J. Hortic. Sci.
Vol. 18(1) : 60-66, 2023

https://doi.org/10.24154/jhs.v18i1.2148

Original Research Paper

Evaluation of tuberose genotype IIHR 17-23SP-08 (IC0642158) for flower yield, quality and response to biotic stress

Bharathi T.U.[1*], Kumar R.[1], Nair S.A.[1], Umamaheswari R.[2], Sonavane P.[2] Kalaivanan D.[3] and Rao V.K.[4]

[1]Division of Flower and Medicinal Crops, [2]Division of Crop Protection,
[3]Division of Natural Resources, [4]Division of Basic Sciences
ICAR-Indian Institute of Horticultural Research, Hesaraghatta Lake Post, Bengaluru - 560089, Karnataka, India
*Corresponding author Email : ushabharathi.t@icar.gov.in

ABSTRACT

Tuberose (*Agave amica*, family Asparagaceae) is an important commercial flower crop valued for its spectacular fragrant flowers. An experiment was conducted to evaluate the single petalled tuberose genotypes for growth, flowering, flower yield, concrete yield and response to biotic stress for two consecutive years from 2020 to 2022. Tuberose genotype IIHR 17-23SP-08 was found to be superior with highest plant height (55.53 cm), early flowering (94.93 days), highest number of spikes/plant (8.47), longest spikes (114.61cm) and rachis (32.11 cm) and maximum number of florets/spike (54.87). The matured bud weight of IIHR 17-23SP-08 was 1.29 g, which is preferable in the medium segment range with higher number of flower buds (725 buds per kg). It is a high yielder producing the highest number of spikes/m^2 (76.20) and loose flower yield 18.88 t/ha/year among the genotypes evaluated. The genotype IIHR 17-23SP-08 was also found to be a good multiplier with the maximum bulb production of 8.94 bulbs per clump. It was found to be resistant to root knot nematode (*Meloidogyne incognita*) and tolerant to leaf burn disease (*Alternaria polianthi*) under field conditions. It was found suitable as loose flower for garland preparation with the shelf life of 2 days under ambient conditions and for concrete extraction with the concrete yield of 0.095%. It produces white buds (RHS colour: NNI55D, white group, Fan 4) with green tinge on the tip. Thus, the genotype IIHR 17 23SP 08 was found promising and novel among the single types with better flower and bulb yield parameters.

Keywords : Concrete, evaluation, flowering, single type, shelf life, tuberose, yield.

INTRODUCTION

Tuberose, *Agave amica* (Medik.) Thiede & Govaerts (formerly *Polianthes tuberosa* Linn.) is one of the most important tropical bulbous flowering plants that belongs to the family Asparagaceae and is native to Mexico. It is an important commercial crop preferred due to its pleasant fragrance, longer keeping quality and wide adaptability. It is commercially cultivated in India in about 21,970 ha, with a loose flower production of 1,21,860 metric tonnes and cut flower production of 93,680 metric tonnes (Anon., 2021). The flowers of tuberose are highly fragrant containing 0.08 to 0.14 % of concrete and having high demand in the international market. Globally, tuberose concrete and absolute are produced and traded in India, Egypt and France. Commercial cultivation of tuberose in India is confined to West Bengal, Karnataka, Tamil Nadu, Maharashtra, Andhra Pradesh, Uttar Pradesh, Chhattisgarh and the National Capital Region (NCR).

