Indian Journal of Agricultural Sciences **87** (11): 1549–53, November 2017/Article
https://doi.org/10.56093/ijas.v87i11.75790

Field evaluation of double petalled tuberose (*Polianthes tuberosa*) genotypes for vegetative growth, floral and bulb production parameters

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Received: 13 April 2017; Accepted: 11 July 2017

ABSTRACT

Tuberose (*Polianthes tuberosa*) occupies a very selective and special position for loose flower, cut flower and essential oils trade. Generally, in cut flower trade, Double petalled genotypes are more popular than single petalled. A particular genotype may or may not perform satisfactorily in a given location. Hence, seven double petalled tuberose genotypes, viz. Pearl Double, Arka Suvasini, Hyderabad Double, Arka Vaibhav, STR 505, Calcutta Double and Swarn Rekha were evaluated during 2012-2013 for various vegetative growth, floral and bulb traits under open field condition at ICAR- Directorate of Floricultural Research, New Delhi. Significant variations for all studied parameters were recorded in evaluated genotypes. Cultivar Swarn Rekha produced significantly higher plant height (47.03 cm) followed by cv. Arka Vaibhav (44.43 cm). The lowest plant height was recorded in cv. STR 505 (38.26 cm). Maximum width of leaves (2.29 cm), fresh weight of leaves (130.28 g) and dry weight of leaves (19.18 g) per clump and number of spikes per plot (143.00) were recorded in cv. Arka Vaibhav. Cultivar Hyderabad Double took maximum number of days to first flowering (120.00) and cv. Arka Suvasini took least days to first flowering (100.00). Higher number of leaves per clump (33.55), flowering duration (24.55 day), spike length (91.91 cm), rachis length (47.84 cm), spike diameter (12.41 mm), number of florets/spike (69.90), fresh weight of florets/spike (253.83 g), fresh weight (191.90 g) and dry weight (19.14 g) of cut spike, number of tepals/floret (24.19), diameter (5.46 cm) and length (6.40 cm) of open floret, diameter (12.24 mm) and length (5.31 cm) of mature floret and weight of 10 open (46.80 g) and mature (23.20 g) florets, number of bulbs (17.00) and bulblets (9.38) per clump, total weight of bulbs (302.53 g) and bulblets (29.96 g) per clump, average diameter of bulb (28.09 mm) and bulblet (11.23 mm), average weight of bulb (27.03 g) and bulblet (3.78 g) and average length of bulb (7.46 cm) were obtained in cv. Arka Suvasini. In all genotypes, no seed setting was reported. Cultivar Arka Vaibhav developed greenish floret at bud stage, while remaining six genotypes developed pinkish flower bud. Higher internodal length was measured in cv. STR 505 (6.40 cm) and shorter in Arka Vaibhav (4.71 cm). The lowest values for majority of the vegetative growth, floral and bulb parameters were recorded in cv. Swarn Rekha. However, the lowest values for bulblet development parameters were obtained in cv. Arka Vaibhav. Conclusively, based on overall yield and quality parameters, cv. Arka Suvasini and Arka Vaibhav were found to be most promising and can be recommended for future commercialization.

Key words: Bulb, Cut flower, *Polianthes tuberosa,* Spike, Tuberose

The flowers of many ornamental plants are fragrant and used in ceremonial functions as a component of garlands and bouquets because of the fine and delicate odour which impart freshness. Among them tuberose (*Polianthes tuberosa*) occupies a very selective and special position for loose flower, cut flower and essential oils industry. It is a member of family Agavaceae and native to Mexico. The cultivation of tuberose is a profitable business as returns are double than cost. Because of this popularity, a number of countries including Kenya, India and Mexico are growing tuberose commercially for export markets in United States of America, Europe and Japan (Usman and Ashfaq 2013). Owing to its perennial nature in flowering, tuberose produces flowers almost round the year which helps to farmers for reducing poverty and improve their socio-economic status. Presently, tuberose is under cultivation in countries like France, Italy, South Africa, Taiwan, United States of America, Bangladesh, Pakistan and in many tropical and sub-tropical regions of the world including India. It is estimated that in India tuberose is commercially cultivated over 30000 ha area (Singh *et al.* 2010). In India, major tuberose growing states are Asom, Andhra Pradesh, Haryana, Karnataka, Maharashtra, Odisha, Tamil Nadu, Uttarakhand, Uttar Pradesh and West Bengal. The fragrant flowers of tuberose are added alongwith stimulants or sedatives to popular beverages prepared for chocolate and served either cold or hot. The essential oils of tuberose is used in non-

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alcoholic beverages, ice-creams, candy and baked produces. The bulbs of tuberose are considered as diuretic and emetic. They are rubbed with turmeric and butter and applied as paste to remove red pimples of infants. The dried bulbs in the powdered form are used as remedy for gonorrhoea. Tuberose plants are helpful in phyto-remediation of soils contaminated with chromium (Ramana *et al.* 2012).

