Study on the Effect of Different Chemicals and Essential Oils on the Vase Life Of Gladiolus (Var American Beauty) Cut Flower

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Abstract

An experiment was conducted at the Department of Horticulture, Institute of Agriculture and Animal Science Paklihawa, Rupandehi to study the effect of different chemicals and essential oils on the vase life of cut flowers of gladiolus (Gladiolus grandiflora cv. "American Beauty"). The experiment was based on a completely randomized design with eight treatments (sucrose 4%, sucrose 4% + ethanol 25 + salicylic acid (200 ppm), sucrose 4% + silver nitrate (200 ppm), sucrose 4% + citric acid (200 ppm), sucrose 4% + ethanol 25%, sucrose 4% + ethanol 25% + eucalyptus oil 1%, sucrose 4% + ethanol 25% + palmarosa oil 1% and distilled water) for each treatment unit. Silver nitrate (200 ppm) had a maximum beneficial effect on fresh weight retention, solution uptake, spike diameter, and floret wilting at the end of vase life which was closely followed by Citric acid (200 ppm). The citric acid (200 ppm) had maximum positive effects on bud opening and floret opening at the end of vase life which was closely followed by Silver nitrate (200 ppm). And, the effects of silver nitrate (200 ppm) and citric acid (200 ppm) were the same on the basal floret diameter on the ninth day. A strong positive correlation existed between the vase life of cut flowers and other parameters such as fresh spike weight, solution uptake, bud opening, floret opening, and basal floret diameter. The longest vase life (18.56 days) was observed in silver nitrate (200 ppm), which was closely followed by citric acid (200 ppm) i.e., 18.11 days, and the shortest vase life (9.89 days) was observed in eucalyptus oil 1% in comparison to control (15.56 days). A blend solution of citric acid (200 ppm) and sucrose 4% is recommended to use for prolonging the vase life of gladiolus cut flowers.

Keywords: Antimicrobial, Eco-friendly, Gladiolus, Vase-life.

Introduction

Gladiolus (*Gladiolus grandifloras* Andrews*)* belongs to the monocot family Iridaceae, is supposed to be a native of Europe, Mediterranean region, Tropical and South Africa, and Mascarnea Islands (Rao, 1979). It is popularly known as "Sword lily" and often known as "queen of the bulbous flowers" and, rated as the most popular flower in the world, especially from the commercial point of view (Hamilton, 1976). Gladiolus is cultivated in most of the tropical and subtropical regions throughout the world (Lim, 2014) as well as in Nepal, as a winter season flower.

The gladiolus is a perennial bulbous and half-hardy flowering plant containing attractive, elegant, and delicate florets opening in sequence from bottom to top along with the spikes. They vary in their height from one to four feet; some are soft and light, others robust and strong adapted to any climate except the frigid condition (Childs, 1873). Gladiolus spikes take 60 to 100 days after planting to be harvested depending upon the cultivar and season (Jenkins, 1963), and floret spikes normally last for only 6-7 days, which is too less a post-harvest life for marketing for the distant markets. The vase life of gladiolus cut flower is increased by pulsing with sucrose or using vase preservatives containing sucrose (Marousky, 1968) and biocides like ionic silver compound (Veen, 1979). But the adverse effect of chronic exposure to soluble forms of silver is permanent bluish-gray discoloration and irritation of the skin and eyes, liver and kidney damage, respiratory and intestinal problems, and changes in blood cells (Drake & Hazelwood, 2005). The American Conference of Governmental Industrial Hygienists has recommended exposure limit of soluble silver compounds by $0.01 mg/m^3$. While ionic silver compound has a toxic effect on human as well as environment and, organic acid and essentials oil had a noticeable effect on the improvement of vase life of cut gladiolus flowers which might be due to their antibacterial properties that reduce bacterial proliferation in the stem vessels of cut flowers (Jowkar et. al., 2012; Marandi et al., 2011). Thus, the present study is conducted to explore the maximum longevity of the cut spikes of the gladiolus by using various vase solutions including organic acid and essentials oils which possess no adverse effects on human health as well as the environment.

Methodology

Plant Materials

The study was conducted at the laboratory of Department of Horticulture, Institute of Agriculture and Animal Science, Paklihawa Campus, Rupandehi, from December 29th 2018 to January 21st 2019. Cut sticks of gladiolus (var. American Beauty) having 1 or 2 opened floral buds were obtained from Abloom Flora Farm, Chitwan. The floral spikes of 95 cm length were harvested in the evening from single plot and transported to the laboratory with proper packaging and careful handling. Spikes were pulsed with tap water for 20 hours before the experiment. Spikes were cut with secateurs to 70 cm and the cutting was done underwater to exclude the entry of air bubble into the xylem vessel of spikes.

Preparation of Treatment Solutions

Solutions were freshly prepared at the start of the experiment. 8 treatments were carried out in this study. Name of chemical reagents with their manufacturing company is listed in table 1:

Table (1): List of Chemical reagents used in the experiment.

