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# Effect of holding solutions on carnation cut flowers (*Dianthus caryophyllus* L.) CV. Charmant

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**Abstract**
The present study entitled, "Effect of holding solution on carnation (*Dianthus caryophllyus* L.) C.V. Charmant" was carried out in Horticultural Lab, School of Agriculture lovely professional university, Jalandhar, Punjab during the year 2020-2021. The main objective of the investigation was to evaluate the viable postharvest treatment solutions and methodology to extend the vase life of cut carnation based on physical and physiological components. The experiment was laid out in complete random block design consisting of six treatments of different combinations of sucrose, growth inhibitors in different concentration in three replications. Observation was recorded on interval days for eight physical and physiological parameters and were subjected to statistical analysis. The result indicated that the highest WU (14.661) was recorded with 6% Sucrose + 50 ppm AgNo3 followed by 9% Sucrose + 50 ppm $AgNo_3$ (13.64) and 3% Sucrose + 20 ppm $AgNo_3$ (11.33). However, the treatment control recorded lowest WU (6.47). Similar results were also reported by Prashanth (2006) [7] in cut gerberas. Among the treatments, 6% Sucrose + 50 ppm $AgNo_3$ recorded highest WB (6.25), followed by 2% Sucrose + 200 ppm 8-HQC + 100 ppm GA3 (5.87) and 9% Sucrose + 50 ppm $AgNo_3$ (5.747). However, control recorded lowest WB (3.16). The highest FW was observed with 6% Sucrose + 50 ppm $AgNo_3$ (101.38) followed by 3% Sucrose + 20 ppm $AgNo_3$ (99.65) and 9% Sucrose + 50 ppm $AgNo_3$ (99.27), whereas, the treatment control recorded significantly lowest FW (89.66) and the remaining treatments recorded intermediate results. Highest FD however was recorded with 2% Sucrose + 200 ppm 8-HQC + 100 ppm GA3 on day 2, 4, 6, 8 and 10 (4.81, 5, 5.2, 5.5 and 5.8 respectively). On day 2, 4, 6, 8 and 10 the lowest FD was noted with control (3.5, 3.7, 3.7, 3.8 and 4.2 respectively). Among the different concentration of treatment combinations, 6% Sucrose + 50 ppm $AgNo_3$ recorded highest flower diameter and control recorded lowest flower diameter during entire vase life period. Full flower opening was significantly delayed with sucrose 6% + 50 ppm $AgNo_3$ (6.23), which was on par with sucrose 9% + 50 ppm $AgNo_3$ (5.12). The flowers held in control (3.82) were the earliest in full flower opening and the remaining treatments recorded intermediate values. The vase life of cut carnation flowers differed significantly with different sucrose treatments. The longest vase life was observed with sucrose 6% + 50 ppm $AgNo_3$ (11.98) which was on par with sucrose 9% + 50 ppm $AgNo_3$ (11.34) and sucrose 3% + 20 ppm $AgNo_3$ (10.29). Whereas, the treatment, control recorded significantly shortest vase life (6.69). The remaining treatments stayed on par with each other.

**Keywords:** carnation, holding solution, pulsing, packaging, storage, water uptake, transpiration loss, vase life, flower diameter, fresh weight, electrolyte leakage

## Introduction
Carnation (*Dianthus caryophyllus* L.) known as divine flower, is one of the world's most popular and leading cut flowers in the world. They are also called as clove gillyflowers, clove pinks and gilly flowers. It belongs to Caryophyllaceous family. With diploid chromosome (2n=30) Patil *et al*., (2004) [6] reported that carnation is an important and excellent cut flower most demanded across the world and ranks second on global floriculture screen. In 300 B.C. Theophrastus written the book, "History of Plants" and provide references for carnation cultivation. Dhua (1999) [2] mentioned that in 16$^{th}$ century, the usage and improvement on carnation was initiated. The name 'carnation' derived from Greek 'coronation' since it was used in beautifying Greek athlete's crown. In the International cut flower trade among the top ten cut flowers, because of carnation's excellent keeping quality, it holds an esteemed position. People believe that Mediterranean region as its native and it is a National flower of Spain. In genus *Dianthus*, there were 250 cultivated species, of which only few are cultivated, i.e., *Dianthus caryophyllus D. barbatus* and *D. chinensis*. Ability to withstand long distance transportation, wide range of color forms, remarkable ability to rehydrate along with its lighter weight and excellent keeping quality have made carnation flowers a unique item in cut flower trade.

