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# Effect of preharvest sprays of certain chemicals on physiological and postharvest life of cut tuberose (*Agave amica*) cv. Arka Prajwal

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**Abstract**
An experiment was conducted on tuberose cv. Arka Prajwal with pre harvest sprays of ten treatments, Oxalic acid at 2%, 3%, 4%, Sodium nitroprusside at 100, 150, 200 ppm, Boric acid at 0.2%, 0.4%, 0.6% and Control (distilled water) in Complete Randomized Design with three replications. After two days of pre harvest spray, to study postharvest vase life, all the spikes were placed in standard vase solution containing sucrose 4% + citric acid 100 ppm. The findings of this experiment were focused on physiological, vase solution parameters, and vase life. Boric acid positively influenced the physiological parameters, the highest water uptake, transpirational loss of water, water balance and change in fresh weight of spikes were recorded in boric acid at 0.6% ($T_9$). This treatment also increased the pH, EC of vase solution, whereas decreased the OD (Optical Density) of vase solution. Boric acid extended the vase life of spikes (10.00 days) by 37% more than control preserving post-harvest flower quality.

**Keywords:** Oxalic acid, sodium nitroprusside, boric acid, pre harvest spray, tuberose, post-harvest life

## Introduction

Tuberose (*Agave amica*), a half-hardy perennial bulbous flowering plant of family Asparagaceae is celebrated globally for its elegant flowers, distinctive fragrance. The plant thrives under both open-field conditions and protected cultivation (Brundell and Steenstra, 1985) [4] being widely used in ceremonial garlands, bouquets, and decorative arrangements. Arka Prajwal, a hybrid of Shringar x Mexican released by Indian Institute of Horticulture Research, Bengaluru bears single type of white flowers and yields 15.5-18 t/ha/year. Several factors like bacterial contamination, vascular blockage and oxidative stress cause browning and floret wilting in cut flowers (Shahri and Tahir, 2011) [23]. Tuberose is particularly valued for its long-lasting flowers, intense fragrance, and post-harvest longevity. Despite its popularity and economic significance, the vase life of cut tuberose flowers remains a significant challenge, primarily due to their high ethylene sensitivity. Ethylene, a plant hormone responsible for promoting senescence, accelerates wilting, yellowing and degradation of cut flowers, reducing their post-harvest longevity (Perez-Arias *et al.*, 2019) [18]. This vulnerability not only impacts the aesthetic value of the flowers but also reduces their marketability. Therefore, managing post-harvest deterioration is crucial to extend the vase life and preserve the visual and aromatic qualities. (Jowkar and Salehi, 2003) [12]. additionally, microbial contamination in the vascular system hinders water absorption, causing wilting and reducing vase life (Singh *et al.*, 2018) [25].

Hence, to improve the post-harvest longevity of cut flowers, preharvest sprays with chemicals always become a handy tool. Sodium nitroprusside (SNP) which is a nitric oxide (NO) donor is an important compound gaining attention for its potential in improving vase life, has been shown to inhibit ethylene production in flowers, thus preventing premature senescence and improving the overall quality of ornamental plants (Ahmadi *et al.*, 2021) [1]. In addition boric acid, a plant growth regulator, has been shown to retard senescence and extend vase life in several ornamental plants. It functions by slowing down ethylene production and enhancing water uptake, resulting in better hydration, increased flower diameter and reduced weight loss (Serrano *et al.*, 2001; Ahmadnia *et al.*, 2013) [2, 22]. Further, oxalic Acid (OA) has been shown to delay senescence and reduce oxidative damage by improving cellular integrity and maintaining phenolic content (Serna-Escolano *et al.*, 2021) [21]. Pre harvest applications of OA have demonstrated potential in enhancing flower quality and extending longevity. (Jabeen and Ahmad, 2013; Ali *et al.*, 2020) [3, 11] by post-harvest sprays. These challenges emphasize the need to enhance the postharvest life of tuberose. While many efforts have been made to improve the longevity of cut flowers using preservative solutions, this study intends to offer valuable insights into the effectiveness of preharvest chemical sprays of oxalic acid, sodium nitroprusside and boric acid to enhance both the longevity and quality of cut tuberose flowers.