S.N	Chemical Reagents	Manufacturing Company
1.	Sucrose	Qualikems Fine Chem Pvt. Ltd, Gujarat, India
2.	Ethanol	Changshu Hongsheng Fine Chemical Co. Ltd, China
3.	Salicylic Acid (SA)	Paskem Fine Chem Pvt Ltd, Uttar Pradesh, India
4.	Silver Nitrate (SN)	SD Fine Chem Limited, Mumbai, India
5.	Citric Acid (CA)	Qualikems Fine Chem Pvt. Ltd, Gujarat, India
6.	Eucalyptus Oil	Herbs Production & Processing Co. Ltd, Kathmandu, Nepal
7.	Palma Rosa Oil	Herbs Production & Processing Co. Ltd. Kathmandu, Nepal

Treatment solutions were prepared with the following procedures:

1) T1: Sucrose 4%

   80g sucrose were dissolved in 2 liters of distilled water to obtain sucrose 4% solution.

2) T2: Sucrose 4% + Ethanol 25% + SA (200 ppm)

   20 grams of sucrose were dissolved in 375 ml of distilled water and 125 ml of ethanol was added to make 500 ml of sucrose 4% + ethanol 25% solution. Then, 1 gram of SA was added in 500 ml of sucrose 4% + ethanol 25% solution to make the stock solution of SA (2000 ppm) and the solution was stirred with a magnetic stirrer for quick solubilization of salicylic acid, which gets partially dissolved.

   Using dilution equation,

   $C_1V_1 = C_2V_2$ Where, C_1= concentration of stock solution

   $2000*V_1 = 200*300$ V_1= required volume of stock solution to be taken

   $V_1= (200*300)/2000$ C_2= concentration of dilute solution

   $V_1=30$ ml V_2= volume of dilute solution

   Hence, 30 ml of stock solution was mixed with 270 ml of sucrose 4% and ethanol 25% solution to make 300ml of sucrose 4% + ethanol 25% + SA (200 ppm) solution.

3) T3: Sucrose 4% + SN (200 ppm)

   20 grams of sucrose were dissolved in 500 ml of distilled water and 1 gram of SN was added to make a stock solution of SN (2000 ppm).

   Again,

   $$C_1V_1 = C_2V_2$$
   $$2000*V_1 = 200*300$$
   $$V_1= (200*300)/2000$$
   $$V_1=30 \text{ ml}$$

   Hence, 30 ml of stock solution was mixed with 270 ml of sucrose 4% solution to make 300ml of sucrose 4% and SN (200 ppm) solution.

4) T4: Sucrose 4% + CA (200 ppm)

   The same procedure was followed as the preparation of sucrose 4% + SN (200 ppm).

5) T5: Ethanol 25% + Sucrose 4%

   40 grams of sucrose were dissolved in 750 ml of distilled water and 250 ml ethanol was added to obtain ethanol 25% and sucrose 4%.

6) T6: Sucrose 4% + Ethanol 25% + Eucalyptus Oil 1%
   40 grams of sucrose were dissolved in 750 ml of distilled water and then 250 ml of ethanol was added to make 1 liter of ethanol 25% and sucrose 4% solution. Later, 297 ml of thus prepared solution was taken and 3ml of eucalyptus oil was added to make 300 ml of sucrose 4% + ethanol 25% + eucalyptus oil 1% solution.
7) T7: Sucrose 4% + Ethanol 25% + Palmarosa Oil 1%
   The same procedure was followed as the preparation of sucrose 4% + ethanol 25% + eucalyptus oil 1% solution.
8) T8: Control
   300ml distilled water was taken for each treatment.

Observed Parameters

Fresh weight determination of the spike was made just before the immersion of the spikes into the vase solutions. Then, the weight of spikes was measured on every alternate day by taking out of water for as short a time as possible (20-30s). The volume of solution uptake was measured on every alternate day. Solution uptake was calculated by subtracting the present reading of the volume of solution from the previous reading of the volume of the solution. Spike diameter was measured at the 3 cm below the first floret with a digital caliper on every alternate day. Bud was considered open when the calyx was opened and the tinge color of the petal was seen. The number of opened and unopened floral buds were counted daily. The total number of buds on each spike was counted before the immersion of the spikes into the vase solutions and the bud opening percentage was calculated using the following formula.

$$\text{Percentage of opened bud} = \frac{\text{Number of open buds on the spike}}{\text{Total no. of bud on the spike}} \times 100$$

Floret was considered open after the bud opening stage in which the petals were wide open and the anthers were seen clearly. The number of florets was counted daily. The total number of buds on each spike was counted before the immersion of the spikes into the vase solutions and the floret opening percentage was calculated using the following formula.

$$\text{Percentage of flowering} = \frac{\text{Number of florets on the spike}}{\text{Total no. of bud on the spike}} \times 100$$

