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EFFECT OF PRE-STORAGE PULSING AND STORAGE DURATION ON QUALITY AND LONGEVITY OF CUT IRIS SPIKES (*IRIS CROCEA JACQUEM*)

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ABSTRACT

The present investigation was carried out in the month of June 2019 at Divisional Laboratory of Floriculture and Landscape Architecture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar campus, Srinagar. The experiment was laid out in two factor Completely Randomized Design with 18 treatment combinations. Factor I involved pulsing having six levels (P_1: Silver Thiosulfate (STS) (0.25 mM) +Sucrose (4 %), P_2: STS (0.50 mM) + Sucrose (4 %), P_3: STS (1.00 mM) +Sucrose (4 %), P_4: STS (0.25 mM) + Sucrose (6 %), P_5: STS (0.50 mM) + Sucrose (6 %) and P_6: STS (1.00 mM) + Sucrose (6 %). Factor II involved storage with three levels (24 hrs, 36 hrs and 48 hrs at 4 ± 2°C). It was found that treatment combination Sucrose (6 %) + STS (0.50 mM) stored for 48 hour proved significantly superior in terms of water uptake (5.85 g/spike), water loss (5.17 g/spike), water balance (-0.05 g/spike), water loss/water uptake ratio (0.99) fresh weight change (-3.20 %), relative water content (93.32 %), max floret diameter (97.53 mm), falls and standard (87.53 mm x 29.70 mm) and (77.47 mm x 27.81 mm) and vase life (10.67 days).
***Keywords* :** Pulsing, Storage, Holding, Chemical preservatives, STS, Sucrose, Iris.

Introduction

Irises have been used for centuries not only as ornamentals but also as a source of perfumes and a model for adornments. The shape of the flowers resembles the orchid, and the diversity of colours make Irises desirable cut flowers. The name of the genus is derived from the female messenger of the gods, Iris, who brought peace to the human race, and reflects the diversity of the colours of the rainbow. The major part of the Iris genus belongs to the group of rhizomatous plants, with the bulbous types being fewer in number.

Irises are found throughout the temperate and subtropical zones of Northern-hemisphere, and more than 300 species are known (Hoog, 1980). This is only a small number compared to that obtained when all the subspecies, varieties, natural hybrids and cultivars are totalled. The most widely cultivated hybridised and horticulturally important species are *Iris germanica,* (tall bearded iris), *Iris pseudacorus*, (yellow-flag iris), and *Iris sibirica* (Siberian iris), each with numerous commercially important cultivars. Iris species are found in diverse habitats on every continent in the Northern hemisphere and have been important models for study of plant evolution, ecology and hybrid speciation. Chromosome numbers and ploidy are highly variable among and within species in the genus, ranging from 2n=16 in *Iris attica* to 2n=108 in *Iris Vesicolor*. In the Kashmir Himalaya Irises grow in Glacial moraines, alpine and sub-alpine grasslands, roadsides, gardens, saffron fields, stream banks and in graveyards and cemeteries at altitudes from 1650 to 3500 MSL.

The Iris species studied and found growing across Kashmir Himalayas have previously been reported by Randolph and Randolph (1959). There is a general consensus that majority of these have been introduced as ornamentals by Mughals and the British. However, species like *Iris ensata*, *Iris reticulata*, *Iris hookeriana*, *and Iris kashmiriana*, are native and grow wild throughout Kashmir and Ladakh and are reported to be endemic to this region. No evaluation regarding its Horticultural uses have been done in Kashmir valley. As a prelude to its commercial use as a cut flower, there is a need to evaluate its post-harvest behaviour in cold store, its ability to rehydrate after storage and subsequent vase life. There is a need to scientifically establish and standardize basic pulsing, and storage protocol. Keeping in view the present investigation was carried out to evaluate the effect of pulsing and storage on water relation and vase life of *Iris crocea* Jacquem.

