Original Research Article

Effect of Different Pulsing Solutions on Postharvest Life of Tuberose (*Polianthes tuberosa* L.) cv. Prajwal

Comment [i1]: Pulsing Solutions effects on Postharvest Life of Tuberose (*Polianthestuberosa* L.) cv. Prajwal

Abstract

Tuberose flower (*Polianthes tuberosa* L.) is a perennial and bulbous flowering plant, related to the Amaryllidaceae family and now it is placed in family Agavaceae. The investigation entitled "Effect of different pulsing solutions on postharvest life of tuberose (*Polianthes tuberosa* l.) cv. Prajwal" was carried out at the experimental farm and laboratory of Department of Floriculture and Landscape Architecture, College of Horticulture, SVPUAT, Meerut during the year of 2021& 2022. Experiment was laid out in Completely Randomized Design with 10 treatments and 3 replications. It was observed that the overall best treatment for different parameters for improving the vase life of tuberose were recorded under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) followed by the treatment T_6 (Sucrose 10% + 8-HQC 300 ppm) and T_8 (Sucrose 15% + 8-HQC 200 ppm) resulted in most of the postharvest parameters such as amount of pulsing solution consumed (13.16, 15.82 ml), days taken to opening of floret (2.53, 2.54 days), floret diameter (3.38, 3.40 cm), vase life (10.78, 10.80 days), weight change/loss in cut spike (13.29 %, 14.52 %), fungal infection, fragrance score (2.95, 2.96), freshness index (4.97, 4.98) and moisture content (89.89, 85.60, 83.21%).

Keywords: Tuberose, Pulsing, Sucrose, 8-HQC, Pulsing solution, distilled water and Vase life.

1. Introduction

Tuberose flower (*Polianthes tuberosa* L.) is most important bulbous flower plant related to a member of the Amaryllidaceae family and now it is placed in the family Agavaceae. It originated from Mexico and was grown before its conquest in 1522. It is

one of the most popular and fragrant cut flowers grown in India as well as worldwide (Singh and Shankar 2011). For single-stemmed tuberose, the basic chromosome number is 2n=60, whereas the chromosome number of double-flowered species have ranged from 2n=50 to 2n=54, 60 and 120 (Lin and Shen 2004), (Karihaloo, 2019).

Single-flowered cultivars that have one row of corolla sections are mostly used to extract essential oils and loose flowers etc., while double-type of cultivars of tuberose that have more than two rows of corolla sections are used for cut flowers and displays of garden. The 'single type' of tuberosesare more fragrant than the 'double type' and concentration ranges from 0.08-0.14 per cent (Singh and Uma 1995).

Sucrose plays almost important role in the quality of cut flowers because it is act as a source of food or respiratory substrate and delayed the protein degradation and improvesthe balance of water in cut flowers(Asrar, 2012).The addition of sucrose to the solution increased the mechanical rigidity of the stem inducing thickening of the cell wall and lignifications of vascular tissues (Steinitz, 1982).The addition of sucrose replaces the depletion of carbohydrates from cut stems and maintains the respiratory pool therebyprolonging vase life (Marousky, 1971). 8-hydroxyquinoline citrate (8-HQC) plays an important role in decreasing the physiological blockage in the sterile tissue (Rogers, 1973) and (Elhindi, 2012). It acts as an antimicrobial agent for its activity thus it helps in maintaining the flower head diameter of flowers (Nowak and Rudnicki 1979). 8-hydroxyquinoline citrate (8-HQC) has been better known to possess property like anti-microbial that inhibit bacterial and physiological vascular blockage and enhance uptake of water in cut flowers (Larsen and Cromarty 1967).

