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# Effect of different vase solution for improving vase life on physical attributes of Gerbera (*Gerbera jamesonii*) *cv*. Intense

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**Abstract**
The investigated the effects of different vase solution for improving vase life of Gerbera (*Gerbera jamesonii*) *cv.* Intense. Weight of flower, flower diameter, stem diameter, transpirational loss of water, stem bending curvature, physiological loss in weight of flower, water uptake were evaluated to assess the efficacy of different vase solution. Treatment $T_5$ featuring Sprite 500 ml $L^{-1}$ consistently exhibited favorable outcomes across multiple parameters. The demonstrated the maximum weight of flower (16.80 g), maximum flower diameter (78.43 mm), maximum stem diameter (6.83 mm), minimum transpirational loss of water (8.60 g/f), minimum stem bending curvature (20.70 g/f), minimum physiological loss in weight of flower (0.2 g), maximum water uptake (7.60 g/f). These finding underscored the effectiveness of Sprite 500 ml $L^{-1}$ in preserving post-harvest quality and reducing microbial contamination of Gerbera cut flower.

**Keywords:** Improving, microbial contamination, cut flower, vase life

## Introduction
Gerbera (*Gerbera jamesonii*) also known as the African daisy, Barberton daisy or Transvaal daisy, is a member of the Asteraceae family. The species *jamesonii* was named for British Conical Sateman Dr. L.S. Jameson, while the genus Gerbera was named for German naturalist Traugott Gerber. The South African species known as Barberton daisy, *Gerbera jamesonii* was first described scientifically by J.D. Hooker in Curtis` Botanical Magazine in 1889. The cut flower trade around the world benefits greatly from the flowers` diverse color and appealing shape. In the global cut flower trade, it is ranked fifth, behind Tulips, Roses, Carnations and Chrysanthemum. In recent years, Gerbera is gaining commercial importance in high profile events as it is widely used for floral arrangement and flower bouquets. In both domestic and foreign markets, the cut flower trade has grown significantly.
The beauty of flowers is their ability to remain fresh for longer periods of time without losing their aesthetic appeal. Cut flower lose a significant amount of their value throughout the marketing process, potentially amounting to half of the farm`s value. Gerbera cut flowers are typically harvested when the outer ray floret are fully extended. Vase life is crucial is a crucial metric for assessing the marketability of cut flowers and both internal and external factors influence the flower ability to kept fresh. The rate of transpiration and water absorption determines the internal factors that maintain the cut blooms quality. Another internal element that impacts the lifespan of cut flowers is respiration. Cut flower lifespan is also impacted by few environmental factors including temperature, relative humidity and wind speed (Meman and dabhi, 2006) [9]. Hence addition of chemical preservative as supplements to the holding solution is recommended to prolong the vase life of cut flowers in floral arrangements and bouquets which is essential parameters of florist industry.
Any chemical formulation used to prolong the vase life of flowers is referred to as a floral preservative. Floral preservatives enhance flower opening, size, shape and color in addition to extending vase life

## Materials and Methods
### Collection of flowers
Gerbera 'Intense' variety were collected from Kolhapuri farm Rajnandgaon, which is 2o km

far MGUVV-College of Horticulture and Research Station, Sankra, Patan, Durg (C.G.). The stalks of Gerbera of flowers were cut when Disc florets are perpendicular to the stem and when ray florets are fully extended. The blooms should be stored in container of fresh water after picking. Flowers should be handled cautiously since they are quite delicate; otherwise there is risk of being damaged and loosing quality.

**Chemical used**

**Sucrose**

The disaccharide sucrose is made up of glucose and fructose. It is the primary component of white sugar and its naturally produced in plants. $C_{12}H_{22}O_{11}$ is its molecular formula. Sucrose has been germicides because treating flower with sugar alone encourages the growth of bacteria which shortens the life of the vase. As a flower preservative, sucrose is widely used. It acts as a food source or a substrate for respiration, slow down the breakdown of proteins and helps the cut flowers stay hydrated.

**Salicylic Acid**

Salicylic Acid improves the postharvest life by preserving cell membrane integrity, enhancing solution uptake, regulating stomatal transpiration and magnifying the activities of several antioxidant enzymes (Radwan *et al*., 2019; Abdelaal *et al*., 2020) [11, 1]. Salicylic acid is well known phenol that may inhibit ACC oxidase, which is a direct precursor of ethylene, as well as reduce ROS by increasing enzyme antioxidant activity.

**Silver Nitrate**

Silver nitrate ($AgNO_3$) is one of the most common types of silver salts used in commercial flower preservatives. It is mostly used to stop ethylene from binding. Pulsing cut flower preservatives. It is mostly used to stop ethylene from binding. Pulsing cut flowers with ($AgNO_3$) made their vase life and solution uptake much better (Singh and Tiwari, 2002) [12]. Darras *et al*. (2010) [2] also said that pulsing with 20 or 40 mg $L^{-1}$ $AgNO_3$ for 24 hours increased vase life by 1.6 and 1.9 days respectively, compared to the control.

