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Standardization of planting materials and effect of plant growth regulators on tuberose (*Polianthes tuberosa* L.) cv. Arka Prajwal

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Abstract
A field experiment entitled "Standardization of planting materials and effect of growth regulators on tuberose (*Polianthes tuberosa* L) cv. Arka Prajwal" was conducted during 2018-2019 at the Department of Floriculture and Landscaping, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. Different sizes of bulbs treated with GA_3 @ 150 ppm and control (distilled water) for 24 hours before planting after removal scales and bulblets of tuberose cultivar "Arka Prajwal" were used in the experiment. The observations were recorded at nursery stage and after planting. Among the different sized bulbs and bulblets, bulbs cut into two halves(T_2), bulbs cut in four halves(T_3) and bulblets(T_4) was found to be more effective planting material with regard to nursery stage growth parameters. Among this, bulbs cut into two halves (T_2) significantly increased characters *viz.*, days taken for sprouting and 70% sprouting (4.50 and 9.0 days), number of sprouts (90%), sprouting percentage (100%), plant vigour (2220.0) and also bulbs cut into two halves (T_3) was maximum for characters like plant height (19.0 and 28.35 cm), leaf length (13.20 and 26.55 cm) on 30th and 60th day after planting.

Keywords: Tuberose, bulbs cut into two halves, bulbs cut into four halves, bulblets and nursery stage

Introduction
Tuberose (*Polianthes tuberosa* L.) is a bulbous perennial plant belonging to the family Asparagaceae with chromosome number 2n = 60. It is one of the important commercially cultivated loose flower crops known for its fragrant white flowers. Tuberose is cultivated on large scale in France, Italy, South Africa, North Carolina in USA and in many tropical and sub-tropical areas including in India. Tuberose is half-hardy, herbaceous perennial, bulbous plant. It is a monocotyledonous erect herb, 60-120 cm height with stout and short bulbs. Bulbs are made of scales and leaf bases and stem remain concealed within scales and the fibrous roots are mainly adventitious and shallow.

It is a cross pollinated crop with basal leaves, 6-9 in number, 30-45cm long, about 1.3 cm wide, linear, grass like foliage, bright green, reddish near base. The foliage is narrow at the base and wider at the top and in a rosette at the base.

Tuberose inflorescences bears 25±10 pairs of florets which open acropetally. The flowers are attractive, elegant with sweet fragrance. Flowers have a funnel shaped perianth and are fragrant, tubular and waxy white, about 25 cm long, the tube bent only near the base, filaments attached on upper part of corolla, fragrant, in long terminal racemes. Stamens are six in number, ovary three locular, ovules numerous and fruit is capsule.

Tuberose is mainly used for garland making, hair adornment and oil extraction with recovery percentage of about 0.08-0.11 % and double types are used as cut flower. It is propagated through bulbs and bulblets and seeds but commercially used propagating material is bulbs. In India, tuberose is mainly cultivated in Mysore, Tumkur, Belgaum and Devanhalli taluk (Karnataka), Coimbatore, Madurai, Dharmapuri and Kanyakumari districts (Tamil Nadu), Midnapore, Kolaghat, Panskura, Ranaghat and Krishna Nagar (West Bengal), East Godavari, Guntur, Chittoor and Krishna districts (Andhra Pradesh), Guwahati and Jorhat (Assam), Navsari and Valsad (Gujarat), Pune, Thane, Sangli (Maharashtra), Uttar Pradesh, Punjab and Haryana. In India tuberose is commercially cultivated in over 3000 hectare. Arka Prajwal is an important commercial cultivated hybrid of tuberose in Tamil Nadu and Karnataka released by Indian Institute of Horticultural Research, Bengaluru released during 2001. It is a hybrid of parentage Shringar × Mexican Single producing white single flowers with pink tinge at its tip.

It gives about 20% more loose flower yield than 'Shringar'. It gives higher recovery of concrete and absolute, than 'Mexican Single'. It is recommended for use as both loose and cut flower trade. The florets are star shaped, waxy and loosely arranged on spikes that can reach 95 cm in length with yield potential of about 20 tonnes per hectare in a year.(Jawaharlal *et al.,*2018) [25]. Since, the area under the cultivation of tuberose is being increasing in Tamil Nadu among the farmers. But the availability of quality planting materials and high cost for the healthy bulbs remains a great hindrance for tuberose cultivation. Hence, the present study has been taken up to standardize the planting materials for mass multiplication of tuberose and the growth regulator treatment for improved growth and yield in tuberose. This study is aimed to reduce the cost of planting materials.