Pulsing is a process in which freshly harvested flowers are kept in a solution for few second to hours to extend their vase life (Sao and Verma 2020). It has been reported that pulsing treatments prevent infections of vascular and ethylene production inhibit and results in prolong period of storage and flowers with high quality and increased vase life (Vidhya and Bhattacharjee 2002). The main challenge of tuberose is that being a cut flower, it is a short-lived and is prone to rapid deterioration. The other important challenges and symptoms that shorten the vase life are abscission of buds, lack of bud opening and leaf yellowing due to the sensitivity of cut tuberose as referred

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by Reid and Jiang (2012). In India, pulsing helps enhance the vase life of cut Tuberose, there is a wide scope for experimentation, standardization and improvement of different techniques in tuberose. Therefore the present study was carried out with the objective to evaluate the effect of different Pulsing solutions on the Postharvest Life of Tuberose (*Polianthes tuberosa* L.) cv. Prajwal.

2. Materials and Methods

The present investigation was carried out in the Laboratory of the Department of Floriculture and Landscape Architecture, College of Horticulture, SVPUAT, Meerut during the year of 2021&2022. The experimental location, Meerut comes under the semi-arid region and Agro-climatic plain zone of Uttar Pradesh state and lies at North West Plain Zone, India, 28.99° N Latitude and 77.7° E Longitude with an altitude of 220 m above the mean sea level. The general climate in Meerut region of Western Uttar Pradesh is dry sub-humid type with annual rainfall varying from 900-1000 mm approximately every year.

Comment [i7]: State the commencement date in 2021 and when it ended in 2022

2.1 Plant material

Tuberose (*Polianthes tuberosa* L.) cultivar 'Prajwal' uniform, healthy and disease free bulbs were obtained from the previous year tuberose crop grown in the field of Horticulture Research Centre (HRC), Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. Planting was done in beds at a spacing of 30x30 cm. The cut spikes of uniform size were harvested in the morning hours (7-8 am) with the help of sharp secateurs.

2.2 Treatments and observations

The experiments were repeated twice for confirmation of the results, with ambient temperature of 15-18°C, 60±5 Relative humidity and average radiation around 5000 Lux for a period of 8±2 h/day. After harvesting, cut spikes were taken to the laboratory for conducting the experiment. When the first 1-2 florets start opening, these spikes were immediately placed in a bucket containing distilled water. After transporting to our laboratory, a slanting cut was given at the base of each cut spikes in such a

manner that the final length of cut spike remained 50-55 cm. Before placed cut spikes in different pulsing solutions, firstly their fresh weights were recorded. Thereafter, these cut spikes were placed in 500 ml of glass bottles containing 250 ml of pulsing solution at different levels for 12 hours at room temperature. The neck of each bottle was covered with the help of aluminum foil to check evaporation of the solution or distilled water. The experiment were subjected to 10 treatments of pulsing and holding solutions with 3 replications, arranged in a completely randomized design.

Treatment details of holding solutions used in the experiment consists of : T_0: Control (Distilled water), T_1: Sucrose 5% + 8-HQC (100 ppm), T_2: Sucrose 5% + 8-HQC (200 ppm), T_3: Sucrose 5% + 8-HQC (300 ppm), T_4: Sucrose 10% + 8-HQC (100 ppm), T_5: Sucrose 10% + 8-HQC (200 ppm), T_6: Sucrose 10% + 8-HQC (300 ppm), T_7: Sucrose 15% + 8-HQC (100 ppm), T_8: Sucrose 15% + 8-HQC (200 ppm), T_9: Sucrose 15% + 8-HQC (300 ppm). The observations were recorded on different post-harvest parameters such as, amount of pulsing solution consumed, days taken to opening of floret, floret diameter, vase life, weight change/loss in cut spike, fungal infection, fragrance score, freshness index and moisture content.

2.3 Statistical analysis

The recorded data were statistically analysis (ANOVA) using the software Graph pad prism, USA. Source of variation were pulsing agents *viz*.,Sucrose and 8-HQC. Mean data were also compared by using Duncan's new multiple range test whereas the effect were significant at 5% level of significance.

