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Standardization of pulsing solutions for buds opening and longer vase-life of gladiolus (*Gladiolus grandiflorus* L.) flower cv. nova lux

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Abstract
An investigation was carried out to standardization of pulsing solutions for buds opening and longer vase-life of *Gladiolus grandiflorus* L. flower cv. Nova Lux during the year 2014-2015. The flower spikes were harvested in early morning at basal pair opened bud stage from the main experiment field. The maximum 12.00 days vase-life of flower was found with continuous increase in spike length, absorption of vase solution first increase thereafter decreased, continuous florets opening, maximum spike weight and moderate florets drooping could be get, when gladiolus spikes were pulsed in to 20% pulsing solution for 24 hours. Thereafter spikes were put in to conical flask containing vase solution of 5% sucrose and kept at ambient temperature in post graduate laboratory of Department of Horticulture

Keywords: Pulsing solution, sucrose, *Gladiolus grandiflorus* L., buds opening. spike weight and vase-life

1. Introduction
Gladiolus (*Gladiolus grandiflorus* L.) is belongs to the family Iridaceae and one of the leading cut flower of India and world. It has been appropriately crowned as "Queen of Bulbous Flower". The flower is popular for its majestic spikes which comprise attractive, elegant, dazzling and delicate florets. The opening of florets in sequence over longer duration makes it to be a good quality of cut flower. The gladiolus is available in fantastic colour range and spikes of almost any colour near black to white, white, pink, yellow, violet, mauve and combination of these colours are available. In India the gladiolus is cultivated of commercial scale in Jammu and Kashmir, Darjeeling and Kalimpong in West Bengal, Chaubattia and Lucknow in Uttar Pradesh, Jorhat and Shillong in Assam, Delhi, Maharashtra and Shimla in Himanchal Pradesh. The main cities having demand for gladiolus blooms are Delhi, Chennai, Kolkatta, Mumbai, Poona and Bangalore. As regards the aesthetic value of cut flower, the bulbous flowers are very popular throughout the world. Bulbous ornamentals constitute one of the most important groups of the floriculture wealth of the country. The beauty, fragrance, wide range of colour and form make them the most attractive group among flowers. Bulbous flowers have become integral part of commercial floriculture. The changing life style of Indians with a tendency to "say it with flower" and celebration of festivals like Valentine's day, Christmas, Mather's day has created a tremendous demand of cut flowers like rose, carnation, gerbera, gladiolus, and tuberose.

Improvement of keeping quality and enhancement of vase-life of cut flowers are important areas in Horticultural research. Sucrose and 8-HQS (hydroxyquinoline sulphate) increased cut flower life, by increasing water uptake and maintaining higher fresh weight of flowers (Larsen and Cromary, 1967) [9]. The vase-life of gladiolus are around 6-7 days under normal condition. Since it has many florets which open sequentially, extension of vase-life of these flowers will help more economic utilization of this flower industry. Several attempts have been made to study the effect of different chemicals and sugars on the longevity and economic value of cut flowers (Halevy and Mayak, 1979) [3]. Kumar and Deen (2017) [8] advocated that sucrose is usefull as a respiratory substrate as an osmolite that helps in the maintenance of a favourable water balance. In the earlier times, most of cut flowers were kept in water but now days; scientists have introduced many floral preservatives to improve the vase-life of cut flowers. Investigations pertaining to improved the vase-life of cut flowers by the chemical treatments

after harvest have been made with varying success. Sucrose have been used in different formulations to enhance the vase-life of tuberose flower Kumar and Deen (2015) [7]. Use of floral preservatives is the most economical and practicable method for extending the post-harvest life of cut flowers (Salunkhe *et al.,* 1990) [13]. Flower remains fresh longer if they are placed in a suitable floral preservative (Nowark and Rundnicki, 1990) [10]. The silver nitrate and STS have been banned as flower preservative become they are pollutants and threat to healthy environment therefore, search for alternative combination of preservative is required for vase solution. Thus the present experiment was conducted to the best pulsing solution for improving maximum buds opening and longer vase-life of gladiolus flower.