**Soft Drinks**

These days soft drinks are more fascinating among the peoples these soft drinks have been formed of substance like sugar, citric acid, phosphoric acid, sodium benzoate.

Sugar serves as a respiratory substrate and germicide keep dangerous bacteria at by and keep conducting tissues from becoming clogged. The most popular sugar among all the varieties of extending the vase life of cut flowers has been discovered to be sucrose. In addition to providing the cut flowers with a much needed respiration substrate, the exogenous application of sucrose allows cut flowers harvested at the bud stage to open, something that would not otherwise be possible.

Citric acid promotes floral opening and preserve the cut spike post-harvest quality. As a pH regulator that lowers bacterial growth and improves water conductance in the xylem of cut flowers, citric acid is a common component of many vase solution formulations.

Phosphoric acid lower the waters pH, which helps dilates the stem, increasing water uptake and reducing wilting thereby extending the vase life.

Sodium benzoate inhibited ethylene production and bacterial population. Increased protein content and Brix (Imani *et al*., 2012) [6]. Maintained water balance and improved vase life.

**Table 1:** Treatment Details

| Treatments | Treatment combinations |
|---|---|
| $T_0$ | Distilled Water |
| $T_1$ | Salicylic Acid 200 PPM + Sucrose 5% |
| $T_2$ | AgNO3 200 PPM + Sucrose 5% |
| $T_3$ | Sprite 200 ml $L^{-1}$ |
| $T_4$ | Sprite 350 ml $L^{-1}$ |
| $T_5$ | Sprite 500 ml $L^{-1}$ |
| $T_6$ | 7UP 200 ml $L^{-1}$ |
| $T_7$ | 7UP 350 ml $L^{-1}$ |
| $T_8$ | 7UP 500 ml $L^{-1}$ |


Silver Nitrate


Sucrose


Distilled Water


7UP

Sprite


Cut Gerbera

**Plate 1:** Chemical and equipment's


**Plate 2:** Overview of experiment on vase life of Gerbera

One-way ANOVA was used to analyze the experimental Data and the the CRD was used to analyze the data in this study.

## Result and Discussion

### Weight of Flower (g)

The initial weight of flower was no significant differences between any of the treatment combinations because the differences were less than the critical. So the treatments are all the same when it comes to weight of flower.

The weight of flower is directly correlated with the water content in stems and flowers. The significant effect of flower observed in the study. The maximum flower weight (16.80 g) at the end of vase life was observed in Treatment $T_5$ (Sprite 500 ml $L^{-1}$) followed by $T_8$ 7UP 500 ml L-1 (15.96 g) respectively. The lowest flower weight (11.43 g) was recorded from the $T_0$ Distilled Water (Control).

The weight of flower is largely dependent on their ability to absorb and retain water which in turn maintains cell turgidity and freshness during vase life. Adequate water uptake prevents wilting and contributes to higher fresh weight of flowers (Halevy & Mayak, 1981) [5].

**Table 2:** Effect of different vase solution on weight of flower (g) of Gerbera (*Gerbera jamesonii*) cut spikes.

| Treatment No. | Treatment details | Initial weight of flower (g) | Final weight of flower (g) |
|---|---|---|---|
| T0 | Distilled water | 16.86 | 11.43 |
| $T_1$ | Salicylic acid 200 ppm + Sucrose 5% | 16.93 | 13.60 |
| $T_2$ | AgNO3 200 ppm + Sucrose 5% | 16.96 | 14.36 |
| $T_3$ | Sprite 200 ml $L^{-1}$ | 16.90 | 12.53 |
| $T_4$ | Sprite 350 ml $L^{-1}$ | 16.90 | 15.16 |
| $T_5$ | Sprite 500 ml $L^{-1}$ | 17.00 | 16.80 |
| $T_6$ | 7UP 200 ml $L^{-1}$ | 16.90 | 14.10 |
| $T_7$ | 7UP 350 ml $L^{-1}$ | 17.00 | 14.76 |
| $T_8$ | 7UP 500 ml $L^{-1}$ | 17.06 | 15.96 |
| | SE (m) | 0.22 | 0.21 |
| | C.D. | 5.37 | 0.65 |

