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Effect of Sucrose on the Post Harvest Quality of Rose Cv. Tajmahal

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A B S T R A C T

The study was carried out to observe the effect of post harvest application of sucrose on extension of vase life of cut rose cv. Tajmahal. The data was recorded on the physical and physiological parameters on every alternate day. The flowers were held in different concentrations of sucrose solutions with flowers harvested at two stages *i.e.* tight bud stage and first petal unfurl stage. The study revealed that post harvest application of 6% sucrose in vase solution for the flowers harvested at tight bud stage was the best treatment and the vase life was extended up to 6.50 days under ambient conditions when compared to 4.00 days in flowers harvested at first petal unfurl stage.

Introduction

Rose (*Rosa hybrida* L.) belongs to family Rosaceae and genus *Rosa*. Rose is the most important and largest traded cut flower grown in almost all the countries of the world (Flora Holland, 2014). Rose is called as the 'Queen of flowers' indicating 'Queenliness' (Beauty, Grace and Cultural refinement) which are its inherent qualities. Rose being the most preferred flower in the international market and the area under cultivation of roses is increasing in a huge way in view of increasing demand as cut flower. In the commercial use of cut flowers it is usually the life span of petals which determine the effective life of the flowers but petals are generally short lived owing to their tenderness and delicate nature leading to rapid deterioration in quality and ultimately shorten vase life of flower.

The cut flowers carry on all the life processes at the expense of stored reserved food in the form of carbohydrates, proteins and fats limiting their longevity. Post harvest success begins with harvest of the flowers at optimum stage and vase life is often used as an indicator of post harvest longevity in cut flowers which is determined by number of days from harvest until the flower senses (Sunandharani, 2007).

Post harvest losses are the major threats to floriculture industry. There are about 10-30% losses due to post harvest damage in cut flowers. Post harvest losses was highest at retail level (39.82%) followed by wholesaler (27.52%), producer (18.87%) and local trader (13.78%) per hundred of all flowers (Bagchi and Raha, 2011). Post harvest longevity of cut flowers can often be improved by usage of suitable post harvest management practices.

An effective flower food contains three basic components to extend life of flowers which include treating the flower stems with various chemicals like sugars, biocides, antioxidants, anti transpirants, natural oils, and appropriate packing of the flowers.

Sugars act as the source of food for the flowers during the vase life (Jitendra *et al.*, 2012).Thus keeping the comprehensive view of constraints and present market demand for cut roses, the current investigation was carried out study the effect of sucrose on the post harvest quality and extension of vase life of rose cv. Tajmahal.

Materials and Methods

The present investigation was carried under seven experiments at Post Graduate Laboratory of College of Horticulture, Rajendranagar, Hyderabad during the year June 2017 – September 2019. The experimental flowers were held at ambient room temperature of 22 ± 2^{0}C with 45 to 55 per cent relative humidity (RH) under 40W cool white fluorescent tubes to maintain 12 hours photoperiod.

Procurement of rose flowers

The present study was conducted on cut rose variety "Tajmahal". The flowers of rose variety 'Tajmahal' were collected from a well maintained poly house of a farmer at Kovvaguda village in Shamshabad mandal, near Hyderabad. All the chemicals used in the experiment were of laboratory grade and were provided by the College of Horticulture, Rajendranagar.

Experimental design: Completely Randomized Design (CRD) with two factors.

Factor: 1 – Stages of Harvest (S)

S_1: Tight bud stage/ colour break stage

S_2: First petal unfurl stage

Factor: 2 – Different concentrations of sucrose (T)

T_1- Sucrose 3%

T_2- Sucrose 6%

T_3- Sucrose 9%

T_4- Sucrose 12%

T_5- Sucrose 15%

T_6- Control (Tap water).

Flower harvesting and preparation of plant material

The flowers were harvested in the morning hours at 6.30 a.m. with a stalk length of above 50 to 60 cm from the flower head with sharp secateurs.

Immediately after harvest, they were kept in de-ionized water and carried to the laboratory of Post harvest laboratory of the college of Horticulture, Rajendranagar, Hyderabad. The basal portion of stalks were re-cut under distilled water to maintain a uniform length of 30 cm stalk length and the leaves and thorns were removed.