Materials and Methods:

The experiment was conducted at the Department of Floriculture and Landscaping, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during the year 2018-2019. The field experiment was conducted in a Complete Randomized Design with twelve treatments in two replications with the tuberose cultivar Arka Prajwal. The planting was carried out in September - October season. The different treatment details are; T_1 (whole bulbs as control), T_2 (bulbs cut into two halves), T_3 (bulbs cut into four halves), T_4 (bulblets), T_5 (scooped bulbs with single bud), T_6 (scooped bulbs with two buds), T_7 (whole bulbs treated with GA_3 @ 150 ppm soaking for 24 hours),T_8 (bulbs cut into two halves treated with GA_3 @150 ppm soaking for 24 hours), T_9 (bulbs cut into four halves with GA_3 @150 ppm soaking for 24 hours), T_{10} (bulblets with GA_3 @150 ppm soaking for 24 hours), T_{11}(scooped bulbs with single bud GA_3 @150 ppm soaking for 24 hours), T_{12} (scooped bulbs with two buds GA_3 @150 ppm soaking for 24 hours). The bulbs (whole, scooped and split) are dipped in fungicide solution Bavistin@1g/l for preventing the fungal attack after soaking in GA_3 treatment for 24 hours for certain treatments. In the nursery stage, the observations on growth attributes *viz.*, days taken for sprouting (days), plant height(cm), number of leaves per clump, days taken for 70% sprouting (days), number of sprouts, leaf length (cm), leaf width (cm), root length (cm), number of roots, sprouting percentage (%), plant vigour, root/shoot dry weight ratio, Relative Growth Rate were recorded from five randomly selected plants of each replication using standard procedure. The observations were statistically analyzed as per the procedure described by Complete Randomized Design.

Results and Discussion:

Effect of bulb sizes and growth regulators in nursery stage

Growth parameters *viz.,* days taken for sprouting, sprouting percentage, plant height (cm), number of leaves per clump, leaf length (cm), leaf width (cm), number of roots per clump, root length (cm), plant vigour, root/shoot ratio were recorded and the results are presented in the Table 1.

The plant height recorded varied significantly among the treatments. The maximum plant height of 19 cm and 28.5 cm was recorded in the treatment of bulbs that were cut into four halves (T_3) at 30th and 60th day after planting respectively and the minimum plant height of 5.8 cm and 14.10 cm was reported in scooped bulbs with two buds treated with GA_3 @150 ppm (T_{12}) at 30th and 60th day after planting respectively. The improved plant height may be due to some amount of stored food materials present in cut bulbs helped in early and rapid growth of the sprouts as reported by Mahesan *et al.,* (2015) [1].

More number of leaves per clump (4.5 and 5.70) was recorded in the control treatment of whole bulbs (T_1) at 30th and 60th day after planting respectively. The highest leaf length (13.20 cm and 26.55 cm) was observed in the treatment of bulbs that were cut into four halves (T_3) at 30th and 60th day after planting respectively while the maximum leaf width (1.70 cm) was recorded in the treatment of bulbs that were cut into four halves (T_3) at 30th day after planting. The minimum leaf width and length was recorded in scooped bulbs with two buds treated with GA_3 @ 150 ppm (T_{12}) at 30th and 60th day after planting. The increased bulb size promotes emergence of more leaves and the highest leaf length and leaf width in tuberose are accordance with the results of Rao *et al* (1992) [9] and Mahanata *et al.,* (1998) [8] also have stated that the bulb size is directly proportional to number of leaves in tuberose.

The number of roots from the bulbs and bulblets was recorded and the maximum number of roots (14.9 and 21.95) was observed in the control treatment of whole bulbs (T_1) at 30th and 60th day after planting respectively followed by the bulbs cut into two halves (T_2) and the minimum number of roots (2.8 and 4.9) in the scooped bulbs with single bud GA_3 @150 ppm (T_{11}) at 30th and 60th day after planting respectively. Significant results of root length were observed on 30th day after planting, the highest root length was recorded in the bulblets (T_4) and lowest in the scooped bulbs with single bud GA3 @150 ppm (T_{11}) at 60th day after planting, the maximum root length in the bulbs cut into two halves (T_2) and minimum in the scooped bulbs with two buds GA3 @150 ppm (T_{12}). Roland Ennos *et al.,* (1990) [22] reported that root length supports for better anchorage of sprouted bulbs in the soil.