## Material and Methods

Spikes of tuberose (*Agave amica*) cv. Arka Prajwal were obtained from Chevella mandal of Rangareddy district. Spikes were sprayed with oxalic acid (2, 3 and 4%), sodium nitroprusside (100, 150 and 200 ppm) and boric acid (0.2, 0.4 and 0.6%) two days before harvest with 1-2 pairs of florets opened, cut flowers were brought to the Research Laboratory of Floricultural Research Station, Hyderabad and were transferred to a vase solution of sucrose 4% + citric acid 100 ppm for further study.

The post-harvest experiment in 10 treatments including control (T10 - distilled water) with three replications in Completely Randomised Design. Physiological parameters like Water uptake (WU), Transpirational Loss of Water (TLW), Water balance (WB) and Change in Fresh Weight (CFW), and vase solution parameters like pH, EC and OD along with vase life (days) were recorded.

### Water uptake (WU) (g/spike)

It is calculated as the difference between consecutive measurements of the container and solution (without the spike) recorded every other day until the vase life concludes (Venkatarayappa *et al.*, 1981) [27]. This difference indicates the amount of water absorbed during that specific time period and is expressed in grams per spike.

$$WU = \frac{\text{Initial weight of container} - \text{Final weight of container (without flower spikes)}}{\text{Number of flower spikes in the bottle}}$$

### Transpirational loss of water (TLW) (g/spike)

The difference between consecutive measurements of container, solution and spike recorded every other day until the vase life concludes (Venkatarayappa *et al.*, 1981) [27] and represented as grams per spike

$$TLW = \frac{\text{Initial weight of container with flower spikes} - \text{Final weight of container with flower spikes}}{\text{Number of flower spikes in the bottle}}$$

**Water balance of spike tissue (WB) (g/spike):** Water balance in the spike tissue was calculated as the difference between water uptake and transpirational loss of water and represented as grams per spike (Venkatarayappa *et al.*, 1981) [27].

WB = WU-TLW

**Change in fresh weight of spikes (%):** The difference between the weight of the container + solution + flower and the weight of container + solution recorded once in two days to measure the fresh weight change of flower during that particular period/duration of time (Venkatarayappa *et al.*, 1981) [27]. The weight of the flowers on the first day of each experiment was assumed to be 100 per cent. Subsequent weights were referred to as percentage of the initial weights were referred to as percentage of initial values.

### Vase life (days)

Vase life was considered to have ended when 50% of the florets lost their ornamental value.

### pH of vase solution

Solution pH was determined using a digital pH meter.

### Electrical Conductivity (EC) (dS/m)

EC of vase solution was determined by using digital Electrical Conductivity meter and measured.

### Optical Density of Vase Solution (ODVS) (480 nm)

Solution turbidity attributable to microbial growth was assessed by measuring absorbance at 480 nm with a spectrophotometer.

### Statistical analysis

Statistical analysis of data of various characters was carried out as per Completely Randomized Design (CRD). Analysis of variance was worked out using standard statistical procedures as described by Panse and Sukhatme (1985) [16]. Standard Error of Mean (S.E m±), Critical Difference (CD) at 5% probability and Co-efficient of Variance (CV%) was worked out for the interpretation of the results.

## Results and Discussion

### Water uptake (WU) (g/spike)

From the results it was revealed that significant differences were observed among the treatments on water uptake on 2nd, 4th and 6th day (Table 1). On 2nd day, the highest water uptake was recorded in $T_9$ - Boric acid at 0.6% (24.70 g/spike), while the lowest was recorded in $T_{10}$- control (15.00 g/spike). A similar trend was observed on 4th day, with T9 showing the maximum value (23.40 g/spike) and T10 the minimum (13.90 g/spike). On the 6th day as well, $T_9$ recorded the highest (21.50 g/spike) whereas $T_{10}$ the lowest (11.50 g/spike) confirming consistent decrease of uptake. The maximum water uptake in $T_9$- Boric acid at 0.6% was due to the enhanced and continuous water absorption. Which can be attributed to its role in maintaining cell wall structure and enhancing the plant's ability to absorb water. Boron also plays role in the regulation of stomatal aperture, which can influence transpiration rates and water use efficiency (Priyanka *et al.*, 2024) [19]. Boron treatments have been shown to maintain higher fresh weights of florets, reduce rotting and extending vase life. Similar results were also observed by Ahmadnia *et al.* (2013) in carnation [2].