Preparation of treatment solutions

One gram of chemical dissolved in100 ml of distilled water gives one per cent solution. Based on this formulae 3%, 6%, 9%, 12% and 15% sucrose solutions were prepared by dissolving, 3 g, 6g, 9g, 12g and 15 g of sucrose in 100 ml distilled water, respectively.

Method of treatment: Holding

The flowers were continuously held in the test treatment till the end of vase life until the flowers lost their ornamental value.

Observations recorded

Fresh weight of flower (g)

The fresh weight of the stalk is calculated with the help of a digital balance before treating the flowers with holding solutions and expressed in grams (g).

Water uptake (grams/flower stalk)

$$\text{Water uptake} = \frac{\text{Initial wt. of container without stalk} - \text{Final wt. of container without stalk}}{\text{No. of stalks in the bottle}}$$

Transpirational loss of water (grams/flower stalk)

$$\text{TLW} = \frac{\text{Initial wt. of container with stalk} - \text{Final wt. of container with stalk}}{\text{No. of stalks in the bottle}}$$

Water balance (g/f)

Water balance in the flower tissue was calculated as the difference between water uptake and transpirational loss of water and represented as gram per fresh weight (Venkatarayappa *et al.,* 1981).

Relative water content (%)

$$\text{RWC} = \frac{\text{Fresh weight of the petal} - \text{dry weight of the petal}}{\text{Turgid weight of the petal} - \text{dry weight of the petal}} \times 100$$

Diameter of florets (cm)

The diameter of the spike was recorded with a digital Vernier caliperse for all the number of flowers in the bottle and the average value is taken as the diameter of flower.

TSS of petals (^{o}Brix)

The total soluble solids (TSS) of petals were obtained by using digital refractrometer (0-35) range.

Results and Discussion

Fresh weight of flower (g)

The data recorded on fresh weight of flowers from the initial day to end of vase life was presented in table 1.

As the number of days increased, the fresh weight of the flower also gradually increased up to 4th day. Among the two stages of harvest (S) studied, the flowers harvested at tight bud stage (S_1) recorded maximum fresh weight of 20.35 g over first petal unfurl stage (S_2). No significant difference in increase in fresh weight was observed on the fourth day.

There was a significant difference in the fresh weight of the flower with respect to different concentrations of sucrose (T). The flowers treated with 6 per cent sucrose (T_2) recorded maximum fresh weight of 20.67g which is on par with 20.33 g in 3 per cent sucrose treated flowers (T_1) while the minimum fresh weight 19.63 g was recorded in flowers treated with 9 per cent sucrose (T_3) and control (tap water) (T_6) on initial day. On the fourth day, the

flowers treated with 6 per cent sucrose (T_6) recorded a significantly maximum fresh weight (22.38g) followed by 21.17g in flowers treated with 3 per cent sucrose treated flowers (T_1).the least fresh weight of 20.63 g was recorded by control (T_6).

There was no significant difference in the fresh weight of the flowers with respect to interaction of stage of harvest and different concentrations of sucrose (SXT) except on second day. All the flowers harvested at first petal unfurl stage (S_2) terminated their vase life. On sixth day the flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2) recorded a fresh weight of 22.53 g.

From the results it is clear that the flowers harvested at tight bud stage and treated with 6 per cent sucrose recorded a maximum fresh weight over other treatments.

The flowers harvested at tight bud stage maintained maximum fresh weight and water status in the flower tissue which may be due to maximum water uptake and maintenance of proper water balance.

The significant higher fresh weight in flowers treated with 6 per cent sucrose may be because of sucrose, it might have reduced the water loss thereby increasing the fresh weight of the flower (Marousky, 1971). Similar results were earlier reported by Sunanda rani (2007) in carnations.

Water uptake (g/f)

The data recorded on water uptake by the flowers from initial day to end of vase life was presented in table 2.

The water uptake gradually decreased as the number of days of vase life proceeded. The flowers harvested at tight bud stage (S_1) recorded maximum water uptake of 8.52 g/f over 7.73 g/f in flowers harvested at first petal unfurl stage (S_2). No significant difference in water uptake was observed on fourth day of flowers harvested.

