due to variation in their intrinsic factor (Ranchana *et al.*) [17]. The diameter of cut spikes was found to be maximum for Arka Nirantara (5.55) being at par with in Sikkim

Selection (5.33 cm) and significantly greater than rest of the genotypes to minimum in Arka Prajwal (3.81 cm). Among the genotype studied the highest number of florets per spike was recorded in Kalyani Single (46.17) which was statistically at par with Arka Prajwal (45.00) and Sikkim Selection (44.33). While lowest number of florets per spike was recorded for Bidhan Snigdha-1 (30.00). This variation might be due genetic variability among the different genotypes, the prevailing environmental conditions during the field trial. Similar findings have also been reported by Bhaskar and Reddy [18] under Northern Telangana conditions, Dimri *et al.* [10] under Gharwal Himalayas and Choudhary *et al.* [4] under Meerut conditions in tuberose. The genotypes under study exhibited significant differences in rachis length. Highest rachis length was observed for Kalyani Single (32.88 cm) which was statistically at par with Arka Prajwal (32.51 cm) and Sikkim Selection (31.70 cm) and significantly higher than rest of the treatments whereas, shortest rachis was attained by Bidhan Snigdha-1 (18.44 cm). Singh *et al.* [7], Madhumati *et al.* [11], Dalvi *et al.* [19] and Rajput *et al.* [20] reported variation in rachis length among different varieties studied.

Genotype Bidhan Snigdha-1 produced florets with maximum length (6.59 cm) which were at par with GKTC-4 (6.22 cm), Arka Shringar (5.94 cm) and Arka Nirantara (5.94 cm) while minimum floret length was recorded in genotype Single (4.31 cm). Moreover, maximum floret diameter was exhibited by Sikkim Selection (4.17 cm) which was statistically at par with Bidhan Ujjwal (4.05 cm) and significantly higher than other genotypes while minimum floret diameter was recorded in Mexican Single (3.52 cm). Accumulation of more carbohydrate during the flower bud development may contributes to more floret size. Significantly maximum floret weight (2.80 g) was recorded in Sikkim Selection over all other genotypes. The floret weight for Arka Nirantara (2.33 g) and Arka Shringar (2.32 g) were at par. More weight of the florets might be due to big size florets. However, the differences between the genotypes, on the other hand, could be attributed to differences in genetic makeup and environmental conditions during the growing period. This is supported with the findings of Singh *et al.* [7], Madhumati *et al.* [11], Chawla *et al.* [15], Dogra *et al.* [12] and Sivakumar *et al.*

^[13] in tuberose. Among all the single cultivars maximum days to vase life was observed in Sikkim Selection (14.63 days) which was statistically at par with Kalyani Single (14.37 days) and Arka Prajwal (14.30 days) whereas, minimum days to vase life (11.48 days) was recorded in Bidhan Snigdha-1. Vase life could also be dependent on the carbohydrate reserve of the plants as blooming is an energy requiring process (Sirohi *et al.* 2017) and is also directly correlated with number of florets per spike. These results were also experimentally supported by the findings of Dimri *et al.* ^[10] and Chawla *et al.* ^[15].

A significant difference was observed for number of spikes per clump and per hectare produced annually. Significant difference was observed among all the genotypes for spike yield. Maximum number of spikes per clump was recorded for Arka Nirantara (5.10) which was statistically at par with Kalyani Single (4.83) and Mexican single (4.75) and significantly higher than all the other genotypes while minimum was observed for Sikkim Selection (3.00). Similarly, Arka Niantara was only observed to have highest yield of spikes per hectare (5.61 Lacs) which was at par with Kalyani Single (5.32 Lacs) and Mexican single (5.23 lacs) whereas least yield was recorded for Sikkim Selection (8.97 lacs). The number of leaves generated per plant is directly proportional to spike yield. As a result, there will be more area available for photosynthesis, resulting in improved overall plant development (Bindiya *et al.*) ^[16]. This in turn it will help in production of a greater number of spikes per plant and per hectare. Similar results were also reported by Martolia and Srivastava, ^[9] in Shringar, Choudhary *et al.* ^[4] in Hyderabad Single, Madhumati *et al.* ^[11] in Rajat Rekha, Dogra *et al.* ^[12] in Arka Nirantara and Sivakumar *et al.* ^[13] in Prajwal. Yield of the florets per plant was found to be maximum for Kalyani Single (223.14) which was at par with Arka Nirantara (204.00) but significantly higher than all the other genotypes whereas, minimum yield of the florets per plant was noticed for Pratap Rajni (120.75). The results are supported by the findings of Martolia and Srivastava [9] and Dogra *et al.* ^[12].