The maximum sprouting percentage (100%) was recorded in the treatment of bulbs that were cut into two halves (T_2) at 30th and 60th day after planting respectively and the minimum sprouting percentage (44.5% and 65%) was reported in whole bulbs at 30th and 60th day after planting respectively. The improved sprouting percentage may be due to bulbs with two halves that contained higher amount food reserves at the base on bulbs as reported by Iftikhar Ahmad *et al.,* (2009) [5].

Highest plant vigour (2220 and 3885.90) was recorded in the treatment of bulbs cut into two halves (T_2) and lowest number of plant vigour (319.45 and 413.70) was recorded in scooped bulbs with single buds in GA_3 @ 150 ppm soaking for 24 hours (T_{11}) at 30th and 60th day after planting respectively. More number of root/shoot ratio was (1.16 and 1.71) recorded in the treatment of bulbs that were cut into two halves (T_2) at 30th and 60th day after planting respectively and the lowest number root/shoot ratio (0.02) was whole bulbs (T_1), scooped bulbs with single buds (T_6), Whole bulbs in GA_3 @ 150 ppm soaking for 24 hours (T_7) was reported in 30th and 60th day after planting respectively. The results indicated a trend that the root /shoot dry weight ratio is directly influenced nitrogen concentration, it may be encouraged vegetative growth of plant as indicated by Argen *et al,* (1987) [6].

The days taken for 70% sprouting recorded varied significantly among the treatments. The maximum days taken for 70% sprouting (16 days) recorded by scooped bulbs with single buds in GA_3 @ 150 ppm soaking for 24 hours (T_{11}) and the minimum days taken for 70% sprouting reported in T2 (4.5days) at 30th days after planting respectively. The maximum days taken for 70% sprouting (61 days) recorded at whole bulbs (T_1) and the minimum days taken for 70%

sprouting reported in T_2 (9 days) at 60th days after planting respectively. This may be attributed that to the fact that dormancy breaking of apical bud takes place earlier than that of auxiliary buds present on cut pieces. Mahesan *et al*., (2015) [1] (Table 1 & 2).

The highest plant growth rate (0.016 mg/g/day) was observed in the bulbs that are cut into two halves (T_2) and lowest (0.002 mg/g/day) in the treatment of bulbs cut into two halves treated with GA_3 @150 ppm soaking for 24 hours (T_8).Biomass allocation to the leaves and ratio between leaf area and leaf weight were positively correlated with Plant Growth Rate. The results were in a concurrence to the findings of Hendrick porter, (1989) [23] (Table 3).

Table 1: Performance of different type bulbs and bulblets on growth characters at 30DAP

Characters/ Treatments	Plant height (cm)	No. of leaves per clump	Leaf length (cm)	Leaf width (cm)	No. of roots per clump	Root length (cm)	Sprouting Percentage (%)	No. of sprouts	Plant vigour	Root/ shoot dry weight ratio
T1	12.30	4.50	2.90	1.30	14.90	4.95	44.40	44.50	851.90	0.02
T2	14.40	4.40	2.70	1.50	10.60	7.80	100.00	90.00	2220.00	1.16
T3	19.00	4.20	13.20	1.80	9.80	6.65	96.70	87.00	2080.35	0.48
T4	14.60	3.20	4.65	1.70	9.30	8.35	90.00	81.50	2059.90	0.10
T5	8.90	2.40	9.15	1.00	3.80	5.25	57.80	62.00	976.15	0.04
T6	9.10	2.00	9.00	1.05	3.20	3.85	54.40	50.50	655.85	0.02
T7	10.10	3.05	11.45	1.35	8.05	3.30	46.60	45.00	668.15	0.02
T8	11.60	3.25	8.60	1.20	8.15	4.40	76.70	73.50	1302.40	0.05
T9	9.30	2.05	6.95	1.60	3.35	3.55	66.70	69.50	988.78	0.06
T10	14.80	1.90	7.80	1.45	8.65	3.45	72.20	72.50	1475.75	0.03
T11	7.00	2.50	6.40	1.40	2.80	2.20	36.70	31.00	319.45	0.04
T12	5.80	1.80	5.70	0.95	2.90	2.35	60.00	54.00	475.80	0.05
Mean	11.39	2.94	9.90	1.36	7.13	4.68	66.70	63.42	1206.21	0.17
SE(d)	0.27	0.10	0.20	0.04	0.18	0.10	8.77	7.89	123.44	0.06
CD(0.05)	0.58	0.22	0.44	0.09	0.39	0.21	19.09	17.90	268.95	0.14