**Transpirational Loss of Water (TLW) (g/spike)**

Significant differences were observed among the treatments on transpirational loss of water on 2nd, 4th and 6th day (Table 2). On the 2nd day, the highest TLW was recorded in T9- boric acid at 0.6% (23.98 g/spike) while the lowest was in T10 - control (17.70 g/spike). On the 4th day, the highest TLW was recorded in T9 (boric acid at 0.6%) with 22.92 g/spike, while the lowest was recorded in T10 (control) at 17.10 g/spike. Similarly, on the 6th day, a significant variation in TLW was evident, maximum was observed in T9- boric acid at 0.6% (22.13 g/spike) and the minimum transpiration loss was observed in T10- control (15.50 g/spike) showing gradual decrease in transpiration loss of water (TLW). This result was in accordance with (Wang *et al.*, 2016) [28]. Increase in transpiration under $T_9$- boric acid at 0.6% and T8- Boric acid at 0.4% likely occurs because boron maintains water balance. Boric acid can enter cells via aquaporins (e.g., Nodulin-26-like Intrinsic Protein (NIP)/ Plasma membrane Intrinsic Protein (PIP) channels, increasing membrane permeability and hydraulic conductivity, which boosts water flow through both symplastic and apoplastic routes. The results were in accordance with Khattab *et al.* (2017) in cut gladiolus and Chawla *et al.* (2020) in tuberose [6, 13].

**Water balance (WB) (g/spike):** All the treatments differed significantly on 2nd, 4th and 6th day (Table 3). On the 2nd day, the highest water balance was observed in $T_9$ (Boric acid at 0.6%) with 5.70 g/spike, while the lowest was observed in $T_{10}$ (control) at 2.30 g/spike. On the 4th day, $T_9$ again exhibited the maximum water balance (5.50 g/spike), whereas $T_{10}$ showed the minimum (1.80 g/spike). By the 6th day, $T_9$ maintained the highest value at 4.40 g/spike, and $T_{10}$ recorded the lowest at 1.00 g/spike. Similar results were observed by Camacho-Cristobal *et al.*, 2008 [5]. The improvement can be credited to boron's important role in strengthening cell walls, stabilizing membranes and helping water move through the plant by regulating aquaporins all of which support better hydration and stress resistance (Chen *et al.*, 2023) [7].

**Change in Fresh Weight of spikes (%)**

From the results it was revealed that significant differences were recorded among the treatments on change in fresh weight of spikes on 2nd, 4th and 6th day (Table 4). On the 2nd day, the highest fresh weight was recorded in $T_9$ (Boric acid at 0.6%) with 108.61%, while the lowest was noted in $T_{10}$ (Control) at 94.50%. On 4th day, $T_9$ showed the maximum change (101.50%), whereas $T_{10}$ exhibited the minimum (85.18%). On the 6th day, T9 maintained the highest value of fresh weight change (90.99%) and T10 recorded the lowest (65.94%). Fresh weight of the spikes gradually decreased as the days progressed.

The boric acid treatment maintained better water relations and resulted in reduced weight loss during the vase life period. For maintaining cell wall structure, pectin cross-linking and nutrient transport boron is essential and due to improved cell expansion and structural integrity through borate-bridged RG-II in pectins fresh weight loss was maintained (Chormova *et al.*, 2014) [8]. Ahmadnia *et al.* (2013) [2] reported that boric acid used could extend the vase life and prevent fresh weight loss due to the inhibition of ethylene synthesis. Similar results were also reported by Fleischer *et al.* (1998) and Suntipabvivattena and Tongdeesuntorn (2016) in Jasmine [10].

**pH of Vase solution:** Vase solution of sucrose 4% and citric acid 100 ppm was taken as common preservative for all the treatments. There was a significant difference observed among the pH of vase solutions and the data is presented in Table 5. The initial pH of the vase solution was 3.87 which was increased in all the treatments at the end of vase life of individual treatment. Maximum increase in pH was observed in T9- Boric acid at 0.6% (5.20) whereas, the minimum change in pH was observed in T10- control (3.90).