The basal floret is usually the biggest so it is also a key parameter for the marketability of gladiolus cut flowers. Basal bud diameter and basal floret diameter was measured daily using a digital caliper. The number of wilted florets (drooped and shed) was counted daily. The total number of opened buds on each spike was counted and the floret wilting percentage was calculated using the following formula:

$$\text{Percentage of floret wilting} = \frac{\text{Number of wilted florets on the spike}}{\text{Total no. of (opened buds + florets) of a spike}} \times 100$$

Wilting of florets was used as the criterion for the termination of the vase life. Visual observation of flower wilting was evaluated daily during the vase life of flowers. Vase life was defined as the number of days in vase life required for 50% of flowers to reach the wilting stage. Daily temperature and relative humidity were measured using a data logger and digital hygrometer.

Experimental Set-Up

The experiment was laid out in a completely randomized design (CRD) with eight treatments and three replications. After recording the weight of each empty conical flask and fresh weight of the spikes, 3 spikes were placed in each treatment vase of 500ml conical flask containing 300 ml preservative solution. Each treatment, replication, and flower were tagged separately. Spikes were supported with cotton on the mouth of the conical flask to avoid bruising and to reduce the evaporation of the vase solution. The conical flasks were placed above filter paper spaced at a distance of 30 cm. The spikes were held at ambient temperature (17±2°C) and relative humidity 64% - 82%. 3 cm of the spike was recut on the fifth day and 200ml additional treatment solutions were added in each conical flask on the tenth day of the experiment.

Statistical Analysis

All observed parameters were subjected to analysis of variance (ANOVA). Significant effects of treatments were identified by analyzing data using IBM SPSS software version 20. Mean comparisons to identify significant differences among treatment were performed using Duncan's multiple range test (DMRT) with significance level of 5% and graphs were plotted using Microsoft Excel 2016.

Result and Discussion

Fresh Spike Weight

During the first five days of the experiment relative fresh weight of all treatments showed an increasing trend and between treatments, SN (200 ppm) resulted in better fresh weight retention (69.66gm). From the fifth day onwards fresh weight retention showed a decreasing trend in treatments SA (200 ppm), sucrose 4% + ethanol 25%, eucalyptus oil 1%, palma rosa oil 1%, and control but the relative fresh weight was still increasing for the treatments sucrose 4%, SN (200 ppm) and CA (200 ppm) up to the ninth day of the study 'Figure 1'. The lowest spike weight (38.72gm) was observed in the control at the end of vase life. SN (200 ppm) (71.56gm) followed by CA (200 ppm) (57.19gm) showed the highest fresh weight retention and therefore resulted in the least fresh weight loss at the end of vase life. In a similar study in two cultivars (White Friendship and Nova-Lux) of gladiolus, fresh weight increased to the maximum level on the third day with 200 ppm SN solution (Tiwari et al., 2010) and SN (250 ppm) + sucrose 3% had maximum spike fresh weight in the gladiolus "Alexandra" variety (Manzoor et al., 2018). This might be due to the maximum uptake of the solution with reserved food from SN and CA solutions, and this silver nitrate and citric acid in vase solution acts as a germicide and sucrose as reserved food. Jowkar et al. (2012) also found that citric acid as a preservative solution resulted in higher weight increment for cut rose flowers.

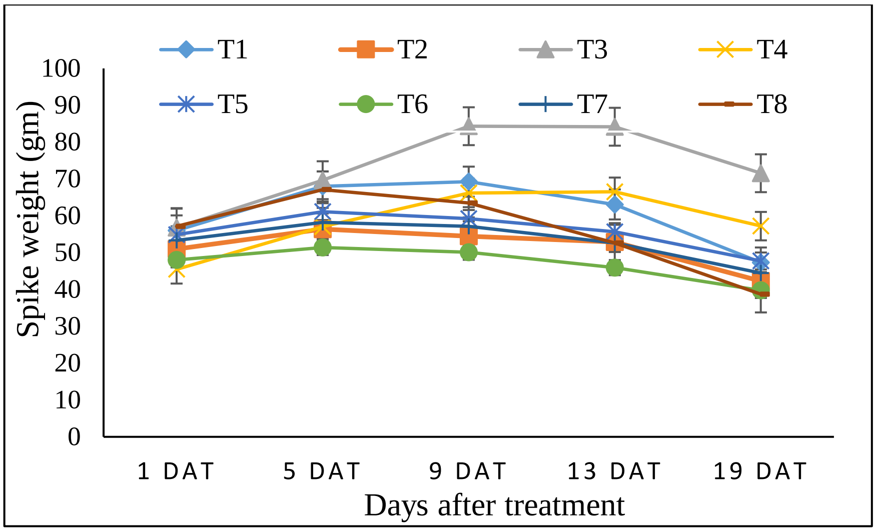

Figure (1): Effect of different chemicals and essential oils on the spike weight of gladiolus "American Beauty" cut flowers. T1: Sucrose 4%, T2: Sucrose 4% + Ethanol 25% + SA (200 ppm), T3: Sucrose 4% + SN (200 ppm), T4: Sucrose 4% + CA (200 ppm), T5: Sucrose 4% + Ethanol 25%, T6: Sucrose 4% + Ethanol 25% + Eucalyptus Oil 1%, T7: Sucrose 4% + Ethanol 25% + Palma Rosa Oil 1%, T8: Distilled Water (control).