In India, potentiality for cultivating quality carnations remained in cool climatic regions viz., Kashmir, Kullu Valley, Kalimpong, Bengaluru, etc. The area around Delhi, U.P., Punjab, Nasik, Srinagar, Solan, Coimbatore including Nilgiri hills are the favorable carnation growing zones in India. The perpetual flowering types of *Dianthus* is hybrids. There are two major class of carnation which were Spray and Standard. The bloom which is larger on longer flower stalks are standard type carnation and many small flowers with weaker stem are the spray type carnation. Carnation is a long day plant. Several factors influence its growth and flowering. For better performance, standard type carnation was grown in cool climate and spray time grown in higher temperature. For carnation, the optimum day temperature was 18-24 ºC; night temperature during winter was 10-11 ºC and in summer was 13-15.5 ºC. Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Haryana, Tamil Nadu, Rajasthan, and West Bengal have emerged as major floriculture centres. About 322 thousand hectares of the area were under Cultivation for floriculture in 2020-21. Production of flowers is estimated to be 2151.96 thousand tonnes of loose flowers and 828.09 thousand tonnes of cut flowers in 2020-21. The country has exported 23,597.17 MT of floriculture products to the world for the worth of Rs. 771.41Crores/103.47 USD Millions in 2021-22. (Anonymous 2021) [1] in normal development cycle of plants, post-harvest senescence plays an important role and it is highly planned proves that involves, molecular, structural, and biochemical changes in the plant tissue. Postharvest senescence of flower has been ascribed mainly to ethylene. In the International market, Carnation is the most important flower as cut flower. In the existence of ethylene, cut carnation flowers have restriction for their fruitful marketing due to petal enrolling and discoloration. It leads to flower senescence and reduction in vase life.

Ethylene is a naturally happening plant hormone that boosts the senescence and cuts the vase life of many flowers (Hunter *et al.*, 1999) [3]. In the same way, cut carnations are very sensitive to ethylene injury. Though, pulsing treatment of flowers either with inhibitors of ethylene biosynthesis, such as amino-oxyacetic acid, amino-ethoxy-vinylglycine and α-aminoisobutyric acid (AIB) or by inhibitors of ethylene action, such as silver thiosulfate (STS), 2, 5-norbornadiene and 1-Methylcyclopropene (1-MCP) postponements the onset of flower senescence. Gibberellic acid is known to upsurge the plant height and number of leaves that might have led to enlarged rate of photosynthesis. As a result of this, availability of metabolites to the developing corm and cormels might have increased, thereby leading to increase in the weight of corm in gladiolus. Sharifuzzaman *et al*. 2011 [8] reported that foliar application of 150 ppm GA3 produced higher number of suckers, maximum number of cut blooms with longer stalk and bigger flower size in chrysanthemum. Maximum flower size and flower yield were observed in China aster cv. 'Kamini' with foliar spray of GA3 200 ppm by Gupta *et al*. Kasturi and Chandrasekhar reported that spray of GA3 recorded minimum number of days to bud sprout in carnation. Longest vase life of cut tuberose spike was recorded with the foliar application of GA3 200 ppm as reported by Kurve *et al.*[5] In the international trade market, carnation is one among the top three cut flowers and it has been sold as cut flowers. As carnation have ability to rehydrate after transportation, its flower quality during long distance transportation should be maintained. Thus, arises the prime importance to test the flowering, flower quality and yield parameters in its varieties for adaptability and suitability. Hence, in view to extend the cut flowers vase life, there arises a need to understand the importance of physical, physiological, and biochemical parameters.

## Materials and Methods

Present study entitled "Effect of holding solutions on (*Dianthus caryophyllus* L.)" was studied in Jalandhar, Punjab. The experiment includes six different treatments to evaluate the effect of holding solutions. The experiment was carried out at Horticultural Lab, School of Agriculture lovely professional university. Jalandhar, Punjab during the year 2020-2021. The flowers to be experimented were kept in Horticulture laboratory at about 25+2 ºC in ambient room temperature, 45 to 55 percent relative humidity (RH) and 40 W cool white fluorescent tubes to maintain 12 hours photoperiod.