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3. Results and discussion

3.1 Amount of pulsing solution consumed: (ml)

It is evident from Table 1 that the maximum pulsing solution consumed (13.16 ml) during the first season 2021-22 were recorded under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) at par (12.90 ml and 12.89 ml, respectively) under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) and T_6 (Sucrose 10% + 8-HQC 300 ppm) while, minimum pulsing solution consumed (5.11 ml) was recorded under T_0 (Control). During

the second season of 2022-23, maximum pulsing solution consumed (15.82 ml) was recorded under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) followed by (14.75 ml and 13.25 ml, respectively) under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) and T_6 (Sucrose 10% + 8-HQC 300 ppm) While, minimum pulsing solution consumed (6.24 ml) was recorded under T_0 (Control).In the present experiment, pulsing solution consumed was maximum under these treatments, it might be due to the fact that 8-HQC is known to enhance uptake of solution (Larsen and Cromarty, 1967) in cut flower. These treatments improved longevity of flower by decreasing microbial growth in bundles of vascular and increased tendency of cut flowers to absorb more solution. Similar findings were reported by (Marousky, 1969in roses, Nowak and Rudnicki, 1990in cut flowers, Murry, 2014 in tuberose and Thakur *et al.,* 2019in iris).

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Table 1:Effect of different pulsing solutions on pulsing solution consumed (ml) by *Polianthes tuberosa* L. cv. Prajwal

Treatment	Pulsing Solution	Pulsing Solution Consumed (ml)	
		2021-22	2022-23
T_0	Control (Distilled Water)	5.11	6.24
T_1	Sucrose 5% + 8-HQC (100ppm)	8.28	10.32
T_2	Sucrose 5% + 8-HQC (200ppm)	9.31	10.78
T_3	Sucrose 5% + 8-HQC (300ppm)	8.92	9.77
T_4	Sucrose 10% + 8-HQC (100ppm)	10.45	11.56
T_5	Sucrose 10% + 8-HQC (200ppm)	10.14	11.40
T_6	Sucrose 10% + 8-HQC (300ppm)	12.89	13.25
T_7	Sucrose 15% + 8-HQC (100ppm)	11.51	12.42
T_8	Sucrose 15% + 8-HQC (200ppm)	12.90	14.75
T_9	Sucrose 15% + 8-HQC (300ppm)	13.16	15.82
	SEm ±	0.34	0.39
	C.D.(*p*=0.05)	1.03	1.19

3.2 Days taken to opening of floret: (days)

It is clear from Table 2that solution of pulsing improved days taken to opening of floret of cut spikes of tuberose. The minimum days taken to opening of floret (2.53 days) during the first season 2021-22 were recorded under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) at par (2.65 days and 2.74 days, respectively) under the treatment

T_9(Sucrose 15% + 8-HQC 300 ppm) and T_6 (Sucrose 10% + 8-HQC 300 ppm) while, maximum days taken to opening of floret (4.13 days) was recorded under T_0 (control). During the second season of 2022-23, minimum days taken to opening of floret (2.54 days) were recorded under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) at par (2.66 days and 2.75 days, respectively) under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) and T_6 (Sucrose 10% + 8-HQC 300 ppm) while, maximum days taken to opening of floret (4.16 days) was recorded under T_0 (control). In the present experiment, minimum days taken to floret opening under these treatments, it might be due to opening of floret is dependent on levels of carbohydrate in the petal (Doorn *et al.,* 1991 in carnation) and growth of petal is associated with opening of flower bud which results from expansion of cell and this requires the influx of water and carbohydrates into cell of petal (Evan and Reid 1988 in bedding plants). The solutions of sugars and biocide are effective for bud opening of cut flowers like carnation, chrysanthemum and gladiolus (Bhattacharjee, 1999 in cut flowers). The absence of any pulsing solution (control) did not induced earliness for floret opening as nutrients supply was inhibited. Similar findings were reported by (Sigma *et al.,* 2018in tuberose, Thakur *et al.,* 2019in iris and Baidya and Chakrabarty 2020in tuberose).

