Postharvest Treatments for Extending the Vase Life of Cut Stock (Matthiola incana L.) cv. ‘Gold Cut Series’

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ABSTRACT
This study was conducted to investigate the effect of different preservatives to extend the vase life of cut stock. Different surfactants viz. sucrose and 8-hydroxyquinoline sulphate (8-HQS) were compared to ascertain its role in improving the water balance (relative fresh weight and vase solution uptake) and longevity (vase life) of cut stock. The experiment was laid out in a completely randomized design (CRD). Several parameters were studied and obtained data were analysed statistically according to Fisher’s analysis of variance technique and treatment means were compared with Turkey’s test at p ≤ 0.05. The results showed that 8-HQS had significant effect on postharvest life, both in holding and pulsing solutions having 7.7 and 9.8 days vase life respectively. The most effective 8-HQS containing treatments were 200 mg l⁻¹ 8-HQS plus 15% sucrose (in holding solutions) and 500 mg l⁻¹ 8-HQS (in pulsing solutions for 24 h).

Keywords: Cut flower, holding solution, longevity, pulsing, water relation.

Abbreviations:
8-HQS: 8-hydroxyquinoline sulphate; RFW: Relative Fresh Weight; VSU: Vase Solution Uptake Rate.

INTRODUCTION
Stock (Matthiola incana L.), a member of the family Brassicaceae, is a common garden plant which produces flowers in terminal clusters. It is a highly valuable specialty cut flower and is one of the most fascinating flowers all over the world. Maximum cultivation of stock is in the Netherland followed by European countries and USA. In developing countries, its cultivation is very limited and grown in open field or pots. Stock flowers are highly perishable and exhibit short post-harvest longevity. Vase-life is an indicator for the cut flowers postharvest quality and is an important target for improving flower characteristics, using chemical treatments or plant breeding approaches (Yamda et al., 2003; Ardebili et al., 2013). Also, the quality and vase life of flowers are greatly associated with pre-harvest balanced application of macro and micronutrients during its cultivation (Younis et al., 2013). Use of chemical preservatives are reported to extend the longevity of cut flowers (Song et al., 1996; Macnish et al., 2010). Nowak and Rudnicki (1975) reported the considerably increased vase life of previously tested cut stock cultivars with the use of preservatives. The vase life and general keeping qualities are markedly improved, often doubled by the use of preservatives as reported in cut roses (Younis et al., 2006). High carbohydrate content in the leaves of harvested cut flowers is a prerequisite for long vase life (Marissen, 1995).

Longevity of vase life is an important factor in consumer preference. On the other hand, short postharvest vase life is one of the most limiting factors related to cut flowers (Kader, 2003; Ahsan et al., 2012). The germicide 8-hydroxyquinoline sulphate is an important preservative used in floral industry (Nowak and Rudnicki, 1975). It controls the growth of bacteria and reduces the chances of blockage of conducting organs due to bacterial plugging. Germicides control harmful bacteria and prevent microbial plugging of the water conducting tissues. 8-hydroxyquinoline sulphate (HQs) may act as an antimicrobial agent and hence, reduce stem plugging. 8-HQS is well-known to prolong the vase life of cut flowers, by preventing the accumulation of microorganism in xylem vessels (Larsen and Cromarty, 1967).

Sucrose acts as a source of food supply and respiratory substrate that enhances the quality of cut flowers and extends the vase life by extending the span of flowers showing colour as it provides sufficient energy to ensure continuous
development of flowers after harvest. The use of preservatives such as 8-HQS and sucrose increased the vase life of cut stock cultivars (Song et al., 1996). If the cut stems are kept in holding solutions bearing inorganic salts and sugars, the absorption of water from the stems could be increased (Song et al., 1996). They have also observed that the length and thickness of the stem and the size of cut flowers significantly influenced the postharvest vase life of the flowers.

The objectives of the study were to evaluate the performance of M. incana 'Gold Cut Series' to study their response at different concentrations of holding and pulsing solutions of sucrose and 8-HQS for extending their longevity and vase life.

**MATERIAL AND METHODS**

**Plant Material:**
Cut stems of stock (M. incana L.) 'Gold Cut Series' were harvested when one-half to two-third of the flowers were opened or a minimum of 6 open flowers in a spike were observed. Cut flowers were harvested from open field plantings at Rosa project, Horticultural field area, University of Agriculture, Faisalabad, Pakistan. Harvesting was conducted between 07:00 am to 09:00 am in the March. Healthy stems were cut with clean and sharp seateurs, then wrapped in papers and sorted on the basis of stem length, bud diameter and flower health (flower health was evaluated on the basis of visual inspection, flowers having sign of insect/pest or disease attack were discarded). After sorting, flowers were bunched in the bundles of 20 stems, tied and placed into buckets having distilled water with maximum two bunches in each bucket. Buckets containing the flower stems were shifted to Postharvest Floriculture laboratory, at Institute of Horticultural Sciences, University of Agriculture, Faisalabad.