The pH of vase solutions was increased gradually in the treatments as the vase life period increased, the treatments that lost longer periods recorded more pH. However, the pH was in permissible limits of vase solution. The results were in accordance with Paul and Gantait (2022) [17], who observed a gradual increase in pH of preservative solutions over time due to microbial growth and flower metabolism. This trend aligns with Shanan (2017) [24], who linked rising pH to microbial proliferation and stem physiology. The buffering or antimicrobial properties of boric and oxalic acid likely helped stabilize the pH initially.

**Electric Conductivity of vase solution (dS/m)**

There was a significant difference observed among the treatments in EC of vase solutions and the data is presented in Table 5. The initial EC of vase solution was 0.118 dS/m which was gradually increased in all the treatments corresponding the length of vase life. The Maximum increase in EC was observed in $T_9$- Boric acid at 0.6% (0.162 dS/m) whereas the same EC was was observed in $T_{10}$- control (0.118 dS/m) as that of initial. Similar findings were found by Kuiper *et al.* (1995) [14] and Da Costa (2015) [9]. Increased EC in boric acid treatments may have enhanced solute availability and water uptake. However, maintaining EC within optimal limits is crucial, these results highlight the positive influence of boric acid sprays on vase solution chemistry and flower quality. Water uptake decreased with increase in EC of solution (Regan and Dole, 2009) during the vase life period in all the treatments [20].

**OD value of vase solution (ODVS) (nm)**

Significant differences were observed among the treatments in ODVS and the data is presented in Table 5. Initial ODVS was 0.003, at the end of vase life of each treatment, significant increase in ODVS values was observed. The minimum increase in ODVS value was observed in $T_9$- boric acid at 0.6% (0.022 nm) whereas, the maximum value was recorded in $T_{10}$- Control (0.241 nm).

Similar results were observed by Paul and Gantait (2022) [17], who reported that microbial proliferation in vase solutions significantly reduces water uptake and flower quality in cut flowers due to vascular blockage, which is the indicator of microbial load increased in all treatments compared to the initial value of 0.003. However, the extent of increase varied significantly among treatments. These findings support the role of boric and oxalic acids as effective microbial inhibitors, contributing to clearer vase solutions and better post-harvest water uptake in tuberose. The results are further corroborated by Kuiper *et al.* (1995) [14] stating the acidic and antimicrobial vase solutions reduce bacterial growth, improving longevity and freshness of cut flowers. Thus, the significantly lower ODVS in treated solutions indicate improved vase hygiene and suggest that these compounds can enhance vase life and overall post-harvest performance in tuberose.

**Vase life (days):** There was a significant difference observed in vase life among the treatments and the results were depicted in Table 5. The Maximum vase life was recorded in T9- Boric acid at 0.6% (10.00 days) with maximum percentage of increase of

37% and $T_{10}$ was recoded the minimum vase life (6.30 days). According to Serrano *et al.* (2001) [22], the extension of vase life by boric acid was due to the inhibitory effect on ethylene production. Further, the boric acid has antiseptic, antifungal and antiviral properties. However, the mechanism of action is not known. In the present study, the better water relations and availability of total proteins and phenols in the flower stalks aided in maintaining the freshness for longer time compared to other treatments. Boron is effective in increasing flowering of tuberose plants, vase life of their spikes (Mudassir *et al.*, 2021) [15].