Table 2:Effect of different pulsing solutions on days taken to opening of floret (days) in *Polianthes tuberosa* L. cv. Prajwal

Treatment	Pulsing Solution	Days taken to opening of floret (days)	
		2021-22	2022-23
T_0	Control (Distilled Water)	4.13	4.16
T_1	Sucrose 5% + 8-HQC (100ppm)	3.36	3.38
T_2	Sucrose 5% + 8-HQC (200ppm)	3.18	3.21
T_3	Sucrose 5% + 8-HQC (300ppm)	3.56	3.57
T_4	Sucrose 10% + 8-HQC (100ppm)	2.96	2.98
T_5	Sucrose 10% + 8-HQC (200ppm)	3.10	3.12
T_6	Sucrose 10% + 8-HQC (300ppm)	2.74	2.75
T_7	Sucrose 15% + 8-HQC (100ppm)	2.87	2.89
T_8	Sucrose 15% + 8-HQC (200ppm)	2.53	2.54
T_9	Sucrose 15% + 8-HQC (300ppm)	2.65	2.66
	SEm ±	0.10	0.11
	C.D.(*p*=0.05)	0.32	0.33

3.3 Floret diameter: (cm)

Data presented in Table 3 revealed that solution of pulsing improved diameter of floret. The maximum diameter of floret (3.38 cm) during the first season 2021-22 were recorded under the treatment T_6 (Sucrose 10% + 8-HQC 300 ppm) at par (3.25 cm and 3.15 cm, respectively) under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) and T_9 (Sucrose 15% + 8-HQC 300 ppm) While, minimum diameter of floret (2.35 cm) was recorded under T_0 (Control). During the second season of 2022-23, maximum diameter of floret (3.40 cm) was recorded under the treatment T_6 (Sucrose 10% + 8-HQC 300 ppm) at par (3.27 cm and 3.18 cm, respectively) under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) and T_9 (Sucrose 15% + 8-HQC 300 ppm) While, minimum diameter of floret (2.37 cm) was recorded under T_0 (Control). In the present experiment, diameter of floret was maximum under these treatments; it might be due to blockage avoidance of xylem tissues by 8-HQC and sucrose utilization as source of energy by the cut flowers. The carbohydrates accumulation and more water uptake had direct effect on increase in the volume of cell. The cell of petal of untreated flowers with poor water uptake might have been flaccid and deplasmolysed, leading to reduced cell size and that of petals. Our findings were corroborated with (Kumar and Gupta 2014 inGladiolus, Jain *et al*., 2014in Chrysanthemum,Jadeja *et al.,* 2017in Tuberose,Thakur *et al.,* 2019in Iris andHappy *et al.,*2021in Tuberose).

Table 3:Effect of different pulsing solutions on floret diameter (cm) of *Polianthes tuberosa* L. cv. Prajwal

Treatment	Pulsing Solution	Floret diameter (cm)	
		2021-22	2022-23
T_0	Control (Distilled Water)	2.35	2.37
T_1	Sucrose 5% + 8-HQC (100ppm)	2.60	2.63
T_2	Sucrose 5% + 8-HQC (200ppm)	2.80	2.82
T_3	Sucrose 5% + 8-HQC (300ppm)	2.71	2.74
T_4	Sucrose 10% + 8-HQC (100ppm)	2.99	3.01
T_5	Sucrose 10% + 8-HQC (200ppm)	2.88	2.89
T_6	Sucrose 10% + 8-HQC (300ppm)	3.38	3.40
T_7	Sucrose 15% + 8-HQC (100ppm)	3.07	3.08

T_8	Sucrose 15% + 8-HQC (200ppm)	3.25	3.27
T_9	Sucrose 15% + 8-HQC (300ppm)	3.15	3.18
	SEm ±	0.10	0.10
	C.D.(*p*=0.05)	0.31	0.31