Table 2: Performance of different type bulbs and bulblets on growth characters at 60 DAP

Characters/ Treatments	Plant height (cm)	No. of leaves per clump	Leaf length (cm)	Leaf width (cm)	No. of roots per clump	Root length (cm)	Sprouting percentage (%)	No. of sprouts	Plant vigour	Root/ Shoot dry weight ratio
T1	25.00	5.70	18.60	1.30	21.95	9.10	65.00	58.50	2215.30	0.02
T2	26.55	5.35	25.85	1.70	17.00	12.30	100.00	90.00	3885.00	1.70
T3	28.35	4.00	26.55	1.50	14.25	9.45	99.95	88.85	3785.00	0.54
T4	26.15	3.95	24.85	1.35	16.75	11.05	99.90	88.95	3760.00	0.13
T5	21.85	2.95	21.95	0.95	7.80	8.10	79.45	71.50	2374.10	0.05
T6	23.25	3.25	22.40	1.10	5.45	5.20	72.80	65.50	2069.90	0.33
T7	24.40	4.75	24.70	1.20	18.05	5.55	73.90	66.50	2211.20	0.04
T8	22.65	5.45	21.70	1.45	13.20	8.45	95.00	85.50	2953.70	0.06
T9	18.65	2.00	12.40	1.60	6.15	6.85	93.90	84.50	2398.10	0.07
T10	25.65	2.35	24.55	1.40	14.80	6.90	94.45	85.00	3072.95	0.04
T11	19.10	3.00	18.15	1.15	4.90	4.20	60.55	54.50	1413.70	0.07
T12	14.10	2.45	14.60	1.00	5.00	4.15	78.90	71.00	1443.65	0.06
Mean	22.98	3.77	21.36	1.31	12.11	7.61	84.48	70.03	2631.47	0.23
SE(d)	0.67	0.11	2.14	0.07	0.34	0.02	204.07	6.33	007.06	0.08
CD(0.05)	1.44	0.24	4.67	0.14	0.73	0.14	444.62	13.80	015.39	0.17

Table 3: Performance of different type bulbs and bulblets on growth characters

Characters/ Treatments	Days taken for sprouting (days)	Days taken for 70% sprouting (days)	Relative growth rate (mg $g^{-1}day^{-1}$)
T_1	13.00	61.00	0.009
T_2	**4.50**	**09.00**	**0.016**
T_3	5.50	13.00	0.011
T_4	10.00	20.50	0.012
T_5	11.00	27.00	0.005
T_6	10.50	36.50	0.004
T_7	14.00	59.00	0.006
T_8	6.00	25.00	0.002
T_9	6.50	24.00	0.004
T_{10}	7.00	21.50	0.006
T_{11}	16.00	60.00	0.005
T_{12}	12.00	45.00	0.010
Mean	9.67	33.46	0.011
SE(d)	1.84	6.57	0.001
CD	4.00	14.30	0.002

Conclusion

From the present investigation, it could be conclude that T_2 (bulbs cut into two halves) was the best for following characters like days taken for sprouting(4.50 days), sprouting percentage (100%), plant vigour (2220.00 and 3885.00 at 30th and 60th DAP), relative growth rate (0.016 mg $g^{-1}day^{-1}$) followed by T_3 (bulbs cut into four halves) which had superior values for some characters like plant height (19.00cm and 28.35cm at 30th and 60th DAP), leaf length(13.20cm and 28.35cm at 30th and 60th DAP), leaf width (1.80cm and 1.70cm at 30th and 60th DAP). T_4 (bulblets) only had the highest value of root length (8.35cm). Hence for commercial tuberose production, the cut bulbs can be used and this can reduce cost of planting materials and improve flower yield in tuberose cv. Arka Prajwal.

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