**Table 1:** Effect of pre harvest sprays on Water Uptake of cut tuberose (*Agave amica*) cv. Arka Prajwal

| Treatment | Water Uptake (g/spike) | | | | | |
|---|---|---|---|---|---|---|
| | Days | | | | | |
| | 2 | 4 | 6 | Mean | 8 | 10 |
| $T_1$ - Oxalic acid @ 2% | 20.70$^c$ | 19.50$^d$ | 17.30$^d$ | 19.17 | 15.17 | - |
| $T_2$ - Oxalic acid @ 3% | 21.20$^c$ | 20.10$^{cd}$ | 18.20$^{cd}$ | 19.83 | 16.93 | - |
| $T_3$ - Oxalic acid @ 4% | 17.50$^e$ | 16.40$^f$ | 14.50$^f$ | 16.13 | - | - |
| $T_4$ - Sodium nitroprusside @ 100 ppm | 19.30$^d$ | 18.20$^e$ | 16.00$^e$ | 17.83 | 14.17 | - |
| $T_5$ - Sodium nitroprusside @ 150 ppm | 16.80$^e$ | 15.60$^f$ | 13.50$^g$ | 15.30 | - | - |
| $T_6$ - Sodium nitroprusside @ 200 ppm | 18.80$^d$ | 17.70$^e$ | 15.60$^e$ | 17.37 | 13.93 | - |
| $T_7$ - Boric acid @ 0.2% | 21.80$^{bc}$ | 20.50$^{bc}$ | 18.70$^c$ | 20.33 | 16.47 | 14.80 |
| $T_8$ - Boric acid @ 0.4% | 22.50$^b$ | 21.30$^b$ | 19.70$^b$ | 21.17 | 17.67 | 15.83 |
| $T_9$ - Boric acid @ 0.6% | 24.70$^a$ | 23.40$^a$ | 21.50$^a$ | 23.20 | 19.50 | 17.27 |
| $T_{10}$ - Control (distilled water) | 15.00$^f$ | 13.90$^g$ | 11.50$^h$ | 13.47 | - | - |
| Mean | 19.83 | 18.66 | 16.65 | | | |
| SE m(±) | 0.44 | 0.34 | 0.31 | | | |
| CD at 5% | 1.30 | 0.99 | 0.92 | | | |
| CV | 3.85 | 3.12 | 3.23 | | | |

Vase solution $T_1$ to $T_{10}$ - sucrose 4% + citric acid 100 ppm

**Table 2:** Effect of pre harvest sprays on Transpirational Loss of Water of cut tuberose (*Agave amica*) cv. Arka Prajwal

| Treatment | Transpirational Loss of Water (g/spike) | | | | | |
|---|---|---|---|---|---|---|
| | Days | | | | | |
| | 2 | 4 | 6 | Mean | 8 | 10 |
| $T_1$ - Oxalic acid @ 2% | 21.30$^b$ | 20.60$^{bc}$ | 19.60$^c$ | 20.50 | 18.93 | - |
| $T_2$ - Oxalic acid @ 3% | 21.40$^b$ | 20.70$^{bc}$ | 20.10$^{bc}$ | 20.73 | 20.10 | - |
| $T_3$ - Oxalic acid @ 4% | 19.00$^{cd}$ | 18.50$^{ef}$ | 17.90$^{ef}$ | 18.47 | - | - |
| $T_4$ - Sodium nitroprusside @ 100 ppm | 20.10$^c$ | 19.77$^{cd}$ | 18.70$^d$ | 19.52 | 18.17 | - |
| $T_5$ - Sodium nitroprusside @ 150 ppm | 18.70$^{de}$ | 18.10$^f$ | 17.20$^f$ | 18.00 | - | - |
| $T_6$ - Sodium nitroprusside @ 200 ppm | 19.90$^c$ | 19.40$^{de}$ | 18.50$^{de}$ | 19.27 | 18.20 | - |
| $T_7$ - Boric acid @ 0.2% | 21.40$^b$ | 20.32$^{bc}$ | 19.80$^{bc}$ | 20.51 | 18.83 | 18.93 |
| $T_8$ - Boric acid @ 0.4% | 21.90$^b$ | 20.92$^b$ | 20.50$^b$ | 21.11 | 19.63 | 19.93 |
| $T_9$ - Boric acid @ 0.6% | 23.98$^a$ | 22.92$^a$ | 22.13$^a$ | 23.01 | 21.33 | 21.17 |
| $T_{10}$ - Control (distilled water) | 17.70$^e$ | 17.10$^g$ | 15.50$^g$ | 16.77 | - | - |
| Mean | 20.54 | 19.83 | 18.99 | | | |
| SE m(±) | 0.40 | 0.31 | 0.26 | | | |
| CD at 5% | 1.17 | 0.90 | 0.78 | | | |
| CV | 3.34 | 2.67 | 2.41 | | | |