Solution Uptake

There was high solution uptake in all treatments up to the fifth day, maximum (123.67ml) with sucrose 4%. After the fifth day, there was a decreased solution uptake rate in treatments SA (200 ppm), sucrose 4% + ethanol 25%, eucalyptus oil 1%, and palma rosa oil 1% but solution uptake rate decreased only after the ninth day in case of sucrose 4%, SN (200 ppm), CA (200 ppm) and control 'Figure ii'. Although at initial stages solution uptake in sucrose 4% were maximum but at most stages throughout the experiment, SN (200 ppm) followed by CA (200 ppm) had the highest solution uptake with 391.67 ml and 345 ml respectively, in comparison to control (193.33 ml) and minimum (148.33 ml) solution uptake was recorded with eucalyptus oil 1%. This was more evident during the first five days of the experiment and especially at the end of vase life 'figure 2'. Since silver nitrate and citric acid acts as antibacterial agents, reduces the bacterial infection avoiding xylem blocking thus induces the continuous solution uptake (Meeteren, 1978). Mehdikhah et al. (2016) found the most effective treatment on vase solution uptake was 100mgl^{-1} CA as compared to the SA and control (distilled water). CA can alleviate water uptake and extend vase life due to its anti-embolism trait (Bhattacharjee et al., 1993) and our present study also showed similar findings.

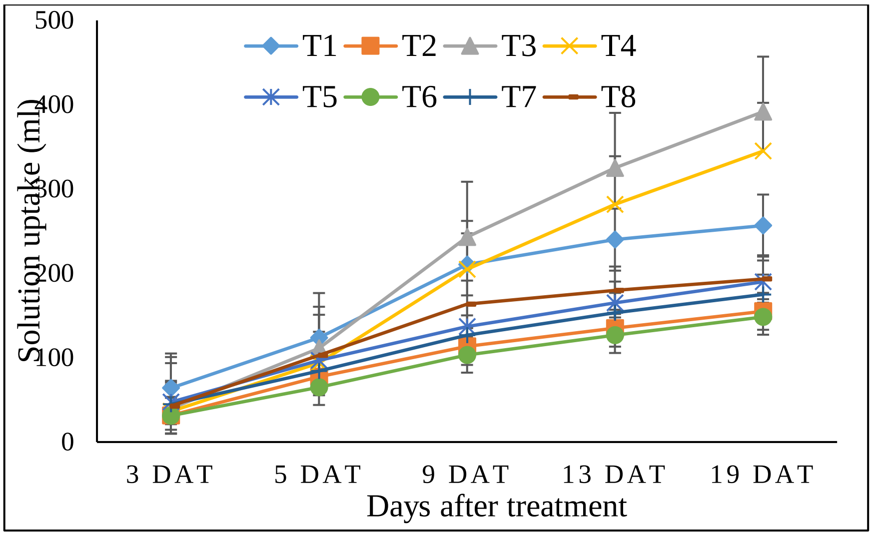

Figure (2): Effect of different chemicals and essential oils on solution uptake by gladiolus "American Beauty" cut flowers.

Spike Diameter

The spike diameter for all treatments was recorded similar in the initial days (up to day four) and found in decreasing trend after the fourth day of the study 'Figure 3'. There was no significant difference in spike diameter of gladiolus cut flower on the eighth day of the experiment for all the treatments. But at the end of vase life, maximum spike diameter (9.65mm) was recorded with SN (200 ppm) followed by control (9.50mm) and minimum (8.04mm) with eucalyptus oil 1%. Since SN (200 ppm) solution was the highest solution uptake by spikes, in which absorbed sucrose acts as carbohydrate substrate and help to retain the freshness of spikes, maintaining mechanical rigidity of stem including cell wall thickening and lignification of vascular tissue (Steinitz, 1982) and lowest solution uptake was observed in eucalyptus oil 1%, which had affected spike diameter inversely. Similar finding that the maximum spike diameter of yellow gladiolus observed with 3% sucrose + 100 ppm STS was reported by Jamal Uddin et al. (2016).

