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Effect of eco-friendly vase solution on maximum buds opening and longer vase-life of tuberose (*Polianthes tuberosa* L.) cv. Hyderabad Double

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Abstract
An investigation was carried out to increase the vase-life and maximum buds opening of tuberose flower by eco-friendly vase solution. The maximum vase-life of cut tuberose spikes provided 12 days with continuous opening of florets till 8th day, continuous cumulative increase in spike length, absorption of vase solution moderately decreased with periods and florets drooping were observed. When spikes were cut at basal pair opened bud stage from the field at early morning and spikes were put in to conical flask containing 5% sucrose and 100ppm aluminium sulphate as a vase solution, in post graduate laboratory of Horticulture Department at ambient temperature.

Keywords: Vase-life, Vase solution, Flower buds opening, Eco-friendly

1. Introduction
Tuberose (*Polianthes tuberosa* L.) belongs to family Amaryllidiaceae. It is mostly cultivated in tropical and subtropical regions of the world, like Iran, Iraq, Pakistan, and Mexico. Tuberose flower inflorescences have up to 20 pairs of florets that open bottom-up (Babarabie *et al.,* 2017) [1]. Safeena *et al.* (2016) [14], stated that tuberose spikes of Double type (more than two rows of perianth) are used as cut flowers for table decoration, garden display and floral arrangements and interior decoration. Ranchana and Kannan (2016) [13], stated that tuberose is commercially cultivated as a cut flower and loose flower as well as for extraction of natural essential oil. Keeping quality of the spike is only three days. In earlier time most of the cut flowers were kept in water but now-a-day's many preservatives have been introduced to improve the vase-life of the cut flowers. Several preservatives/chemicals i.e. sucrose, is the main source of energy and good respiratory substrate for the maintenance of osmotic potential to improve the vase-life of flower (Meman and Dabhi, 2006) [10]. The addition of aluminium sulphate to increase the post-harvest life of tuberose flower because, it reduces the bacterial contamination and transpiration rate (Mohammadi *et al.,* 2012) [11]. Therefore, use of aluminium sulphate, act as antimicrobial compound to enhance the post-harvest life of cut flowers is recommended Figueroa *et al.* (2005) [3]. Whereas sucrose is useful as a respiratory substrate as an osmolite that helps in the maintenance of a favourable water balance. Borochov *et al.* (1976) [2], indicated that sucrose have an antagonist effect on abscissic acid in delaying the senescence of rose flower. In addition to the inhibitory effect of aluminium sulphate on reducing micro-organism activities, it reduces the transpiration rate in cut roses. Therefore, present study was conducted with object to find out a best combination of different eco-friendly chemicals like sucrose and aluminium sulphate as vase solution for longer vase-life of tuberose spike.

2. Materials and methods
The experiment was conducted during the year 2010-11 on Hyderabad Double a cultivar of tuberose yielding fragrant white flower. The cut tuberose spikes were obtained from commercial cultivation of Main Experiment Station, Department of Horticulture of the University.

The healthy and blemish free spikes were selected and harvested at basal pair opened bud stage in the early morning hours by sharp knife. After cutting, the spikes were dipped in bucket containing distilled water and brought to P. G. laboratory. In laboratory 3 cm lower portion of the spikes were removed by making slanting cut then spikes were put treatment wise in to conical flasks of 200 mL capacity containing different concentration of vase solutions as per treatment i.e. T_1= Distilled water (control), T_2= 1%sucrose+100ppm aluminium sulphate, T_3= 3% sucrose+100ppm aluminium sulphate, T_4= 5% sucrose+100ppm aluminium sulphate, T_5= 1%sucrose+200ppm benzoic acid, T_6= 3%sucrose+200ppm benzoic acid and T_7= 5%

sucrose+200ppm benzoic acid. The conical flasks with spikes were kept at ambient temperature in laboratory and observations were recorded at 2 days interval on florets opening (%), increase in spike length (%), absorption of vase solution (mL), florets drooping (%) and vase-life (Days). The experiment was laid out in completely randomized design with three replications and results were evaluated at 5% level of significant.

3. Results and Discussion

Result on vase-life of tuberose (*Polianthes tuberosa* L.) flower was obtained are presented in table one to five.

3.1 Opening of florets

The treatment comprising 5% sucrose +200ppm benzoic acid was observed to be the best for maximum and continuously of florets opening for longer period with 83.67 per cent up to 10th day (Table-1) and a flower buds opening was completely stopped on 10th day in all treatments except 5% sucrose+200ppm benzoic acid. This might be due to absorption of higher amount of vase solution in comparison to other treatments that facilitated to more uptake of sucrose which was main source of energy for maintaining mitochondrial structure in flower spikes. Waithaka *et al.* (2010) [15] also reported that opening of gladiolus flower was accompanied by carbohydrate concentration. The results of present study are in close conformity to the findings of Waithaka *et al*. (2010) [15] in carnation flower.