Vase solution $T_1$ to $T_{10}$ - sucrose 4% + citric acid 100 ppm

**Table 3:** Effect of pre harvest sprays on Water Balance of cut tuberose (*Agave amica*) cv. Arka Prajwal

| Treatment | Water Balance (g/spike) | | | | | |
|---|---|---|---|---|---|---|
| | Days | | | | | |
| | 2 | 4 | 6 | Mean | 8 | 10 |
| $T_1$ - Oxalic acid @ 2% | -0.60 (4.40)$^d$ | -1.10 (3.90)$^d$ | -2.30 (2.70)$^e$ | 3.67 | -3.80 (1.20) | - |
| $T_2$ - Oxalic acid @ 3% | -0.20 (4.80)$^c$ | -0.60 (4.00)$^c$ | -1.90 (3.10)$^d$ | 3.97 | -3.20 (1.80) | - |
| $T_3$ - Oxalic acid @ 4% | -1.50 (3.50)$^g$ | -2.10 (2.90)$^f$ | -3.40 (1.60)$^h$ | 2.67 | - | - |
| $T_4$ - Sodium nitroprusside @ 100 ppm | -0.80 (4.20)$^e$ | -1.60 (3.40)$^e$ | -2.70 (2.30)$^f$ | 3.31 | -4.00 (1.00) | - |
| $T_5$ - Sodium nitroprusside @ 150 ppm | -1.90 (3.10)$^h$ | -2.50 (2.50)$^g$ | -3.70 (1.30)$^i$ | 2.30 | - | - |
| $T_6$ - Sodium nitroprusside @ 200 ppm | -1.10 (3.90)$^f$ | -1.70 (3.30)$^e$ | -2.90 (2.10)$^g$ | 3.10 | -4.3 (0.70) | - |
| $T_7$ - Boric acid @ 0.2% | 0.40 (5.40)$^b$ | 0.20 (5.20)$^b$ | -1.10 (3.90)$^c$ | 4.83 | -2.4 (2.60) | -4.10 (0.90) |
| $T_8$ - Boric acid @ 0.4% | 0.60 (5.60)$^a$ | 0.40 (5.40)$^a$ | -0.80 (4.20)$^b$ | 5.06 | -2.0 (3.00) | -4.10 (0.90) |
| $T_9$ - Boric acid @ 0.6% | 0.70 (5.70)$^a$ | 0.50 (5.50)$^a$ | -0.60 (4.40)$^a$ | 5.19 | -1.8 (3.20) | -3.90 (1.10) |
| $T_{10}$ - Control (distilled water) | -2.70 (2.30)$^i$ | -3.20 (1.80)$^h$ | -4.00 (1.00)$^j$ | 1.70 | - | - |
| Mean | 4.29 | 3.83 | 2.66 | | | |
| SE m(±) | 0.06 | 0.05 | 0.06 | | | |
| CD at 5% | 0.16 | 0.14 | 0.17 | | | |
| CV | 2.22 | 2.10 | 3.64 | | | |

Vase solution $T_1$ to $T_{10}$ - sucrose 4% + citric acid 100 ppm

Note: The data was analysed statistically after uniform addition of a base value 5.0. Transformed values are mentioned parentheses.

**Table 4:** Effect of pre harvest sprays on Change in Fresh Weight (CFW) of cut tuberose (*Agave amica*) cv. Arka Prajwal

