Postharvest quality of Strelitzia reginae Ait. cut flowers in relation to 8-hydroxyquinoline sulphate and gibberellic acid treatments

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ABSTRACT

The effects of 8-Hydroxyquinoline sulphate (8-HQS) as well as gibberellic acid (GA3) treatments on the vase life and postharvest quality of bird of paradise were investigated. 8-HQS was used at 150, 200 and 250 ppm while GA3 levels were 100, 150 and 200 ppm as overnight pulsing solutions. 8-HQS and GA3 treatments significantly extended the vase life and number of opened florets compared with the control. Moreover, the fresh weight gain from the initial as well as relative water content (RWC) was improved. Chlorophyll content, total carbohydrates as well as membrane stability were maintained as a result of applying 8-HQS or GA3 treatments. Therefore, treating bird of paradise flowers with 8-HQS at 250 ppm or GA3 at 200 ppm was recommended to maximize longevity as well as postharvest quality.

Key words: 8-HQS – GA3 – vase life – carbohydrate – ion leakage

Introduction

Bird of paradise (Strelitzia reginae Ait) plant belongs to Family Strelitziaceae and considers one of the most important cut flower crops in different counties. It occupies a high rank in the floral market and is also used in landscape design. This flowers exhibit irregular and incomplete floret opening as well as floret wilting within a few days after harvest. The challenges encountered by growers of tropical flowers like Strelitzia reginae, are mostly the flowering control and ensuring adequate vase life (Pizano, 2005).

A major cause of quality deterioration in these cut flowers is the blockage of xylem vessels by microorganisms that accumulate in the vase solution or in the vessels themselves. When the stem is blocked, continuing transpiration results in net loss of water of flower and stem tissues. 8-hydroxyquinoline sulphate (8-HQS) is very important germicide in preservatives used in floral industry (Nowak and Rudnicki 1990). HQS acts as an anti-microbial agent (Ketsa et al., 1995) and is increasing water uptake, fresh weight and carbohydrate content (Kim and Lee 2002; Hassam et al., 2003; Hassam et al., 2004). HQS treatment maintained the hydraulic conductance of stem segments near their initial level and suppressed the decrease of carbohydrate concentration after harvest (Ichimura et al., 1999 a, b). The usefulness of 8-HQS on postharvest quality of cut flowers was previously reported (Beura et al 2001; Kim and Lee 2002 a; Tiwari et al 2002; Chikkasubbanna and Yogitha 2002; Dineshbabu et al 2002; Tar and Hassan, 2003).

The postharvest quality of various flowering bulbs was influenced by GA3 application. El-Mokadem et al. (1994) on Strelitzia reginae mentioned that the number of florets/inflorescence, percentage of opened florets/inflorescence, floret vase life and inflorescence duration was increased as a result of GA3 treatment. GA3 treatment has been reported to increase the longevity as well as fresh weight of cut flowers (Mutuee et al., 2001; Sing et al., 2008). GA3 had positive effect on preventing leaf yellowing and increasing soluble sugar and retarding degradation protein and chlorophyll (Faraji et al., 2011) and hence increased the longevity of cut flowers (Eason, 2002; Hunter et al., 2004). Vase life and membrane
stability of cut spike of gladiolus have been increased by using GA₃ which significantly increased solution uptake, fresh weight and dry weight of cut spikes (Singh et al., 2008). Several investigators reported that GA₃ may improve the postharvest quality because of its role on chlorophyll degradation inhibition of leaves (Skutnik et al., 2001; Janowska and Jerzy, 2003 a, b; Janowska, and Stanek, 2011).

On the contrary of the previous literature, Kushal et al. (2000) found that GA₃ treatment did not appear to play any significant role in increasing the vase life or buds opening of tuberose cut flowers. In addition, there were no clear criteria for the optimum levels of 8-HQS or GA₃ for improving the quality of Strelitzia reginae flowers. Therefore, the objective of this work was to study the effects of 8-HQS and GA₃ on the longevity as well as postharvest quality of Strelitzia reginae plant.

Materials and Methods

The flowers of this experiment were obtained from the experimental farm of Faculty of Agriculture, Tanta University, Tanta. Cut flowers were immediately brought to the laboratory of Horticulture Department, Faculty of Agriculture, Tanta University. Bird of paradise flowers were harvested when one floret was fully opened during November 2011 season from the field and immediately transported to the laboratory before trimming to a length of 75 cm.