2. Materials and Methods

The present investigation was standardization of pulsing solution for buds opening and longer vase-life of *Gladiolus grandiflorus* L. flower cv. Nova Lux was conducted at post graduate laboratory of Department of Horticulture, Narendra Deva University of Agriculture and Technology, Faizabad (U.P.), India during 2014-2015. The spikes were procured from gladiolus field at Main Experiment Station of Department of Horticulture. The site falls under subtropical climate is geographically situated at 26.47 ^{0}N latitude, 82.12 ^{0}E longitude and 113 meter altitude. The site receives 1150 mm average annual rainfall out of which nearly 75 per cent rainfall occurs during June to September months of the year. The experiment was conducted with treatments i.e. T_1 = Distilled water (control), T_2 = 5% sucrose, T_3 = 10% sucrose, T_4 = 15% sucrose, T_5 = 20% sucrose, T_6 = 25% sucrose, T_7 = 30% sucrose. The spikes were harvested at basal pair opened bud stage in morning by sharp knife and brought to laboratory into bucket containing distilled water. In laboratory 3 cm lower portion of the spikes were removed by making slanting cut and pulsed into treatment wise of pulsing solution for 24 hours. There after spikes were put into conical flasks containing 5% sucrose solution and observations were recorded on opening of florets, absorption of vase solution, fresh weight loss of spike, drooping of florets and vase-life of flower at 2 days intervals.

2.1. Statistical Analysis

The experiment were conducted in Completely Randomized Design with 3 replications during vase-life study. The collected data were analyzed to find out the significant treatment at 5 per cent (Panse and Sukhatme, 1985) [11].

3. Results and Discussion

3.1. Opening of florets

Data as embodied in Table-1, clearly reveals that the maximum florets opened were recorded with 20% sucrose on 10th day of observation. The maximum floret opening was continuously increased till end of the experiment with 20% sucrose was due to the favorable osmotic pressure and carbohydrate concentrations and water uptake. Sucrose increase the osmotic potential and improves their ability to take up maintain turgidity (Acock and Nichols, 1979) [1] and (Halevy and Mayak, 1974) [4]. Kumar and Deen (2015) [7] also reported that the opening of tuberose florets was maximum with 20% sucrose as a pulsing solution.

3.2. Absorption of vase solution

It can be seen from the data presented in Table-2, on absorption of vase solution during vase-life study. The absorption of vase solution was recorded increasing trend up to 4th day of observation, there after absorption was decreased with advancement of periods. The increased of absorption of vase solution might be due to first increase the physiological activities like opening of florets and spike growth up to 4th day might be due to fact that sucrose provides necessary energy for physiological activities needed for uptake of vase solution. Thereafter the decrease in absorption of vase solution with advancement of vase-life periods might be due to decrease florets opening rates as well as increase the drooping of florets. Hutchinson *et al.* (2003) [5] also found that pulsing the tuberose cut flowers for 24 hrs in sucrose to proved their water relation.

3.3. Fresh weight loss of spike

Data portrayad in Table-3, apparently indicated that changes the fresh weight of spikes was increased up to 4th day of observation in all the treatments, there after weight of spike was decreased till end of the experiment. The increased in spike weight was might be due to increase being larger in flowers kept in sucrose than those kept in distilled water, and sucrose solution improve the opening of florets and absorption of vase solution. The maximum (30.90 g) spike weight was recorded on 10th day of observation with 20% sucrose as a pulsing solution. Decline in fresh weight of spikes may be attributed to decrease in water relation parameters. Besides the second peak (climacteric rise) in the respiratory drift, which is considered to decide the final senescence stage and decrease in pool of dry matter and respirable substrates especially in petals. This is in consonance with the findings of Wani *et al.* (2010) [14] in Asiatic lilium cv. Novecento.

3.4. Drooping of florets

There was no drooping (Table-4) was recorded till 4th day of observation and there after a progressive increase in florets drooping up till end of the experiment. The minimum drooping was observed with 20% sucrose on 10th day it was 42.10% that might be because the fact that sucrose acts as carbon source, maintains mitochondrial structure and provide longer period energy to delay the senescence of florets (Halevy and Mayak, 1981 [2]; Kaur *et al*., 2006) [6]. Similarly, increase in drooping of florets with advancement of period has been reported in tuberose flower (Kumar and Deen, 2015) [7]. These reported observations supported the present findings.