Bulb attributes- Data in relation to bulb characters is depicted in the Table 3. The data related to bulb showed significant variations among varieties. The highest number of bulbs per clump (16.00) was recorded for Arka Nirantara followed by Mexican Single (14.58) and Kalyani Single (13.10) but significantly higher than all the other genotypes while least bulbs per clump was observed for Sikkim Selection (8.97). Similarly yield of the bulb per hectare was also observed to be maximum in Arka Nirantara (17.60 lacs) followed by Mexican Single (16.04 lacs) and Kalyani Single (14.41 lacs) and significantly higher than all the other genotypes while minimum was found for Sikkim Selection (9.86 lacs). Maximum yield of bulblets per clump was also recorded for Arka Nirantara (18.97) which was statistically at par with Kalyani Single (17.77) and Mexican Single (17.55). However, least yield of the bulblets per clump (8.97) was recorded in Sikkim Selection. Yield of the bulblets per hectare was also found to be highest for Arka Nirantara (20.86 lacs) which was statistically at par with Kalyani Single (19.54) and Mexican Single (19.31) and least for Sikkim Selection (9.94 lacs). More number of bulbs might be attributed to the fact that the genotypes with a greater number of leaves have improved photosynthetic activity, source and sink relationship and thus accumulates more carbohydrates which improves the bulb and bulblet yield per clump, per m² and per hectare. (Bindiya *et al.*) ^[16]. The variation may also be due to genetic differences of the different genotypes under study. Similar findings have also been reported by Chaturvedi *et al.* ^[14], and Chawla *et al.* ^[15]. The genotypes differed significantly with respect to number and weight of bulblets produced per plant. The maximum weight of the bulb and bulblet was recorded in Arka Nirantara (31.67 g) and Kalyani Single (5.04 g) respectively which was significantly higher than any other variety while minimum was attained by Sikkim Selection. This difference in the bulb weight may be due to the balanced portioning of dry matter between floral parts and storage organs (Ranchana *et al.*) ^[17]. The results are in accordance with the findings of Chaturvedi *et al.* ^[14] in Arka Nirantara, and Sivakumar *et al.* ^[13] in Prajwal.

Table 3: Floral and bulb attributes in single-type tuberose genotypes under foot hills of Himalayas (Two years pooled data)

Sl. No	Name of the genotypes	Diameter of the cut spike (cm)	Vase life (days)	Yield of spikes/ clump	Yield of spikes/ ha (lacs)	Yield of florets per plant	No. of bulbs/ clump	Yield of bulbs / ha (lacs)	Weight of Ind. Bulb (g)	Yield of bulblets/ clump	Yield of bulblets / ha (Lacs)	Weight of Ind. Bulblet (g)	Flower bud color
01.	Bidhan Snigdha-1	4.75	4.75	3.77	4.14	116.14	10.93	12.03	12.03	13.98	15.38	3.63	Pinkish
02.	Bidhan Ujjwal	5.10	5.10	4.55	5.01	162.28	12.18	13.40	13.40	15.35	16.89	4.26	Whitish
03.	Arak Shringar	4.77	4.77	3.57	3.92	150.99	10.87	11.95	11.95	12.27	13.49	3.92	Pinkish
04.	Sikkim Selection	5.33	5.33	3.00	3.30	133.00	8.97	9.86	9.86	9.03	9.94	2.95	Greenish
05.	GKTC-4	4.76	4.76	3.77	4.14	148.78	10.87	11.95	11.95	11.53	12.69	4.07	Greenish
06.	Kalyani Single	4.14	4.14	4.83	5.32	223.14	13.10	14.41	14.41	17.77	19.54	5.04	Greenish
07.	Mexican Single	4.60	4.60	4.75	5.23	169.42	14.58	16.04	16.04	17.55	19.31	3.72	Greenish
08.	Phule Rajni	5.28	5.28	4.40	4.84	175.27	12.23	13.46	13.46	16.05	17.66	4.11	Greenish
09.	Hyderabad Single	4.64	4.64	3.52	3.87	151.80	10.22	11.24	11.24	10.25	11.28	4.20	Pinkish
10.	Single	4.32	4.32	3.97	4.36	141.48	11.65	12.82	12.82	14.28	15.71	3.96	Greenish
11.	Arka Prajwal	3.81	3.81	4.28	4.71	192.75	10.62	11.68	11.68	12.02	13.22	3.91	Pinkish
12.	Arka Nirantara	5.55	5.55	5.10	5.61	204.00	16.00	17.60	17.60	18.97	20.86	3.82	Pinkish
13.	Shyadari Vaman	4.95	4.95	4.03	4.44	147.89	11.42	12.56	12.56	14.68	16.15	4.26	Pinkish
14.	Pratap Rajni	4.47	4.47	3.50	3.85	120.75	12.47	13.71	13.71	13.10	14.41	3.81	Greenish
15.	Coloured Tuberos - 1	4.17	4.17	3.78	4.16	130.53	11.88	13.07	13.07	10.08	11.09	3.38	Pinkish
16.	Coloured Tuberos - 2	4.08	4.08	3.57	3.92	127.81	11.75	12.93	12.93	11.85	13.04	3.26	Yellowish
	C.D at 5%	0.373	1.099	0.454	0.548	22.937	1.084	1.219	2.118	1.664	1.831	0.529	
	SE (m)	0.133	0.390	0.161	0.195	7.541	0.385	0.433	0.752	0.591	0.649	0.188	

Conclusion

Out of the sixteen genotypes studied the genotypes Arka Nirantara, Mexican Single Kalyani Single and Phule Rajni were found to be superior in terms of various growth, floral and yield parameters studied. Hence, these can be used for large scale commercial cultivation owing to their high yielding potential over others under the agro- climatic conditions of foot hills of Himalayas.

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