| Treatment | Change in Fresh Weight (%) | | | | | |
|---|---|---|---|---|---|---|
| | Days | | | | | |
| | 2 | 4 | 6 | Mean | 8 | 10 |
| $T_1$ - Oxalic acid @ 2% | 103.55[b] | 94.41[b] | 80.58[c] | 92.85 | 72.40 | - |
| $T_2$ - Oxalic acid @ 3% | 103.01[b] | 93.54[bc] | 81.10[bc] | 92.55 | 75.66 | - |
| $T_3$ - Oxalic acid @ 4% | 101.97[bc] | 88.66[de] | 75.22[cd] | 88.62 | - | - |
| $T_4$ - Sodium nitroprusside @ 100 ppm | 97.70[d] | 89.89[cd] | 75.00[cd] | 87.53 | 70.36 | - |
| $T_5$ - Sodium nitroprusside @ 150 ppm | 99.55[cd] | 90.51[cd] | 77.58[c] | 89.21 | - | - |
| $T_6$ - Sodium nitroprusside @ 200 ppm | 98.26[d] | 91.58[bcd] | 69.66[de] | 86.50 | 64.25 | - |
| $T_7$ - Boric acid @ 0.2% | 106.85[a] | 98.55[a] | 87.06[ab] | 97.49 | 79.82 | 64.88 |
| $T_8$ - Boric acid @ 0.4% | 107.11[a] | 100.20[a] | 88.54[a] | 98.62 | 80.25 | 69.26 |
| $T_9$ - Boric acid @ 0.6% | 108.61[a] | 101.53[a] | 90.99[a] | 100.38 | 82.92 | 71.63 |
| $T_{10}$ - Control (distilled water) | 94.50[e] | 85.18[e] | 65.94[e] | 81.87 | - | - |
| Mean | 102.11 | 93.41 | 79.17 | | | |
| SE m(±) | 0.98 | 1.30 | 2.07 | | | |
| CD at 5% | 2.89 | 3.85 | 6.12 | | | |
| CV | 1.66 | 2.42 | 4.54 | | | |

Vase solution $T_1$ to $T_{10}$ - sucrose 4% + citric acid 100 ppm

**Table 5:** Effect of pre harvest sprays on vase life (days) of cut tuberose (*Agave amica*) cv. Arka Prajwal

| Treatment | pH at the end of vase life | EC at the end of vase life (dS/m) | OD at the end of vase life (at 480 nm) | Vase life (days) | Percentage increase from control |
|---|---|---|---|---|---|
| $T_1$ - Oxalic acid @ 2% | 4.58[abcde] | 0.131[e] | 0.048[de] | 9.10[ab] | 30.79 |
| $T_2$ - Oxalic acid @ 3% | 4.60[abcd] | 0.139[d] | 0.045[de] | 9.23[ab] | 31.77 |
| $T_3$ - Oxalic acid @ 4% | 4.00[de] | 0.126[f] | 0.122[bc] | 7.50[d] | 16.00 |
| $T_4$ - Sodium nitroprusside @ 100 ppm | 4.48[bcde] | 0.129[e] | 0.082[cd] | 8.53[bc] | 26.17 |
| $T_5$ - Sodium nitroprusside @ 150 ppm | 4.13[cde] | 0.119[g] | 0.140[b] | 8.10[cd] | 22.22 |
| $T_6$ - Sodium nitroprusside @ 200 ppm | 4.40[bcde] | 0.126[f] | 0.103[bc] | 7.33[d] | 14.09 |
| $T_7$ - Boric acid @ 0.2% | 4.71[abc] | 0.146[c] | 0.045[de] | 9.50[ab] | 33.68 |
| $T_8$ - Boric acid @ 0.4% | 5.00[ab] | 0.159[b] | 0.039[e] | 9.80[a] | 35.71 |
| $T_9$ - Boric acid @ 0.6% | 5.20[a] | 0.162[a] | 0.022[e] | 10.00[a] | 37.00 |
| $T_{10}$ - Control (distilled water) | 3.90[e] | 0.118[g] | 0.241[a] | 6.30[e] | 0.00 |
| Mean | 4.50 | 0.136 | 0.089 | 8.54 | |
| SE m(±) | 0.24 | 0.001 | 0.015 | 0.33 | |
| CD at 5% | 0.70 | 0.002 | 0.043 | 0.99 | |
| CV | 9.11 | 0.999 | 28.315 | 6.79 | |

Vase solution $T_1$ to $T_{10}$ - sucrose 4% + citric acid 100 ppm
Note: Initial pH, EC and OD of vase solution are 3.87, 0.118 dS/m and 0.003 nm respectively.

## Conclusion

The Pre-harvest application of boric acid at 0.6% extended the vase life to 10 days, marking a 37% increase compared to the control. Moreover it showed positive influence on key physiological attributes.

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