3.4 Vase life: (days)

The data as per Table 4reveals that there is significant effect of different pulsing solution on vase life of cut flower of tuberose. The maximum vase life (10.78 days) during the first season 2021-22 were observed under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) which was *at par* (10.12 days and 9.48 days, respectively) under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) and T_6 (Sucrose 10% + 8-HQC 300 ppm) while, minimum vase life (5.06 days) was recorded under T_0 (Control). During the second season of 2022-23, maximum vase life (10.80 days) were observed under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) *at par* (10.14 days and 9.50 days, respectively) under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) and T_6 (Sucrose 10% + 8-HQC 300 ppm) while, minimum vase life (5.07 days) was recorded under T_0 (Control). In the present experiment, vase life was observed maximum under these treatments, it might be due to the fact that once blockage of vascular is avoided by 8-HQC with sucrose that facilitated the higher water intake and accumulation of total soluble sugars in the cells of petal probably by enhancing the osmotic driving force for the uptake of solution, resulting in longer vase life (Nagarjuna *et al*., 2002) in tuberose. The present study is in line with the previous findings made by (Jain *et al*., 2014in chrysanthemum, Naznin *et al.,* 2015 in tuberose, Sigma *et al.,* 2018in tuberose, Thakur *et al.,* 2019in iris and Baidya and Chakrabarty 2020in tuberose).

Table 4:Effect of different pulsing solutions on vase life (days) of *Polianthes tuberosa* L. cv. Prajwal

Treatment	**Pulsing Solution**	**Vase life (days)**	
		2021-22	**2022-23**
T_0	Control (Distilled Water)	5.06	5.077
T_1	Sucrose 5% + 8-HQC (100ppm)	6.68	6.70
T_2	Sucrose 5% + 8-HQC (200ppm)	7.76	7.77
T_3	Sucrose 5% + 8-HQC (300ppm)	7.05	7.08
T_4	Sucrose 10% + 8-HQC (100ppm)	8.71	8.73

T_5	Sucrose 10% + 8-HQC (200ppm)	8.25	8.32
T_6	Sucrose 10% + 8-HQC (300ppm)	9.48	9.50
T_7	Sucrose 15% + 8-HQC (100ppm)	9.04	9.07
T_8	Sucrose 15% + 8-HQC (200ppm)	10.78	10.80
T_9	Sucrose 15% + 8-HQC (300ppm)	10.12	10.14
	SEm ±	0.30	0.29
	C.D.(*p*=0.05)	0.92	0.89

3.5 Weight change/loss in cut spike: (%)

A perusal of data presented in Table 5 revealed that the significant effect of pulsing solution on weight change. The minimum weight change/loss in cut spike (13.29 %) during the first season 2021-22 were recorded under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) followed by (15.45 % and 17.28 %, respectively) under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) and T_7 (Sucrose 15% + 8-HQC 100 ppm) while, Maximum weight change/loss in cut spike (45.12 %) was recorded under T_0 (control). During the second season of 2022-23, minimum weight change/loss in cut spike (14.52 %) during the first season 2021-22 were recorded under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) followed by (16.79 % and 18.56 %, respectively) under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) and T_7 (Sucrose 15% + 8-HQC 100 ppm) while, Maximum weight change/loss in cut spike (47.15 %) was recorded under T_0 (control). In the present experiment, weight change/loss in cut spike was minimum under these treatments, it might be due to sucrose is used as nutrition (Marousky, 1972) in cut flowers, while 8-HQC prevents physiological and microbial vascular blockage as well as stimulate closure of stomata (Larsen and Frolich 1969) in carnation that ultimately leads to minimum weight change/loss in cut spike in tuberose. Similar findings were reported by Jain *et al*., 2014in chrysanthemum, Murry, 2014 in tuberose, Kumar and Gupta 2014 inGladiolus, andThakur *et al.,* 2019in iris).