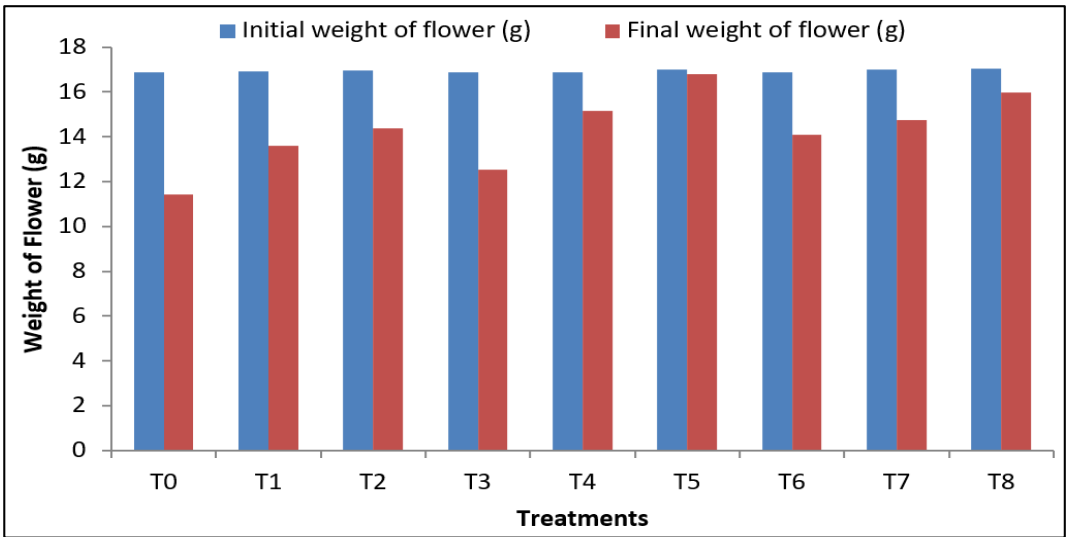


**Fig 1:** Effect of different vase solutions on weight of flower of Gerbera (*Gerbera jamesonii*) cut spikes.

**Flower Diameter (mm)**

The initial flower diameter was no significant differences between any of the treatment combinations because the differences were less than the critical. So the treatments are all the same when it comes to flower diameter.

From the result, the maximum flower diameter (78.43 mm) was observed in vase solutions containing Treatment $T_5$ Sprite 500 ml $L^{-1}$ followed by $T_8$ 7UP 500 ml L-1 (75.40 mm) respectively and the minimum flower diameter (64.16 mm) was recorded in $T_0$ Distilled water (Control).

The increase in flower diameter observed in Sprite treatment can be attributed to the presence of soluble sugar (sucrose and fructose) which act as an immediate energy source of cellular metabolism. Sugar absorbed through the cut stem is utilized for respiration and osmotic regulation, supporting petal cell expansion and turgor maintenance, ultimately enhancing floral diameter (Halevy & Mayak, 1981) [5]. Moreover, the presence of sodium benzoate in sprite has preservatives properties which can inhibit microbial growth in vase solutions, thereby maintaining xylem conductivity and prolonging flower freshness (Van Doom, 2008) [3].

**Table 3:** Effect of different vase solution on flower diameter of Gerbera (*Gerbera jamesonii*) cut spikes.

| Treatment No. | Treatment Details | Initial Flower Diameter (mm) | Flower diameter (mm) |
|---|---|---|---|
| $T_0$ | Distilled water | 64.33 | 64.16 |
| $T_1$ | Salicylic acid 200 ppm + Sucrose 5% | 63.56 | 68.66 |
| $T_2$ | AgNO3 200 ppm + Sucrose 5% | 64.20 | 72.73 |
| $T_3$ | Sprite 200 ml $L^{-1}$ | 64.80 | 66.36 |
| $T_4$ | Sprite 350 ml $L^{-1}$ | 66.63 | 74.53 |
| $T_5$ | Sprite 500 ml $L^{-1}$ | 72.60 | 78.43 |
| $T_6$ | 7UP 200 ml $L^{-1}$ | 65.46 | 71.43 |
| $T_7$ | 7UP 350 ml $L^{-1}$ | 64.23 | 73.36 |
| $T_8$ | 7UP 500 ml $L^{-1}$ | 64.50 | 75.40 |
| | SE(m) | 0.60 | 0.58 |
| | C.D. | 1.80 | 1.74 |