The experiments were conducted with post-harvest treatments of flower stalks holding with sucrose, growth regulators, ethylene inhibitors and biocides. All the flowers used for the following experiments were exposed to pre-cooling conditions (4 ºC). Holding solutions of different treatment combinations are used such as T0-Control, T1-Sucrose 10% + 100 ppm Citric acid + 400 ppm 8-Hydroxy Quinoline, T2-2% Sucrose + 200 ppm 8-HQC + 100 ppm GA3, T3-3% Sucrose + 20 ppm $AgNo_3$, T4-6% Sucrose + 50 ppm $AgNo_3$, T5-9% Sucrose + 50 ppm $AgNo_3$. All the chemicals used in the experimentation and analytical work were of A.R. grade, obtained from standard Indian chemical companies.

One micro liter (or) one milligram of chemical dissolved in 1000 ml (1 lit) of distilled water gives one ppm. One molar solution is prepared by dissolving one molecular weight of the chemical in one litter. Based on this formulae aluminum sulphate, 8-hydroxy quinoline sulphate (8-HQS), citric acid, gibberellic acid, silver nitrate was prepared by dissolving required quantity of chemical in appropriate volume of distilled water to get required concentration of each solution. Similarly, to get 1 per cent of sucrose solution, one gram of sucrose dissolved in 100 ml of distilled water and respective concentrations of sucrose were made by dissolving required quantity in required volume of distilled water.

During the experimental period 18 plants were collected at paint bud stage from the field. Three plants per solution were placed along with control, so we have total six solutions in which we have to measure different physiological changes during vase life and to find the best treatment combinations. In each glass bottle, 3 flowers were placed and considered as one replication. After recording fresh weight, the individual flower stalks were placed randomly in the 500 ml glass bottles containing 250 ml of aqueous test solutions of different treatments. The bottle mouths were sealed with aluminum foil, to prevent the evaporation loss of aqueous test solutions. The weight of each container and the test solution/distilled water with and without flower stems was recorded once in two days. Vase life and other visual observations of the flowers were recorded daily.

## Result and Discussion

### 1.1 Water uptake (ml/f)

Data recorded during vase life period of cut carnation on water uptake in different concentrations are indicated in table.1.1.

**Table 1.1:** Effect of holding solutions of different treatment combination on no. of days taken for water uptake (ml/f) during vase life period of cut carnation

| Sr. No | Treatments | Days | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2 | 4 | 6 | 8 | 10 | 12 | Total |
| T1 | Sucrose 10% + Citric acid 100 ppm + 8-Hydroxy Quinoline 400 ppm | 17.27 | 15.62 | 9.59 | 6.45 | 4.74 | 0 | 53.67 |
| T2 | 2% Sucrose + 200 ppm 8-HQC + 100 ppm GA3 | 17.62 | 15.483 | 10.573 | 6.767 | 4.973 | 2.163 | 55.40 |
| T3 | 3% Sucrose + 50 ppm $AgNo_3$ | 18.58 | 16.64 | 14.423 | 8.357 | 6.19 | 3.84 | 64.18 |
| T4 | 6% Sucrose + 50 ppm $AgNo_3$ | 20.573 | 18.43 | 17.48 | 14.517 | 10.39 | 6.573 | 81.39 |
| T5 | 9% Sucrose + 50 ppm $AgNo_3$ | 19.5 | 17.463 | 18.24 | 12.18 | 8.213 | 6.257 | 75.59 |
| T0 | Control (DW) | 10.553 | 8.49 | 7.267 | 5.833 | 4.33 | 0 | 36.40 |
| | Mean | 17.351 | 15.354 | 12.929 | 9.017 | 6.473 | 3.139 | |
| | C.D. | 0.291 | 0.182 | 0.271 | 0.19 | 0.188 | 0.194 | |
| | SE(m) | 0.094 | 0.059 | 0.087 | 0.061 | 0.06 | 0.062 | |
| | SE(d) | 0.132 | 0.083 | 0.123 | 0.086 | 0.086 | 0.088 | |
| | C.V. | 0.934 | 0.661 | 1.167 | 1.171 | 1.619 | 3.436 | |

The cut carnations held in different concentrations of treatment combinations differed significantly on WU. Highest WU (81.39 ml) was recorded with 6% Sucrose + 50 ppm $AgNo_3$ followed by 9% Sucrose + 50 ppm $AgNo_3$ (75.59 ml) and 3% Sucrose + 20 ppm $AgNo_3$ (64.18 ml). However, the treatment control recorded lowest WU (36.40). Significant differences in WU were observed due to vase life period. The WU decreased from day 2 (17.351) to day 10 (6.473) at each successive interval of observation.