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Table 5:Effect of different pulsing solutions on weight change/loss after ending of vase life in cut spike (%) of *Polianthes tuberosa* L. cv. Prajwal

Treatment	Pulsing Solution	Weight change in cut spike (%)	
		2021-22	2022-23
T_0	Control (Distilled Water)	45.12	47.15
T_1	Sucrose 5% + 8-HQC (100ppm)	36.53	37.32

T_2	Sucrose 5% + 8-HQC (200ppm)	28.09	30.25
T_3	Sucrose 5% + 8-HQC (300ppm)	32.78	33.68
T_4	Sucrose 10% + 8-HQC (100ppm)	25.63	26.47
T_5	Sucrose 10% + 8-HQC (200ppm)	23.87	25.13
T_6	Sucrose 10% + 8-HQC (300ppm)	20.59	22.40
T_7	Sucrose 15% + 8-HQC (100ppm)	17.28	18.56
T_8	Sucrose 15% + 8-HQC (200ppm)	15.45	16.79
T_9	Sucrose 15% + 8-HQC (300ppm)	13.29	14.52
	SEm ±	0.91	0.96
	C.D.(*p*=0.05)	2.74	2.87

3.6 Fungal infection

A perusal of symbols on fungal infection are presented in Table 6 revealed that during both season (2021-22 and 2022-23), showed that T_0, T_1, T_3 and T_7 treatment solutions were infected by fungus and rest of the solutions were significantly not infected by fungal infection. Adding a suitable germicide in vase solution can prevent the growth of microbes and increase the tendency for uptake of water (Anjum *et al*., 2001) in tuberose.

Table 6:Effect of different pulsing solutions on fungal infection in *Polianthes tuberosa* L. cv. Prajwal

Treatment	**Pulsing Solution**	**Fungal infection**	
		2021-22	**2022-23**
T_0	Control (Distilled Water)	**+**	**+**
T_1	Sucrose 5% + 8-HQC (100ppm)	**+**	**+**
T_2	Sucrose 5% + 8-HQC (200ppm)	**-**	**-**
T_3	Sucrose 5% + 8-HQC (300ppm)	**+**	**+**
T_4	Sucrose 10% + 8-HQC (100ppm)	**-**	**-**
T_5	Sucrose 10% + 8-HQC (200ppm)	**-**	**-**
T_6	Sucrose 10% + 8-HQC (300ppm)	**-**	**-**
T_7	Sucrose 15% + 8-HQC (100ppm)	**+**	**+**
T_8	Sucrose 15% + 8-HQC (200ppm)	**-**	**-**
T_9	Sucrose 15% + 8-HQC (300ppm)	**-**	**-**
	SEm ±		
	C.D.(*p*=0.05)		

'+' represent infected by fungus

'-' representnot infected by fungus

3.7 Fragrance score

The data as presented in Table 7 for Fragrance scorerevealed that the strong fragrance score (2.95) during the first season 2021-22 were noticed under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) at par (2.80 and 2.63, respectively) under the treatment T_6 (Sucrose 10% + 8-HQC 300 ppm) and T_8 (Sucrose 15% + 8-HQC 200 ppm) while, undesirable and least fragrance score (1.13) was noticed under T_0 (Control). During the second season of 2022-23, strong fragrance score (2.96) were noticed under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) at par (2.81 and 2.65, respectively) under the treatment T_6 (Sucrose 10% + 8-HQC 300 ppm) and T_8 (Sucrose 15% + 8-HQC 200 ppm) while, undesirable and least fragrance score (1.14) was noticed under T_0 (Control). In the present experimentTuberose flower pre cooled at room temperaturewhich retained better freshness. The endogenous and exogenous ethylene leads to loss of fragrance (Sexton *et al*., 2005) in sweet pea. This ethylene action could be delayed by effect of sucrose(Pun *et al.,*2016). Production of many flowers, fragrances displays a circadian cycle that is they are stronger at certain times during the day or night where as tuberose are more fragrant during evening as they are blooming in night in nature. In this context the present findings were in line with the findings made by (Reethu *et al*., 2022 in tuberose).