3.2 Increase in spike length

The continuous cumulative increase in spike length till 12th day of observations were observed in all the treatments except in control (Table-2) which was obvious because sucrose provided necessary energy for cell division and elongation that was continued in spike even after harvesting. The growth in spike length was totally stopped on 12th day in control probably due to non availability of carbohydrates in to vase solution of control treatment and pre stored carbohydrates in spikes was not able to supply energy for longer period to increase spike length. The higher growth was recorded on 12th day on spikes put in vase solution containing 3% sucrose + 100ppm aluminium sulphate. This might be because of difference in respiration rate of spikes of different treatments that consumes carbohydrates available for growth and germicidal effect of aluminium sulphate. Similar observation was also reported by Kumar and Deen (2013) [8] in vase-life studies of tuberose flower.

3.3 Absorption of vase solution

Absorption of vase solution (Table-3) decreased with periods in marginal amount was recorded in all treatments till 12th day of observations but uptake was totally stopped in treatment containing 1% sucrose + 100ppm aluminium sulphate followed by lesser uptake was recorded in both the treatments (1.50 mL) with containing 3% sucrose + 100ppm aluminium sulphate and 5% sucrose +100ppm aluminium sulphate this might be because of the sucrose as well as aluminium sulphate let to slight decrease in the water uptake by the stems because sucrose and aluminium sulphate are also known to cause closer of stomata leading to reduction in water loss (Halevy and Mayak, 1981) [5]. The results of present study are in close conformity to the findings of Meman and Dabhi (2006) [10] in gerbera, Kazemi *et al*., 2010) [7] in carnations and Kumar and Deen (2013) [8] in tuberose flower, absorbed vase solution at decreasing rate with periods.

3.4 Drooping of florets

The drooping of florets increased with period that was because of senescence. Significantly minimum (28.22%) drooping of florets was observed till 10th day (Table-4) of observation with 5% sucrose + 200ppm benzoic acid followed by (38.60%) drooping of florets with 3% sucrose + 100ppm aluminium sulphate but there was no significant difference between these two treatments that might be because of higher per cent (5%) of sucrose in these treatments that provided necessary carbon and respiratory substrate to release energy required for florets opening. The rapid senescence of cut flowers may be possible reasons due to the blockage of water conducting vessels of the xylem Kazemi *et al.* (2010) [7]. The results are in confirming with established practice with the findings of Kumar and Deen (2013) [8] **i**n vase-life of tuberose spike.

3.5 Vase-life

The maximum (11.67 days) vase-life (Table-5) was recorded with 5% sucrose + 100ppm aluminium sulphate followed by 10.67 days with 5% sucrose + 200ppm benzoic acid, both treatments different significantly in comparison to control but there was no significant difference between these two treatments that might be due to equal concentration of sucrose in to the both treatments. The increase in vase-life might be due to sucrose that acts as carbon source for maintaining mitochondrial structure, function and maintained water balance in flower stems. The results of present study are in agreement with those reported in gladiolus Kaur *et al*. (2006) [6] and Namita *et al*. (2006) [12] that might be the reason for longer vase-life of tuberose spikes. Vase-life of cut flower depends on various factors such as water uptake, reduction in transpiration rate, improved water balance etc. Addition of sucrose replaces the depletion of carbohydrates from cut stems and maintains respiratory pool there by prolongs vase-life (Marousky, 1971) [9].

Table 1: Effect on vase solution on opening of florets

Vase solutions		Florets opening (%)				
		2nd day	4th day	6th day	8th day	10th day
T1	Water (control)	26.88	38.07	50.86	0.00 (0.71)	0.00 (0.71)
T2	1%sucrose + 100ppm aluminium sulphate	33.33	58.33	72.22	0.00 (0.71)	0.00 (0.71)
T3	3% sucrose + 100ppm aluminium sulphate	28.03	36.15	57.80	67.26 (54.59)	0.00 (0.71)
T4	5% sucrose + 100ppm aluminium sulphate	29.92	36.40	59.84	63.76 (53.02)	0.00 (0.71)
T5	1% sucrose +200 ppm benzoic acid	24.72	36.94	49.02	60.00 (51.14)	0.00 (0.71)
T6	3% sucrose + 200 ppm benzoic acid	51.48	62.59	75.73	79.44	0.00

					(63.79)	(0.71)
T7	5% sucrose + 200 ppm benzoic acid	35.11	51.66	61.22	75.77 (60.82)	83.67 (70.51)
SEm ±		4.42	8.05	8.13	5.76	3.72
CD at 5%		13.62	NS	NS	17.75	11.46

In parenthesis angular transformed data ($Y = \sqrt{x + \frac{1}{2}}$)