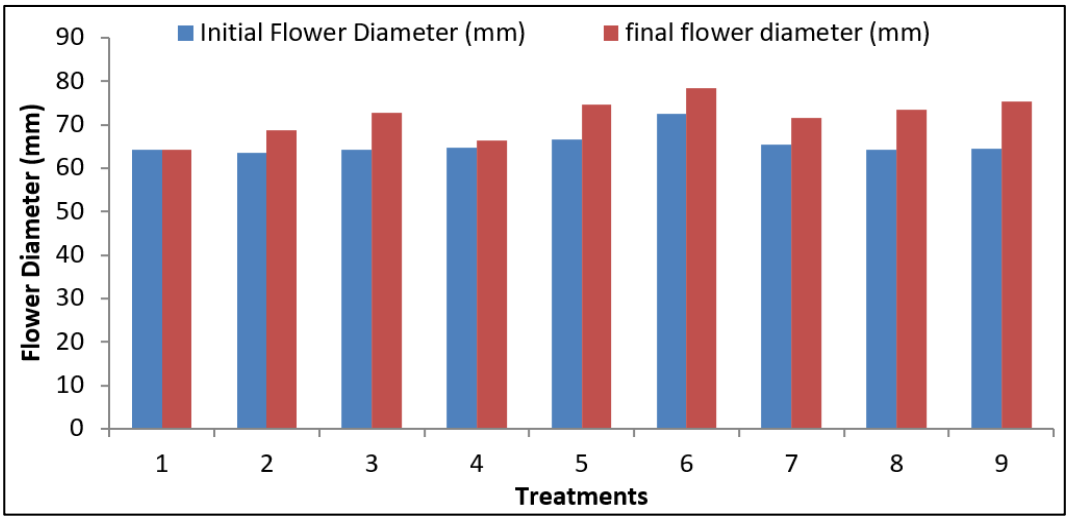


**Fig 2:** Effect of different vase solutions on flower diameter of Gerbera (*Gerbera jamesonii*) cut spikes.

**Stem Diameter (mm)**

The initial stem diameter was no significant difference between any of the treatment combinations because the differences were less than the critical. So the treatments are all the same when it comes to stem diameter.

From the results, the maximum stem diameter (6.83 mm) was observed in vase solution containing Treatment $T_5$ Sprite 500 ml $L^{-1}$ followed by $T_8$ 7UP 500 ml $L^{-1}$ (6.33 mm) respectively. And the minimum stem diameter (4.36 mm) was recorded in $T_0$ Distilled water (Control) treatment.

The increased stem diameter in $T_5$ Sprite 500 ml $L^{-1}$ may be attributes the presence of soluble sugar (Sucrose and Fructose) in sprite, which improves osmotic potential and facilitates better hydration of tissues, leading to enhanced stem strength and girth. Similar findings were reported by Ichimura & Goto (2003) [10], who observed that sucrose supplementation improves vascular function and maintain stem integrity in cut flower.

**Table 4:** Effect of different vase solutions on stem diameter of Gerbera (*Gerbera jamesonii*) cut spikes.

| Treatment No. | Treatment Details | Initial Stem diameter (mm) | Final Stem diameter (mm) |
|---|---|---|---|
| $T_0$ | Distilled water | 4.33 | 4.36 |
| $T_1$ | Salicylic Acid 200 ppm + Sucrose 5% | 5.26 | 5.33 |
| $T_2$ | AgNO3 200 ppm + Sucrose 5% | 5.40 | 5.53 |
| $T_3$ | Sprite 200 ml $L^{-1}$ | 5.30 | 5.10 |
| $T_4$ | Sprite 350 ml $L^{-1}$ | 5.43 | 6.13 |
| $T_5$ | Sprite 500 ml $L^{-1}$ | 6.43 | 6.83 |
| $T_6$ | 7UP 200 ml $L^{-1}$ | 5.36 | 5.40 |
| $T_7$ | 7UP 350 ml $L^{-1}$ | 5.40 | 5.93 |
| $T_8$ | 7UP 500 ml $L^{-1}$ | 5.90 | 6.33 |
| | SE(m) | 0.18 | 0.04 |
| | C.D. | 0.56 | 0.14 |

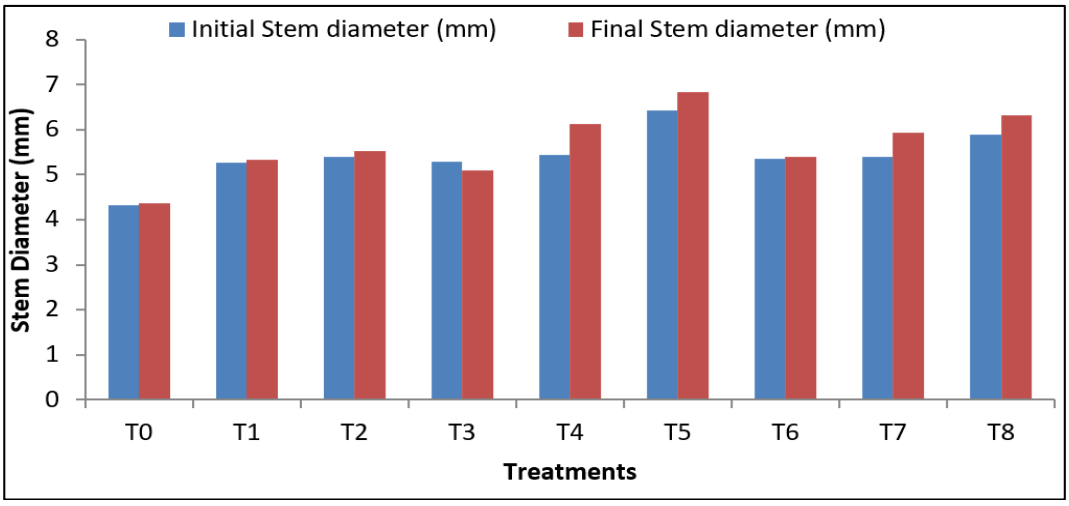


**Fig 3:** Effect of different vase solutions on stem diameter of Gerbera (*Gerbera jamesonii*) cut spikes.

**Transpirational loss of water (g/f)**

The present investigation revealed that there were significant differences among the treatment in the transpirational loss of water (TLW) of cut Gerbera during the vase life period. Treatment $T_5$ (Sprite 500 ml $L^{-1}$) recorded the lowest TLW (8.60 g/f) followed by $T_8$ 7UP 500

ml L-1 (8.03 g/f) respectively. While the $T_0$ distilled water (control) exhibited the highest TLW (6.73 g/f). The reduction in TLW in sprite treated flower might be attributed to the presence of sugar and carbonated compounds, which maintain cell turgidity, reduce stomatal opening and thereby minimize water loss.

