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Scientific Article

Extension of the vase life of cut sunflower by different vase solutions

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Abstract

Sunflower (*Helianthus annuus* L.) as a cut flower has been an increasing demand in floral industry. However, its vase life is limited because of scape bending, abscission and early wilting of ray flowers. This study was conducted to evaluate the effects of different vase solutions on the vase life of cut sunflower 'Sunrich Orange'. 'Sunrich Orange' was chosen because it is widely used in cut flower industry. Seven treatments were tested: with distilled water (control) as vase solution. The vase life, relative fresh weight, daily and total solution uptake were measured. The results showed that vase life of 'Sunrich Orange' sunflower was significantly affected by different vase solutions. The longest vase life was obtained from the STS (12.3 ± 0.3 days) which increased the vase life by 38.1% compared to the control (8.9 ± 0.5 days).

Keywords: *Helianthus annuus,* salicylic acid, succinic acid, 8-HQS, STS

Introduction

Sunflower (*Helianthus annuus* L.) as a cut flower has been increasing in economic importance in the floral industry (Devecchi, 2005). However, their vase life is short. Vase life of sunflowers varies between 4-13 days depending on cultivar and is terminated by symptoms such as scape bending, abscission and wilting of ray flowers (Gast, 1995; Mensuali-Sodi and Ferrante, 2005). Scape bending is thought to be correlated with genetic backgrounds (Ferrante et al., 2007) however abscission and wilting of ray flowers are known to be caused by senescence. Ethylene is a major factor in senescence especially ethylene sensitive flowers (Tripathi and Tuteja, 2007). Although not clearly understood, there are studies reporting that sunflower is sensitive to ethylene depending on the variety (Reid, 2004; Nazirimoghaddam et al., 2014). The other factor affecting senescence is water stress (Burg, 2014). Reasons for insufficient solution uptake include blockage of xylem vessels by microorganisms, the presence of air emboli in the vascular system, formation of tyloses or deposition of materials in the lumen of xylem vessels (Jedrzejuk et al., 2012). Sunflower stems have many coarse hairs and ridged-thick structure that allows bacteria to easily hold on the stem and subsequently be transferred to the vase solution. So, cut sunflowers can be said to be sensitive to water stress due to bacterial blocking the xylem in the stem (Carlson and Dole, 2013).

Preventing or decreasing ethylene action and blockage of xylem vessels for extending the vase life of cut flowers is possible with using vase solutions containing germicide, surfactant, acidifier or ethylene inhibitor. Several preservative substances which have these properties such as salicylic acid (SA), succinic acid (SUA), benzethonium chloride (BC), 8-hydroxyquinoline sulphate (8-HQS), silver thiosulfate (STS) and glycolic acid (GIA) have been used in several studies and they have been found successful in extending the vase life according to the species, and even cultivars (Kazemi et al., 2011; Bayat and Aminifard, 2017; Uddin, et al., 2016; Kazaz et al., 2019a; Kazaz et al., 2019b). Some of them also have been tested in the vase life of cut sunflowers. Some researchers have reported that vase solutions have positive effects on sunflower vase life whereas other researchers indicated they have no or negative effects (Devecchi, 2005; Clark et al., 2010; Dole et al., 2013; Amin, 2016). This discussion shows that further research is needed to attain the best postharvest quality that maximizes vase life of cut sunflowers. The objective was to determine the effect of the different vase solutions containing STS, 8-HQS, SUA, BC, SA and GIA on the vase life of cut sunflowers.

Materials and Methods

Cut stems of *Helianthus annuus* L. cv. 'Sunrich Orange' were harvested when presented colored ray florets and they just started to lift from the disc (harvest stage 2) (VBN,

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2019) by a commercial grower in Antalya-Turkey and transported dry at 10 ºC to vase life room within 16 hours.

At the vase life room, the flower stems were recut to 55 cm, and all leaves except for the upper two were removed. Five flowers were then placed in each of 1000 mL glass bottles with 750 mL of distilled water (control), 150 mg L^{-1} salicylic acid [SA, (Merck, Cas No: 69-72-7)], 100 mg L^{-1} succinic acid [SUA, (Merck, Cas No:110-15-6)], 20 mg L^{-1} benzethonium chloride [BC, (Sigma-Aldrich, Cas No:121-54-0)], 200 mg L^{-1} 8-hydroxyquinoline sulphate [8-HQS, (Sigma-Aldrich, Cas No:207386-91-2)], 2 mL L^{-1} silver thiosulfate [STS, (VitaSTS)] or 38 mg L^{-1} glycolic acid [GIA, (Merck, Cas No:S7172386703)]. The flowers were kept at 21 ± 1 ºC under 65% ± 5% relative humidity and cool-white fluorescent lamps provided by 1000 lux light for 12 h photoperiod. All solutions were prepared freshly with distilled water at the beginning of experiment and fresh solution was added to the bottles when solution fell below approximately 100 mL.