Materials and Methods

Location and Climate

The present study was conducted in the Division of Floriculture and Landscape Architecture, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir during the year 2019. The experimental site is located in Srinagar, the summer capital of the Union Territory of Jammu and Kashmir at coordinates 34^0 5′ – 34^0 7′ N latitude and 74^0 8′ – 74^0 9′ E longitude at an altitude of approximately 1575 meters above mean sea level (MSL). The region experiences a temperate climate with average summer and winter temperatures of 19.6°C and 6.8°C, respectively.

Plant Material

Spikes of *Iris crocea* Jacquem. were sourced from a natural population in the Harwan hills approximately 4 km north of the University Campus on June 3, 2019.

Pulsing Treatments

Spikes were pulsed in solutions containing varying concentrations and combinations of sucrose and silver thiosulphate (STS) for 12 hours. Pulsing solutions included sucrose at 4% and 6% concentrations and STS at 0.25 mM, 0.50 mM and 1.0 mM concentrations.

Preparation of STS Solution

Silver thiosulphate (STS) was prepared following the method outlined by Reid *et al*. (1983):

$Na_2S_2O_3$ solution (8 mM): Anhydrous sodium thiosulphate ($Na_2S_2O_3$) was accurately weighed and dissolved in distilled water using a magnetic stirrer.

$AgNO_3$ solution (2 mM): Silver nitrate was similarly prepared in a separate container.

STS (1 mM): $AgNO_3$ solution was slowly added to the rapidly stirring $Na_2S_2O_3$ solution in a 1:4 molar ratio producing STS with final concentrations of 1 mM (Ag^+) and 4 mM ($S_2O_3^{2-}$).

Dilutions 0.50 mM STS was prepared by mixing equal parts of 1 mM STS solution and distilled water. 0.25 mM STS was further prepared by diluting the 0.50 mM STS solution with an equal volume of distilled water.

Preparation of Sucrose Solution

4% sucrose solution was prepared by dissolving 4 grams of sucrose in 100 ml of distilled water.

6% sucrose solution followed the same protocol using 6 grams per 100 ml.

Storage Conditions

Following pulsing the spikes were wrapped in newspaper and stored upright in a cold storage chamber at 4 ± 2°C for durations of 24, 36 and 48 hours in the Division of Food Science and Technology, SKUAST-K Shalimar. Upright storage was employed to prevent geotropic bending of the stems.

Post-storage Evaluation

After cold storage the spikes were transferred to vases filled with distilled water at ambient temperature. Evaluations were carried out daily over an 8-day vase life period to assess water relations, physiological responses and floral quality.

Table 1 : Effect of pulsing and storage on water relation of *Iris crocea* Jacquem.

Treatments	Water uptake	Water loss	Water balance	Water loss / Water uptake ratio	Relative water content (%)	Maximum floret size (mm)	Days taken to opening of 1st floret
P_1 x S_1	3.56	6.46	-2.65	1.73	87.07	85.53	1.33
P_1 x S_2	3.86	6.29	-2.64	1.63	87.23	86.50	1.33
P_1 x S_3	4.10	6.16	-2.60	1.58	87.63	87.5	1.33
P_2 x S_1	4.14	5.98	-2.54	1.64	88.24	88.50	1.33
P_2 x S_2	4.19	5.87	-2.43	1.63	88.91	89.50	1.33
P_2 x S_3	4.27	5.82	-2.36	1.62	89.75	90.23	1.33

P_3 x S_1	3.10	6.93	-2.74	1.88	86.14	82.00	1.00
P_3 x S_2	3.14	6.83	-2.72	1.87	86.55	83.57	1.33
P_3 x S_3	3.44	6.78	-2.67	1.74	86.58	84.50	1.33
P_4 x S_1	4.56	5.46	-0.66	1.18	91.01	92.60	1.67
P_4 x S_2	4.84	5.41	-0.57	1.12	91.56	93.43	2.00
P_4 x S_3	4.96	5.37	-0.50	1.10	92.18	94.50	2.33
P_5 x S_1	5.21	5.30	-0.48	1.09	92.47	95.70	2.67
P_5 x S_2	5.54	5.24	-0.16	1.03	92.68	96.37	2.67
P_5 x S_3	5.85	5.17	-0.05	0.99	93.32	97.53	3.00
P_6 x S_1	4.35	5.80	-0.82	1.19	89.90	91.53	2.00
P_6 x S_2	4.51	5.70	-0.81	1.16	90.53	91.60	1.67
P_6 x S_3	4.64	5.69	-0.73	1.14	90.72	91.17	1.67
C.D($p \leq 0.05$)	**0.08**	**0.14**	**0.15**	**1.73**	**4.52**	**0.63**	**NS**