**Table 5:** Effect of different vase solutions on transpirational loss of water of Gerbera (*Gerbera jamesonii*) cut spikes.

| Transpirational Loss of Water (g/f) | | | | |
|---|---|---|---|---|
| **Treatment No.** | **Treatment Details** | **(4th day)** | **(8th day)** | **(12th day)** |
| $T_0$ | Distilled water | 5.10 | 5.96 | 6.73 |
| $T_1$ | Salicylic acid 200 ppm + Sucrose 5% | 5.96 | 6.3 | 7.36 |
| $T_2$ | AgNO3 200 ppm + Sucrose 5% | 6.60 | 7.16 | 7.53 |
| $T_3$ | Sprite 200 ml $L^{-1}$ | 5.46 | 6.13 | 7.33 |
| $T_4$ | Sprite 350 ml $L^{-1}$ | 7.30 | 7.83 | 7.63 |
| $T_5$ | Sprite 500 ml $L^{-1}$ | 7.70 | 8.56 | 8.60 |
| $T_6$ | 7UP 200 ml $L^{-1}$ | 6.23 | 6.66 | 7.43 |
| $T_7$ | 7UP 350 ml $L^{-1}$ | 7.16 | 7.43 | 7.60 |
| $T_8$ | 7UP 500 ml $L^{-1}$ | 7.43 | 8.16 | 8.03 |
| | SE(m) | 0.05 | 0.07 | 0.05 |
| | C.D. | 0.14 | 0.23 | 0.17 |

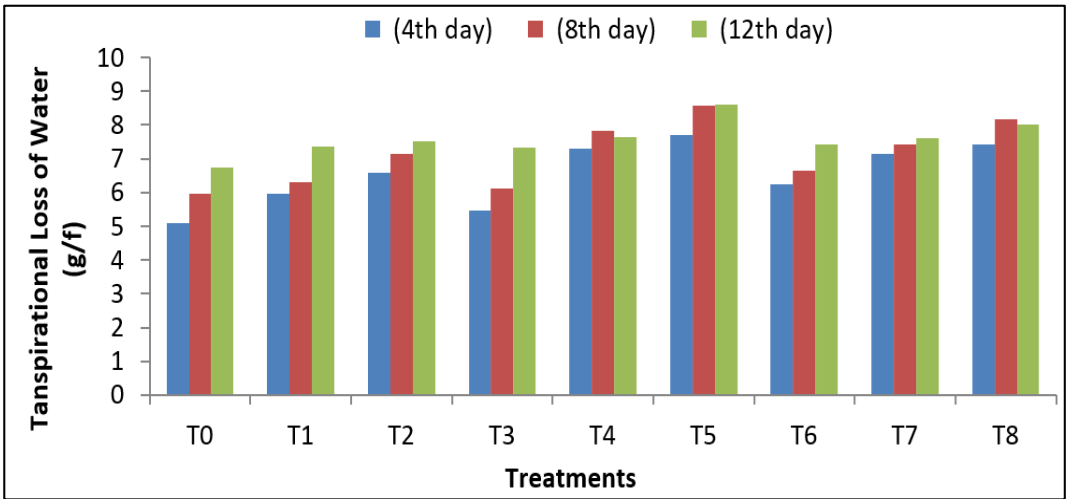


**Fig 4:** Effect of different vase solutions on transpirational loss of water of Gerbera (*Gerbera Jamesonii*) cut spikes.

**Stem Bending curvature (Degree)**

There were significant differences among the treatment for scape bending curvature of cut Gerbera during different days of vase life period. Significantly lowest stem bending curvature was recorded in $T_5$ Sprite 500 ml $L^{-1}$ (20.70 degree) followed by $T_8$ 7UP 500 ml $L^{-1}$ (21.53 degree). Significantly highest scape bending recorded with $T_0$ distilled water (control) (45.36 degree).

Scape bending curvature in cut Gerbera is widely recognized postharvest problem, often leading to early senescence. The significantly lower bending curvature observed in treatment $T_5$ (Sprite 500 ml $L^{-1}$) (20.70 degree) followed by $T_8$ 7UP 500 ml $L^{-1}$ (21.53 degree) compared to the $T_0$ distilled water (control) (45.36 degree) can be attributed to the presence of soluble sugar and possibly other iconic components in preservative solution. Sugar such as sucrose and fructose improve osmotic potential and turgor maintenance has helping to preserve cell rigidity and delay structural collapse (Halevy & Mayak, 1981) [5].