In the experiment, vase life, fresh weight and solution uptake were examined. Vase life was recorded with the termination determined by one or more of the following criteria: wilting ray flowers, loss of 50% or more of ray flowers and bending of the scape. Fresh weight change was calculated as relative fresh weight (RFW; %) while solution uptake calculated as daily (DSU; g $stem^{-1}day^{-1}$) and total solution uptake (TSU; g $stem^{-1}$**)**, according to He et al. (2006).

The experiment with seven treatments was conducted in completely randomized design with three replicates. Fifteen flowers were used for each treatment. All measurements recorded daily. Data were subjected to analysis of variance (one-way ANOVA) using the IBM SPSS Statistic 20.0. Means were compared by the Duncan's test at P≤0.05.

Results and Discussion

Based on the experimental results, the different vase solutions significantly affected vase life of 'Sunrich Orange' sunflower. The longest vase life was recorded in STS (12.3 ± 0.3 days) which was improved the vase life by 3.4 days compared to control (8.9 ± 0.5 days). Although control showed the lowest vase life, there was no significant difference between control and the other vase solutions tested: GIA (9.1 ± 0.6 days), SA (9.3 ± 0.4 days), SUA (9.5 ± 0.8 days), BC (9.7 ± 0.3 days), 8-HQS (9.9 ± 0.8 days) (Figure 1). Several authors have reported that STS increased the vase life of many cut flower species such as rose (Hayat et al., 2012), carnation (Sharma and Bhardwaj, 2015) and gerbera (Siresha and Reddy, 2016).

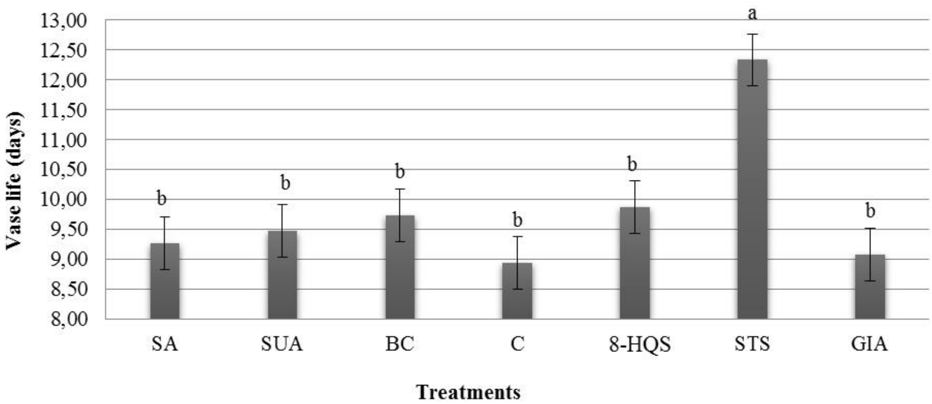

Figure 1. The effects of different vase solutions on vase life of cut sunflowers (Means followed by the same letter are not significantly different at p ≤ 0.05) SA:salicylic acid, SUA:succinic acid, BC:benzethonium chloride, C:control-distilled water, 8-HQS:8-hydroxyquinolin sulphate, STS:silver thiosulfate, GIA:glycolic acid

Similar to vase life results, significant effects were found on RFW. Solutions of 8-HQS and STS were determined more successful than other vase solutions in preserve to RFW. Solutions of 8-HQS and STS increased RFW until the day 6 while other vase solutions, including the control were until day 5. From day 5 and 6 onwards, RFW gradually decreased with time. The onset of the loss in RFW of other vase solutions occurred earlier than 8-HQS and STS. After day 5, RFW showed significant difference according to the vase solutions. The least RFW loss from the day 5 to the end of the vase life was observed in STS (10.4 %) and there was no significant difference between 8-HQS (13.1%) where the highest RFW loss was in GIA (27.6%) (Figure 2). Moreover, the highest average RFW was obtained in STS and 8-HQS respectively and the lowest average RFW was recorded in GIA (Data not shown). Other experiments with cut flowers such as hydrangea, rose and gerbera by Kazaz et al. (2019a), Marandi et al. (2011), Khan et al. (2015) reported that 8-HQS and STS treatments had a positive effect on RFW.