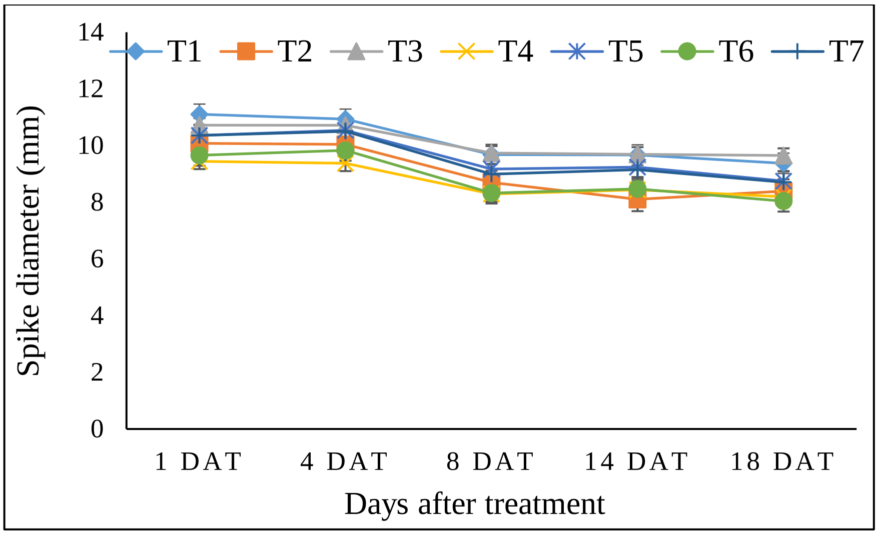

Figure (3): Effect of different treatment solutions on spike diameter of gladiolus "American Beauty" cut flowers.

Bud Opening

Sucrose, citric acid and silver nitrate, and essential oils individually, increased bud opening in comparison to control. There was a high bud opening rate during the first five days of the experiment for all treatments after which there was a decrease in bud opening rate. Throughout the experiment, maximum (88.50%) bud opening was recorded with CA (200 ppm) followed by SN (200 ppm) (84.49%), and minimum bud opening (61.83%) was found with control 'Figure 4'. Similar finding by Srilaong & Buanong (2007) suggests that embolism can reduce the water uptake and sugar from the preservative solution and it can reduce anthesis.

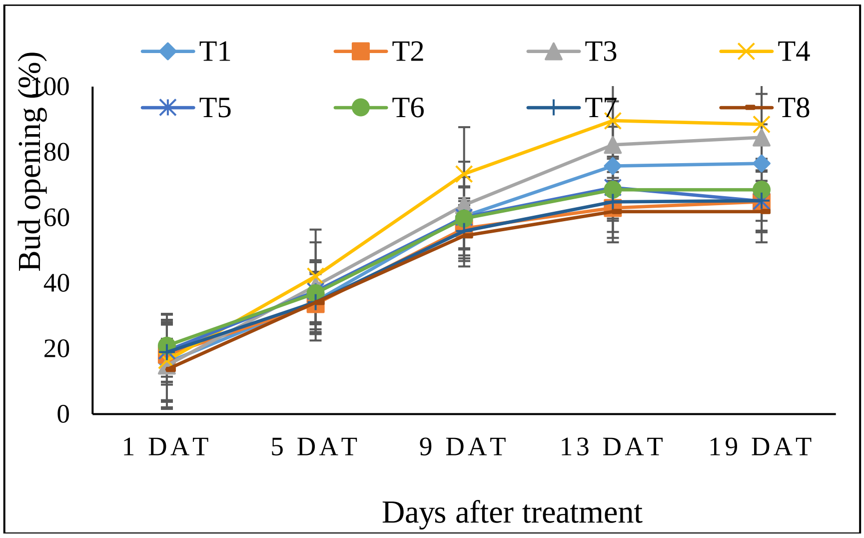

Figure (4): Effect of different chemicals and essentials oils on bud opening of gladiolus "American Beauty" cut flowers.

Floret Opening

The opening of floret starts after the third day of the treatment. There was no significant difference in floret opening during the fifth day of the experiment. The minimum floret opening (36.03%) was recorded in SA (200ppm) treatment followed by eucalyptus oil 1% (44.19%) and the maximum floret opening (87.71%) was seen in the CA (200 ppm) followed by SN (200 ppm) (84.49%) at the end of vase life 'Figure 5'. The treatments containing ethanol showed a minimum floret opening. These results may be probably due to the using silver nitrate and citric acid at a suitable concentration in vase solution led to a decrease of carbohydrate depletion and delay senescence (Serek et al., 1994) and increase the vase solution uptake (Meeteren, 1978). All these attributes led to an increase in the cumulative synthesis materials in the cut gladiolus spikes, consequently, the number of fully opened florets per spike could be increased. Similar to our finding, Hassan et al. (2004) found that the number of open florets increased when ethylene action inhibitors, such as silver thiosulphate (STS)/silver compound or 1-methyl cyclopropane (1MCP), were used. The addition of silver containing compound with sucrose 3% in holding solution had a positive effect on floret opening of cut white gladiolus which also extended vase life (Jamal Uddin et al., 2016).

