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INFLUENCE OF VARIOUS HOLDING SOLUTIONS ON VASE LIFE OF *CHRYSANTHEMUM* CV. PUJA

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ABSTRACT

The present experiment entitled "Influence of various holding solutions on vase life of *Chrysanthemum* (*Dendranthema grandiflora*) cv. Puja" was carried out under Complete Randomized Design with three replications in the Horticulture Laboratory of School of Agricultural Sciences and Technology RIMT University, Mandi Gobindgarh, Punjab during 2020. The result showed that the vase life was significantly affected by different holding solutions. Among the various treatments, T_{10} (Sucrose 6% + Citric acid 300ppm) was resulted in minimum number of days taken (3.22 days) for bud opening, fresh weight of spike (11.04 g), flower height (6.89 cm), stem diameter (4.85 mm), minimum moisture loss (44.44%), maximum vase life (19.33 days) and dry weight of spike (2.46 g). Whereas, treatment T_9 (Sucrose 4% + Citric acid 200 ppm) was resulted in maximum total solution consumption (24.00 ml). Maximum diameter of the flower on 6th, 9th and 15th days of experiment was recorded in treatment T_{10} (Sucrose 6% + Citric acid 300 ppm). Treatment T_9 (Sucrose 4% + Citric acid 200 ppm) was also resulted in maximum diameter of the flower on 3rd and 12th day of trial. Treatment T_{10} (Sucrose 6% + Citric acid 300 ppm) was resulted in maximum weight of spikes on 3rd, 6th and 9th day of experiment. And also maximum weight of spikes on 12th and 15th days of trial was observed in treatment T_9 (Sucrose 4% + Citric acid 200 ppm).

Keywords: *Chrysanthemum*, Holding solutions, Vase life, Citric acid, Sucrose and Puja

INTRODUCTION

Chrysanthemum (*Dendrathema grandiflora* L. 2n = 2x = 18) commonly known as Gul-e-Daudi or mum flower, is a short day flowering plant belonging to the largest family of Asteraceae. It is known as queen of flowers (Sajid *et al*., 2018). *Chrysanthemum* flowers are herbaceous perennial plants or subshrubs. They have alternately arranged leaves divided into leaflets with toothed or occasionally smooth edges. The compound inflorescence is an array of several flower heads, or sometimes a solitary head. The head has a base covered in layers of phyllaries. The simple row of ray florets is white, yellow and red. Cut flowers are parts of plants, characteristically including the blooms or "inflorescences" and some attached plant materials, but not including roots and soil. Fresh cut flowers are used for decorative purposes such as vase arrangements and bouquets at formal event (Allah *et al.,* 2019). *Chrysanthemum* is one of the most common cut flowers and of the highest economic importance in the floriculture industry for decoration and adornment and are also traded both as potted plants and cut flowers in world markets (Ola, 2017).

In general, cut flowers are highly perishable and *Chrysanthemum*s are no exception to it. The high perishability of flowers renders them vulnerable to considerable postharvest losses (Bhattacharjee, 1999). The vase life of cut flowers is influenced by variety of factors like climate, variety, harvesting time, postharvest handling, cell programmed death, ethylene induced senescence, dehydration or loss of assimilates and substrates etc. Among the above mentioned, water relation and balance play a major role in postharvest quality and longevity of cut flowers and water stress during this period is often the reason of short vase life for cut flowers (Mahdi *et al*., 2012).

A wide range of floral preservatives in the form of germicides, ethylene antagonistics and source of energy (sucrose) are in use to preserve flower quality and extending Postharvest longevity of cut flowers. Postharvest management and value addition can increase prices of cut flowers up to 9-10 times. The longevity of cut *Chrysanthemum* and the improvement in the vase life of flowers are positively affected by various vase solutions i.e. Citric Acid, Sucrose etc. Among acidifiers, citric acid is the most common compound and is used to lower the p^H of the preservative solutions and control microbial proliferation. Citric acid has been found effective for cut roses, gladiolus, carnations *Dianthus,* tuberoses, and lisianthus (Ahmad and Dole, 2014).Sucrose has been found to be the most commonly used sugar in prolonging vase-life of cut flowers. The exogenous application of sucrose supplies the cut flowers with much needed substrates for respiration, and enables cut flowers harvested at the bud stage to open, which otherwise could not occur naturally, and it acts as osmotically active molecule, thereby leading to the promotion of subsequent water relations (Khalid, 2012).