As number of days increased the water uptake gradually decreased with respect to different concentrations of sucrose (T).

The flowers treated with 6 per cent sucrose (T_2) recorded significantly highest water uptake of 9.83g/f followed by 8.11 g/f in flowers treated with 3 per cent sucrose (T_1) on the second day and on fourth day, the flowers treated with 6 per cent sucrose (T_1) recorded significantly highest water uptake of 7.86 g/f followed by 6.81 g/f in flowers treated with 3 per cent sucrose (T_1).

The least water uptake of 7.49 g/f and 5.33 g/f was recorded in flowers under control (T_6) on second and fourth day respectively.

Among the interaction effects of stage of harvest and different concentrations of sucrose (SXT) a significant difference was seen in water uptake on second day and the flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2) recorded highest water uptake of 11.66 g/f followed by 8.19 g/f in flowers harvested at same stage and treated with 3 per cent sucrose (S_1T_1).

All the flowers harvested at first petal unfurl stage lost their vase life on fifth day and on the sixth day the flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2) recorded a water uptake of 5.88 g/f.

The highest water absorption by the flowers harvested at tight bud stage may be due to the fact that the flower stem may have greater area of xylem as well as more amounts of carbohydrates resulting in higher water absorption (Varu and Barad, 2010).

Exogenous application of sucrose might have increased the ability of flowers to absorb water by influencing water potential and osmotic potential leading to higher water uptake than control. These results are in accordance to earlier reports of Prasanth (2006) in gerbera flowers.

Transpirational loss of water (g/f)

The data recorded on the transpirational loss of water (TLW) from initial day to end of vase life was presented in table 3.

The TLW gradually decreased with different concentrations of sucrose (T). On second day the flowers treated with 6 per cent sucrose (T_2) recorded a TLW of 7.43g/f followed by 6.32 g/f in the flowers treated with 3 per cent sucrose (T_1) and the least water uptake of 5.27g/f was recorded in control flowers (T_6).

On the fourth day, the flowers treated with 6 per cent sucrose (T_2) recorded a highest transpirational loss of water of 6.12g/f followed by 5.62 g/f in the flowers treated with 3 per cent sucrose (T_1) and the least water uptake of 3.95g/f was recorded in control flowers (T_6).

No significant difference in the transpirational loss of water was observed with respect to interactions of stage of harvest and different concentrations of sucrose.

On the sixth day the flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2) recorded a transpirational loss of 5.80 g/f.

The flowers treated with 6 per cent sucrose (T_2) recorded highest transpirational loss. Sucrose might have increased the ability of flowers to absorb water by influencing water potential and osmotic potential leading to higher water uptake than control. These results are in accordance to earlier reports of Prasanth (2006) in gerbera flowers. Halevy and Mayank (1979) also reported similar results in cut flowers.

Water balance (g/f)

The data recorded on water balance of flowers from initial day to end of vase life was presented in table 4.

The water balance of the flower gradually decreased as the number of days of vase life preceded. There was a significant difference in the water balance of flower with respect to stage of harvest on second day and the flowers harvested at tight bud stage (S_1) recorded a water balance of 2.38 g/f over 1.82 g/f in flowers harvested at first petal unfurl stage (S_2).

Among the different treatments (T), 15 per cent sucrose treated flowers (T_5) recorded maximum water balance of 2.66 g/f followed by the 2.40 g/f in flowers treated with 6 per cent sucrose (T_2) on the second day and least water balance of 1.41 g/f was recorded by the control (Tap water) (T_6) and maximum water balance of 1.63 g/f was recorded in the flowers treated with 6 per cent sucrose (T_2) which is on par with 1.40 g/f in flowers treated with 3 per cent sucrose (T_1). The least water balance of 0.75 g/f was recorded in control (T_6) on the fourth day.

Among the interaction effects of stage of harvest and different concentrations of sucrose (SXT), the flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2) recorded a maximum water balance of 3.72 g/f which is on par with 2.83 g/f in flowers harvested at first petal unfurl stage and treated with 15 per cent sucrose (S_1T_5). The least water balance of 1.00 g/f was recorded in control flowers harvested at first petal unfurl stage (S_2T_6).