Flowers were treated with 8-hydroxyquinolone sulfate (8-HQS) at 150, 200 and 250 ppm and GA₃ at 100, 150 and 200 ppm. Both treatments were done as overnight pulsing solutions. After the duration of treatments, the flowers were placed in beakers containing 400 ml distilled water during the vase life evaluation period. The control flowers were kept in distilled water. Four replications of five flowers each were used per treatment in this experiment and the cut flowers were arranged in a complete randomize design.

Vase life determination

The longevity of Strelitzia reginae cut flowers was determined under the laboratory conditions at normal day light at 22 ± 1°C and 70-75% RH and number of open florets and vase life were evaluated daily. Flowers were discarded when the oldest full opened floret was completely wilted and brown as described by Finger et al. (1999).

Fresh weight measurements

Fresh weight determinations of cut flowers were made just before the immersion of the flowers into the solutions and were repeated on the day 7 when the vase life of the control flowers was terminated at the stage which previously mentioned. The spikes were taken out of solutions for such a short time as possible (20-30s). The fresh weight of each flower was expressed relative to the initial weight to represent the % of weight increment for all treatments.

Total carbohydrate content

Total carbohydrate content was determined in florets and samples were taken on day 0 and were repeated on day 7 when the vase life of control flowers was terminated from the second opening floret. The samples were oven dried at 70°C till constant weight and ground into a homogenized fine powder. A 0.5 g sub-sample of this powder was used for extracting the soluble carbohydrate. Total carbohydrates were determined according to Herbert et al., (1971).

Chlorophyll content

Chlorophyll content of spadix was determined according to Sadasivam and Manickam (1992) by using spectrophotometer (Pharmacia, LKB-Novaspec II and calculated as (mgg⁻¹ FW). Samples were taken on day 0 and were repeated on day 7 when the vase life of control flowers was terminated.

Leakage of ions

Froet samples from each treatment were taken on day 0 and were repeated on day 7 for determining ions leakage by using the method of Sairam et al. (1997). Two flroet samples (0.2 g) were taken and placed in 20 ml of double distilled water in two different 50 ml flasks. The first one was kept at 40°C for 30 min while the second one was kept at 100°C in boiling water bath for 15 min. The electric conductivity of the first (C₁) and second (C₂) samples were measured with a conductivity meter. The leakage of ions was expressed as the membrane stability index according to the following formula, MSI = [1 - (C₁/C₂)] X 100

Statistical analysis of results

Seven treatments of four replicates each, in this experiment, were arranged in a completely randomized design. The experiment was performed twice and had qualitative and quantitative similar results. The results were combined and analysis of variance (ANOVA) was performed using SPSS program Base 9, SPSS Inc. USA. Means were compared by using Duncan multiple range test at 0.05 level.
Results

Vase life and opened florets

It is obvious from results of Table (1) that all treatments of 8-HQS or GA3 significantly extended the vase life and increased number of opened florets of Strelitzia reginae cut flowers compared with the control. The longest vase life was obtained by using 200 ppm GA3 (11.76 Days) followed by 250 ppm 8-HQS (10.85 Days) however, untreated flowers recorded (5.55 Days) only. In addition, both treatments resulted in the maximum number of opened florets compared with control or the other treatments. Otherwise, there were no significant differences between the previous two treatments in this regard.

Table 1. Effect of 8-hydroxyquinoline sulphate (8-HQS) and gibberillic acid (GA3) treatments on vase life, number of opened florets and fresh weight changes of Strelitzia reginae cut flowers.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Vase life (Days)</th>
<th>No. of opened florets</th>
<th>Fresh weight changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6.55e</td>
<td>1.75d</td>
<td>Day 0: 81; Day 7: 83; Gain (%): 2.47f</td>
</tr>
<tr>
<td>150 ppm 8-HQS</td>
<td>8.24d</td>
<td>2.45c</td>
<td>Day 0: 80; Day 7: 88; Gain (%): 10.00e</td>
</tr>
<tr>
<td>200 ppm 8-HQS</td>
<td>9.64c</td>
<td>2.77c</td>
<td>Day 0: 82; Day 7: 93; Gain (%): 13.41d</td>
</tr>
<tr>
<td>250 ppm 8-HQS</td>
<td>10.85b</td>
<td>3.52a</td>
<td>Day 0: 80; Day 7: 97; Gain (%): 21.25b</td>
</tr>
<tr>
<td>100 ppm GA3</td>
<td>8.43d</td>
<td>2.51c</td>
<td>Day 0: 81; Day 7: 89; Gain (%): 9.88e</td>
</tr>
<tr>
<td>150 ppm GA3</td>
<td>10.67b</td>
<td>3.12b</td>
<td>Day 0: 81; Day 7: 95; Gain (%): 17.28c</td>
</tr>
<tr>
<td>200 ppm GA3</td>
<td>11.76a</td>
<td>3.63a</td>
<td>Day 0: 80; Day 7: 99; Gain (%): 23.75a</td>
</tr>
</tbody>
</table>

Means followed by different letters differ significantly for each other according to Duncan multiple range test at P = 0.05.