MATERIALS AND METHODS

The present investigation was carried out in the horticulture laboratory of School of Agricultural Sciences and Technology RIMT University, Mandi Gobindgarh, Punjab during 2020. The climate of Mandi Gobindgarh is typically semi-arid and sub-tropical with hot and dry summer (April to June), hot and humid monsoon period (July to September), mild winter (October to November) and cold winter (December to February). For the present studies experiment were conducted on bud stages of *Chrysanthemum* cv. Puja having 35-40 cm cut stem length. The experiment consists of 10 treatments viz. Control (T_1), Citric acid 100ppm (T_2), Citric acid 200ppm (T_3), Citric acid 300ppm (T_4), Sucrose 2% (T_5), Sucrose 4% (T_6), Sucrose 6% (T_7), Citric acid 100ppm + Sucrose 2% (T_8), Citric acid 200ppm + Sucrose 4% (T_9) and Citric acid 300ppm + Sucrose 6% (T_{10}) in a Completely Randomized Design (CRD) with three replications. Three flowers were kept in each replication according to the treatments. The data on various holding solutions were recorded and statistically analysed. The qualitative characters were analyzed by the analysis of variance (ANOVA) technique. The data to be recorded will be analyzing using MS-excel as per the design of experiment for working out the values. Analysis of variance was done partitioning the total variance in total variation due to the treatments and replications according to the procedure (Panse and Sukhatame, 1964). The critical difference values were calculated at 1% level of significance.

RESULT AND DISCUSSION

A lab experiment was conducted to determine the influence of various holding solutions on vase life of *Chrysanthemum* cv. Puja. Data on different parameters were collected and analysed. The results obtained with respect to vase life of cut flowers have been discussed with a view to find out the effect of different holding solutions.