The named cultivars are very few in tuberose and their nomenclature is based on the number of tepals each floret possesses. The cultivar with a one row of tetals is designated as Single while the one which bears more than three rows of tepals is called Double. The genotype Semi-double bears flowers with two to three rows of tepals. Sadhu and Bose (1973) reported existence of four genotypes of tuberose, viz. Single, Double, Semi-double and Variegated. Later on, Bankar and Mukhopadhyaya (1980) evaluated these genotypes under Bengaluru (Karnataka state) condition and concluded that commercially Single appears to be a much better genotype but aesthetically Double and Variegated genotypes also rank very high. Generally, Single petalled genotypes are more suitable for loose flowers and essential oils, while Double petalled genotypes are more popular in cut flower trade. However, depending upon the situation, Single and Double petalled genotypes are utilized for loose and cut flowers purposes. The Variegated genotypes have variegated leaves with golden yellow or silvery strikes along the margin of leaves and produce attractive foliage and spikes. In the last three decades or so a few new tuberose cultivars specially Double petalled (Swarn Rekha, Arka Suvasini, Arka Vaibhav, STR 505 and Hyderabad Double) have been developed and released in India. Tuberose as being a commercially potential flower crop, its introduction and popularization of suitable genotypes have gained much importance to the commercial growers. A particular genotype may or may not perform satisfactorily in a given location. Hence, available seven Double petalled genotypes of tuberose, viz. Pearl Double, Arka Suvasini, Hyderabad Double, Arka Vaibhav, STR 505, Calcutta Double and Swarn Rekha were collected from different sources at ICAR-Directorate of Floricultural Research, New Delhi, were evaluated to find out the promising genotypes for commercialization for their various vegetative growth, floral and bulb production parameters under open field condition of Delhi.

MATERIALS AND METHODS

The present investigation was conducted at the research farm of ICAR-Directorate of Floricultural Research, IARI Campus, New Delhi during 2012-2013. The Directorate of Floricultural Research is situated at 77.12° East and 28.35° North and an altitude of 228.60m above mean sea level. Geographically, New Delhi belongs to trans-gangetic plains of agro-climatic zone of India. It falls in the semi-arid and sub-tropical climatic condition characterized by hot and dry summer followed by cold winter, intervened by short span of monsoon from July to September. May and June are the hottest months with the maximum temperature ranging between 41 to 44°C and December and January being the coldest months with the minimum temperature ranging between 3° to 7°C. Frost occurs occasionally during December-January. The soil is of Yamuna alluvium origin and belonging to the order inceptisol. The texture class of soil is loam, having pH 8.3, clay 23.76%, silt 40.00%, sand 36.24%, organic carbon 0.48%, nitrogen 138.00 kg/ha, phosphorus 30.50 kg/ha and potassium 187.90 kg/ha. The experimental field was prepared well by adopting deep ploughings followed by planking to a fine tilth of soil. The weeds, stubbles of previous crops, stone pieces, etc. whatsoever were removed to attain clean and levelled field with find soil texture. The required area was marked and beds of 2×2m sized were prepared. Seven genotypes of Double petalled tuberose namely, Pearl Double, Arka Suvasini, Hyderabad Double, Arka Vaibhav, STR 505, Calcutta Double and Swarna Rekha were planted under open field condition and evaluated for their vegetative growth, floral and bulb production parameters. Healthy and almost uniform sized bulbs having diameter of 3.0-4.0 cm, well seasoned after dormancy, were planted at a depth of 8-10 cm, at 30×30 cm spacing on flat beds. Each treatment consisted of 36 bulbs per replication. The experiment was laid out in randomized block design with four replications. Uniform recommended package of practices were followed during the entire experimentation along with nutritional application and normal flood irrigation. Data on different

Table 1 Vegetative growth behaviour of different Double petalled tuberose genotypes