In India, the preference of flower colour of tuberose varieties is limited to white, although some varieties show pinkish and greenish tinge in bud stage. Garland segment in tuberose prefer varieties with green tinge on the bud tip. Though, the local variety of tuberose under cultivation is with green tinge on the bud tip, but its yield potential is very low and is highly susceptible to pests and diseases. Market demand is for medium sized flowers weighing less than 1.5 g/bud which makes a greater number of flowers per unit (kg). This stipulates the development of high yielding tuberose varieties with green tinge on the bud tip and medium bud weight suitable for garland purpose. With respect to biotic stresses, crop loss of 10 to 14% was reported due to root knot nematode

infestation in tuberose (Khan and Parvatha Reddy, 1992). Leaf burn disease caused by *Alternaria polianthi* is extensive in tuberose causing significant yield losses (Mariappan *et al*., 1977; Muthukumar *et al*., 2007 and Mazumdar *et al*., 2021). Keeping the above in view, the present research work was carried out with the objective of breeding medium sized flowers with green tinge on bud tip for loose flower and garland purpose that are resistant/tolerant to root knot nematode and leaf burn disease.

MATERIALS AND METHODS

The tuberose genotype IIHR 17-23SP-08 was developed through seedling selection from GK-TC-4 during the year 2017. It was vegetatively fixed through bulbs and multiplied. Seven single petalled type of tuberose genotypes namely IIHR 17-23SP-08, GK-TC-4, Phule Rajani, Bidhan Ujwal, Calcutta Single, Arka Prajwal (commercial check) and Mexican Single (local check) were evaluated for growth, flowering, flower and concrete yield and response to biotic stress in randomized block design with three replications from 2020 to 2022 at the Division of Flower and Medicinal Crops, ICAR-Indian Institute of Horticultural Research, Bengaluru, India.

Bulbs of medium size (2.5 cm diameter) were planted on raised bed of 30 cm height with a spacing of 30 cm x 30 cm with the bed size of 2.4 m^2. Standard cultural practices were followed throughout the experiment. Observations were recorded on 15 plants in total, comprising 5 plants per replication for various parameters *viz*., plant height (cm), days to spike emergence, days to opening of first floret, number of spikes per clump, spike length (cm), rachis length (cm), number of florets per spike, length of floret (cm), diameter of floret (cm), bud length (cm), matured bud weight (g), weight of 100 florets (g), number of spikes per m^2, loose flower yield per ha per year (tons), number of bulbs per clump, shelf life (days) and concrete content (%).Tuberose concrete was extracted by solvent extraction method (ASTA, 1960) with food grade hexane as solvent. The concrete content was calculated on fresh weight basis and expressed in percentage. Tuberose genotypes were screened for the resistance against root-knot nematode (*M. incognita*) for two consecutive years. Gall Index (GI) was registered in the roots in a 0-5 scale (0- immune, 1- highly resistant, 2- resistant, 3- tolerant, 4- susceptible, 5- highly susceptible) as per Taylor and Sasser (1978) at the time of bulb harvest. The per cent disease index (PDI) and host reaction of the tuberose genotypes to leaf blight (*A. polianthi*) was recorded on 0-5 disease severity scale (0- immune, 1- resistant, 2-moderately susceptible and 3- highly susceptible) under field condition at 15 days interval for three times, as per Narayanappa and Chandra (1984). The data of two years were pooled and analysed statistically (Gomez and Gomez,1984).

RESULTS AND DISCUSSION

The perusal of data presented in Table 1, revealed significant differences in the growth, flowering and yield traits among the different genotypes. Plant height was maximum in genotype IIHR 17 23SP 08 (55.53 cm), which was on par with the commercial check Arka Prajwal (54.84 cm), while, it was minimum in GK-TC-4 (36.05 cm). The variation in plant height

Table 1 : Evaluation of tuberose genotype IIHR 17 23SP 08 (IC0642158) with checks