**Table 6:** Effect of different vase solutions on stem bending curvature of Gerbera (*Gerbera jamesonii*) cut spikes.

| Treatment No. | Treatment Details | Stem Bending Curvature (degree) |
|---|---|---|
| $T_0$ | Distilled water | 45.36 |
| $T_1$ | Salicylic acid 200 ppm + Sucrose 5% | 25.56 |
| $T_2$ | AgNO3 200 ppm + Sucrose 5% | 24.06 |
| $T_3$ | Sprite 200 ml $L^{-1}$ | 25.93 |
| $T_4$ | Sprite 350 ml $L^{-1}$ | 22.13 |
| $T_5$ | Sprite 500 ml $L^{-1}$ | 20.70 |
| $T_6$ | 7UP 200 ml $L^{-1}$ | 24.63 |
| $T_7$ | 7UP 350 ml $L^{-1}$ | 22.83 |
| $T_8$ | 7UP 500 ml $L^{-1}$ | 21.53 |
| | SE(m) | 0.04 |
| | C.D. | 1.13 |

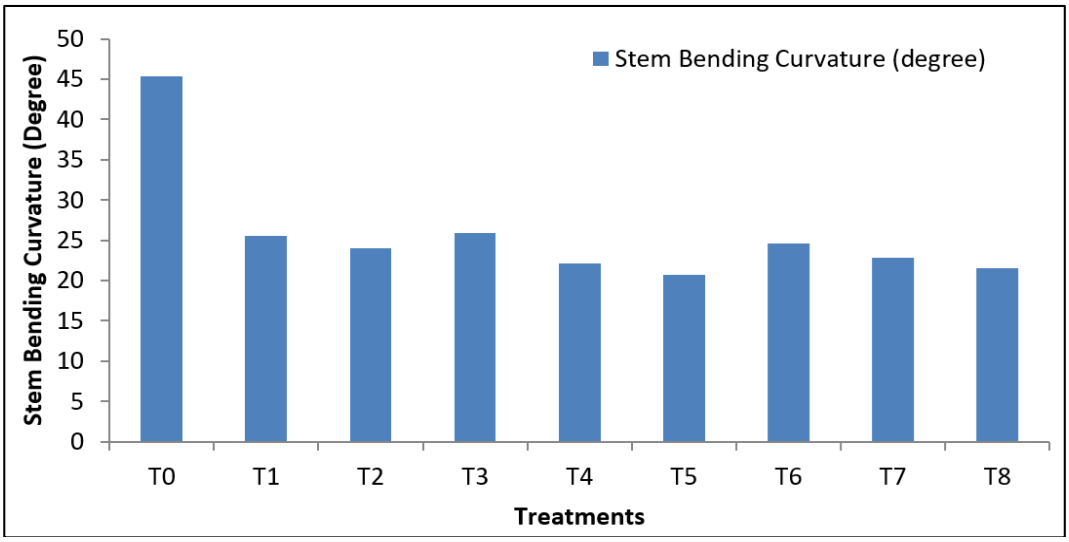


**Fig 5:** Effect of different vase solutions on stem bending curvature of Gerbera (*Gerbera jamesonii*) cut spikes.

**Physiological loss in weight of flower**

Physiological loss in weight of cut flowers is a key indicator of senescence progression and overall freshness. Increased PLW is typically associated with diminished turgor, elevated respiration rates and the depletion of stored carbohydrates, all of which accelerates postharvest deterioration.

In the present study Treatment $T_5$ sprite 500 ml $L^{-1}$ exhibited the lowest physiological loss in weight of flower (0.2 g) followed by $T_8$ 7UP 500 ml $L^{-1}$, while the control $T_0$ distilled water showed the highest physiological loss in weight of flower (5.43 g). This reduction in weight loss could be attributed to the presence of soluble sugar in sprite which serve as energy source, support osmotic balance and help maintain turgor and there by slow down the physiological weight loss.

**Table 7:** Effect of different vase solutions on physiological loss in weight of flower of Gerbera (*Gerbera jamesonii*) cut spikes.

| Treatment No. | Treatment details | Initial weight of flower | Final weight of flower | Physiological loss of water |
|---|---|---|---|---|
| T0 | Distilled water | 16.86 | 11.43 | 5.43 |
| T1 | Salicylic Acid 200 ppm + Sucrose 5% | 16.93 | 13.60 | 3.33 |
| T2 | AgNO3 200 ppm + Sucrose 5% | 16.96 | 14.36 | 2.6 |
| T3 | Sprite 200 ml $l^{-1}$ | 16.90 | 12.53 | 4.37 |
| T4 | Sprite 350 ml $l^{-1}$ | 16.90 | 15.16 | 1.74 |
| T5 | Sprite 500 ml $l^{-1}$ | 17.00 | 16.80 | 0.2 |
| T6 | 7UP 200 ml $l^{-1}$ | 16.90 | 14.10 | 2.82 |
| T7 | 7UP 350 ml $l^{-1}$ | 17.00 | 14.76 | 2.24 |
| T8 | 7UP 500 ml $l^{-1}$ | 17.06 | 15.96 | 1.1 |
| | SE (m) | 0.22 | 0.21 | |
| | C.D. | 5.37 | 0.65 | |