**Treatment:**
Two experiments were performed simultaneously. In first experiment stem were placed in holding solution and in second experiment, stems were placed in pulsing solutions. Cut stems were placed on the benches after untie from bunches, were re-cut under water to remove air emboli and to give them a uniform stem length of 30cm (Bansode et al., 2005). All the experiments were performed at 25 ± 2°C and 70 ± 10% relative humidity under a PAR flux of 10-12 μmol m⁻² s⁻¹ from white florescent tubes on a daily 12 h photoperiod.

**Holding Solutions and Pulsing Solutions:**
In holding trial, cut stock stems were directly placed in glass vials containing 250 ml of different solutions according to the treatments. Treatments were as follows: T₁ = Control (distilled water), T₂ = 5% sucrose +100 mg l⁻¹ 8-HQS, T₃ = 10% sucrose + 100 mg l⁻¹ 8-HQS, T₄ = 15% sucrose + 100 mg l⁻¹ 8-HQS, T₅ = 5% sucrose + 200 mg l⁻¹ 8-HQS, T₆ = 10% sucrose + 200 mg l⁻¹ 8-HQS, T₇ = 15% sucrose + 200 mg l⁻¹ 8-HQS.

In pulsing trial, stem ends were dipped in different concentrations of sucrose and 8-HQS for 24 hours, after that individual stems were shifted in glass vials containing 250 ml of distilled water (pH 7.2 and EC 77.6 μS/cm) in each vial. Treatments were as follows: T₁ = Control (distilled water), T₂ = 1% sucrose, T₃ = 5% sucrose, T₄ = 10% sucrose, T₅ = 20% sucrose, T₆ = 200 mg l⁻¹ 8-HQS, T₇ = 500 mg l⁻¹ 8-HQS.

Data was recorded on daily basis and following parameters were calculated.

**Relative Fresh Weight:**
The weight of glass vials with and without flowers was recorded daily to calculate the total water uptake, total water loss and change in flower fresh weight (van Meeteren, 1978). Relative fresh weight was measured by using formula:

\[
\text{Relative fresh weight (\% initial fresh weight)} = \left( \frac{FW_t}{FW_{t-1}} \right) \times 100 \quad (\text{He et al., 2006})
\]

Where FWₜ is weight of stem (g) at t = day 0, 1, 2, 3 ......... . FW₁₀ is the fresh weight of same stem (g) at t = day 0

**Vase Solution Uptake Rate:**
VSU rate was measured [g, g⁻¹ initial fresh weight (IFW)] according to the bellow formula (Damunupola, 2009):

\[
\text{VSU rate} = \left( S_{t-1} - S_t \right) / \text{IFW of stem}
\]

Where S, is weight of vase solution (g) at t = day 1, 2, 3, ....... . S₁₀ is wt. of vase solution (g) on previous day. Initial fresh weight is FW on day 0.

**Vase Life:**
In each treatment of present experiment, there were ten replications. The vase life was calculated on the basis of visual observations. It determined the number of days for which a flower remained fresh and marketable. Cut flowers were evaluated daily and vase life was recorded at the time when senescence started. Symptoms of senescence included: fading of petal colour, petal wilting or curling, petal abscission, leaf yellowing or blackening and stem bending (calculated on the basis of visual observations when compared with fresh flowers) (Jones et al., 1993).

**Statistical Analysis:**
The experiment was performed according to Completely Randomized Design (CRD) with factorial arrangement and data were analysed and managed statistically according to Fisher's analysis of variance technique and treatment means were compared using Tukey's test at the 5 % level (Steel et al., 1997).
RESULTS

Holding Solutions:

Maximum value of relative fresh weight was observed in T6 (10% sucrose + 200 mg l\(^{-1}\) 8-HQS) followed by T7 (15% Sucrose + 200 mg l\(^{-1}\) 8-HQS). Flowers that were placed in distilled water (T1) and 5% sucrose + 100 mg l\(^{-1}\) 8-HQS (T2) exhibited low RFW compared to other treatments (Fig. 1). Reduction in relative fresh weight in sucrose treatments was observed, while flowers treated with 500 mg l\(^{-1}\) 8-HQS, maximum relative fresh weight was recorded (Fig. 1).