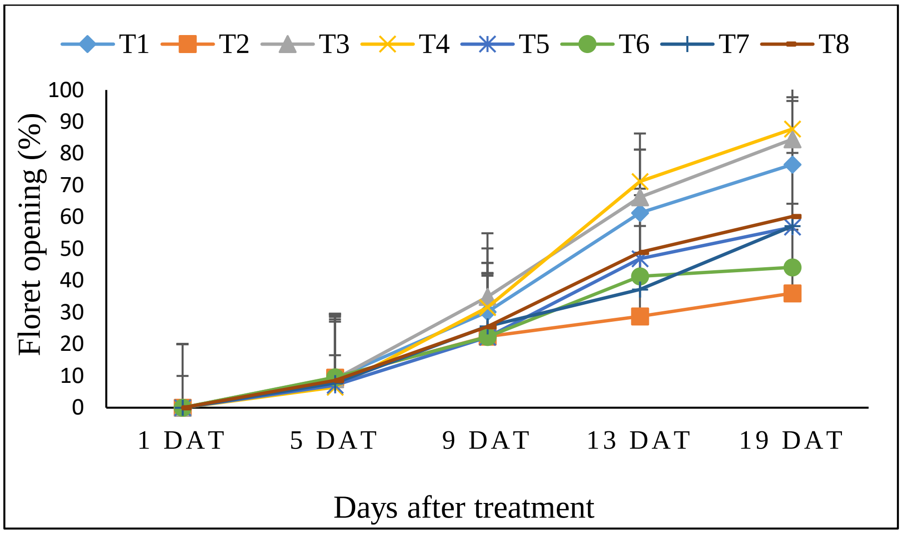

Figure (5): Effect of different chemicals and essential oils on flowering of gladiolus "American Beauty" cut flowers.

Basal Floret Diameter

The present study showed a maximum basal floret diameter for all treatments was recorded on the seventh day of the experiment after which there was a decrease in diameter except CA (200 ppm) 'Figure 6'. On the seventh day, maximum basal floret diameter (10.89cm) was recorded with SN (200 ppm) followed by sucrose 4% (10.29 cm), and minimum basal floret diameter was found with eucalyptus oil 1% (7.06 cm) followed by SA (200 ppm) (7.35 cm). The maximum floret diameter (5.0 inch) in variety "Alexandra" was observed when its spikes were dipped in a solution of SN (250 ppm) + sucrose 3% (Manzoor et al., 2018) and their finding was closely related to the present study. But on the ninth day of study, basal flower diameter (10.67 cm) was the same with both SN (200 ppm) and CA (200 ppm). High positive correlation existed in basal floret diameter and among other parameters such as fresh spike weight retention, solution uptake, floret opening, bud opening at ninth day, and also on vase life whereas, a high negative correlation was found with floret wilting at ninth day. This fact was also in agreement with two cultivars White Friendship and Nova-Lux reported by Tiwari et al.,2010).

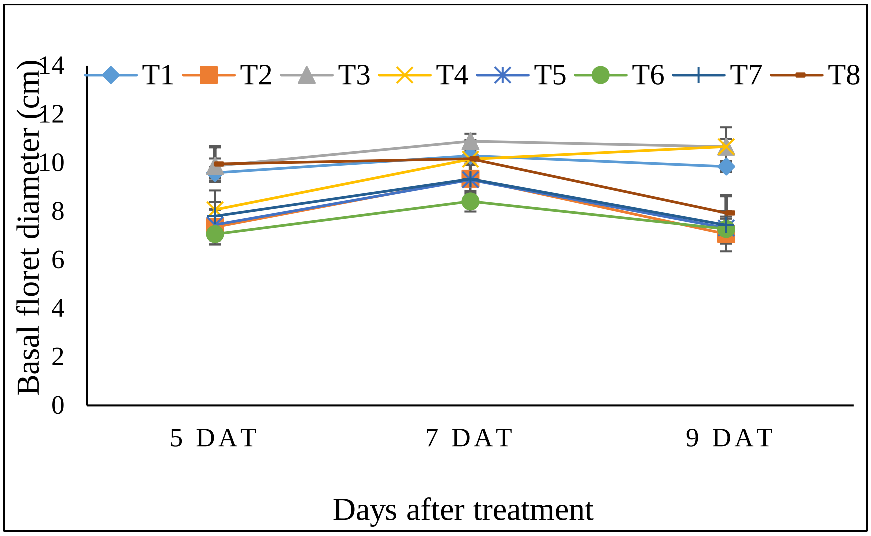

Figure (6): Effect of different treatment solutions on basal flower diameter of gladiolus cut flowers.