Genotype	Plant height (cm)	Number of leaves/ clump	Width of leaf (cm)	Fresh weight of leaves/clump (g)	Dry weight of leaves/clump (g)	Number of tillers/clump
Pearl Double	40.37	25.80	2.11	51.40	9.93	5.65
Arka Suvasini	43.23	33.55	2.18	103.65	14.93	7.65
Hyderabad Double	39.50	26.65	1.87	52.18	10.33	5.25
Arka Vaibhav	44.43	26.15	2.29	130.28	19.18	5.40
STR 505	38.26	24.30	2.08	52.35	10.10	5.60
Calcutta Double	40.32	28.15	2.16	52.70	10.13	5.55
Swarn Rekha	47.03	24.20	1.82	39.73	5.00	3.00
SEm	1.06	1.51	0.05	5.70	0.90	0.58
CD (P=0.05)	3.01	4.35	0.14	17.07	2.69	1.73

Table 2 Floral parameters of Double petalled tuberose genotypes under Delhi condition

Genotype	Number of days taken to first flowering	Flowering duration (day)	Spike length (cm)	Rachis length (cm)	Spike diameter (mm)	Internodal length of rachis (cm)	Number of florets/ spike	Fresh weight of florets/ spike (g)	Fresh weight of cut spike (g)	Dry weight of cut spike (g)	Number of spikes/ plot
Pearl Double	114.00	15.60	88.19	43.77	10.70	4.99	46.98	145.50	101.99	10.52	72.95
Arka Suvasini	100.00	24.55	91.91	47.84	12.41	4.86	69.90	253.83	191.90	19.14	95.25
Hyderabad Double	120.00	16.10	87.15	42.44	9.95	5.26	46.40	157.16	95.13	10.76	84.25
Arka Vaibhav	116.00	17.95	85.15	45.82	12.33	4.71	66.28	119.67	167.36	16.25	143.00
STR 505	119.00	17.00	88.08	42.46	12.30	6.40	41.10	130.75	123.95	15.23	81.50
Calcutta Double	107.00	16.00	86.49	42.37	9.36	5.40	42.40	148.00	89.37	9.55	75.00
Swarn Rekha	106.00	15.00	61.85	37.94	9.61	5.97	33.90	118.50	71.32	8.82	18.00
SEm	1.73	0.57	1.06	1.52	0.25	0.19	1.14	6.94	6.85	0.73	1.45
CD (P=0.05)	5.18	1.72	3.18	4.54	0.76	0.58	3.41	20.79	20.52	2.17	4.36

	Number of tepals/ floret	*Diameter of open floret (cm)*	*Average length of open floret (cm)*	*Diameter of mature floret (mm)*	*Average length of mature floret (g)*	*Weight of 10 open florets (g)*	*Weight of 10 mature florets (g)*	*Seed setting under natural field condition*	*Floret colour at bud stage*
Pearl Double	20.82	5.02	5.31	9.95	4.83	22.42	12.19	No seed setting	Pinkish
Arka Suvasini	24.19	5.46	6.40	12.24	5.31	46.80	23.20	No seed setting	Pinkish
Hyderabad Double	21.06	5.07	5.18	9.82	4.88	21.94	12.57	No seed setting	Pinkish
Arka Vaibhav	16.46	4.92	6.30	9.92	5.21	27.63	12.56	No seed setting	Greenish
STR 505	22.24	4.90	5.12	8.89	4.84	21.21	12.28	No seed setting	Pinkish
Calcutta Double	21.13	4.91	5.35	8.71	4.86	21.97	12.12	No seed setting	Pinkish
Swarn Rekha	21.26	4.75	5.02	8.52	4.58	17.43	10.53	No seed setting	Pinkish
SEm	0.56	0.08	0.08	0.23	0.08	0.91	0.57		
CD (P=0.05)	1.69	0.23	0.24	0.69	0.23	2.71	1.71		

vegetative growth, floral and bulb parameters (Tables 1, 2 and 3) were recorded time to time as and when required upto 10 months of planting. The experimental data pertaining to each parameter of study were averaged and subjected to statistical analysis by using the techniques of analysis of variance (ANOVA) and their significance was tested by F test at 0.05 probabilities (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