A sudden decrease in the vase solution uptake was observed when flowers treated with distilled water (T1) and 10% sucrose + 100 mg l\(^{-1}\) 8-HQS (T3) compared to other treatments. This shows the inability of the stalks to absorb enough solution thus act as a limiting agent in reducing the vase life. Most stable behaviour was shown by T6 (10% sucrose + 200 mg l\(^{-1}\) 8-HQS) and T4 (15% sucrose + 100 mg l\(^{-1}\) 8-HQS) as compared to rest of the treatments (Fig. 2). These concentrations performed a positive role in maintaining a good supply of vase solution to the stems and thus boosting their vase life. Minimum variations were observed in case of T6, which maintained an upper limit against all other treatments even at 7\(^{th}\) day of vase life. Overall, minimum value of vase solution uptake was observed in T1 (distilled water) and then in T3 (10% sucrose + 100 mg l\(^{-1}\) 8-HQS). This decreased value of vase solution uptake was probably because of stem end blockage.

A maximum value of vase life amongst all the holding solutions was shown by T7 (15% sucrose + 200 mg l\(^{-1}\) 8-HQS). This was probably because of average greater uptake rate of sucrose + 8-HQS by stock cut stems. Significant increase in vase life of the stock cut stems was observed in T7 (15% sucrose + 200 mg l\(^{-1}\) 8-HQS) with an average vase life of 7.7 days, followed by T6 (10% sucrose + 200 mg l\(^{-1}\) 8-HQS) and T3 (5% sucrose + 200 mg l\(^{-1}\) 8-HQS) with an average vase life of 7.6 days and 6.5 days respectively compared with control treatment (Table 1). Minimum value of vase life was observed with T1 (distilled water), used as control, with an average vase life of 5.1 days.

First bent neck was observed on the 5\(^{th}\) day of vase life in distilled water (control) and 5% sucrose + 100 mg l\(^{-1}\) 8-HQS treatments while all other treatments were intact. On sixth day, the stock cut stems in distilled water were dead. On the 7\(^{th}\) day of vase life wilting effect was observed in T5 (5% Sucrose + 200 mg l\(^{-1}\) 8-HQS) and T4 (15% sucrose + 100 mg l\(^{-1}\) 8-HQS).

Pulsing:

Data recorded from pulsing solution revealed that relative fresh weight for stock was maximum in pulsing solution having (500 mg l\(^{-1}\) 8-HQS) T7 and (5% sucrose) T5 pulsing solutions while minimum relative fresh weight was recorded in

<table>
<thead>
<tr>
<th>Treatment</th>
<th>RFW*</th>
<th>VSU*</th>
<th>Vase Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 (Control (distilled water))</td>
<td>64.28 ± 1.03 d</td>
<td>0.113 ± 0.01 b</td>
<td>5.1 d</td>
</tr>
<tr>
<td>T2 (5% Sucrose + 100 mg l(^{-1}) 8-HQS)</td>
<td>65.06 ± 1.99 cd</td>
<td>0.150 ± 0.03 ab</td>
<td>5.8 c</td>
</tr>
<tr>
<td>T3 (10% Sucrose + 100 mg l(^{-1}) 8-HQS)</td>
<td>67.43 ± 2.43 bc</td>
<td>0.137 ± 0.03 ab</td>
<td>6.2 bc</td>
</tr>
<tr>
<td>T4 (15% Sucrose + 100 mg l(^{-1}) 8-HQS)</td>
<td>67.04 ± 2.69 b</td>
<td>0.142 ± 0.01 ab</td>
<td>6.4 bc</td>
</tr>
<tr>
<td>T5 (5% Sucrose + 200 mg l(^{-1}) 8-HQS)</td>
<td>69.72 ± 2.15 b</td>
<td>0.168 ± 0.03 a</td>
<td>6.5 b</td>
</tr>
<tr>
<td>T6 (10% Sucrose + 200 mg l(^{-1}) 8-HQS)</td>
<td>72.53 ± 1.36 a</td>
<td>0.144 ± 0.02 ab</td>
<td>7.6 a</td>
</tr>
<tr>
<td>T7 (15% Sucrose + 200 mg l(^{-1}) 8-HQS)</td>
<td>73.88 ± 1.35 a</td>
<td>0.179 ± 0.01 a</td>
<td>7.7 a</td>
</tr>
</tbody>
</table>