Table 7:Effect of different pulsing solutions on fragrance score in *Polianthes tuberosa* L. cv. Prajwal

Treatment	Pulsing Solution	Fragrance score	
		2021-22	2022-23
T_0	Control (Distilled Water)	1.13	1.14
T_1	Sucrose 5% + 8-HQC (100ppm)	1.27	1.29
T_2	Sucrose 5% + 8-HQC (200ppm)	2.13	2.15
T_3	Sucrose 5% + 8-HQC (300ppm)	1.55	1.56
T_4	Sucrose 10% + 8-HQC (100ppm)	2.13	2.15
T_5	Sucrose 10% + 8-HQC (200ppm)	2.30	2.32
T_6	Sucrose 10% + 8-HQC (300ppm)	2.80	2.81
T_7	Sucrose 15% + 8-HQC (100ppm)	2.30	2.32
T_8	Sucrose 15% + 8-HQC (200ppm)	2.63	2.65
T_9	Sucrose 15% + 8-HQC (300ppm)	2.95	2.96
	SEm ±	0.08	0.08

	C.D.(*p*=0.05)	0.24	0.24

3.8 Freshness index

A perusal of data on freshness indexare presented in Table 8 revealed that the original brighter colour of flowers have freshness index (4.97) during the first season 2021-22 were noticed under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm), flowers with faded from original colour at par (4.63 and 4.30, respectively) under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) and T_6 (Sucrose 10% + 8-HQC 300 ppm) while, flowers severely faded from original colour have freshness index (0.98) was noticed under T_0 (Control). During the second season of 2022-23, original brighter colour of flowers have freshness index (4.98) were noticed under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm), flowers with faded from original colour at par (4.65 and 4.31, respectively) under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) and T_6 (Sucrose 10% + 8-HQC 300 ppm) while, flowers severely faded from original colour have freshness index (0.92) was noticed under T_0 (Control). Tuberose flower pre cooled at room temperature retained better freshness. it might be due to pre-cooling is a technique used for the removal of heat of field which leads to reduction of both the rate of metabolism and prevention of loss of water which delays freshness is reported by. Similar findings were reported by (Reethu *et al*., 2022 in tuberose).

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Table 8:Effect of different pulsing solutions on freshness index in *Polianthes tuberosa* L. cv. Prajwal

Treatment	Pulsing Solution	Freshness index	
		2021-22	2022-23
T_0	Control (Distilled Water)	0.98	0.92
T_1	Sucrose 5% + 8-HQC (100ppm)	1.30	1.32
T_2	Sucrose 5% + 8-HQC (200ppm)	2.63	2.64
T_3	Sucrose 5% + 8-HQC (300ppm)	1.30	1.32
T_4	Sucrose 10% + 8-HQC (100ppm)	2.63	2.64
T_5	Sucrose 10% + 8-HQC (200ppm)	3.30	3.32
T_6	Sucrose 10% + 8-HQC (300ppm)	4.30	4.31
T_7	Sucrose 15% + 8-HQC (100ppm)	3.30	3.32
T_8	Sucrose 15% + 8-HQC (200ppm)	4.63	4.65
T_9	Sucrose 15% + 8-HQC (300ppm)	4.97	4.98

	SEm ±	0.12	0.12
	C.D.(*p*=0.05)	0.36	0.37

3.9 Moisture content (%)

In the present investigation the moisture content decreased from 1st day to 5th day of storage. The data on moisture content for both the years (2021-22 and 2022-23)are presented in Table 9 revealed thatat 1st day the maximum moisture content (89.89 %) were recorded under the treatment T_6 (Sucrose 10% + 8-HQC 300 ppm) followed by (88.60 % and 85.85 %, respectively) under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) and T_8 (Sucrose 15% + 8-HQC 200 ppm) while, minimum moisture content (67.91 %) was recorded under T_0 (Control). Similarly, at 3rd day maximum moisture content (85.60 %) were recorded under the treatment T_6 (Sucrose 10% + 8-HQC 300 ppm) followed by (83.69 % and 81.46 %, respectively) under the treatment T_8 (Sucrose 15% + 8-HQC 200 ppm) and T_9 (Sucrose 15% + 8-HQC 300 ppm) while, minimum moisture content (59.68 %) was recorded under T_0 (Control). Moreover, at 5th day maximum moisture content (83.21 %) were recorded under the treatment T_6 (Sucrose 10% + 8-HQC 300 ppm) followed by (79.03 % and 77.94 %, respectively) under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) and T_8 (Sucrose 15% + 8-HQC 200 ppm) while, minimum moisture content (54.95 %) was recorded under T_0 (Control). The present results reportedthat that the slower moisture loss from pre-cooled commodities during storage, it might be due to the fact that such conditions can easily be achieved by lowering the temperature of storage, as the environment tends to be more saturated simply by reduction in temperature which brings down the heat load thus loss of moisture is reduced (Lurie and Ben 1990). In addition to this, the sucrose maintained balance of water.The present results well corroborated the findings obtained in tuberose (Sharma *et al*., 2008 in asiatic hybrid lily and Reethu *et al*., 2022 in tuberose).