The flowers harvested at first petal unfurl stage terminated their vase life on fifth day and on the sixth day, the flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2) recorded a water balance of 1.55 g/f.

The 6 per cent sucrose treated flowers recorded maximum water balance. According to Halevy and Mayak (1979) sugars are responsible for maintenance of water balance in cut flowers by inducing stomata closure and thereby reducing the water loss.

Relative water content (%)

The data recorded on the relative water content of petals (RWC) from initial day to end of vase life was presented in table 5.

RWC gradually decreased as the number of days of vase life proceeded. Among the two stages of harvest (S) studied, the flowers harvested at tight bud stage (S_1) recorded maximum RWC of 68.54% over 64.49 % in the flowers harvested at first petal unfurl stage (S_2) and the flowers harvested at tight bud stage (S_1) recorded maximum RWC of 59.82% over 58.16 % in the flowers harvested at first petal unfurl stage (S_2) on the fourth day.

Among different concentrations of sucrose (T) studied, on the second day the flowers treated with 6 per cent sucrose (T_2) recorded maximum relative water content of 80.96% significantly followed by 69.28 % in flowers treated with 3 per cent sucrose (T_1) and least 58.39% was recorded in control (tap water) (T_6) and on fourth day the flowers treated with 6 per cent sucrose (T_2) recorded maximum relative water content of 73.40 % significantly followed by 63.31 % in flowers treated with 3 per cent sucrose (T_1). The least relative water content of 51.93% was recorded in control (T_6).

Among the interactions of stage of harvest and different concentrations of sucrose (SXT), on second day the flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2) recorded maximum relative water content of 81.60% which is on par with 80.32% in flowers harvested at first petal unfurl stage and treated with 6 per cent sucrose (S_2T_2) and the least relative water content of 58.31 % was recorded in control flowers harvested at first petal unfurl stage (S_2T_6).

On fourth day the flowers harvested at tight bud stage and treated with 6per cent sucrose (S_1T_2) recorded maximum relative water content of 73.81% which is on par with 73.00 % in flowers harvested at first petal unfurl stage and treated with 6 per cent sucrose (S_2T_2) and the least relative water content of 49.92 % was recorded in flowers harvested at first petal unfurl stage and treated with 15 per cent sucrose (S_2T_5).

All the flowers harvested at first petal unfurl stage lost their vase life and on sixth day the flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2) recorded a relative water content of 69.67%.

The flowers harvested at tight bud stage exhibited maximum relative water content of petals which might be due to the fact that flowers harvested at this stage might have an increased area of xylem vessels leading to greater water uptake and transpirational loss, maintaining good water balance thus having highest relative water content in its petals.

Increased in relative water content by sucrose application was likely caused by an increase in water uptake as and a reduction of transpiration and inhibition of microbial growth at the end of stem as concluded by Lu *et al.,* (2010).

Table.1 Effect of post harvest application of sucrose on fresh weight of the flower (g) during vase life period of rose cv. Tajmahal

Treatments	Days interval											
	Day 0		Mean	Day 2		Mean	Day 4		Mean	Day6		Mean
	Stages of harvest			Stages of harvest			Stages of harvest			Stages of harvest		
	S_1	S_2		S_1	S_2		S_1	S_2		S_1	S_2	
T_1	21.17	19.50	20.33	21.67	20.00	20.83	21.00	21.33	21.17	---	----	----
T_2	20.83	20.50	20.67	22.17	21.00	21.58	22.33	22.42	22.38	22.53		----
T_3	20.00	19.25	19.63	20.50	19.77	20.15	21.24	21.07	21.15	---	----	----
T_4	20.42	19.58	20.00	20.92	20.08	20.50	21.25	21.92	21.58	---	----	----
T_5	20.08	19.83	19.96	20.58	20.17	20.38	21.08	21.08	21.08	---	----	----
T_6	19.58	19.67	19.63	20.08	20.17	20.13	20.58	20.67	20.63	---	----	----
Mean	20.35	19.72		20.99	20.19		21.25	21.42		---	----	----
	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
S	0.12		0.36	0.10		0.30	0.12		N.S	----		----
T	0.21		0.62	0.18		0.52	0.21		0.61	----		----
SXT	0.29		N.S	0.25		0.74	0.29		N.S	----		----