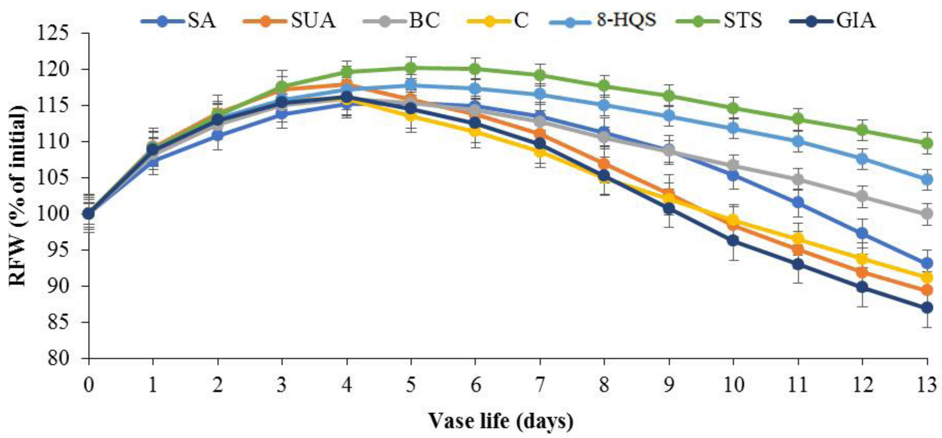

Figure 2. The effects of different vase solutions on relative fresh weight of cut sunflowers
RFW:relative fresh weight, SA:salicylic acid, SUA:succinic acid, BC:benzethonium chloride, C:control-distilled water, 8-HQS:8-hydroxyquinolin sulphate, STS:silver thiosulfate, GIA:glycolic acid

During the vase life, DSU of 'Sunrich Orange' sunflower decreased with time in all treatments except days 4 and 8. The highest DSU was observed on day 1 of all vase solutions. From day 8 onwards, vase life solutions had a significant influence on DSU and the maximum DSU was determined in 8-HQS while the minimum was in SA (Figure 3). Moreover, the highest average DSU was obtained in 8-HQS (59.6 ± 0.9 g stem^{-1}day^{-1}) and the lowest average DSU was recorded in SA (51.1 ± 0.9 g stem^{-1}day^{-1}) (Data not shown).

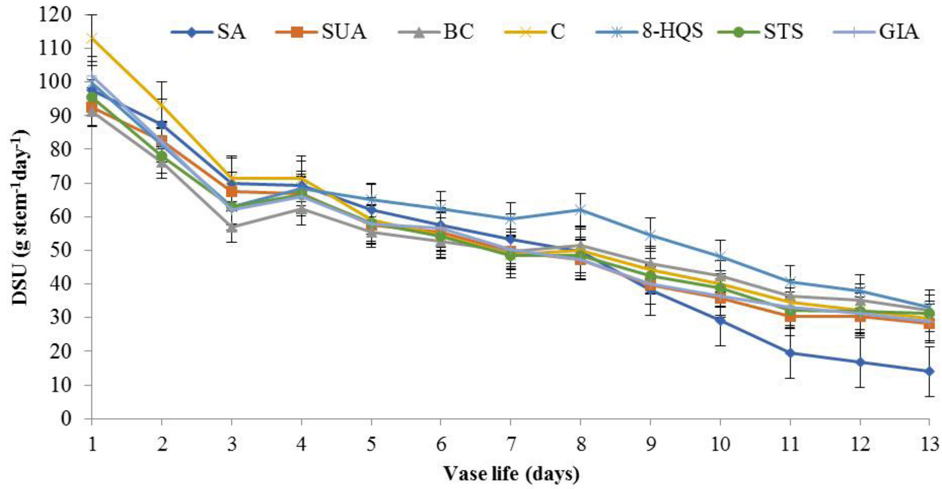

Figure 3. The effects of different vase solutions on daily solution uptake of cut sunflowers
DSU:daily solution uptake, SA:salicylic acid, SUA:succinic acid, BC:benzethonium chloride, C:control distilled water, 8-HQS:8-hydroxyquinolin sulphate, STS:silver thiosulfate, GIA:glycolic acid

Similar results were obtained in TSU. The highest TSU was recorded in 8-HQS (775.6 ± 12.4 g stem^{-1}) while the lowest TSU was in SA (664.3 ± 13.5 g stem^{-1}). The TSU of SUA, BC, STS and GIA solutions were lower than control (Figure 4). This is supported by some studies that 8-HQS is effective to enhance solution uptake (Banaee et al., 2013; Sharma et al., 2018).