The highest WU was observed with 6% Sucrose + 50 ppm $AgNo_3$ on day 2, 4, 6, 8 and 10 (20.573,18.43, 17.48,14.517 and 10.39 respectively) which was on par with 9% Sucrose + 50 ppm $AgNo_3$ on day 2 and 4 (19.5 and 17.46 respectively) and followed by 3% Sucrose + 20 ppm $AgNo_3$ with significant difference on day 6, 8 and 10 (14.423,8.357 and 6.19 respectively). The treatment, control recorded lowest WU on day 2, 4, 6, 8 and 10 (10.553, 8.49, 7.267, 5.833 and 4.33 respectively). The remaining treatments recorded intermediate results.

### 1.2 Water balance (ml/f)

During vase life period of cut carnation, the changes in water balance (WB) in different concentrations of treatment combinations are indicated in Table 1.2.1.

**Table 1.2.1:** Effect of holding solutions of different treatment combination on no. of days taken for water balance (g/f) during vase life period of cut carnation

| | Treatments | Days | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2 | 4 | 6 | 8 | 10 | 12 |
| T1 | Sucrose 10% + Citric acid 100 ppm + 8-Hydroxy Quinoline 400 ppm | 4.423 | 4.193 | 3.88 | 3.5 | 1.353 | 0 |
| T2 | 2% Sucrose + 200 ppm 8-HQC + 100 ppm GA3 | 5.87 | 5.323 | 4.57 | 3.52 | 3.213 | 0 |
| T3 | 3% Sucrose + 50 ppm $AgNo_3$ | 5.343 | 4.62 | 4.04 | 3.687 | 3.173 | 0 |
| T4 | 6% Sucrose + 50 ppm $AgNo_3$ | 6.25 | 6.043 | 5.777 | 4.84 | 4.01 | 0 |
| T5 | 9% Sucrose + 50 ppm $AgNo_3$ | 5.747 | 5.253 | 4.82 | 4.423 | 4.103 | 2.257 |
| T0 | Control (DW) | 3.16 | 2.95 | 2.69 | 2.193 | 2.163 | 1.153 |
| | Mean | 5.132 | 4.731 | 4.296 | 3.694 | 3.003 | 0.568 |
| | C.D. | 0.187 | 0.209 | 0.219 | 0.189 | 0.23 | 0.092 |
| | SE(m) | 0.06 | 0.067 | 0.07 | 0.061 | 0.074 | 0.03 |
| | SE(d) | 0.085 | 0.095 | 0.099 | 0.086 | 0.104 | 0.042 |
| | C.V. | 2.031 | 2.458 | 2.831 | 2.848 | 4.262 | 8.991 |

There were significant differences among the treatments on water balance of cut carnation. Among the treatments, 6% Sucrose + 50 ppm $AgNo_3$ recorded highest WB (6.25), followed by 2% Sucrose + 200 ppm 8-HQC + 100 ppm GA3 (5.87) and 9% Sucrose + 50 ppm $AgNo_3$ (5.747). However, control recorded lowest WB (3.16). There were significant differences in WB during different days of vase life period. The WB decreased from day 2 (6.25) to day 10 (3.16).

The treatment, 6% Sucrose+50 ppm $AgNo_3$ recorded highest WB on day 2, 4, 6, and 8 (6.25, 6.043, 5.777, 4.84 and 4.01 respectively). On day 2, 4, 6, 8 and 10 the lowest WB was recorded with control (3.16, 2.95, 2.69, 2.193 and 2.163 respectively). Among different concentrations of sucrose, 6% Sucrose + 50 ppm $AgNo_3$ and 2% Sucrose + 200 ppm 8-HQC + 100 ppm GA3 recorded good water balance, compared to other treatments of sucrose.

### 1.3 Fresh weight change (% of initial weight)

The changes in fresh weight during vase life period of cut carnation in different concentrations of treatment combinations are indicated in Table 1.3.1.