Table.2 Effect of post harvest application of sucrose on water uptake of the flower (g/f) during vase life period of rose cv. Tajmahal

Treatments	Days interval								
	Day 2		Mean	Day 4		Mean	Day 6		Mean
	Stages of harvest			Stages of harvest			Stages of harvest		
	S_1	S_2		S_1	S_2		S_1	S_2	
T_1	8.19	8.04	8.11	6.94	6.67	6.81	----	----	----
T_2	11.66	8.00	9.83	8.39	7.33	7.86	5.88	----	----
T_3	8.15	7.77	7.96	6.03	6.20	6.12	----	----	----
T_4	7.78	7.83	7.80	5.40	5.93	5.67	----	----	----
T_5	7.57	7.53	7.55	5.63	5.57	5.56	----	----	----
T_6	7.77	7.20	7.49	5.65	5.00	5.33	----	----	----
Mean	8.52	7.73		6.34	6.12		----	----	----
	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
S	0.08		0.24	0.18		N.S	----		----
T	0.14		0.41	0.24		0.66	----		----
SXT	0.20		0.58	0.34		N.S	----		----

Table.3 Effect of post harvest application of sucrose on transpirational loss of water (g/f) during vase life period of rose cv. Tajmahal

Treatments	Days interval								
	Day 2		Mean	Day 4		Mean	Day 6		Mean
	Stages of harvest			Stages of harvest			Stages of harvest		
	S_1	S_2		S_1	S_2		S_1	S_2	
T_1	6.20	6.43	6.32	5.57	5.67	5.62	----	----	----
T_2	7.93	6.93	7.43	6.1	6.13	6.12	5.80	----	----
T_3	6.17	6.20	6.18	5.73	5.43	5.58	----	----	----
T_4	5.60	5.77	5.68	4.97	5.10	5.03	----	----	----
T_5	5.67	4.93	5.30	5.00	4.57	4.78	----	----	----
T_6	5.47	5.07	5.27	4.20	3.70	3.95	----	----	----
Mean	6.17	5.89		5.26	5.10		----	----	----
	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
S	0.12		N.S	0.10		N.S	----		----
T	0.21		0.63	0.17		0.48	----		----
SXT	0.30		N.S	0.23		N.S	----		----

Table.4 Effect of post harvest application of sucrose on water balance (g/f) during vase life period of rose cv. Tajmahal

Treatments	Days interval								
	Day 2		Mean	Day 4		Mean	Day6		Mean
	Stages of harvest			Stages of harvest			Stages of harvest		
	S_1	S_2		S_1	S_2		S_1	S_2	
T_1	1.98	1.60	1.79	1.80	1.00	1.40	----	----	----
T_2	3.72	1.07	2.40	2.06	1.20	1.63	1.55	----	----
T_3	2.18	2.06	2.19	1.18	0.77	0.98	----	----	----
T_4	2.10	2.33	2.22	1.07	0.47	0.77	----	----	----
T_5	2.48	2.83	2.66	1.17	1.37	1.27	----	----	----
T_6	1.81	1.00	1.41	0.83	0.67	0.75	----	----	----
Mean	2.38	1.82		1.35	0.91		----	----	----
	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
S	0.14		0.41	0.25		N.S	----		----
T	0.24		0.71	0.14		0.42	----		----
SXT	0.34		1.00	0.35		N.S	----		----

Table.5 Effect of post harvest application of sucrose on relative water content of petals (%) during vase life period of rose cv. Tajmahal