Fresh weight changes

Fresh weight of cut flowers kept in water or treated with 8-HQS or GA3 was increased in the 7th day compared with the initial weight at the beginning of the experiment. However, 8-HQS or GA3 treatments significantly maximized this increment compared with control (Table 1). Generally, GA3 was more effective than 8-HQS one. The highest fresh weight gain (23.75 %) was obtained by 200 ppm GA3 treatment followed by (21.25 %) when 250 ppm 8-HQS was applied however, untreated flowers gained (2.47 %) only

Relative water content (RWC)

The effects of 8-HQS or GA3 treatments on RWC of bird of paradise cut flowers were presented in Table (2). RWC was decreased with the progressive development during postharvest days in both treated and non treated spikes. However, 8-HQS or GA3 treatments significantly reduced this decline in florets compared to the control. The highest relative water content was recorded by 200 ppm GA3 followed by 250 ppm 8-HQS since there were no significant differences between them.

Table 2. Effect of 8-hydroxyquinoline sulphate (8-HQS) and gibberillic acid (GA3) treatments on relative water content (RWC) and spadix chlorophyll content of Strelitzia reginae cut flowers.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>RWC (%)</th>
<th>Chlorophyll content (mg g⁻¹ fresh weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 0</td>
<td>Day 7</td>
</tr>
<tr>
<td>Control</td>
<td>87.25a</td>
<td>62.64d</td>
</tr>
<tr>
<td>150 ppm 8-HQS</td>
<td>88.43a</td>
<td>75.12c</td>
</tr>
<tr>
<td>200 ppm 8-HQS</td>
<td>87.62a</td>
<td>79.45b</td>
</tr>
<tr>
<td>250 ppm 8-HQS</td>
<td>88.34a</td>
<td>83.47ab</td>
</tr>
<tr>
<td>100 ppm GA3</td>
<td>89.81a</td>
<td>76.25c</td>
</tr>
<tr>
<td>150 ppm GA3</td>
<td>88.74a</td>
<td>80.63b</td>
</tr>
<tr>
<td>200 ppm GA3</td>
<td>88.15a</td>
<td>85.09a</td>
</tr>
</tbody>
</table>

Means followed by different letters differ significantly for each other according to Duncan multiple range test at P = 0.05.

Chlorophyll content

The total chlorophyll content of flowers spadix was decreased during the days of vase life evaluation. However, a sharp decline in chlorophyll content was recorded in control flowers after 7 days (Table 2). Meanwhile, 8-HQS or GA3 treatments significantly retarded this reduction of chlorophyll especially with higher levels. By the 7th day 38.52 % of initial chlorophyll content was reduced in control, whereas, the reduction levels were 20.33 and 8.94 % for 250 ppm 8-HQS and 200 ppm GA3, respectively.

Carbohydrate content

The florets carbohydrate content of Strelitzia reginae cut flowers was positively affected by different 8-HQS or GA3 treatments (Table 3). 8-HQS or GA3 significantly increased carbohydrate content in florets compared with the control in the 7th day. Increasing 8-HQS or GA3 levels gradually increased the carbohydrate content in florets. However,
carbohydrate content was decreased in untreated flowers. The highest florets carbohydrate content (12.87 and 11.67 %) was obtained by 200 ppm GA3 and 250 ppm 8-HQS, respectively.

Table 3. Effect of 8-hydroxyquinoline sulphate (8-HQS) and gibberillic acid (GA3) treatments on carbohydrate content and membrane stability index (MSI) of Strelitzia reginae cut flowers.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Carbohydrate (%)</th>
<th>MSI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 0</td>
<td>Day 7</td>
</tr>
<tr>
<td>Control</td>
<td>10.65a</td>
<td>9.53d</td>
</tr>
<tr>
<td>150 ppm 8-HQS</td>
<td>10.72a</td>
<td>10.65c</td>
</tr>
<tr>
<td>200 ppm 8-HQS</td>
<td>10.69a</td>
<td>10.92bc</td>
</tr>
<tr>
<td>250 ppm 8-HQS</td>
<td>10.71a</td>
<td>11.76b</td>
</tr>
<tr>
<td>100 ppm GA3</td>
<td>10.67a</td>
<td>10.82bc</td>
</tr>
<tr>
<td>150 ppm GA3</td>
<td>10.71a</td>
<td>11.65b</td>
</tr>
<tr>
<td>200 ppm GA3</td>
<td>10.64a</td>
<td>12.87a</td>
</tr>
</tbody>
</table>

Means followed by different letters differ significantly for each other according to Duncan multiple range test at P = 0.05.

