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Evaluations of the Vase-Life of Tuberose (*Polyanthes tuberosa* L.) Cut-Flower Spikes Cv. 'Bizet' in Micro-Cold Storage (mCS of Ecofrost Technologies Pvt. Ltd.) and Room Temperature (Rt)

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Abstract

The experiment was conducted at Ecofrost Technologies Pvt. Ltd., Survey no 134/1, 134/2, 130/3, Jeevan Nagar, Tathawade, Pune, Maharashtra, India. In this study, the effects of sucrose and citric acid in holding solution treatments on the post-harvest vase-life of cut spikes of tuberose cv. Bizet were carried out. After 24 hours holding cut ends of tuberose spike in 5% sucrose solution were studied at room conditions, and then sucrose 5% solution treated two spikes were selected for each replication. The ends of 2 cut spikes were treated with the desired concentration of related holding solution treatments each replication-wise before storage. The treatments T2, T3 and T4 treated spikes along with holding storage treatments were kept for 10 days at 40°C and 92.5% RH under mCS of Ecofrost Technologies Pvt. Ltd, Pune. The T1 treated spikes were kept at room condition. The holding solution treatment 2 % sucrose+citric acid 0.2% (T4) resulted in the maximum weight of single cut spike (gm), number of opened flowers (16) per spike, vase life of spike (14.15 days) and the minimum number of unopened flowers (4.32) per spike, in trial under laboratory conditions tuberose cv. Bizet and then followed by sucrose 2% (T1), tap water (T2) and control treatment (tap water) (T3).

Keywords: Tuberose; Bizet; Sucrose; Citric acid; Vase life; Flower; Storage; Ecofrost

Introduction

Tuberose is grown commercially in a number of countries including India, Kenya, Mexico, Morocco, France, Italy, Hawaii, South Africa, Taiwan, North Carolina, USA, Egypt, China and many other tropical and subtropical areas in the world. In India, commercial cultivation of tuberose is popular in Bagnan, Kolaghat, Midnapur, Panskura, Ranaghat, Krishnanagar of West Bengal; Coimbatore and Madurai districts of Tamil Nadu; Pune, Nashik, Ahmednagar, Thane, Sangli of Maharashtra; East Godavari, Guntur, Chitoor, Krishna District of Andhra Pradesh; Mysore, Tumkur, Kolar, Belgaum and Devanhalli taluka in Karnataka; Guwahati and Jorhat in Assam; Udaipur, Ajmer and Jaipur in Rajasthan; Navsari and Valsad of Gujarat and parts of Uttar Pradesh and Punjab. As per area and production statistics of the National Horticulture Board [1], the total area under tuberose cultivation in the country is about 7.95 lakh hectares. The production of loose and cut-flowers is estimated to be 27.71 '000 MT and 1560.70 lakh No's respectively [2]. In India, tuberose has become a very popular flower and millions and millions of spikes are sold every year. Tuberoses are cultivated for the production of flower spikes and loose flowers on a commercial scale for the domestic market. The Tuberose flowers throughout the year. The Tuberose can be grown outdoor and under greenhouse conditions. The production of field grown cut flowers has become quite popular in recent years. The variety of flowers grown has also increased dramatically. While production of high-quality flowers is an important factor, it is equally critical to handle the flowers properly after they are harvested from the field. There are reports that improper post-harvest handling accounts for 20 to 30% of cut-flower loss during marketing. Still an important commercial cut flower despite a substantial decline in production in recent years, gladiolus responds well to proper post-harvest management. Tuberose flowers are in demand for their elegant attractive spikes of different hues and good keeping quality. Tuberoses can be easily grown with a little care and attention in beds for garden decoration and cut flower production and also in pots for interior and outdoor decoration. Tuberose flowers are very sensitive to stresses of storage and transportation, particularly at warm temperatures.