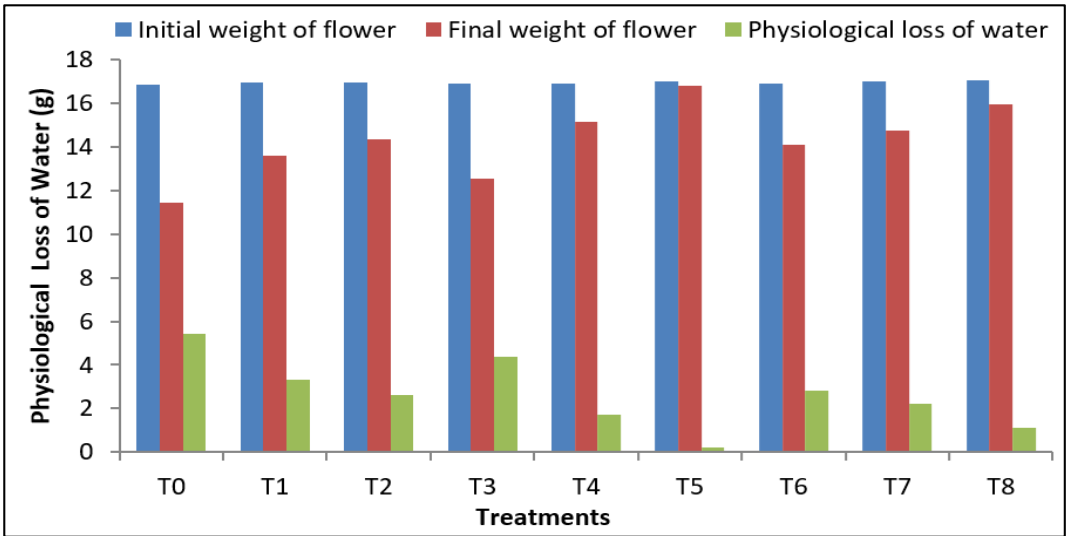


**Fig 6:** Effect of different vase solutions on physiological loss in weight of flower of Gerbera (*Gerbera jamesonii*) cut spikes.

**Water Uptake (g/f)**

Water uptake is a critical factor influencing the postharvest longevity and freshness of cut flowers, as it directly maintains turgor, petal expansion and metabolic activity. The balance between water absorption and transpiration determines flower quality and vase life (Van Doom, 2008) [3].

In the present study, maximum water uptake (7.60 g/f) was observed in Treatment $T_5$ sprite 500 ml L-1 followed by $T_8$ 7UP 500 ml $L^{-1}$, while the lowest water uptake (5.23 g/f) was recorded in $T_0$ distilled water (control). The higher uptake in $T_5$ sprite 500 ml $L^{-1}$ can be attributed to the presence of soluble sugar and organic acids in sprite, which improve osmotic potential and facilitate continuous water absorption through the cut stem. Halevy and Mayak, 1981 [5] also emphasized that sugar supplementation in vase solutions enhances water balance and delay wilting in cut flowers. Similarly Ichimura *et al*. (2003) [10] reported that sucrose enriched vase solutions promoted higher water uptake and improved postharvest performance in cut roses.

**Table 8:** Effect of different vase solution on water uptake of Gerbera (*Gerbera jamesonii*) cut spikes.

| Treatment No. | Treatment Details | Water Uptake (g/f) |
|---|---|---|
| $T_0$ | Distilled water | 5.23 |
| $T_1$ | Salicylic Acid 200 ppm + Sucrose 5% | 6.33 |
| $T_2$ | $AgNO_3$ 200 ppm + Sucrose 5% | 6.53 |
| $T_3$ | Sprite 200 ml $L^{-1}$ | 6.13 |
| $T_4$ | Sprite 350 ml $L^{-1}$ | 6.73 |
| $T_5$ | Sprite 500 ml $L^{-1}$ | 7.60 |
| $T_6$ | 7UP 200 ml $L^{-1}$ | 6.43 |
| $T_7$ | 7UP 350 ml $L^{-1}$ | 6.63 |
| $T_8$ | 7UP 500 ml $L^{-1}$ | 7.10 |
| | SE(m) | 0.04 |
| | C.D. | 0.12 |