**Table 1.3.1:** Effect of holding solutions of different treatment combination on no. of days taken for fresh weight change (% of initial weight) during vase life period of cut carnation

| Sr. No | Treatments | Days | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2 | 4 | 6 | 8 | 10 | 12 | Mean |
| T1 | Sucrose 10% + Citric acid 100 ppm + 8-Hydroxy Quinoline 400 ppm | 100.793 | 98.577 | 96.687 | 94.433 | 91.043 | 0 | 96.30 |
| T2 | 2% Sucrose + 200ppm 8-HQC + 100 ppm GA3 | 101.333 | 98.16 | 95.743 | 93.65 | 96.337 | 0 | 97.04 |
| T3 | 3% Sucrose + 50 ppm $AgNo_3$ | 104.15 | 101.14 | 99.313 | 97.537 | 96.13 | 0 | 99.65 |
| T4 | 6% Sucrose + 50 ppm $AgNo_3$ | 105.39 | 103.173 | 101.6 | 99.117 | 97.653 | 96.303 | 101.38 |
| T5 | 9% Sucrose + 50 ppm $AgNo_3$ | 102.213 | 101.457 | 99.243 | 97.14 | 96.3 | 95.193 | 99.27 |
| T0 | Control (DW) | 91.987 | 91.033 | 89.917 | 87.76 | 87.627 | 0 | 89.66 |
| | Mean | 100.978 | 98.923 | 97.084 | 94.939 | 94.182 | 31.916 | |
| | C.D. | 0.209 | 0.27 | 0.269 | 0.282 | 0.235 | 0.161 | |
| | SE(m) | 0.067 | 0.087 | 0.086 | 0.09 | 0.075 | 0.052 | |
| | SE(d) | 0.095 | 0.123 | 0.122 | 0.128 | 0.107 | 0.073 | |
| | C.V. | 0.115 | 0.152 | 0.154 | 0.165 | 0.139 | 0.281 | |

The sucrose treated flowers differed significantly on FW. The highest FW was observed with 6% Sucrose + 50 ppm $AgNo_3$ (101.38) followed by 3% Sucrose + 20 ppm $AgNo_3$ (99.65) and 9% Sucrose + 50 ppm $AgNo_3$ (99.27), whereas, the treatment control recorded significantly lowest FW (89.66) and the remaining treatments recorded intermediate results. There were significant differences in FW during different days of vase life period of cut carnation. The FW was decreased from day 2 (100.39) to day 10 (94.18) significantly. The interaction effect between days and treatments on FW was found to be significant. The treatment 6% Sucrose + 50 ppm $AgNo_3$ recorded highest FW on day 2, 4, 6, 8 and 10 (105.39, 103.17, 101.6, 99.11 and 97.65 respectively) and lesser than 3% Sucrose + 20 ppm $AgNo_3$ (99.65) which was on par with 9% Sucrose + 50 ppm $AgNo_3$ on day 8 (99.27) respectively. The treatment sucrose 6% + 50 ppm $AgNo_3$ recorded highest FW on day 10 (97.65). The treatment control recorded lowest FW on day 2, 4, 6, 8 and 10 (91.98, 91.03, 89.91, 87.76 and 87.627 respectively).

The fresh weight increased slightly from initial day to day 2 and decreased gradually to the end of vase life period. Among the different concentrations of sucrose, the highest fresh weight change was observed with sucrose 6% + 50 ppm $AgNo_3$ and lowest with control.

### 1.4 Flower diameter (cm)

The data recorded on flower diameter (FD) during vase life period of cut carnation in different concentrations of treatment combinations are indicated in Table 1.4.1.

**Table 1.4.1:** Effect of holding solutions of different treatment combination on no. of days taken for flower diameter (cm) during vase life period of cut carnation

| Sr. No. | Treatments | Days | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2 | 4 | 6 | 8 | 10 | 12 |
| T1 | Sucrose 10% + Citric acid 100 ppm + 8-Hydroxy Quinoline 400 ppm | 3.433 | 3.8 | 4.003 | 4.3 | 5 | 0 |
| T2 | 2% Sucrose + 200 ppm 8-HQC + 100 ppm GA3 | 4.81 | 5 | 5.2 | 5.5 | 5.8 | 5.9 |
| T3 | 3% Sucrose + 50 ppm $AgNo_3$ | 4.5 | 4.803 | 4.907 | 5 | 5.2 | 0 |
| T4 | 6% Sucrose + 50 ppm $AgNo_3$ | 4.513 | 4.7 | 4.9 | 5.2 | 5.5 | 0 |
| T5 | 9% Sucrose + 50 ppm $AgNo_3$ | 4.71 | 4.703 | 4.807 | 4.803 | 4.9 | 5.2 |
| T0 | Control (DW) | 3.5 | 3.7 | 3.7 | 3.8 | 4.2 | 0 |
| | Mean | 4.246 | 4.451 | 4.586 | 4.767 | 5.1 | 1.85 |
| | C.D. | 0.315 | 0.268 | 0.303 | 0.391 | 0.277 | 0.164 |
| | SE(m) | 0.101 | 0.086 | 0.097 | 0.125 | 0.089 | 0.053 |
| | SE(d) | 0.143 | 0.122 | 0.137 | 0.177 | 0.126 | 0.075 |
| | C.V. | 4.12 | 3.344 | 3.669 | 4.558 | 3.022 | 4.934 |