Materials and Methods

The present trial was carried out at Ecofrost Technologies Pvt. Ltd., Survey no 134/1, 134/2,130/3, Jeevan Nagar, Tathawade, Pune, Maharashtra, India during the period of September 2016-17. The aim of this study was to examine the effects of a combination of sucrose +citric acid as well as the individual effects of sucrose and citric acid in holding solutions affects the post-harvest vase-life of tuberoses cv. Bizet. August to September is the peak period of flowering. There were 4 treatments consisting of tap water (T2), Sucrose 2% (T3) and Sucrose 2%+Citric acid 0.2% (T4) along with control (only tap water treatment) (T1) and also replicated five times. The tuberose cv. Bizet spikes were collected from Gultekadi flower market, Pune, Maharashtra, India during September, 2016.

Method of treatment procedure application

The stage of cutting of flower spikes depends on the distance to the market, where the flowers are to be sold. For nearby markets, the spikes with the lowest 2 or 3 florets, in about to open condition may be harvested. For distant markets, spikes with well-developed florets in tight conditions with the lowest floret (tip of the floret) showing the

right color are harvested. It is always preferable to cut the spikes in the morning hours. Immediately after cutting, the cut ends of the spikes were kept dipped under tap water. Care was taken that the cut spikes were always kept in an upright position to prevent bending of the spikes. After 24 hours holding cut ends of tuberose spikes in 5% sucrose solution at room conditions, and then sucrose 5% solution treated two spikes were selected to each replication. The ends of 2 cut spikes were treated with the desired concentrations of related holding storage solution treatments per replication-wise before putting in mCS. The treatments like; T2, T3 and T4 treated spikes along with holding storage treatments were kept for 10 days at 4°C and 92.5% RH under mCS of Ecofrost Technologies Pvt. Ltd, Pune. The T1 treated spikes were kept at room conditions. The experiment was replicated five times with completely randomized design [3]. Data was compiled and analyzed statistically using appropriate statistical tools.

Observations Recorded

The observations regarding the post-harvest vase-life (days), average spike weight (gm), opened flowers per spike and unopened flowers per spike were measured during September, 2016. The data was recorded at all treatments replication-wise and cumulative data subjected to statistical analysis.

Statistical analysis

Recorded data was statistically analysed (ANOVA analysis) using the software WASP, (developed at ICAR Research Complex for Goa, India). Mean comparisons were performed using the LSD test to determine whether the difference between the variables was significant at $P<0.05$.

Results and Discussion

From the Table 1 (Figure 1), the average single cut flower spike weight (gm) was observed to be the maximum in treatment sucrose T4 (sucrose 2%+0.2% citric acid) in trials after the 2nd, 5th and 10th days (under mCS) and after the 1st and 2nd day simulation (RT), then followed by treatment T3 (sucrose 2%) and T2 (tap water). Similarly, at the end of the experiment, the minimum cut-flower stalk weight was recorded in treatment T1. Also, in trial, the vase-life of cut stalk (days) was observed to be higher under treatment T4 and then followed by T3 (sucrose 2 %), T2 (tap water) and T1 (control) (Figure 1). Similarly the vase-life of the cut spike (Table 4) went down to the minimum in treatment T1. The maximum percentage of opened flowers per spike and minimum percentage of unopened flowers per spike was obtained in T4 (sucrose 2%+0.2% citric acid) and then was followed by treatments T3 (sucrose 2%), T2 (tap water) and T1 (control with tap water) (Tables 2 and 3). Thus, the results due to the treatment presumably allow the accumulation of adequate sucrose in the leaves and the stem during that time period to aid the development of flowers. When Tuberose spikes are pulsed (held) overnight for 24 hours, a flower opening ensues faster with the minimum unopened flower percentage. Thus, results due to treatment presumably allow the accumulation of adequate sucrose in the leaves and stem during that time period to aid the development of flowers. When, Gladioli are pulsed (held) overnight, in a flower opening faster, the maximum number open florets per spike, the minimum unopened florets per spike and the stem has a longer vase-life [4,5]. We added sucrose because the addition of sugars in vase solutions is essential for good flower development [6]. Sucrose feeding of cut carnations caused an acceleration of enzyme activity and proline accumulation in the petals at the end of the vase-life. The development of buds when treated with a sucrose solution was suppressed which might be due to growth of some micro-organisms. This contributed to the increase of amylase activity and proline content established in the late senescence phase. Recently it has been suggested that in stress situations cells require more sugars to fulfil the energy and carbon needs for the defensive response to stresses [7]. Since the cut-flowers suffer from energy deficiency and are susceptible to different stresses, the demand for hexoses in petals might be satisfied partially by the hydrolysis of starch. Moreover, according to Ref. [8], the activity of α-amylase plays an important role in the mechanism of petal opening and regulates the senescence syndrome.