The minimum number of days taken (3.22 days) for bud opening was resulted by treatment T_{10} (Sucrose 6%+ Citric acid 300 ppm). Whereas, T_1 (control) resulted in higher number of days taken for bud opening (6.48 days). Continuous use of citric acid increased flower opening of lisianthus, which confirmed the role of citric acid in maintaining postharvest quality and increasing colour development during flower opening (Jowkar and Salehi, 2006). This effect of essential oils compound due to antirespiratory properties as antimicrobial compound that prevent catabolism of carbohydrates and improves flower opening index in cut *Chrysanthemum* flowers. Our results are agreement to Hashemabadi, (2011). The results of current experiment about being more effective of high sucrose concentrations are agreed with Doi and Reid (1995) on gladiolus and liatris. It seems that carbon is a key factor to anthesis (Yamane *et al.,* 1991). It is possible that sucrose applied as an osmolite in anthesis of cut flowers (Liao *et al.,* 2000). The maximum fresh weight of spike (11.04 g) was observed in treatment T_{10} (Sucrose 6% + Citric acid 300 ppm). While, minimum fresh weight of spike (6.08 g) was recorded in T_1 (control). It has also been reported that addition of antimicrobial compounds to the vase solutions containing carbohydrates increase fresh weight of cut stems (Marousky, 1980). After cutting, the fresh weight of cut flowers decreases due to the loss of water uptake and increasing water loss through transpiration (Liao *et al*., 2012 and Mansouri, 2012). Mashhadian *et al.,* (2012) reported that the application of citric acid increased relative fresh weight of *Chrysanthemum* cut flowers in comparison to control. Farokhzad *et al.,* (2005) in lisianthus also reported that the addition of Si and Et to vase solution increased water uptake and fresh weight of cut flowers. The highest height of the flower (6.89 cm) was observed in treatment T_{10} (Sucrose 6% + Citric acid 300 ppm). While, lowest height of the flower (4.94 cm) was recorded in T_2 (Citric acid 100 ppm). The PGR concentration was increased, the flower height was also increased but up to certain level i.e. 50 mg L^{-1}, beyond which the increase was insignificant. Increase in flower height has already been reported in gladiolus when corms were treated with BAP before planting Khan *et al.,* (2011), possibly due to its role in increasing cell division and favour shoot formation. Application of GA_3 has increased flower height in gladiolus (Rana *et al*., 2005, Naveen *et al*., 2008 and Chopde *et al*., 2012), tulip (Saniewski *et al*., 1999), iris (Khassawneh *et al*., 2006) and tuberose (Asil *et al*., 2011), possibly due to its growth promoting effect in stimulating and accelerating cell division or cell enlargement or both. The largest diameter of stem (4.85 mm) was noted in treatment T_{10} (Sucrose 6% + Citric acid 300 ppm). While, lowest diameter of stem (4.01 mm) was recorded in T_2 (Citric acid 100 ppm). Higher calcium concentration in the nutrient solution will be associated with greater stem diameter and dry weight (Picchioni *et al*., 2001). High calcium concentration (7.5 mM) in the nutrient solution has been reported to increase the diameter of the flowering stem in roses (Shams *et al*., 2012). It can in fact be concluded that the application of calcium amino acid (particularly lysine) chelates can promote the absorption of calcium by the flowering stem and hence increase flower and shoot diameter in comparison with control plants. Nikbakht *et al.,* (2008) also tried to improve calcium uptake of hydroponically grown gerbera plants using humic acid (a naturally occurring chelating agent). According to their findings, any method that elevated calcium content in flower scapes could improve postharvest life of the flowers (Nikbakht *et al*., 2008). The maximum total solution consumption (24.00 ml) was recorded with the treatment T_9 (Sucrose 4% + Citric acid 200 ppm). While, the minimum total solution consumption (15.33 ml) was recorded with the treatment T_2 (Citric acid 100 ppm) and T_8 (Sucrose 2% + Citric acid 100 ppm). (Kumar, 2016) who mentioned that treating *Chrysanthemum* cut flowers with different solutions content of sucrose, citric acid and 8-HQC increasing the flowers water uptake, also Zamani *et al.,* (2011) showed that sucrose at 3 % , citric acid, malic acid and salicylic acid increasing water uptake in *Chrysanthemum* cut flowers. Acidifier compounds like AA and CA reduce p^H and prevent the proliferation and accumulation of bacteria in the vase solution and improve the normal flow of water (Alaey *et al*., 2011 and Mansouri, 2012). The minimum moisture loss in cut flowers (44.44%) was recorded in treatment T_{10} (Sucrose 6% + Citric acid 300 ppm). Whereas, the highest moisture loss in cut flower (77.56%) was observed in treatment T_2 (Citric acid 100 ppm). According to (Bhattacharjee, 1998) use of sucrose in the vase solution influenced water uptake, transpiration loss of water, maintained better water relations thereby improved Moisture loss of the cut flower. Similar finding was reported by Luo *et al.,* (2003) in cut carnation flowers. Moisture loss is one of the most important physiological disorders of ornamental flowers after harvest, which reduced the vase life and quality. To enhance the vase life of CFs, maintain their moisture loss is significant for commercial values (Saeed *et al*., 2016). The preservative solution contained $CaCl_2$ with 3% sucrose decreased moisture loss. This may be due to the effect of sucrose in delaying petal aging and flower wilting (Halevy and Mayak, 1979). The maximum vase life (19.33 days) was recorded with the treatment T_{10} (Sucrose 6% + Citric acid 300ppm). While, the minimum vase life (12.667 days) was recorded with the treatment T_1 (Control). The prolonging effects of the two BA concentrations on *N. exaltata* cut foliage vase life may be due to that cytokinins are known to retard senescence of detached leaves by delaying proteolysis (Subhashini *et al*., 2011). Continuous use of C-IS or C-QA was more effective than commercial preservatives for cut stems of lisianthus and snapdragon or had similar effect to that of commercial preservatives for cut stems of stock and zinnia. Addition of isothiazolinone or quaternary ammonium chloride effectively controlled bacterial populations in the vase solutions (visual observation), had high water uptake, and had low p^H of the vase solution, which might have extended the vase life of cut stems (Gast, 2000). Kafie *et al.,* (2014) investigate that the *Chrysanthemum* cut flowers were held in the vase solution containing Silver nitrate (75 ppm) + Citric acid (150 ppm) + Sucrose at (3%) was increased significant vase life (19.5 and 17.2 days, respectively). Preservative solutions containing (400 ppm) 8-HQC and (1.5%) Sucrose gave that maximum vase life of *Chrysanthemum* (*Dendranthema grandiflora*, Ramat) cv. White Reagan cut flowers (Jain *et al*., 2014). The treatment T_{10} (Sucrose 6% + Citric acid 300 ppm) was recorded the maximum dry weight of spike (2.47 g). While, the minimum dry weight of spike was recorded in treatment T_1 (control). Continuous availability of sugars with low p^H in solutions containing soda might have maintained continued metabolic activities and water uptake resulting in maintaining higher dry matter in the cut stems until termination (Ahmad and Dole, 2014). Similar results have been reported that the positive effect of herbal essential oils on increasing dry matter of gladiolus cut flowers (Hegazi and Gan, 2009). Increasing of dry matter percent can be due to reduced metabolism with reduction in transpiration. In addition, antimicrobial compounds control microorganisms and indirectly increased fresh and dry weight which will be effective on dry matter percent (Blankenship and Dole, 2003 and Hashemabadi, 2009).