Genotype	Plant height (cm)	Days to spike emergence	Days to first floret open	No. of spikes per clump	Spike length (cm)	Rachis length (cm)	Number of florets per spike	Single bud weight (g)
IIHR 17-23SP-08	55.53	94.93	22.17	8.47	114.61	32.11	54.87	1.29
Mexican Single	37.81	111.10	19.73	4.17	88.11	20.01	43.83	1.01
Arka Prajwal	54.84	101.03	29.00	5.18	97.39	30.90	52.50	2.04
GK-TC-4	36.05	125.03	19.77	4.00	65.25	18.29	49.67	1.22
Phule Rajani	39.02	148.17	24.10	4.00	58.14	20.15	44.10	1.09
Bidhan Ujwal	36.07	106.87	23.30	4.23	55.11	16.21	56.87	1.04
Calcutta Single	40.77	105.77	19.80	4.13	91.22	11.28	33.57	0.82
SEm±	0.79	1.77	0.35	0.12	2.10	0.88	1.25	0.03
CD (P=0.05)	2.45	5.51	1.08	0.36	6.54	2.75	3.90	0.10
CV (%)	3.18	2.70	2.67	4.15	4.47	7.20	4.52	4.75

might be due to the inherent genetic makeup of the particular genotype. Similar results on variation in plant height were also reported by Mahawer *et al*. (2013) and Dogra *et al*. (2020) in tuberose.

Days to spike emergence varied from 94.93 to 148.17 days. The genotype IIHR 17 23SP 08 was found to be early flowering (94.93 days) followed by Arka Prajwal (101.03 days) and Phule Rajani (148.17 days). Ramachandrudu and Thangam (2009) also reported early flowering in cv. Hyderabad Single. Days to opening of first floret ranged from 19.73 (Mexican Single) to 29.00 days (Arka Prajwal), however, genotype IIHR 17 23SP 08 recorded 22.17 days for first floret opening and was early as compared to commercial check Arka Prajwal. The genotypes with early flowering catch the early market and would be remunerative to the farmers. Madhumathi *et al*. (2018) also observed variation in spike emergence in different cultivars of tuberose.

The number of spikes per plant has direct influence on the yield of the tuberose. The genotypes IIHR 17 23SP 08 registered the highest number of spikes per clump (8.47), whereas, lowest was in GK-TC-4 and Phule Rajani (4.00). This variation in the production of spikes per clump might be due to the inherent genetic factor of different cultivars under prevailing environmental conditions. The results are in conformity with the findings of Dalvi *et al*. (2021) and Gandhi and Bharathi (2021) in tuberose.

The genotype IIHR 17 23SP 08 recorded the longest spike (114.61 cm), while, Bidhan Ujwal registered shortest spike (55.11 cm). The rachis length varied from 11.28 (Calcutta Single) to 32.11 cm (IIHR 17 23SP 08). Variation in spike length and rachis length might be due to the inherent genetic potential of the genotype coupled with environmental conditions during the growing period. Madhumati *et al*. (2018) also observed variation in spike length of tuberose and reported maximum rachis length in Arka Prajwal (33.40 cm), whereas, minimum rachis length was recorded in GKTC-4 (23.93 cm).

The number of florets per spike has a direct association with the flower yield of the crop. Number of florets per spike ranged from 33.57 (Calcutta Single) to 56.87 (Bidhan Ujwal). The genotype IIHR 17 23SP 08 recorded 54.87 number of florets per spike which was on par with commercial check Arka Prajwal (52.50) and was superior than the local check Mexican Single (43.83). Bharathi and Umamaheswari (2018) also reported similar results in tuberose.

Weight of matured bud is an important economical trait for loose flowers as they are sold on weight basis. Current market demand in tuberose is for the variety that produces flowers buds which weigh less than 1.5 g per bud and have a greater number of flowers per unit (kg). In the present study, matured bud weight varied from 2.04 g (Arka Prajwal) to 0.82 g (Calcutta Single). The genotype IIHR 17 23SP 08 recorded matured bud weight of 1.29 g/bud which is in the range of medium segment and is preferred in the market. Based on the individual mature bud weight, IIHR 17 23SP 08 contains approximately 725 buds per kg. Similar observations were also made by Ramachandrudu and Thangam (2009) in tuberose cv. Arka Prajwal. Hundred bud weight was recorded maximum in Arka Prajwal (219.63 g) and minimum in Calcutta Single (80.80 g). The results are in corroboration with the findings of Vijayalaxmi and Lakshmidevamma (2016) in tuberose.