Floret Wilting

The minimum wilting of floret was seen in the SN (200 ppm) (32.79%) followed by CA (200 ppm) (37.31%) on the 16th day after treatment, which may be due to ethylene inhibition and biocidal activity of silver ions (Veen, 1979) as well as citric acid (Jowkar et al., 2012) and also due to sucrose that causes an increase in starch concentration, as starch is an indication of carbohydrates availability to the petals thus providing energy for florets to retain their freshness (Marousky, 1968). The maximum wilting of florets (63.93%) was recorded with Sucrose 4% + ethanol 25% followed by SA (200 ppm) (63.78%) on the 16th day after treating 'Figure 7'. Normally the treatments with minimum wilting show a good post-harvest life because as wilting rate decreases thereby increasing the vase life. The present study has indicated that SN (200 ppm) with sucrose 4% is more effective in delaying petal senescence and reducing floret wilting which is similar to the findings of Manzoor et al. (2018) for improving post-harvest quality of gladiolus (*Gladiolus grandiflorus*) cut spikes. Low concentrations of ethanol 2% have been shown to inhibit ethylene production and increased water uptake (Farokhzad et al., 2005). But higher concentrations of ethanol lead to increased membrane permeability and damages the site of ethylene action i.e., lipid bilayers (Podd & Staden, 2002). In the present study, ethanol 25% masked the longevity of the vase life of cut flowers.

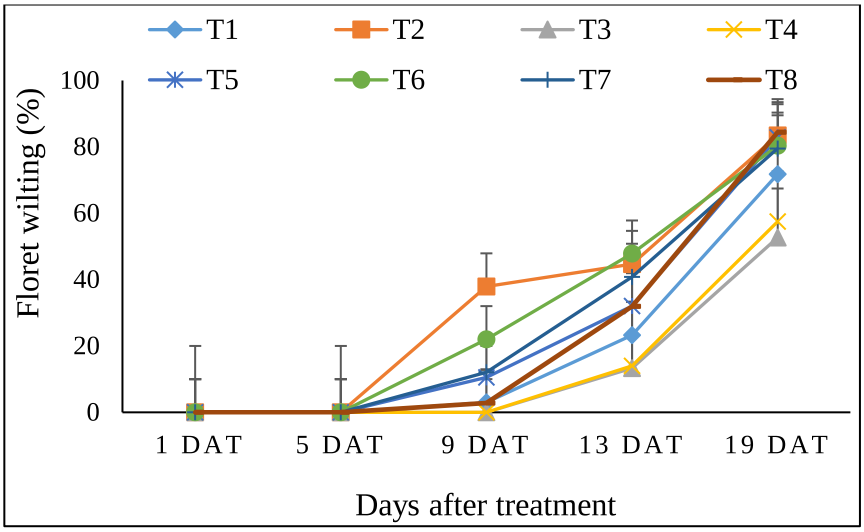

Figure (7): Effect of different chemicals and essential oils on wilting of gladiolus "American Beauty" cut flowers.

Vase Life

The vase life of gladiolus cut flowers ranged from 9.89-18.56 days due to the variation of the vase solutions. The highest vase life was recorded with SN (200 ppm) with 18.56 days, which was statistically not significant to the effect of CA (200 ppm) i.e., 18.11 days, and the least vase life of 9.89 days was observed with eucalyptus oil 1% in comparison to control (15.56 days) 'Figure 8'. Since silver nitrate acts as an antimicrobial compound, it gives the best protection and least damage to the flowers even when it was continuously applied (Van Doorn et al., 1990). Organic acids are attractive as an antimicrobial activity which reduces the bacterial count thus prolonging the self-life of cut flowers (Cherrington et al., 1991; Jowkar et al., 2012). Also, sucrose acts as a substrate for carbohydrate (food) or respiratory substrate for the cut spikes which helps to increase the vase life by retaining the freshness of flowers, delayed the degradation of protein and improved water balance (Marousky, 1968). There was high positive correlation between vase life of cut flowers and other parameters such as spike weight, solution uptake, buds opening, and basal floret diameter whereas, high negative correlation was found with floret wilting on a ninth day. Similar to our findings, vase solutions containing silver nitrate and citric acid blended with sucrose significantly increased vase life, floret diameter, florets opening and change in fresh weight of cut flowers, decreased contamination in vase solution, improved water balance for cut flowers, and increased total sugars content in florets (El-Ghait et al., 2012; Manzoor et al., 2018).