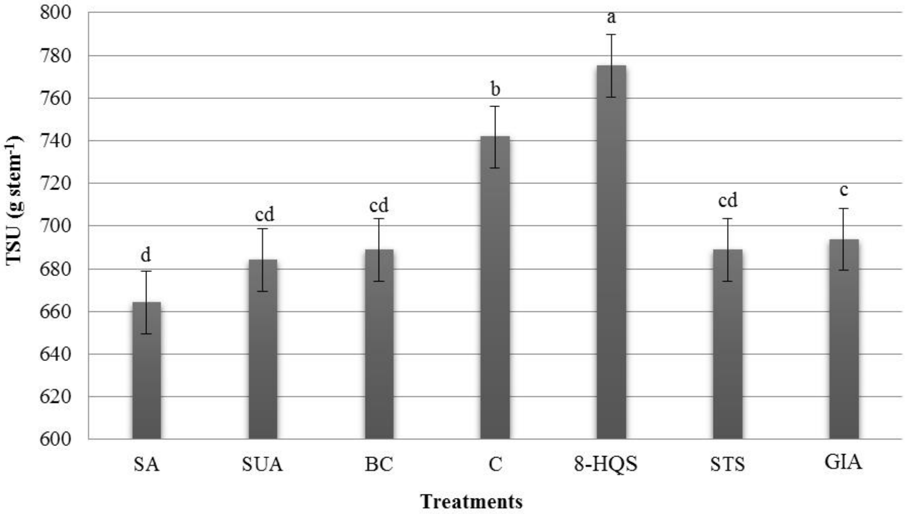

Figure 4. The effects of different vase solutions on total solution uptake of cut sunflowers (Means followed by the same letter are not significantly different at $p \leq 0.05$)
TSU:total solution uptake, SA:salicylic acid, SUA:succinic acid, BC:benzethonium chloride, C:control-distilled water, 8-HQS:8-hydroxyquinolin sulphate, STS:silver thiosulfate, GIA:glycolic acid

STS and 8-HQS are two compounds which improve the vase life by increasing fresh weight and solution uptake. In the results of this study, it was found that STS increased the fresh weight and vase life of 'Sunrich Orange' sunflower but was not very effective on solution uptake. 8-HQS was found to be highly effective on solution uptake and increased fresh weight whereas had no effect on extending the vase life. 8-HQS caused better solution uptake than STS and was effective on fresh weight as well as STS. 8-HQS is a germicide that prevents microbial proliferation in vase solution and also acts as a surfactant decreasing surface tension (Rahman et al., 2012). Therefore, both attributes could have collaborated on improving the solution uptake. Also, less fresh weight loss in 8-HQS is thought to be related with increasing solution uptake. Seyf et al. (2012) stated that there is a positive correlation between fresh weight and solution uptake. But positive effects on solution uptake and fresh weight of 8-HQS were not reflected in vase life of 'Sunrich Orange' sunflower. It may be due to the fact that 'Sunrich Orange' sunflower could be sensitive to ethylene (not clearly defined and ethylene sensitivity of 'Sunrich Orange' was not test in this study). STS is an ethylene inhibitor, was effective to increase the vase of 'Sunrich Orange' sunflower by reduce in fresh weight loss in this study. However, STS, which is also a germicide did not improve solution uptake. STS may be not more effective germicide for cut sunflowers as well as 8-HQS when was thought the micro flora on stems of cut flowers in vase solutions can change (Damunupola and Joyce, 2008). Similar to Damunupola and Joyce (2008), Put (1990) also reported that the microbial density and composition on stems vary across the cut flowers and the microorganisms, present on the stems, were mainly also present in the vase water (Put, 1990). Also, it is thought that the low fresh weight loss despite the low solution uptake may be due to the suppression of ethylene production, which promotes respiration leading to loss in existing carbohydrates. Hayat et al. (2012) indicated that STS can be said as an ethylene inhibitor resulting in reduced respiration rates and achievement of greater fresh weight.

Other vase solutions used in this study were not found effective on 'Sunrich Orange' sunflower vase life. But many researchers determined that BC, SA, SUA and GIA increased the vase life of many cut flowers (Bayat and Aminifard, 2017; Kazaz et al., 2019a; Kazaz et al., 2019b). This result can be explained by the fact that effects of vase solutions depend on the cultivar and dose. SUA and GIA could not have succeeded for extending the vase life of 'Sunrich Orange' sunflower because of the low dose. On the other hand, BC and SA were observed to cause browning on stem of 'Sunrich Orange' sunflower in this experiment and they might have caused toxicity because of high dosage. Many researchers have been reported that high dose of some compounds in vase solution cause toxicity in some cut flower species (Reid, 2009; Aros et al., 2016).

Conclusions

In the study, the longest vase life has been obtained in STS (2 mL L^{-1}) treatment. BC and SA have been observed to cause toxic effects on the stem whereas SUA and GIA no effects. The suitable doses of STS and even BC, SA, SUA, GIA should be investigated on vase life of other sunflower varieties.

Author Contribution

T.K.[0000-0002-0528-7552] and **S.K.**[0000-0002-6644-9690]**:** contribute in all phases. **E.G.E.Ş.**[0000-0002-8088-797X] and **M.U.**[0000-0002-5084-2690]**:** experiment conduction.

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