The data presented in Table 2 indicates significant variation in different flower traits. The bud length varied from 5.27 cm (Bidhan Ujwal) to 6.41 cm (Mexican Single), however, the genotype IIHR 17 23SP 08 recorded the bud length of 6.20 cm, which was found to be superior to the commercial check Arka Prajwal (6.15 cm). Variation in bud length of tuberose might be due to the difference in inbuilt genetic factor of the genotypes as reported by Singh *et al*. (2018) and Bharathi and Umamaheswari (2018) in tuberose. Diameter of floret varied from 3.82 cm (Bidhan Ujwal) to 5.17 (GK-TC-4). The diversity in flower diameter is in close conformity with the findings of Singh and Dakho (2017), Singh *et al*. (2018) and Bharathi and Kirthishree (2019) in tuberose.

The highest number of spikes per m^2 was recorded in IIHR 17-23SP-08 (76.20), whereas lowest was recorded in GK-TC-4 and Phule Rajani (36.00). Loose flower yield was maximum in IIHR 17-23SP-08 (18.88 t/ha/yr) followed by Arka Prajwal (17.48 t/ha/yr), whereas the lowest loose flower yield was recorded in Calcutta Single (5.08 t/ha/yr). Number of spikes per clump and number of florets per spike were found to be the highest in the tuberose genotype IIHR 17 23SP 08 which directly related to the highest loose flower yield. The distinct variation in the flower yield may be attributed to the distinguished inherent genetic

Table 2 : Evaluation of tuberose genotype IIHR 17 23SP 08 (IC0642158) with checks

Genotype	Bud length (cm)	Hundred bud weight (g)	Diameter of floret (cm)	No. of spikes per m^2	Loose flower yield/ha/ year (tons)	No. of bulbs per clump	Shelf life (days)
IIHR 17 23SP 08	6.20	134.69	4.33	76.20	18.88	8.94	2.17
Mexican Single	6.41	108.63	4.31	37.50	8.10	7.00	2.00
Arka Prajwal	6.15	219.63	4.88	46.65	17.48	6.87	3.00
GK-TC-4	6.37	135.41	5.17	36.00	8.86	6.17	1.50
Phule Rajani	5.49	97.39	4.01	36.00	6.87	3.19	1.42
Bidhan Ujwal	5.27	116.56	3.82	38.10	8.99	5.67	1.25
Calcutta Single	5.61	80.80	4.08	37.20	5.08	6.44	2.33
SEm±	0.07	2.53	0.08	1.05	0.21	0.25	0.07
CD (P=0.05)	0.21	7.89	0.27	3.28	0.65	0.65	0.22
CV (%)	1.95	3.44	3.50	4.15	3.39	3.39	6.35

makeup of cultivars as reported by Naik *et al*. (2018) and Dalvi *et al*. (2021) in tuberose.

The multiplication efficiency of a variety is important for large scale propagation and wider spread among the farmers and ease of availability. Number of bulbs per clump ranged from 3.19 (Phule Rajani) to 8.94 (IIHR 17-23SP-08). The variations observed in the bulb parameters are due to the presence of wide genetic variability among the tested genotypes of tuberose. Similar observations were recorded by Martolia and Srivastava (2012) in tuberose.

Shelf life was found to be the highest in the commercial check Arka Prajwal (3.00 days) followed by Calcutta Single (2.33 days) and IIHR 17 23SP 08 (2.17 days). Variation among the tuberose cultivars for the shelf life may be attributable to the hereditary traits, which is further interpreted by prevailing climatic conditions. Safeena *et al*. (2019) reported the presence of genotypic variation in post-harvest life of tuberose.