There were no significant differences among the treatments on flower diameter. There were significant differences in flower diameter during different days of vase life period of cut carnation. The FD increased from day 2 (4.81) to day 10 (5.8). The interaction effect on flower diameter due to days and treatments was found to be significant. No significant differences were observed among the treatments on FD of cut carnation on day 2. Highest FD however was recorded with 2% Sucrose + 200 ppm 8-HQC + 100 ppm GA3 on day 2, 4, 6, 8 and 10 (4.81, 5, 5.2, 5.5 and 5.8 respectively). On day 2, 4, 6, 8 and 10 the lowest FD was noted with control (3.5, 3.7, 3.7, 3.8 and 4.2 respectively).

### 1.5 Full flower opening days

In cut carnation, days taken for full flower opening were observed in different concentrations of treatment combinations are indicated in Table 1.5.1.

**Table 1.5.1:** Effect of holding solutions of different treatment combination on no. of days taken for full flower opening and vase life (days) during vase life period of cut carnation

| Sr.no | Treatments | No. of days for full flower opening | Vase life (days) |
|---|---|---|---|
| T1 | Sucrose 10% + Citric acid 100 ppm + 8-Hydroxy Quinoline 400 ppm | 4.52 | 9.42 |
| T2 | 22% Sucrose + 200 ppm 8-HQC + 100 ppm GA3 | 4.37 | 8.71 |
| T3 | 3% Sucrose + 50 ppm $AgNo_3$ | 4.98 | 10.29 |
| T4 | 6% Sucrose + 50 ppm $AgNo_3$ | 6.23 | 11.98 |
| T5 | 9% Sucrose + 50 ppm $AgNo_3$ | 5.12 | 11.34 |
| T0 | Control (DW) | 3.82 | 6.69 |
| | Mean | 4.84 | 9.74 |
| | C.D. | 0.154 | 0.292 |
| | SE(m) | 0.049 | 0.094 |
| | SE(d) | 0.07 | 0.132 |
| | C.V. | 1.763 | 1.665 |

The flowers held in different concentrations of treatment combinations of solution exhibited significant difference on full flower opening days. Full flower opening was significantly delayed with sucrose 6% + 50 ppm $AgNo_3$ (6.23), which was on par with sucrose 9% + 50 ppm $AgNo_3$ (5.12). The flowers held in control (3.82) were the earliest in full flower opening and the remaining treatments recorded intermediate values.

### 1.6 Vase life (days)

The data recorded on vase life period of cut carnation in different concentrations of treatment combinations are indicated in Table 1.5.1.

The vase life of cut carnation flowers differed significantly with different sucrose treatments. The longest vase life was observed with sucrose 6% + 50 ppm $AgNo_3$ (11.98) which was on par with sucrose 9% + 50 ppm $AgNo_3$ (11.34) and sucrose 3% + 20 ppm $AgNo_3$ (10.29). Whereas, the treatment, control recorded significantly shortest vase life (6.69). The remaining treatments were on par with each other.

### 1.7 Transpiration loss of water (g/f)

The changes in transpiration loss of water (TLW) during vase life period of cut carnation in different concentrations of treatment combination are indicated in Table 1.6.1.