*RFW: relative fresh weight; VSU: vase solution uptake rate.
T₁ (distilled water) and T₂ (1% sucrose) respectively (Fig. 3). As far as vase solution uptake rate was concerned, almost all the treatments responded differently. From the 1st day, there was a drastic decrease in vase solution uptake rate in all the treatments. Vase solution uptake was maximum in pulsing solution T₇ (500 mg l⁻¹ 8-HQS) followed by T₅ (20% sucrose) and T₄ (200 mg l⁻¹ 8-HQS) while minimum vase solution uptake was recorded in pulsing solution T₁ (distilled water) followed by T₂ (1% sucrose) (Fig. 4). In general vase solution uptake was maximum in the pulsing solution having high concentration of 8-HQS this is used as biocide which helps to eliminate the bacterial population.

T₇ (500 mg l⁻¹ 8-HQS) excelled the rest of the treatments with giving a maximum vase life of 9.8 days which is significantly different from the control treatment as shown in Table 2. Other treatments were also at par with T₇ (500 mg l⁻¹ 8-HQS) and extended the vase life of stock cut stems for 9.4 days is T₅ (20% sucrose). The lowest vase life of 6.5 days was recorded in distilled water (control) treatment followed by T₂ (1% sucrose) of 6.6 days.

There was no bent neck observed in flowers treated with 8-HQS and 20% sucrose even up to day nine of vase life. But the flowers kept in distilled water, showed bent neck that leads to termination of vase life. At 7th day of vase life, some leaf drying was observed in T₅ (20% sucrose). After 10 days of vase life, bent neck was not obvious in T₇ (500 mg l⁻¹ 8-HQS) and different sucrose concentrations. In this regard, T₇ (500 mg l⁻¹ 8-HQS) is the best treatment among all other treatments.

![Table 2](https://example.com/table2)

Table 2. Effects of different pulsing solution treatments on RFW, VSU and vase life.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>RFW⁺</th>
<th>VSU⁺</th>
<th>Vase Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁: Control (distilled water)</td>
<td>99.68 ± 2.29 c</td>
<td>0.194 ± 0.01 c</td>
<td>6.5 c</td>
</tr>
<tr>
<td>T₂ (1% Sucrose)</td>
<td>103.18 ± 1.64 c</td>
<td>0.233 ± 0.01 c</td>
<td>6.6 c</td>
</tr>
<tr>
<td>T₃ (5% Sucrose)</td>
<td>105.59 ± 2.54 bc</td>
<td>0.247 ± 0.01 b</td>
<td>7.5 bc</td>
</tr>
<tr>
<td>T₄ (10% Sucrose)</td>
<td>106.32 ± 2.54 bc</td>
<td>0.298 ± 0.01 b</td>
<td>7.4 bc</td>
</tr>
<tr>
<td>T₅ (20% Sucrose)</td>
<td>110.27 ± 2.78 a</td>
<td>0.336 ± 0.02 a</td>
<td>9.4 a</td>
</tr>
<tr>
<td>T₆ (200 mg l⁻¹ 8-HQS)</td>
<td>105.26 ± 2.02 ab</td>
<td>0.287 ± 0.02 a</td>
<td>8.6 ab</td>
</tr>
<tr>
<td>T₇ (500 mg l⁻¹ 8-HQS)</td>
<td>113.99 ± 2.28 a</td>
<td>0.364 ± 0.01 a</td>
<td>9.8 a</td>
</tr>
</tbody>
</table>

*RFW: relative fresh weight; VSU: vase solution uptake rate.

**DISCUSSION**

Vase life longevity of cut flowers is one of the main factors in consumer preference while selecting the cut flowers. Different chemicals were tested to increase the postharvest longevity of different cut flowers in various experiments (Beura et al., 2001; Younis et al., 2006). The germicide 8-hydroxyquinoline sulphate is one of the important preservative used in floral industry and Song et al. (1996) reported the positive effects of 8-HQS in controlling bacterial development in stocks held in vase solutions containing sucrose and similar beneficial effects using NaOCl, which delayed the bacterial contamination of vase solution; thereby maintaining fresh weight and prolonging the vase life of the flowers (Song et al., 1996; Elgimabi and Ahmed, 2009). These results are in accordance with present study results (Table 2).