Table 2 : Effect of pulsing and storage on Vase Life of *Iris crocea* Jacquem.

Treatment	Size of Falls	Size of standards	Vase life (days)
P_1 x S_1	75.53 × 25.97	65.37 × 13.80	8.33
P_1 x S_2	76.50 × 26.73	66.33 × 14.83	8.33
P_1 x S_3	77.50 × 27.07	67.33 × 15.77	8.67
P_2 x S_1	78.50 × 27.25	68.30 × 16.93	9.00
P_2 x S_2	79.5 × 27.32	69.40 × 17.80	9.00
P_2 x S_3	80.23 × 27.48	70.27 × 18.87	9.33
P_3 x S_1	72.00 × 22.73	61.93 × 10.87	7.67
P_3 x S_2	73.57 × 23.57	63.43 × 11.87	8.00
P_3x S_3	74.50 × 24.87	64.40 × 12.73	8.00
P_4 x S_1	82.60 × 28.73	74.50 × 22.83	9.67
P_4 x S_2	83.43 × 28.93	74.07 × 23.90	9.67
P_4 x S_3	84.5 × 29.23	74.60 × 24.90	10.00
P_5 x S_1	85.70 × 29.30	75.60 × 25.80	10.33
P_5 x S_2	86.37 × 29.47	76.21 ×26.83	10.33
P_5 x S_3	87.53 × 29.70	77.47 × 27.81	10.67
P_6 x S_1	81.53 × 27.57	71.70 × 19.67	9.33
P_6 x S_2	81.60 × 27.83	72.47 × 20.87	9.33
P_6 x S_3	81.72 × 28.10	73.37 × 21.80	9.33
C.D($P \leq 0.05$)	**0.63 × 0.74**	**0.10 × 0.13**	**0.81**

Result & Discussion

Water Uptake (g/spike) & Water Loss (g/spike)

Water uptake significantly varied across Pulsing × Storage combinations. It increased until Day 3 peaking at 16.15 g/spike under P5 × S3 then declined until Day 8. Spikes stored for 48 hours had higher uptake overall especially with 6% sucrose treatments. The lowest uptake (3.10 g/spike) was recorded in P3 × S1 on Day 8. Water loss also peaked on Day 3 (12.32 g/spike in P5 × S3) then dropped through Day 8. Treatments with 6% sucrose had significantly lower water loss. The lowest value (5.17 g/spike) on Day 8 was again in P5 × S3. P3 × S1 had the least water loss on Day 4 but still underperformed overall. Cut spikes stored at 4 ± 2°C for 24-, 36- and 48-hours post-pulsing showed a trend of increasing water uptake up to the third day of vase life. Pulsing with 6% sucrose consistently resulted in higher water uptake and loss than 4% sucrose attributed to improved osmotic potential (Abdul-Wasea, 2012; Nematl *et al.*, 2013; Wani *et al.*, 2010). Similar outcomes were reported in Gerbera and Lilium when pulsed with sucrose and antimicrobial agents (Sharma *et al.*, 2018a; Jafarpour *et al.*, 2015; Acharyya *et al.*, 2013; Amiri *et al.*, 2009).