Treatments	Days interval								
	Day 2		Mean	Day 4		Mean	Day6		Mean
	Stages of harvest			Stages of harvest			Stages of harvest		
	S_1	S_2		S_1	S_2		S_1	S_2	
T_1	76.36	62.19	69.28	60.10	66.52	63.31	----	----	----
T_2	81.60	80.32	80.96	73.81	73.00	73.40	69.67	----	----
T_3	65.48	63.21	64.34	58.61	55.00	56.80	----	----	----
T_4	64.90	63.49	64.20	58.55	53.50	56.03	----	----	----
T_5	64.43	59.42	61.93	54.97	49.92	52.44	----	----	----
T_6	58.46	58.31	58.39	52.86	51.00	51.93	----	----	----
Mean	68.54	64.49		59.82	58.16		----	----	----
	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
S	0.22		0.65	0.20		0.59	----		----
T	0.38		1.12	0.35		1.03	----		----
SXT	1.59		1.57	0.70		1.46	----		----

Table.6 Effect of post harvest application of sucrose on diameter of the flower (mm) during vase life period of rose cv. Tajmahal

Treatments	Days interval											
	Day 0		Mean	Day 2		Mean	Day 4		Mean	Day6		Mean
	Stages of harvest			Stages of harvest			Stages of harvest			Stages of harvest		
	S_1	S_2		S_1	S_2		S_1	S_2		S_1	S_2	
T_1	35.17	38.17	36.67	37.11	46.16	41.63	50.73	49.17	49.95	----	----	----
T_2	35.20	38.17	36.68	41.54	52.50	47.02	59.03	60.00	59.56	55.40	----	----
T_3	35.10	38.13	36.62	40.25	41.57	40.91	49.06	56.71	52.89	----	----	----
T_4	35.20	38.13	36.67	33.01	45.72	39.36	41.50	58.37	49.94	----	----	----
T_5	35.03	38.17	36.60	35.30	40.07	37.68	46.87	51.22	49.04	----	----	----
T_6	35.07	38.13	36.60	37.68	35.53	37.10	39.58	48.86	44.22	----	----	----
Mean	35.13	38.15		37.48	43.76		47.79	54.06		----	----	----
	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
S	0.01		0.03	1.33		3.89	1.49		4.38	----		----
T	0.02		0.06	2.29		N.S	2.58		N.S	----		----
SXT	0.03		N.S	3.24		N.S	3.65		10.71	----		----

Table.7 Effect of post harvest application of sucrose on TSS of petals(Brix) during vase life period of rose cv. Tajmahal

Treatments	Days interval											
	Day 0		Mean	Day 2		Mean	Day 4		Mean	Day6		Mean
	Stages of harvest			Stages of harvest			Stages of harvest			Stages of harvest		
	S_1	S_2		S_1	S_2		S_1	S_2		S_1	S_2	
T_1	10.20	10.10	10.15	10.53	11.90	11.22	13.00	11.00	12.00	----	----	----
T_2	10.70	10.20	10.45	15.00	11.27	13.01	12.50	17.63	15.07	10.00	----	----
T_3	9.70	10.00	9.85	10.83	11.37	11.10	12.20	11.00	11.60	----	----	----
T_4	10.90	9.00	9.95	10.77	10.53	10.65	10.77	12.13	11.45	----	----	----
T_5	9.20	10.00	9.60	10.43	9.60	10.08	10.50	11.00	10.75	----	----	----
T_6	8.00	8.00	8.00	6.90	7.03	6.97	9.33	7.50	8.42	----	----	----
Mean	9.78	9.55		10.74	10.28		11.70	11.38		----	----	----
	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
S	0.001		N.S	0.08		0.23	0.10		0.28	----		----
T	0.001		N.S	0.14		0.41	0.17		0.48	----		----
SXT	0.001		N.S	0.20		0.57	0.23		0.68	----		----

T_1- Sucrose- 3% T_2- Sucrose -6% T_3- Sucrose -9% T_4- Sucrose -12% T_5- Sucrose- 15% T_6- Control (tap water)
S_1 - Tight bud stage S_2 - First petal unfurl stage

Diameter of flower (mm)

The data recorded on diameter of flower from initial day to end of vase life was presented in table 6.

The diameter of flower gradually increased up to the fourth day. Among the two stages of harvest (S) studied, the flowers harvested at first petal unfurl stage (S_2) recorded significantly higher diameter 38.15 mm of flower over 35.13 mm in tight bud stage (S_1) on initial day and on the fourth day, the flowers harvested at first petal unfurl stage (S_2) recorded a maximum flower diameter of 54.06 mm, over 47.79 mm in flowers harvested at tight bud stage (S_1) on fourth day respectively.