On the 3rd day of experiment, the maximum diameter of the flower (6.07 cm) was observed in treatment T_9 (Sucrose 4% + Citric acid 200 ppm). Whereas, T_2 (Citric acid 100 ppm) resulted in minimum weight of spike (5.23 cm). On the 6th day of trial, the maximum diameter of the flower (5.80 cm) was observed in treatment T_{10} (Sucrose 6% + Citric acid 300 ppm). Whereas, T_1 (control) resulted in minimum diameter of the flower (5.33 cm). On the 9th day of investigation, treatment T_{10} (Sucrose 6% + Citric acid 300 ppm) resulted in the maximum diameter of the flower (5.23 cm). Whereas, T_1 (control) resulted in minimum diameter of the flower (4.67 cm). On the 12th day of demonstration, the maximum diameter of the flower (4.77 cm) was observed in treatment T_9 (Sucrose 4% + Citric acid 200 ppm). While, T_2 (Citric acid 100 ppm) resulted in minimum diameter of the flower (4.27 cm). On the 15th day of inquiry, treatment T_{10} (Sucrose 6% + Citric acid 300 ppm) resulted in the highest diameter of the flower (4.10 cm). Whereas, T_1 (control) resulted in minimum diameter of the flower (3.40 cm). Development of flower bud requires carbohydrate and sucrose otherwise could not open naturally (Pun and Ichimura, 2003) as it provides essential substrate for respiration, structural material and carbon skeletons for bud opening (Mayak *et al*., 1973). Similarly conversion of polysaccharide to monosaccharide is also responsible for flower opening or closure (Doorn and Meeteren, 2003). Flower diameter was significantly higher in treatments having inorganic salts particularly $CaCl_2$. The change of flower weight was consistent with the change of flower diameter, as previously reported by Soad *et al.,* (2011).

On the 3rd day of experiment, the maximum weight of spike (11.64 g) was resulted by T_{10} (Sucrose 6% + Citric acid 300 ppm). Whereas, T_8 (9.21 g) resulted minimum weight of spike. On the 6th day of trial, T_{10} (Sucrose 6% + Citric acid 300 ppm) resulted maximum weight of spike (12.32 g). Minimum weight of spike (6.11 g) was weighted under T_1 (control). On the 9th day of investigation, T_{10} (Sucrose 6% + Citric acid 300 ppm) resulted maximum weight of spike (9.15 g). While, minimum weight of spike (5.13 g) was weighted under T_2 (Citric acid 100 ppm). On the 12th day of inquiry, treatment T_9 (Sucrose 4% + Citric acid 200 ppm) was recorded maximum weight of spike (7.39 g). Whereas, minimum weight of spike (3.73 g) was weighted under T_1. On the 15th day of trial, the maximum weight of spike (5.93 g) was observed in treatment T_9 (Sucrose 4% + Citric acid 200 ppm). Considering that, minimum weight of spike (3.73 g) was weighted under T_1 (control). Marandi *et al.,* (2011) reported that *Carom copticum* oil and *Satureja hortensis* oil improved vase life, solution uptake and fresh weight of cut rose flowers. Generally resulting in higher weight of spikes is considered good

Table 1: Influence of various holding solutions on days to bud opening, fresh weight of spike (g), flower height (cm), stem diameter (mm), total solution consumption (ml), total moisture loss (%), vase life of flowers (days) and dry weight of spike (g) in *Chrysanthemum (Dendranthema grandiflora)* cv. Puja.

Treatments	Days to bud opening	Fresh weight of spike (g)	Flower height (cm)	Stem diameter (mm)	Total solution consumption (ml)	Total moisture loss in cut flowers (%)	Vase life of flowers (Days)	Dry weight of spike (g)
T1	6.48	6.08	4.94	4.34	15.66	60.18	12.66	1.43
T2	5.44	8.40	5.77	4.01	15.33	77.56	14.66	1.62
T3	4.59	7.40	5.75	4.35	15.66	55.43	16.00	1.77
T4	4.84	10.12	5.98	4.20	17.33	63.30	16.66	1.96
T5	4.46	8.17	5.83	4.11	16.66	62.00	16.00	1.96
T6	4.45	9.96	6.25	4.32	19.66	66.00	18.00	1.92
T7	4.10	8.85	6.23	4.38	15.66	47.94	17.66	1.90
T8	4.02	6.45	6.06	4.54	15.33	59.51	16.00	2.14
T9	3.71	7.48	6.44	4.74	24.00	60.52	16.66	2.25
T10	3.23	11.04	6.89	4.85	21.33	44.44	19.33	2.47
CD at 1%	1.11	1.78	2.12	0.93	3.83	2.66	2.23	0.39

Table 2: Influence of various holding solutions on fresh weight of spike in *Chrysanthemum (Dendranthema grandiflora)* cv. Puja.