Treatment Details	After 2 days storage	After 5 days storage	After 10 days of storage	After 1 day post-storage
	Average weight of cut spike (gm)			
	Room Conditions			
T1- Tap water	51.2	46.58	38.73	36.15
	Ecofrost Conditions			**Room Conditions**
T2- Tap water	44.04	42.41	40.8	38.82
T3-Sucrose 2%	50.89	50.74	41.23	39.57
T4-Sucrose 2%+Citric acid 0.2%	55.38	55.18	42.2	40.64
SEM (±)	0.92	0.27	0.36	0.77
CD 0.05	2.75	0.80	1.08	2.32
CV (%)	4.07	1.23	1.97	4.46
Significance	**	**	**	**

**- Highly significant, n=2.

Table 1: Effects of different holding solution treatments on average weight of cut flower spike of tuberose cv. Bizet during storage.

Figure 1: Photo after 11 days storage of tuberose spikes cv. Bizet as per treatments. The ends of cut spike were treated with 5% level of sucrose solution overnight (about 24 hrs) at room temperature before treating storage treatments.

Treatment Details	After 2 days storage	After 5 days storage	After 10 days of storage	After 1 day simulation	After 3 days simulation
	Average number of opened flowers per spike				
	Room Conditions				
T1- Tap water	5.98	9.32	11.08	11.08	11.10
	Ecofrost conditions			**Room Conditions**	
T2- Tap water	4.18	5.74	9.74	11.25	12.60
T3-Sucrose 2%	5.30	6.77	10.46	13.68	14.10
T4-Sucrose 2%+Citric acid 0.2%	3.13	6.53	12.55	14.93	16.05
SEM (±)	0.19	0.32	0.45	0.84	0.85
CD 0.05	0.57	0.96	1.34	2.52	2.56
CV (%)	9.20	9.72	9.15	14.78	14.19
Significance	**	**	**	**	**

**- Highly significant, n=2	

Table 2: Effects of different holding solution treatments on average number of opened flowers per spike of tuberose cv. Bizet during storage (n=2).

Treatment Details	Average number of unopened flowers/Spike cv. Bizet
T1- Tap water	11
T2- Tap water (Ecofrost)	7.46 (Ecofrost+RT)
T3-Sucrose 5% (Ecofrost)	5.5 (Ecofrost+RT)
T4-Sucrose 5%+Citric acid 0.2% (Ecofrost)	4.32 (Ecofrost+RT)
SEm (±)	0.42
C.D. 0.05	1.25
CV (%)	13.15
Significance	**
**- Highly significant, n=2	

Table 3: Effects of different holding solution treatments on average number of unopened flowers per spike of tuberose cv. Bizet during storage (n=2).

Treatment Details	Average vase life (Days)
T1- Tap water	4.85
T2- Tap water (Ecofrost)	12.26 (Ecofrost+RT)
T3-Sucrose 2% (Ecofrost)	13.23 (Ecofrost+RT)
T4-Sucrose 2%+Citric acid 0.2% (Ecofrost)	14.15 (Ecofrost+RT)
SEm (±)	0.30
C.D. 0.05	0.89
CV (%)	5.94
Significance	**
**- Highly significant, n=2	

Table 4: Effects of different holding solution treatments on average vase life of cut stalk flower of tuberose cv. Bizet during storage (n=2).

Conclusion

In conclusion, it is reported that holding solution treatments can extend the longevity of tuberose cut spikes cv. Bizet, its effects may vary depending on the preservative chemicals. In this study, a combined 0.2% citric acid+sucrose 2% treatment was found to be the best treatment than sucrose treatment for tuberose cultivar 'Bizet'.

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