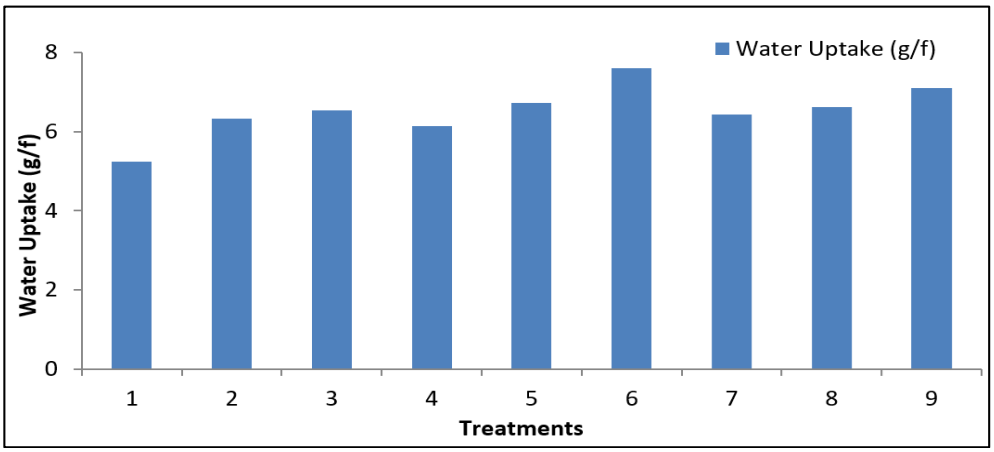


**Fig 7:** Effect of different vase solution on water uptake of Gerbera (*Gerbera jamesonii*) cut spikes.

**Conclusions**

In conclusions, drawn from the experimental analysis highlights that $T_5$ sprite 500 ml $L^{-1}$ followed by T8 7UP 500ml $L^{-1}$ exhibited superior performance across all parameters. This is because the sprite 500 ml $L^{-1}$ can make flowers more attractive in term of freshness of physical attributes and longevity of flower. The result revealed that sprite 500 ml $L^{-1}$ showed significant performance on various parameters as maximum weight of flower (16.80 g), maximum flower diameter (78.43 mm), maximum stem diameter (6.83 mm), minimum transpirational loss of water (8.60 g/f), minimum stem bending curvature (20.70 degree), minimum physiologiocal loss in weight of flower (0.2 g), maximum water uptake (7.60 g/f).

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**Disclaimer (Artificial Intelligence)**

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**Competing Interests**

Authors have declared that no competing interests exist.

**References**

1. Abdelaal KA, Attia KA, Alamery SF, El-Afry MM, Ghazy AI, Tantawy DS, *et al*. Exogenous application of proline and salicylic acid can mitigate the injurious impacts of drought stress on barley plants associated with physiological and histological characters. Sustainability. 2020;12(5):1736.
2. Darras A, Ioannidou A, Pompodakis N. Evaluation and improvement of post-harvest performance of cut *Viburnum tinus* inflorescences. Sci Hortic. 2010;124:376-380.
3. van Doorn WG, de Witte Y, Perik R. Effect of antimicrobial compounds on the number of bacteria in stems of cut rose flowers. J Appl Microbiol. 2008;68(2):117-122.
4. Goszcynska DM, Rudnicki RM. Storage of cut flowers. Hortic Rev. 1988;10:35-62.

5. Halevy AH, Mayak S. Senescence and postharvest physiology of cut flowers. Hortic Rev. 1981;3:59-143.
6. Imani MH, Hashemabadi D, Kaviani B, Zarchini M. Effect of sodium benzoate on longevity and ethylene production in cut rose (*Rosa hybrida* L. cv. Avalanche) flowers. Eur J Exp Biol. 2012;2(6):2485-2488.
7. Jowkar MM, Salehi H. The effects of different preservative solutions on the vase life of cut tuberose (*Polianthes tuberosa* L.) cv. Goldorosht-emahallat. J Sci Technol Agric Nat Resour. 2006;10:299-309.
8. Mayak S, Halevy A. The action of kinetin in improving the water balance and delaying senescence processes of cut rose flowers. Physiol Plant. 1974;32(4):330-336.
9. Meman MA, Dabhi KM. Effect of different stalk lengths and certain chemical substances on vase life of gerbera (*Gerbera jamesonii* Hook.) cv. Savana Red. J Ornam Hortic. 2006;9(4):282-286.
10. Pun UK, Ichimura K. Role of sugars in senescence and biosynthesis of ethylene in cut flowers. Jpn Agric Res Q. 2003;37(4):219-224.
11. Radwan DEM, Mohamed AK, Fayez KA, Abdel-Rahman AM. Oxidative stress caused by Basagran herbicide is altered by salicylic acid treatments in peanut plants. Heliyon. 2019;5(5):e01791.
12. Singh AK, Tiwari AK. Effect of pulsing on post-harvest life of rose cv. Doris Tystermann. South Indian Hortic. 2002;50:140-144.
13. van Doorn WG. Water relations of cut flowers. Hortic Rev. 1997;18:1-85.