Treatments	Fresh weight of spike (g) at				
	3rd day	6th day	9th day	12th day	15th day
T_1	6.93	6.11	5.91	3.73	1.87
T_2	7.01	6.5	5.13	5.81	2.73
T_3	7.94	7.41	6.87	5.71	3.54
T_4	11.05	10.57	8.74	5.01	3.04
T_5	9.23	8.74	6.54	5.43	3.4
T_6	10.87	9.9	9.1	7.2	3.43
T_7	9.01	9.18	8.36	7.21	4.6
T_8	9.21	8.78	6.38	4.64	2.75
T_9	7.94	8.12	7.21	7.39	5.93
T_{10}	11.64	12.32	9.15	7.08	4.2
CD at 1%	1.83	2.98	2.63	2.46	1.91

Table 3: Influence of various holding solutions on flower diameter (cm) in *Chrysanthemum (Dendranthema grandiflora)* cv. Puja.

Treatments	Flower diameter (cm) at				
	3rd day	6th day	9th day	12th day	15th day
T_1	5.53	5.33	4.67	4.43	3.40
T_2	5.23	5.67	5.07	4.27	4.03
T_3	5.93	5.50	5.07	4.63	3.93
T_4	5.80	5.57	5.10	4.67	3.80
T_5	5.93	5.40	4.97	4.30	3.73
T_6	5.57	5.73	4.83	4.37	4.03
T_7	5.80	5.50	5.03	4.63	3.73
T_8	5.83	5.67	5.17	4.60	3.77
T_9	6.07	5.37	4.97	4.77	3.67
T_{10}	5.90	5.80	5.23	4.73	4.10
CD at 1%	0.82	0.63	0.79	0.85	0.71

because they may result in extending vase life compared to those showing fewer ones (Soad *et al*., 2011). Application of inorganic salt in vase solution increased the weight of spikes of CFs of Gerbera than control (Shabanian *et al*., 2018).

CONCLUSION

The result showed that the vase life was significantly affected by different holding solutions. Among the various treatments, minimum number of days taken (3.22 days) for bud opening, fresh weight of spike (11.04 g), flower height (6.89 cm), stem diameter (4.85 mm), minimum moisture loss (44.44%), maximum vase life (19.33 days) and dry weight of spike (2.46 g) was recorded with the treatment T_{10} (Sucrose 6%+ Citric acid 300ppm). Whereas, treatment T_9 (Sucrose 4%+ Citric acid 200 ppm) was resulted in maximum total solution consumption (24.00 ml).

Considering that higher number of days taken for bud opening (6.48 days), minimum fresh weight of spike (6.08 g), minimum vase life (12.667 days) and minimum dry weight of spike (1.43 g) was observed in treatment T_1 (control). Treatment T_2 (Citric acid 100 ppm) also resulted in lowest height of the flower (4.94 cm), lowest diameter of stem (4.01 mm) and the highest moisture loss (77.56 %).While, minimum total solution consumption (15.33 ml) was recorded with the treatment T_2 and T_8 (Sucrose 2% + Citric acid 100 ppm).

Maximum diameter of the flower on 6th, 9th and 15th days of experiment was recorded in treatment T_{10} (Sucrose 6% + Citric acid 300 ppm). Treatment T_9 (Sucrose 4% + Citric acid 200 ppm) was also resulted in maximum diameter of the flower on 3rd and 12th day of trial. Whereas, minimum diameter of the flower on 6th, 9th and 15th days of experiment was observed in treatment T_1 (control). And treatment T_2 (Citric acid 100 ppm) was also resulted in minimum diameter of flower on 3rd and 12th day of investigation.

Treatment T_{10} (Sucrose 6% + Citric acid 300 ppm) was resulted in maximum weight of spikes on 3rd, 6th and 9th day of experiment. And also maximum weight of spikes on 12th and 15th days of trial was observed in treatment T_9 (Sucrose 4% + Citric acid 200 ppm). While, minimum weight of spikes on 3rd, 6th, 12th and 15th days of trial was found in treatment T_1 (control). Considering that minimum weight of spike on 9th day of experiment was also observed in treatment T_2 (Citric acid 100 ppm).

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