Among different concentrations of sucrose (T) studied a significant difference in diameter of flower was observed on initial day and the flowers treated with 6 per cent sucrose (T_2) recorded maximum flower diameter of 36.68 mm which is on par with 36.67 mm in 3 per cent sucrose (T_1) treated flowers. The least flower diameter 36.60 mm was recorded in flowers treated with 15 per cent sucrose (T_5) treated flowers and in control (tap water) (T_6).

Among the interactions of stage of harvest and different concentrations of sucrose (SXT) a significant difference in flower diameter was observed on fourth day and the flowers harvested at first petal unfurl stage and treated with 6 per cent sucrose (S_2T_2) recorded maximum flower diameter of 60.00 mm which is on par with 59.03mm in flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2). The least flower diameter of 39.58mm was recorded in control flowers harvested right bud stage (S_1T_6).

All the flowers harvested at first petal unfurl stage lost their vase life on fifth day and on sixth day the flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2) recorded a flower diameter of 55.40mm.

The flowers harvested at first petal unfurl stage recorded maximum flower diameter this may be due to the reason that these flowers are harvested after the opening process has already begin. After harvest when put in sucrose solution, they might have utilized the sucrose and continued the process of opening when compared to flowers harvested at tight bud stage. Thus they might have recorded maximum flower diameter. Further 6 per cent sucrose treatment contributed to maximum flower diameter due to increase in pool of dry matter and respirable substrates and lowering the osmotic potential of petals (Halevy and Mayak, 1979). These results are in accordance to Sunanda rani (2007).

TSS of petals (^{o}Brix)

The data recorded on TSS of petals from the initial day to end of vase life was presented in table 7.

The TSS of petals also gradually increased with respect to stage of harvest. Among the two stages of harvest (S) studied, on the initial day, no significant difference in the TSS of petals was observed and on the fourth day, the flowers harvested at tight bud stage (S_1) recorded a highest TSS of 11.70 ^{o}brix over 11.38 ^{o}brix in flowers harvested at first petal unfurl stage (S2).

Among different concentrations of sucrose studied (T), on the initial day no significant difference was seen in the TSS of petals but on fourth day, the flowers treated with 6per cent sucrose (T_2) recorded maximum TSS of 15.07 ^{o}brix significantly followed by 12.00 ^{o}brix in flowers treated with 3 per cent sucrose (T_1). The least TSS of 8.42 ^{o}brix was recorded in control (Tap water) (T_6) on fourth day.

A significant difference in TSS of petals was observed with regard to the interactions of stage of harvest and different concentrations of sucrose (SXT). On the second day, the flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2) recorded a maximum TSS of 15.00 ^{o}brix significantly followed by 11.90 ^{o}brix in flowers harvested at first petal unfurl stage and treated with 3 per cent sucrose (S_2T_1).

The least TSS of petals (6.90 ^{o}brix) was recorded by control flowers harvested at tight bud stage (S_1T_6). On fourth day highest TSS of petals (17.63 ^{o}brix) was recorded in flowers harvested at first petal unfurl stage and treated with 6 per cent sucrose (S_2T_2) followed by 12.50 ^{o}brix in flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2). The least TSS of petals (7.50 ^{o}brix) was recorded by control flowers harvested at first petal unfurl stage (S_2T_6).

All the flowers harvested at first petal unfurl stage lost their vase life on the fifth day and on the sixth day the flowers harvested at tight bud stage and treated with 6 per cent sucrose (S_1T_2) recorded a TSS of 10.00 ^{o}brix.

The increase in TSS in the flowers harvested at tight bud stage could be attributed to the breakdown of starch into sugars. The tight bud stage might be optimum stage with abundant food resources leading to deposition of soluble solids in petals. Exogenously applied sucrose might have translocated to flower petals and increased the dry pool matter. (Kaltaler and Steponkus, 1974)..

Thus from the experiment it can be concluded that the flowers harvested at tight bud stage are optimum stage for harvest. Among different concentrations of sucrose the flowers treated with six per cent sucrose recorded better performance when compared to all other concentrations.

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