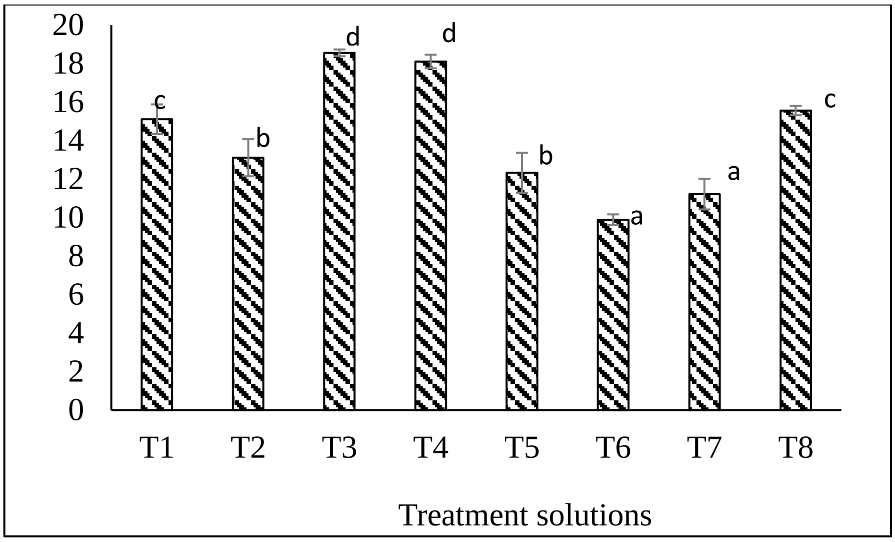

Figure (8): Effect of different chemicals and essential oils on the vase life of gladiolus "American Beauty" cut flowers. The means followed by the same letter in the bar are not significantly different according to the DMRT ($P<0.05$).

Conclusion

Silver nitrate and citric acid combined with sucrose increased the post-harvest life of cut flowers in comparison to sucrose alone. It implies the application of nutrient or substrates only is not sufficient and the addition of antibacterial and antimicrobial chemicals are necessary to prevent growth and multiplication of bacteria and microbes in vase solution as well as inside spikes for extended postharvest life of gladiolus cut flowers. High concentrations of ethanol combined with SA and essential oils are shown to harm the post-harvest life of flowers. The positive effects of ethanol (delaying senescence) and, SA and essentials oil (germicidal) were inhibited by a higher concentration of ethanol.

From the results of the present study, it can be concluded that citric acid (200 ppm) combined with sucrose 4% can be used as a vase solution instead of silver nitrate (200 ppm) solution for the extended post-harvest life of gladiolus cut flowers without any adverse effect of soluble silver compounds on human health as well as the environment.

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Conflict of Interest

The authors of this manuscript have no conflicts of interest to declare.

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دراسة تأثير مواد كيميائية وزيوت عطرية مختلفة في حياة زهرة الجلاديولس بعد القطف

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الملخص:

نُفذت التجربة في قسم البستنة، معهد الزراعة وعلوم الحيوان لدراسة تأثير المواد الكيميائية والزيوت العطرية المختلفة في العمر المزهري لأزهار الجلاديولس المقطوفة (Gladiolus grandiflora cv. "American Beauty”. اعتمدت التجربة على التصميم العشوائي الكامل بثمانية معاملات (سكروز 4٪، سكروز 4٪ + إيثانول 25% + حمض الساليسيليك (200 ملغ/كغ) ، سكروز 4٪ + نترات الفضة (200 ملغ/كغ)، سكروز 4٪ + حامض الستريك (200 ملغ/كغ)، سكروز 4٪ + إيثانول 25٪ ، سكروز 4٪ + إيثانول 25٪ + زيت الأكاليبتوس 1٪ ، سكروز 4٪ + إيثانول 25٪ + زيت الماروزا 1٪ ، شاهد ماء مقطر) لكل معاملة. تفوقت المعاملة بنترات الفضة (200 ملغ/كغ) من حيث الاحتفاظ بالوزن الرطب، وامتصاص المحلول، وارتفاع الأزهار، وذبول الأهار في نهاية المرحلة المزهري ، تلاها المعاملة بحمض الستريك (200 ملغ/كغ). أثر حمض الستريك (200 ملغ/كغ) ايجاباً في

تفتح البراعم وتفتح الزهرة في نهاية العمر المزهري. كما كان لنترات الفضة (200 ملغ/كغ) وحمض الستريك (200 ملغ/كغ) التأثير نفسه في قطر قاعدة الزهرة في اليوم التاسع. لوحظ وجود ارتباط معنوي قوي بين العمر المزهري للأزهار المقطوفة والمؤشرات الأخرى مثل وزن الحامل الزهري الطازج، وامتصاص المحلول، وتفتح البراعم، والتفتح الزهري، وقطر قاعدة الزهرة. لوحظ أن أطول عمر مزهري (18.56 يومًا) كان في المعاملة بنترات الفضة (200 ملغ/كغ)، وتبعه مباشرة حامض الستريك (200 ملغ/كغ) أي 18.11 يومًا، كما لوحظ أقصر عمر مزهري(9.89 يومًا) للمعاملة في زيت الأوكالبتوس 1٪ مقارنةً بالشاهد (15.56 يوم). يوصى باستعمال محلول مزيج من حامض الستريك (200 ملغ/كغ) والسكروز 4٪ لإطالة العمر المزهري لأزهار الجلاديولس المقطوفة.

الكلمة المفتاحية: مضاد ميكروبي، صديق للبيئة، الجلاديولس، العمر المزهري.