3.5. Vase-life

Observations presented in Table-5, reveals that maximum (12.00 days) vase-life was recorded with 20% sucrose solution which was significantly higher in comparison to T_1, T_2, T_3 and T_4 treatments. The longer vase-life might be because of longer period florets opening, maximum spike weight and minimum drooping of florets with 20% sucrose. Drooping of 5th florets was recorded as a day of vase-life of flower. Paull and Goo (1982) [12] reported sucrose as a pulsing treatment has been also found to improve the vase-life of anthurium. Similar results also reported by Kumar and Deen (2015) [7] used 20% sucrose as a pulsing solution found that maximum vase-life of tuberose flower.

4. Conclusion

It can be concluted from the above experiment results indicated that spikes harvested at basal pair opened bud stage and pulsing in to 20% sucrose solution for 24 hrs would gives maximum 12.00 days vase-life with continuous higher florets opening, maximum spike weight and florets drooping when put in to 5% sucrose as a vase solution at room temperature.

Table 1: Effect of pulsing solution on opening of florets

Pulsing solutions	Opening of florets (%)				
	2nd day	**4th day**	**6th day**	**8th day**	**10th day**
T_1 Distilled water (control)	33.30	40.10	50.10	55.00	58.00
T_2 5% sucrose	42.10	55.70	63.20	81.60	83.90
T_3 10% sucrose	38.50	57.10	67.20	82.80	87.20
T_4 15% sucrose	42.10	60.10	71.20	81.60	88.10
T_5 20% sucrose	45.20	62.20	73.90	90.10	92.10
T_6 25% sucrose	42.10	60.50	63.20	86.80	89.30
T_7 30% sucrose	38.70	58.30	68.50	82.80	85.10
SEm±	2.94	3.48	3.76	4.08	4.20
CD at 5%	6.31	7.48	8.07	8.75	9.02

Table 2: Effect of pulsing solution on absorption of vase solution

Pulsing solutions	Absorption of vase solution (mL)				
	2nd day	**4th day**	**6th day**	**8th day**	**10th day**
T_1 Distilled water (control)	25.60	28.00	28.30	23.10	19.10
T_2 5% sucrose	26.40	31.30	28.70	25.30	23.00
T_3 10% sucrose	28.30	33.40	28.90	27.70	27.30
T_4 15% sucrose	28.40	35.10	29.10	26.10	25.90
T_5 20% sucrose	29.10	35.90	29.90	29.00	28.70
T_6 25% sucrose	27.90	32.40	28.90	28.90	28.50
T_7 30% sucrose	25.10	32.50	29.50	29.50	29.00
SEm±	2.53	2.74	2.55	2.47	2.46
CD at 5%	NS	NS	NS	5.30	5.28

Table 3: Effect of pulsing solution on weight of spike

Pulsing solutions	Spike weight (g)				
	2nd day	4th day	6th day	8th day	10th day
T_1 Distilled water (control)	44.70	49.10	42.20	32.30	16.10
T_2 5% sucrose	47.50	52.50	50.80	36.70	22.80
T_3 10% sucrose	53.10	61.70	56.80	41.40	25.70
T_4 15% sucrose	54.50	63.20	58.70	42.40	26.60
T_5 20% sucrose	59.30	71.80	66.10	48.20	30.90
T_6 25% sucrose	58.10	68.70	60.00	46.16	27.00
T_7 30% sucrose	56.20	62.20	57.00	41.70	28.70
SEm±	3.35	3.59	3.45	2.99	2.44
CD at 5%	7.19	7.70	7.41	6.43	5.25

Table 4: Effect of pulsing solution on drooping of florets

Pulsing solutions	Drooping of florets (%)				
	2nd day	**4th day**	**6th day**	**8th day**	**10th day**
T_1 Distilled water (control)	0	0	8.10	35.10	62.70
T_2 5% sucrose	0	0	3.30	22.70	48.50
T_3 10% sucrose	0	0	3.00	28.60	54.80
T_4 15% sucrose	0	0	8.20	29.30	52.80
T_5 20% sucrose	0	0	10.50	26.30	42.10
T_6 25% sucrose	0	0	15.66	31.40	47.20
T_7 30% sucrose	0	0	11.66	26.40	53.10
SEm±	-	-	1.43	2.55	3.35
CD at 5%	-	-	3.08	5.47	7.19

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

Pulsing solutions	Vase-life in days
T_1 Distilled water (control)	5.95
T_2 5% sucrose	6.40
T_3 10% sucrose	8.00
T_4 15% sucrose	8.65
T_5 20% sucrose	12.32
T_6 25% sucrose	10.10
T_7 30% sucrose	8.35
SEm±	1.60
CD at 5%	3.45

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