Tuberose concrete and absolute are much valued in the international market which is used as powerful modifier in floral accords that blends well with other scents. Among the tuberose genotypes tested, the concrete content was found to be the highest in Calcutta Single (0.097 %) followed by IIHR 17-23SP-08 (0.095 %) (Fig 1.). The results of the study confirms that the genotype IIHR 17-23SP-08 can be exploited for concrete extraction besides use as loose flowers which can be value added and used for garland making. The existence of genetic variation among the tuberose genotypes in terms of

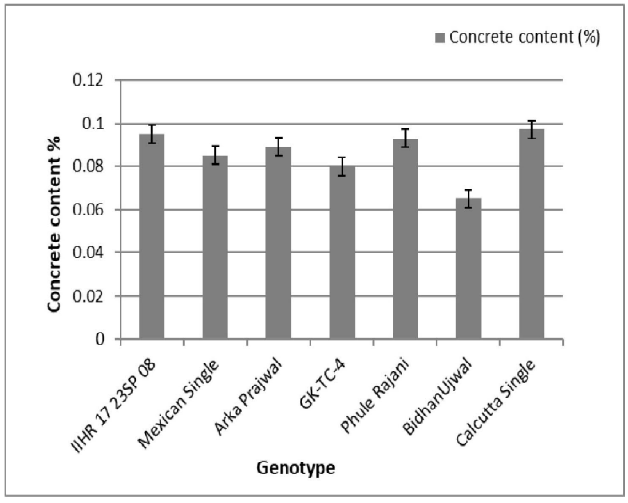

Fig 1 : Evaluation of tuberose genotypes for concrete content on fresh weight basis

concrete and absolute was reported by Chaudhary and Kumar (2017). The authors suggest that this trait may be considered as primary base for improvement programs especially for breeding tuberose varieties with high concrete content. Similar results on variation in concrete and essential oil yield among landraces were reported by Tabaei-aghdaei *et al*. (2002) in rose.

The tuberose genotype IIHR 17-23SP-08 was screened for the tolerance/resistance to root knot nematode (*M. incognita*) under field condition for two consecutive years and pooled analysis revealed that it was highly resistant under field conditions with minimal gall index of 1.31 (Table 3). Genotypic variations towards root knot nematode infestation in tuberose might be due to the genetic

Table 3 : Evaluation of tuberose genotypeIIHR-23 SP 08 with checks for leaf burn disease incidence under field condition

Genotype	Screening for leaf burn disease*	Root knot nematode Screening**
IIHR-23 SP 08	9.79 (18.24)	1.31
Mexican Single	19.20 (26.00)	2.42
Arka Prajwal	21.33 (27.52)	2.14
GK-TC-4	15.23 (22.98)	1.68
Phule Rajani	23.59 (29.06)	1.53
Bidhan Ujwal	21.10 (27.36)	1.38
Calcutta Single	13.00 (21.14)	1.51
SEm±	-	0.11
CD (P=0.05)	-	0.34
CV (%)	-	10.95

*Disease severity scale (Narayanappa and Chandra,1984); **Gall index (Taylor and Sasser,1978); Figures in parenthesis are *arc sine* transformed values

makeup of the particular genotype as reported by Gandhi *et al*. (2019) in tuberose.

The per cent disease index and host reaction of tuberose genotypes against leaf burn disease caused by *A. polianthi* under field conditions was recorded for two years. The results indicated that the tuberose genotype IIHR 17 23SP 08 was tolerant to leaf burn disease as compared to commercial check Arka Prajwal and local check Mexican Single (Table 3). The results are in line with the findings of Mazumdar *et al*. (2021) in tuberose who has observed the genetic inherent variation among the genotypes for *A. polianthi* leaf burn disease.

The quality traits of tuberose genotype IIHR 17 23SP 08 (Fig. 2) along with other genotypes have been presented in the Table 4. All the tuberose genotypes under study belong to single type. The flower/bud size was medium in IIHR 17 23SP 08 and GK-TC-4, large in Arka Prajwal and small in Mexican Single, Phule Rajani, Bidhan Ujwal and Calcutta Single. The tinge on the tip of the bud was green in all the genotypes except Arka Prajwal.