The statistically analysed data presented in Table 1 on vegetative growth parameters showed a significant variation among them and revealed that cv. Swarn Rekha produced significantly taller plants (47.03 cm) followed by cv. Arka Vaibhav (44.43 cm). Significantly lower (shorter) plant height was recorded in cv. STR 505 (38.26 cm). Significantly higher number of leaves/clump (33.55) and number of tillers per clump (7.65) at first flowering stage were produced by cv. Arka Suvasini. Significantly maximum width of leaves (2.28 cm), fresh weight of leaves per clump (130.28 g) and dry weight of leaves per clump (19.18 g) at bulb uprooting stage were recorded in cv. Arka Vaibhav. However, significantly, the lowest width of leaves (1.82 cm), number of tillers (3.00), number of leaves (39.73 g), fresh weight of leaves (39.73 g) and dry weight of leaves (5.00 g) per clump were obtained by cv. Swarn Rekha. Attaining the varying plant height, number of tillers and leaf parameters per clump among the different genotypes may be due to inherent characters of individual genotype and their adaptability to varied agro-climatic condition. These results are in close consonance with the findings of Pratap and Manohar Rao (2003), Sateesha *et al.* (2011), Mahawer *et al.* (2013) and Ranchana *et al.* (2013) in tuberose under agro-climatic condition of Hyderabad (Telangana), Dharwad (Karnataka), Udaipur (Rajasthan) and Coimbatore (Tamil Nadu), respectively.

Data presented in Table 2 indicated that all studied floral parameters recorded significant variation in all evaluated genotypes. Earliness and delayed in first flowering are

Table 3 Bulb and bulblet production parameters in Double petalled tuberose genotypes under Delhi condition

Genotype	Number of bulbs/ clump	Total weight of bulbs/ clump	Average length of bulb (cm)	Average diameter of bulb (mm)	Average weight of bulb (g)	Number of bulblets/ clump	Total weight of bulblets/ clump	Average diameter of bulblet (mm)	Average weight of bulblet (g)
Pearl Double	15.38	284.00	7.37	25.82	26.59	8.88	28.89	11.06	3.77
Arka Suvasini	17.00	302.53	7.46	28.09	27.03	9.38	29.96	11.23	3.78
Hyderabad Double	11.25	203.88	7.28	24.78	22.88	5.63	11.95	11.04	3.62
Arka Vaibhav	8.63	184.01	7.27	24.92	26.87	3.38	11.60	8.92	2.29
STR 505	9.75	211.61	7.29	26.26	25.10	4.88	21.69	10.80	2.80
Calcutta Double	11.75	214.45	7.22	24.86	23.44	3.88	15.00	10.30	2.82
Swarn Rekha	7.88	99.74	6.07	20.07	13.60	8.13	18.58	10.62	2.41
SEm	0.61	15.38	0.19	0.89	1.88	0.79	2.98	0.38	0.34
CD (P=0.05)	1.81	45.05	0.55	2.67	5.63	2.36	8.93	1.13	1.02