Table 9:Effect of different pulsing solutions on moisture content (%) in *Polianthes tuberosa* L. cv. Prajwal

Treat.	Pulsing Solution	Moisture (%) at 1st day	Moisture (%) at 3rd day	Moisture (%) at 5th day

		2021-22	2022-23	Pooled Mean	2021-22	2022-23	Pooled Mean	2021-22	2022-23	Pooled Mean
T_0	Control (Distilled Water)	67.31	68.51	67.91	60.65	58.72	59.68	55.11	54.79	54.95
T_1	Sucrose 5% + 8-HQC (100ppm)	78.56	78.37	78.46	73.51	73.87	73.69	65.60	66.84	66.22
T_2	Sucrose 5% + 8-HQC (200ppm)	75.92	73.85	74.89	69.00	72.45	70.72	62.86	64.98	63.92
T_3	Sucrose 5% + 8-HQC (300ppm)	78.32	76.94	77.63	72.83	79.81	76.32	66.54	67.93	67.23
T_4	Sucrose 10% + 8-HQC (100ppm)	82.72	82.73	82.73	77.30	76.52	76.91	71.99	72.56	72.27
T_5	Sucrose 10% + 8-HQC (200ppm)	83.35	81.31	82.33	80.45	80.44	80.45	73.29	74.41	73.85
T_6	Sucrose 10% + 8-HQC (300ppm)	89.59	90.19	89.89	84.85	86.35	85.60	81.88	84.54	83.21
T_7	Sucrose 15% + 8-HQC (100ppm)	80.30	83.90	82.10	80.64	81.05	80.84	73.88	75.14	74.51
T_8	Sucrose 15% + 8-HQC (200ppm)	83.66	88.04	85.85	83.36	84.02	83.69	75.89	79.99	77.94
T_9	Sucrose 15% + 8-HQC (300ppm)	87.62	89.58	88.60	81.27	81.65	81.46	76.49	81.58	79.03
	SEm ±	0.50	0.44		0.45	0.76		0.72	0.99	
	C.D.(*p*=0.05)	1.52	1.32		1.36	2.29		2.16	2.99	

Conclusion

From the above results, it can be concluded that the overall best treatment for different parameters for improving the vase life of tuberose during the season 2021&2022 were recorded under the treatment T_9 (Sucrose 15% + 8-HQC 300 ppm) followed by the treatment T_6 (Sucrose 10% + 8-HQC 300 ppm) and T_8 (Sucrose 15% + 8-HQC 200 ppm) which significantly improved the postharvest life of tuberose spikes cv 'Prajwal'. The various holding solution significantly improved the different postharvest parameters in tuberose *viz*., amount of pulsing solution consumed, days taken to opening of floret, floret diameter, vase life, weight change/loss in cut spike, fungal infection, fragrance score, freshness index and moisture content significantly influenced and performed better under these treatments.

Future prospects

There is a great scope of Pulsing as it improves and enhances the quality of cut flowers, by reviewing the different factors and approaches associated with the use of the solution of floral preservative under this experiment for the development of proper handling in the industry of cut flowers.

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