**Table 1.6.1:** Effect of post-harvest application of different treatment solutions combination on Transpiration Loss of Water (TLW) (g/f) during vase life period of cut carnation

| Treatments | Days | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 | Mean |
| Sucrose 10% + Citric acid 100 ppm + 8-Hydroxy Quinoline 400 ppm | 17.343 | 15.82 | 12.807 | 9.983 | 8.36 | - | 12.87 |
| 2% Sucrose + 200 ppm 8-HQC + 100 ppm GA3 | 17.687 | 16.123 | 10.783 | 8.4 | 6.65 | - | 11.92 |
| 3% Sucrose + 50 ppm $AgNo_3$ | 12.367 | 10.677 | 9.337 | 8.63 | 7.98 | - | 9.78 |
| 6% Sucrose + 50 ppm $AgNo_3$ | 19.22 | 18.307 | 17.247 | 16.487 | 15.32 | 11.3 | 17.32 |
| 9% Sucrose + 50 ppm $AgNo_3$ | 18.323 | 17.54 | 16.21 | 11.427 | 10.657 | 9.24 | 14.83 |
| Control (DW) | 11.56 | 10.437 | 9.513 | 8.34 | 7.407 | 12 | 9.45 |
| Mean | 16.08 | 14.81 | 12.65 | 10.54 | 8.16 | - | |
| C.D. | 0.129 | 0.136 | 0.143 | 0.114 | 0.176 | - | |
| SE(m) | 0.041 | 0.044 | 0.046 | 0.037 | 0.057 | - | |
| SE(d) | 0.059 | 0.062 | 0.065 | 0.052 | 0.08 | - | |
| C.V. | 0.446 | 0.51 | 0.628 | 0.6 | 1.042 | - | |

The flowers held in different concentrations of treatment combination differed significantly on TLW. The highest TLW (17.32) was observed with 6% Sucrose + 50 ppm $AgNo_3$, followed by 9% Sucrose + 50 ppm $AgNo_3$ (14.83). However, the treatment, control recorded significantly lowest TLW (9.45).

There were significant differences in TLW during different days of vase life period of cut carnation flowers. The TLW significantly decreased from initial day of experimentation to day 10 at each successive interval of observation. The highest TLW was observed on day 2 (19.21) and the lowest was on day 10 (8.16). The interaction between days and treatments on TLW was significant.

Highest TLW was recorded with 6% Sucrose + 5 ppm $AgNo_3$ on day 2, 4, 6, 8 and 10 (19.22, 18.307, 17.247, 16.487 and 15.32 respectively) followed by 9% Sucrose + 50 ppm $AgNo_3$, on day 2,4,6,8 and 10 (18.323, 17.54, 16.21, 11.427 and 10.65 respectively). However, control recorded lowest TLW on day 2, 4 and 6 (11.57, 10.42 and 9.51 respectively). The lowest TLW recorded on day 2 and 10 was 8.34 and 7.40 respectively.

### 1.8. Electrolyte leakage (%)

The changes in electrolyte leakage (EL) during vase life period of cut carnation in different concentrations of treatment combinations are indicated in Table.4.6.

**Table 1.7.1:** Effect of post-harvest application of different treatment solutions combination on electrolyte leakage (%) during vase life period of cut carnation

| Treatments | No. of Days | | | |
|---|---|---|---|---|
| | **0** | **4** | **8** | **Mean** |
| Sucrose 10% + Citric acid 100 ppm + 8-Hydroxy Quinoline 400 ppm | 20.65 | 35.40 | 40.13 | 30.06 |
| 2% Sucrose + 200 ppm 8-HQC + 100 ppm GA3 | 20.65 | 32.68 | 39.20 | 30.84 |
| 3% Sucrose + 50 ppm $AgNo_3$ | 20.65 | 30.24 | 37.16 | 29.35 |
| 6% Sucrose + 50 ppm$AgNo_3$ | 20.65 | 25.13 | 35.42 | 27.07 |
| 9% Sucrose + 50 ppm$AgNo_3$ | 20.65 | 25.89 | 36.75 | 27.76 |
| Control (DW) | 20.65 | 35.98 | 38.12 | 31.58 |
| Mean | 20.65 | 30.89 | 37.80 | |
| C.D. | 0.171 | 0.139 | 0.177 | |
| SE(m) | 0.055 | 0.045 | 0.057 | |
| SE(d) | 0.078 | 0.063 | 0.081 | |
| C.V. | 0.461 | 0.25 | 0.261 | |

The sucrose treated flowers differed significantly on electrolyte leakage. 6% Sucrose + 50 ppm $AgNo_3$ recorded significantly lowest EL (27.07) followed by 9% Sucrose + 50 ppm $AgNo_3$ (27.76) and 3% Sucrose + 50 ppm $AgNo_3$ (29.35) with significant difference. The treatment, control recorded highest EL (31.58) and the remaining treatments recorded intermediate results. There were significant differences in EL during different days of vase life period.

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