Membrane stability index (MSI)

Data presented in Table (3) show that a sharp loss of MSI was occurred in control florets upon the progression of floret senescence during the postharvest days. However, all 8-HQS or GA3 treatments retained the MSI at higher levels compared to the control. At day 7, the MSI for control florets was 51.46 % compared with 74.81 and 75.67 % for 250 ppm 8-HQS and 200 ppm GA3, respectively.

Discussion

The results show the importance of 8-HQS and GA3 in extending the vase life and increasing the postharvest quality of strelitzia cut flowers. The effective role of 8-HQS could be explained through keeping fresh weight and chlorophyll as well as carbohydrates losses by 8-HQS to a minimum. These results are in agreement with the findings of Hussein (1994), Knee (2000) Bhattacharjee (1994), Ichimura et al. (1999) and Kim and Lee (2002a). Applying 8-HQS also may prevent the accumulation of microorganisms in xylem vessels and suppressed the xylem occlusion due to its role as anti-microbial agent and hence, it might reduce stem plugging. 8-HQS treatment prevented the growth of microorganisms in the xylem and thus maintained water uptake by freesia flower stems (Kwon and Kim 2000). The blockage of xylem vessels led to water stress and it is well known that the limiting factor of vase life is water stress that is expressed in the form of early flowers wilting (Henriette and Clerkx 2001).

It could be noticed from the results that 8-HQS treatments led to maximize the fresh weight gain of cut flowers tested in this study. The increment in fresh weight may be due to its additional role in increasing water uptake (Hassan et al., 2003). However, there is a limited water uptake in untreated flowers and unbalance between water uptake and transpiration that finally leads to an unrecoverable situation and the premature end of its vase life (Van Meeteren et al., 2001). This explains the short vase life of untreated control and long vase life when 8-HQS was applied because transporting of water and minerals is of vital importance for the flowers development. However, obstruction of the wood vessels is a commonly occurring problem affecting the vase life of cut flowers. These results are in harmony with the findings of Kim and Lee (2002). The increment in total carbohydrates occurred by 8-HQS was very important in extending the vase life. These results are in agreement with the findings of Abdel-Kader et al. (2004) who found that the higher the reducing sugars in the petals, the longer the vase life of dahlia flowers.

Maintaining the membrane stability by 8-HQS can also explain the improvement of postharvest quality of flowers suggesting that 8-HQS may reduced the plasmolysis of cells which occurred when the rate of cellular water loss is too rapid or too excessive then the inner plasma membrane will break away from the cell wall. These results are in harmony with observations by Kim and Lee (2002b) who mentioned that more lignin was formed in the phloem of roses held in 8-HQS solution than the control. Parenchyma cells of untreated flowers had thinner cell walls and fewer starch grains at senescence compared with those held in 8-HQS solution. In addition, globular crystals were observed in the inner part of cells. It was suggested that these crystals accumulated in cell walls and prevented cell wall decomposition on increased cell wall permeability. Moreover, Amariutei et al. (1995) found that cells from ligulae of gerbera inflorescences held in preservative solution maintained their ultra-structure adequately, as compared with the control, which was in a very advanced phase of degradation after 8 days of vase life.

Our results also indicate the importance of GA3 in enhancing the postharvest quality and extending the vase life of cut flowers. These positive effects of GA3 may be due to its effect on maintaining water balance and improving RWC as our data indicated. Moreover, GA3 also controlled chlorophyll reduction and this is a factor affecting the vase life (Van Doorn et al., 1993). Otherwise, GA3 increased gladiolus vase life via increasing lipids peroxidation and then decrease activity of lipoxigenase enzyme and improving petal cell wall substance (Singh et al., 2008).

GA3 affect on alpha-amylase synthesis significantly, therefore total soluble carbohydrate content increased and this could contribute to improve the energy pool (or resource) and/or increase the osmotic potential of flowers (Andrew et al., 2010). The main effect of applied GA3 in extending cut flower vase life was to maintain mitochondrial structure and functions. GA3 delay the senescence of flower and reduced the effect of ethylene in promoting. There is a possibility of
GA3 by either chemical quality the sensitivity of the tissue ethylene or by delaying the natural rise in ethylene formation. From the results of this study it could be concluded that, in order to obtain the highest postharvest quality of Srtelitizia reginae Ait cut flowers, the treatment 8-HQS at 250 ppm or GA3 at 200 ppm was recommended.

References
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