important parameters in selection of desirable tuberose genotypes which signifies late or early flowering genotypes (Pratap and Manohar Rao 2003). These parameters can be exploited to harvest flowers on a particular occasion and fetch higher income. Cultivar Hyderabad Double took significantly more number of days for first flowering of spikes (120.00 day), however, cv. STR 505 (119.00 day) and Arka Vaibhav (116.00 day) took significantly *at par* number of days to first flowering. The least number of days to first flowering were recorded in cv. Arka Suvasini (100.00 day). The variation in days to first flowering was primarily due to different genetic make-up of genotypes under study and prevailing environmental condition. These findings are in conformity with results obtained by Sateesha *et al.* (2011), Martolia and Srivastava (2012), Ranchana *et al.* (2013) and Mahawer *et al*. (2013) in evaluating Double petalled genotypes of tuberose. In tuberose, sturdy, thicker and taller spikes having lengthy rachis with more number of florets decide more vase life of cut spikes and also individual floret related traits like length, diameter and weight play important role in deciding quality of cut spikes (Ramachandrudu and Thangam 2009). Duration of flowering in tuberose decides the availability of flowers for longer period and also owing to extended flowering duration flower lovers can enjoy beauty and sweet fragrance of flowers for longer period. Normally, genotypes with more flowering duration are preferred over shorter duration (Pratap and Manohar Rao 2003). Data presented in Table 2 revealed that significantly higher flowering duration (24.55 day), spike length (91.91 cm), rachis length (47.84 cm), spike diameter (12.41 mm), number of florets born per spike (69.90), fresh weight of spike (191.90 g), dry weight of cut spike (19.14 g), weight of florets/spike (253.83 g), weight of 10 open florets (46.80 g), weight of 10 mature florets (23.20 g), diameter of open floret (5.46 cm), diameter of mature floret (12.24 mm), length of open floret (64.0 cm) and length of mature floret (5.31 cm) were recorded in cv. Arka Suvasini when compared with rest of the tested genotypes. Significantly the lowest flowering duration (15.00 day), spike length (61.85 cm), rachis length (37.94 cm), number of florets/spike (33.90), weight of florets/spike (118.50 g), fresh weight of cut spike (71.72 g), dry weight of cut spike (8.82 g), length of open floret (5.02 cm), length of mature floret (4.58 cm), weight of 10 open florets (17.43 g), weight of 10 mature florets (10.53 g), diameter of open floret (4.75 cm) and diameter of mature floret (8.52 mm) were recorded in cv. Swarn Rekha. The wide variations in different floral traits were attributed due to varietal differences and genetic makeup of genotypes. The results reported in the present study are in accordance with Ramachandrudu and Thangam (2009), Sateesha *et al.* (2011), Ranchana *et al.* (2013) and Maharwer *et al.* (2013) in Double petalled tuberose under different agro-climatic condition of India. Table 2 revealed that cv. STR 505 expressed longest length of internodes of rachis (6.40 cm) followed by cv. Swarn Rekha (5.97 cm). The shortest length of internodes of rachis was recorded in cv. Arka Vaibhav (4.71 cm) closely followed by cv. Arka Suvasini (4.86 cm). The shorter length of internodes (compactness) improves appearance of cut spikes and suitable for cut flower and exhibition. These results are in line with the findings of Mahawer *et al.* (2013) in tuberose. The highest yield of spikes/plot (2×2 m) in terms of number of cut spikes harvested per plot was recorded in cv. Arka Vaibhav (143.00) followed by cv. Arka Suvasini (95.25), whereas the lowest number of spikes/plot (18.00) was recorded in cv. Swarn Rekha followed by Pearl Double (72.95). Number of spikes produced by plant being a genetically controlled factor. Variation occurred due to hereditary traits of different genotypes under prevailing environment. Similar results were also obtained by Rao *et al.* (2010) and Mahawer *et al.* (2013) in tuberose. The maximum number of tepals/floret was produced by cv. Arka Suvasini (24.19) followed by cv. STR 505, whereas the minimum number of tepals/floret was recorded in cv. Arka Vaibhav (16.48) followed by Pearl Double (20.82). The variation in number of tepals/floret might be due to different genetic make up of the evaluated genotypes and prevailing environmental condition. No seed setting was reported in all evaluated genotypes under natural field condition of Delhi. In tuberose, only Single petalled genotypes are fertile and set seed, while Double petalled are sterile. Therefore seed setting is not observed in Double petalled genotypes of tuberose

(Singh *et al.* 2010). These Double petalled genotypes can be effectively utilized in hybridization programme as female parent for development of hybrids at different locations. Generally, Double petalled genotypes were developed by petaloidy condition i.e. due to fusion of carpet with petals, which resulted into more than one rows of tepals, irregularity at cell division at metaphase/anaphase stage and triploid/tetraploid chromosomal level in the cell (Mahawer *et al.* 2013). Generally, open individual florets of all available tuberose genotypes are pure while. Although, the variation in flower bud stage colour among distinct genotypes used for study showed pinkish or greenish. Cultivar Arka Vaibhav expressed greenish flower bud while remaining all tested genotypes expressed pinkish colour. It might be due to their genetic makeup and colouring pigment present in the genotypes. Genotypes show pinkish flower buds due to flavonoides and greenish colour due to chlorophyll pigment present in cv. Arka Vaibhav. The pigment synthesis also controlled by gene and which expressed under prevailing environment (Mahawer *et al.* 2013).

Tuberose is commercially propagated by means of bulb and bulblet. Generally, heavier and bigger sized bulbs are preferred in planting for commercial crop production. It is evident from the data presented in Table 3 that significant variation was recorded on studied bulb and bulblet development parameters among the evaluated genotypes. Cultivar Arka Suvasini produced significantly higher number of bulbs (17.00) and bulblets (9.38) per clump, average diameter of bulb (28.09 mm) and bulblet (11.23 mm), weight of bulb (27.03 g) and bulblet (3.78 g), length of bulb (7.46 cm) and total weight of bulbs (302.53 g) and bulblets (29.96 g) per clump. Whereas cv. Swarn Rekha produced the lowest number of bulbs (7.88) and total weight of bulbs (99.74 g) per clump, average length (6.07 cm), diameter (20.07g) and weight (13.60 g) per clump. On the other hand, cv. Arka Vaibhav recorded the lowest number of bulblet (3.38) and their corresponding weight (11.60 g) per clump and also average diameter (8.92 mm) and weight (2.29 g) of bulblet. The variation in bulb parameters among tested genotypes at bulb harvest stage might be due to the distinguished genetic makeup of the genotypes with more leaves improve photosynthetic activity, source sink relationship accumulate more carbohydrates and improve bulb and bulblet traits under prevailing climatic condition. Similar findings have also been reported by Ramachandrudu and Thangam (2009) and Mahawer *et al.* (2013) in tuberose.