Sugars with biocides have become an important commercial preservative for several cut flowers such as freesia (Kwon and Kim, 2000), gerbera (Ardebili et al., 2013). Sucrose is the main source of carbon that plays a key role in petal growth and delays the petal senescence. It also provides the necessary energy for different metabolic processes
and flower bud opening. In this study the maximum relative fresh weight was noted in pulsing solutions having 500 mg l\(^{-1}\) 8-HQS and 20% sucrose that was due to the biocide, which inhibits the bacterial growth in the solution, while in sucrose pulsing solution relative fresh weight declined rapidly due to the higher concentration of sucrose that encourage the bacterial growth and cause the blockage of xylem vessels that eventually stop water and nutrient uptake from the solution. These findings are in accordance with the findings of van Meetern (1978) and van Doom (1997) who argued that microbes are the most common cause of stem blockage in preservative solution containing sucrose.

Application of 8-HQS significantly increased the vase life as well as the gain of fresh weight of rose cut flowers and the treatments were more effective when sucrose was combined with 8-HQS (Ichimura et al., 1999). Beura et al. (2001) showed that the combined treatment of 8-HQS and sucrose improved the postharvest quality of gladiolus flowers. In Dendrobium flower, holding solutions (8-HQS + sucrose) increased the vase life, flower quality, water consumption, fresh weight and flower freshness. The combined solution treatment also reduced respiration rate and physiological loss in weight (Dineshbabu et al., 2002). Lower concentrations of sugar are more effective for extending vase life as reported by van Doom (1997) and Teixeira (2003). These researchers described that stem end blockage was one of the major factor in the imbalance between water uptake and water loss from cut flower.

Most of the specialty cut flowers have the shortest vase life in tap water (Auman, 1980) and similar trend was observed in this study (Fig. 1). As tap water lacks necessary food supply and biocide that leads to bud blasting and xylem tissue blockage due to proliferation of bacteria. In postharvest studies on cut roses, tap water proved to be the least effective in enhancement of vase life (Kamataka, 2003). Elgimabi (2011) evaluated the role of sucrose and reported it as effective element in extending the vase life of cut roses. Ketsa and Treetaruyanodha (1998) proved, through experimentation reduced bluing, bent neck and stem end blockage and improved the vase life. This also enhanced the water uptake rate and water conductivity. Song et al. (1996) showed that a preservative that contains carbohydrates further prolonged the vase life of stock flowers by improving bud opening and flower longevity. They further found that holding solution having 5% sucrose and 250 mg l\(^{-1}\) 8-HQC was the most effective regarding water relation and post-harvest durability, whereas in present study 200 mg l\(^{-1}\) 8-HQS (in holding solution) and 500 mg l\(^{-1}\) 8-HQS (in pulsing solution) proved to be the most efficient. Butt (2005) studied the effects of different concentrations of sucrose (20, 25 and 30 g l\(^{-1}\)) on the vase life of rose cultivars ‘Trika’ and ‘Whisky Mac’. Sucrose at 25 g l\(^{-1}\) was superior over the other sucrose concentrations with a vase life of 8.2 days in ‘Whisky Mac’ and 7.5 days in ‘Trika’ compared with that of the control (tap water), which averaged 5.3 days. A vase solution combination consisting of sucrose (20 g l\(^{-1}\)) worked effectively in prolonging the sturdiness of individual floret and promoting the flower opening in hybrid Limonium. Other than this, stem wilting was also a major hindrance in effectiveness of vase solution uptake rate. However, stem end blockage and bacterial invasion are the major factors causing wilting of the stem as it reduces ascent of sap and leading the flower to die (Leeuwen, 1986). Thus 8-HQS treatment inhibited microorganism growth in xylem and retained the water uptake by freesia flower stems and increases the vase life of flower (Beura et al., 2001).

One of the big issues in postharvest flower physiology is the blockage of vascular tissues, due to air or bacterial plugging that decreases water uptake which lead to water stress (Hardenburg, 1968). This is expressed in the form of early wilting of leaves or flowers (Henriette et al., 2001), as a result of premature loss of cell turgidity and might appear when water uptake and transpiration are out of balance during a lasting period of time. This finally leads to wilting and the premature end of flower vase life (van Meetern et al., 2001).

CONCLUSION

Based on the results of this study, it is concluded that 200 mg l\(^{-1}\) 8-HQS, 15% sucrose (in holding solution) and 500 mg l\(^{-1}\) 8-HQS (in pulsing solution) treatments improved stock cut flower quality by increasing vase life as measured by improving water balance (relative fresh weight and vase solution uptake) and longevity (vase life) of cut stock flower. Therefore, these treatments have a potential to be used as a commercial cut flower preservative solutions for prolonging vase life and postharvest quality of stock cut flowers.

REFERENCES

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