Flower spikes of IIHR 17 23SP 08

Fully opened medium size flower

Matured buds with green tinge on the tip

Fig. 2 : Tuberose genotype IIHR 17 23SP 08 (IC0642158)

Table 4 : Quality traits of tuberose genotype IIHR 17 23SP 08 (IC0642158) with checks

Genotype	Flower type	Flower/bud size	Tinge on bud	Nature of spike
IIHR 17 23SP 08	Single	Medium	Green	Straight
Mexican Single	Single	Small	Green	Slight bent
Arka Prajwal	Single	Large	Pink	Straight
GK-TC-4	Single	Medium	Green	Straight
Phule Rajani	Single	Small	Green	Straight
Bidhan Ujwal	Single	Small	Green	Crooked
Calcutta Single	Single	Small	Green	Slight bent

CONCLUSION

On the basis of two years of evaluation of seven genotypes for growth, flowering, flower, bulb, concrete yield and biotic stresses, the tuberose genotype IIHR 17-23SP-08 was found promising and novel for its single type medium size flowers having white (RHS colour: NNI55D, white group, Fan 4) flower buds with green tinge on the tip, more number of flower buds per kg (approx. 725), more number of spikes (8.47) and bulbs (8.94) per clump per year and high loose flower yield (18.88 t/ha/year). It has resistance to root knot nematode and is tolerant to leaf burn disease under field condition. Based on the study, the genotype IIHR 17-23SP-08 can be recommended as loose flower for garland purpose and for concrete extraction.

REFERENCES

Anonymous 2021. Final estimates of 2020-21 Area and Production of Horticulture Crops. https://agricoop.nic.in/sites/default/files/202021%20(Final)%20Advance%20Estimates%202020-21%20(1).pdf. Accessed 31 Mar 2023.

ASTA. 1960. Official analytical methods of the American Spice Trade Association, New York, pp. 41-42.

Bharathi, T.U and Kirthishree, S.P. 2019. Hybridization and evaluation of hybrids in tuberose (*Polianthes tuberosa* L.). *Int. J. Chem. Stud.* **7**(1): 189-193.

Bharathi, T.U and Umamaheswari, R. 2018. Evaluation of advance breeding lines of tuberose (*Polianthes tuberosa* L.) for yield and quality. *J. Plant Dev. Sci.,* **10**(12): 683-687.

Chaudhary, V. and M. Kumar. 2017. Effect of harvesting time of flowers on concrete and absolute recovery in tuberose (*Polianthes tuberosa* L.): A comparative study of single and double petalled cultivars. *Int. J. Chem. Stud.,* **5**(4): 1416-1420.

Dalvi, N.V., Salvi B.R., Pawar C.D., Salvi V.G., Dhekale J.S., Joshi M.S. and Khandeka R.G. 2021. Varietal evaluation on tuberose (*Polianthes tuberosa* L.) under Konkan agro-climatic conditions. *J. Pharm. Innov.,* **10**(10): 444-447.

Dogra, S., Pandey R.K., Laishram N and Singh A. 2020. Varietal evaluation of tuberose under agro-climatic conditions of Jammu. *J. Pharm. Innov.,* **9**(2): 499-501.

Gandhi, D.P. and Bharathi T.U. 2021. Genetic variability and diversity study in tuberose (*Polianthes tuberosa* L.). *Int. J. Chem. Stud.,* **9**(3): 235-240.

Gandhi, D.P., Bharathi, T.U., Umamaheswari, R., Kalaivanan, D. and Prathibha, S. 2019. Response of tuberose genotypes to root knot nematode, *Meloidogyne incognita*: Biochemical, histological and nutritional characterization of host-pathogen interaction. *J. Env. Biol.,* **40**: 1151-1158.