Note: On 12th day there was no opening of florets in all treatments

Table 2: Effect of vase solution on spike length

Vase solutions		Spike length (%)					
		2nd day	4th day	6th day	8th day	10th day	12th day
T1	Water (control)	1.48	2.68	3.59	4.37	4.51	0.00 (0.71)
T2	1% sucrose + 100ppm aluminium sulphate	1.74	2.89	3.63	4.36	5.23	5.23 (13.22)
T3	3% sucrose + 100ppm aluminium sulphate	1.84	3.69	4.47	5.07	5.54	6.13 (14.32)
T4	5% sucrose + 100ppm aluminium sulphate	1.79	3.28	4.31	4.97	5.53	5.94 (14.08)
T5	1% sucrose + 200 ppm benzoic acid	1.50	2.72	3.60	4.35	4.97	4.79 (12.56)
T6	3% sucrose + 200ppm benzoic acid	1.85	3.67	4.44	4.93	5.34	5.57 (13.59)
T7	5% sucrose + 200 ppm benzoic acid	1.97	3.95	4.68	5.25	5.67	5.85 (13.98)
SEm ±		0.30	0.39	0.43	0.47	0.50	0.47
CD at 5%		NS	NS	NS	NS	NS	NS

Note: In parenthesis angular transformed data ($Y = \sqrt{x + \frac{1}{2}}$)

Table 3: Effect of vase solution on absorption of vase solution

Vase solutions		Vase solution absorption (mL)					
		2nd day	4th day	6th day	8th day	10th day	12th day
T1	Water (control)	10.67	6.00	4.67	3.67	2.33	1.67 (1.46)
T2	1% sucrose + 100ppm aluminium sulphate	9.67	6.67	5.67	2.67	1.33	0.00 (0.71)
T3	3% sucrose + 100ppm aluminium sulphate	9.67	7.33	5.33	3.33	2.83	1.50 (1.41)
T4	5% sucrose + 100ppm aluminium sulphate	10.67	8.00	6.00	4.00	3.00	1.50 (1.53)
T5	1% sucrose + 200 ppm benzoic acid	9.33	8.00	6.67	3.33	1.67	0.68 (1.11)
T6	3% sucrose + 200ppm benzoic acid	10.67	8.67	8.33	6.00	5.00	3.67 (2.02)
T7	5% sucrose + 200 ppm benzoic acid	13.33	11.00	10.33	9.67	7.00	5.33 (2.40)
SEm ±		2.03	1.05	1.06	1.00	0.88	0.58
CD at 5%		NS	NS	3.29	3.11	2.70	1.79

Note: In parenthesis angular transformed data ($Y = \sqrt{x + \frac{1}{2}}$)

Table 4: Effect of vase solution on per cent drooping of florets

Vase solutions		Drooping of florets (%)			
		2nd day	4th day	6th day	8th day
T1	Water (control)	17.49 (24.67)	51.51 (45.87)	69.95	85.04
T2	1% sucrose + 100ppm aluminium sulphate	0.00 (0.71)	30.55 (33.51)	55.55	80.55
T3	3% sucrose + 100ppm aluminium sulphate	0.00 (0.71)	0.00 (0.71)	27.60	38.60
T4	5% sucrose + 100ppm aluminium sulphate	0.00 (0.71)	21.97 (27.06)	30.30	53.03
T5	1% sucrose + 200 ppm benzoic acid	0.00 (0.71)	19.86 (25.78)	28.89	41.67
T6	3% sucrose + 200ppm benzoic acid	0.00 (0.71)	16.85 (23.82)	23.33	64.26
T7	5% sucrose + 200 ppm benzoic acid	0.00 (0.71)	11.78 (19.94)	14.22	28.22
SEm ±		0.64	5.00	7.48	8.20
CD at 5%		1.96	15.42	23.06	25.28

Note: In parenthesis angular transformed data ($Y = \sqrt{x + \frac{1}{2}}$)

Table 5: Effect of vase solution on vase-life of spike

Vase solutions		Vase-life in days
T_1	Water (control)	6.00
T_2	1% sucrose + 100 ppm aluminium sulphate	8.00
T_3	3% sucrose + 100 ppm aluminium sulphate	8.00
T_4	5% sucrose + 100 ppm aluminium sulphate	11.67
T_5	1% sucrose + 200 ppm benzoic acid	7.33
T_6	3% sucrose + 200 ppm benzoic acid	10.00
T_7	5% sucrose + 200 ppm benzoic acid	10.67
SEm ±		1.24
CD at 5%		2.29

4. Conclusion

It is concluded from the study that the maximum vase-life of cut tuberose spikes were obtained 12 days, when spikes were cut at basal pair opened bud stage from the field at early morning and spikes were put in to conical flask containing 5% sucrose and 100ppm aluminium sulphate as a vase solution.

5. References

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