From the above findings, it can be concluded that out of seven Double petalled tuberose genotypes evaluated, cultivars Arka Suvasini and Arka Vaibhav were found to be promising for majority of the vegetative growth, floral and bulb parameters for commercial cultivation in and around Delhi condition.

ACKNOWLEDGEMENT

The author is extremely thankful to the Director, ICAR-Directorate of Floricultural Research, IARI Campus, New Delhi for providing all types of necessary facilities for carrying out the study.

REFERENCES

Bankar G J and Mukhopadhyaya A. 1980. Varietal trail in tuberose (*Polianthes tuberosa* L.). *South India Horticulture* **28**(4): 150–51.

Gomez K A and Gomez A A. 1984. *Statistical Procedure for Agricultural Research,* Second Edition, pp 97-107. John Wiley and Sons International Publication, New York, United States of America.

Humphrey H. 2006. Horticulture: Responding to the challenges of poverty reduction and global competition. *Acta Horticulturae* **699**: 19–38.

Kalmegh S. 2016. Floriculture a key to success for marginal farmers in Vidharbha, India. *International Journal of Innovative Research and Development* **5**(6): 330–32.

Labaste P. 2007. The European horticulture market- opportunities for sub-saharan African exporters. *World Bank Working Papers* **63**: 113.

Mahawer N L, Bairwa H L and Shukla A K. 2013. Field performance of tuberose cultivars for growth, floral and economic characters under sub-humid southern plains and Aravalli hills of Rajasthan. *Indian Journal of Horticulture* **70**(3): 411–6.

Martolia K and Srivastava R. 2012. Evaluation of different tuberose (*Polianthes tuberosa*) varieties for flowering attributes, concrete and absolute content. *Indian Journal of Agricultural Sciences* **82**(2): 177–80.

Pratap M and Manohar Rao A. 2003. Assessment of tuberose varieties for commercial cultivation under Andhra Pradesh conditions. (*In*) *One Hundred Research Papers in Floriculture,* pp 296-97. Rajeevan P K, Vasalakumari P K and Misra R L (Eds). Indian Society of Ornamental Horticulture, C/o Division of Floriculture and Landscaping, ICAR-IARI, New Delhi.

Ramana S, Biswas A K, Ajay and Singh A B. 2012. Phytoremediation of chromium by tuberose. *National Academy of Science Letter* **35**(2): 71–3.

Ramachandrudu K and Thangam M. 2009. Performance of tuberose (*Polianthes tuberosa* L.) cultivars in Goa. *Journal of Horticultural Sciences* **4**(1): 76–9.

Rao T M, Srinivas M and Gaddagimath P B. 2010. *Wealth of Ornamental Crops – Varieties Developed at IIHR.* ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka, pp 1-78.

Sadhu M K and Bose T K. 1973. Tuberose for most artistic garlands. *Indian Horticulture* **21**(1): 22–3.

Ranchana P, Kannan M and Jawaharlal M. 2013. Evaluation of tuberose (*Polianthes tuberosa*) genotypes (Double) for yield and genetic variability. *Journal of Ornamental Horticulture* **16**(1&2): 10–4.

Sateesha G R, Kumar A and Birdar M S. 2011. Growth and floral parameters of different tuberose (*Polianthes tuberosa* L.) varieties under field conditions. *Plant Archives* **11**(1): 467–8.

Singh K P, Kadam G B and Jyothi R. 2010. *Production Manual on Tuberose* (*Polianthes tuberosa* Linn.). ICAR-Directorate of Floricultural Research, IARI Campus, New Delhi, pp 1–24.

Usman M and Ashfaq M. 2013. Economics analysis of tuberose production in Punjab, Pakistan. *Sarhad Journal of Agriculture* **29**(2): 279–84.