Gomez, K. A. and Gomez, A. A. 1984. Statistical procedures for Agricultural Research. John Wiley and Sons, New York.

Khan, R.M. and Reddy P. P. (1992). Nematode problems of ornamental crops and management. *Nematode Pests of Crops*., pp. 250-257.

Madhumathi, C., Bhargav V., Reddy D.S., Sreedhar D. and Lakshmi T.N. 2018. Evaluation of tuberose genotypes for vegetative, flowering and yield traits. *Int. J. of Chem. Stud.,* **6**(6):88-90.

Mahawer, L.N., 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 J. Hort.,* **70**(3): 411-416.

Mariappan, V., Babu, K. and Kandasamy, T.K. 1977. A leaf spot disease of tuberose (*Polianthes tuberose* L.) caused by new species of *Alternaria*. *Curr. Sci.,* **46**(9): 311.

Martolia, K. and Srivastava, R. 2012. Evaluation of different tuberose (*Polianthes tuberosa*) varieties for flowering attributes concrete and absolute content. *Indian J. Agric. Sci*., **88**: 170-80.

Mazumder, N., Borah, S.K. and Deka, K.K. 2021. Screening of tuberose cultivars against leaf spot (*Alternaria polianthi*) and its management. *Agric. Sci. Dig*., doi: 10.18805/ag.D-5289.

Muthukumar, A., Bhaskaran, R., Eswaran, A. and Kumar, M. R. 2007. Studies on biochemical properties of healthy and leaf spot infected tuberose plants. *Ind. J. Hortic.*, **46**(2): 190-193.

Naik, B.C., Kamble B.S., Tirakannanavar S. and Parit S. 2018. Evaluation of different genotypes of tuberose (*Polianthes tuberose* L.) for yield and quality. *Int. J. Curr. Microbol. Appl. Sci.*, **7**(08): 53-60.

Narayanappa, M. and Chandra, J.K. 1984. Fungicidal control of leaf spot of marigold caused by *Alternaria tagetica*. *Indian J. Agri. Sci.,* **54**(5): 691-692.

Ramachandrudu, K. and Thangam, M. 2009. Performance of tuberose (*Polianthes tuberosa* L.) cultivars in Goa. *J. Hortic. Sci.,* **4**(1): 76-77.

Safeena, S.A., Thangam, M. and Singh N.P. 2019. Evaluation of different cultivars of tuberose (*Polianthes tuberosa* L.) under humid agro-climatic conditions of Goa. *J. Hortic. Sci.,* **14**(2): 109-114.

Singh, A, Singh AK, Sisodia A. and Padhi M. 2018. Performance of tuberose varieties for flowering and flower yield parameters under indo-gangetic plains of eastern Uttar Pradesh, India. *Int. J. Curr. Microbol. Appl. Sci.,* **7**(08): 2319-7706.

Singh, A.K. and Dakho, J. 2017. Evaluation on performance and superiority of tuberose (*Polianthes tuberosa* L.) cultivars for growth and flowering under North Indian plain. *Env. and Ecol.,* **35**(1A): 341-345.

Tabaei-aghdaei, S.R., Rezaei M.B. and Jaymand, K. 2002. Evaluation of variation of flower yield in the Damask rose (*Rosa damascena* Mill.) genotypes of Kashan (Iran). *Iranian J. Forest Rangeland Plants. Genet. Breed.,* **9**: 99-111.

Taylor, A. L. and Sasser, J. N. 1978. Biology, identification and control of root knot nematode *Meloidogyne spp*. North Carolina State University Graphics, Raleigh, NC, p.111.

Vijayalaxmi, G.P. and Lakshmidevamma, T.N. 2016. Evaluation of tuberose (*Polianthes tuberosa*) varieties for quality traits. *Adv. Life Sci.,* **5**(12): 5370-5371.

(Received : 20.09.2022; Revised : 14.02.2023; Accepted 31.03.2023)