Water Balance (g/spike)

Water balance was highest in P5 × S3 throughout the VLE period and lowest in P3 × S1. Treatments with 6% sucrose had better water balance and delayed the onset of negative values to Day 8 while 4% sucrose led to negative values from Day 7. The final day saw the least negative value (-0.05 g/spike) in P5 × S3. Water balance a proxy for turgidity and eventual vase life was superior in 6% sucrose treatments maintaining positive values up to the 7th day unlike the 4% treatment which turned negative by day 7. The reduced ability of tissues under 1.0 mM STS to retain water reflected silver toxicity echoing earlier findings (Sindhu *et al*., 2003; Wani *et al*., 2009).

Water Loss / Water Uptake Ratio

Favorable water loss/water uptake ratios were observed in 6% sucrose treatments and with 48-hour storage. Differences were not significant until Day 2. On Day 8 P5 × S3 had the most favorable ratio (0.99) while P3 × S1 had the least favorable (1.88). The WL/WU ratio a stress indicator was lower under 6% sucrose highlighting its water retention advantage. In contrast 1.0 mM STS increased this ratio due to impaired water absorption. Spikes stored for 48 hours recorded higher water uptake and balance likely due to better sugar accumulation supporting prolonged tissue hydration. Similar advantages of extended cold storage were reported by Ajinkya *et al*. (2018), Muniz *et al*. (2016), and Sindhu *et al*. (2003).

Fresh Weight Change (%)

No significant differences in fresh weight were observed within 6% or 4% sucrose groups. However, relative water content was highest (93.32%) in P5 × S3 and lowest (86.14%) in P3 × S1. Fresh weight change mirrored water relations, with an increase up to day 4 and declines afterward. Negative fresh weight on days 6–8 was more severe in 4% sucrose treatments confirming lower water retention (Singh *et al*., 2007; Riyaz and Inayatullah, 2018; Vinodh *et al*., 2013).

Floret Size (mm)

Larger florets were recorded in P4–P6 treatments regardless of storage time. The largest floret (97.53 mm) was under P5 × S3 while the smallest (82.00 mm) was in P3 × S1. Quality parameters such as floret size and vase life were superior under 6% sucrose + 0.50 mM STS (P5) with maximum flower opening and extension. This combination enhanced petal cell turgidity through better osmotic loading consistent with Nowak and Mynett (1985), Alka *et al*. (2007) and Ichimura and Hiraya (1999). High STS (1.0 mM) negatively impacted flower expansion (Riyaz and Inayatullah, 2018).

Days to Opening of 1st Floret

No significant difference in the timing of first floret opening across treatments. However, P5 × S3 took the longest (3 days) and P3 × S1 the shortest (1 day).

Size of Falls and Standards (mm)

P4–P6 pulsing treatments produced larger falls and standards with P5 × S3 showing the largest (87.53 × 29.70 mm falls; 77.47 × 27.81 mm standards). P3 × S1 showed the smallest floral parts.

Vase Life (days)

Vase life was longest in P5 × S3 (10.67 days) and shortest in P3 × S1 (7.67 days). P4 and P5 pulsing treatments generally improved vase life across all storage durations. Quality parameters such as floret size and vase life were superior under 6% sucrose + 0.50 mM STS (P5) with maximum flower opening and extension. This combination enhanced petal cell turgidity through better osmotic loading consistent with Nowak and Mynett (1985), Alka *et al*. (2007) and Ichimura and Hiraya (1999). High STS (1.0 mM) negatively impacted flower expansion (Riyaz and Inayatullah, 2018).

Functional vase life increased with P5 treatment and 48-hour storage. Treatment interactions confirmed the role of optimal pulsing and storage duration in extending cut flower longevity (Das *et al*., 2008; Sharma *et al*., 2018; Kumar, 2012).

Conclusion

Pulsing of cut Iris spikes with Silver thiosulphate in combination with sucrose (STS 0.50 mM + suc 6 %) followed by 48 hrs dry storage at 4±2°C resulted in significantly improved Water Relations (in terms of water uptake, water loss, water Balance and water loss/water uptake ratio; Physiological parameters in terms of (fresh weight change, Relative Water Content) and quality parameters in terms of (size of falls and standards, size of floret and vase life there by enhancing post-harvest life and quality of cut flowers.

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