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STUDIES ON THE EFFECT OF ETHYLENE INHIBITORS ON EXTENSION OF VASE LIFE OF CARNATION CUT FLOWER (*DIANTHUS CARYOPHYLLUS* L.) CV. DONA UNDER AMBIENT CONDITIONS

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ABSTRACT

This experiment was conducted in the Floriculture lab at the College of Horticulture in Mojerla, Telangana, India to understand the effect of ethylene inhibitors on extension of vase life of carnation cut flower (*Dianthus caryophyllus* L.) cv. Dona under ambient conditions. Thirteen treatments with three replications were used in a completely randomized design for this experiment. Four different preservative chemicals were used in the treatments: deionized water was used as the control, cobalt chloride at 100, 200 and 300 ppm, salicylic acid at 100, 200, and 300 ppm, malic acid at 100, 200, 300 ppm and citric acid at 100, 200 and 300 ppm. Additionally, 4% sucrose was maintained in each treatment. According to the experiment's results, cobalt chloride at 100 ppm + sucrose at 4% (T_1) produced considerably higher maximum WU, TLW, WB, FWC and lowest ODVS values than the other treatments. Based on the aforementioned findings, it was determined that using vase solution with cobalt chloride at 100 ppm and 4% sucrose was superior for extending the vase life of carnation cv. Dona.

Key words : Carnation, Ethylene inhibitors, Treatment solutions, Water uptake, Transpirational loss of water, Water balance, Fresh weight change, Optical density and vase solution.

Introduction

Due to its beauty, color range, and exceptional keeping quality, the carnation (*Dianthus caryophyllus* L.), a member of the Caryophyllaceae family, is one of the most significant cut flowers in the world (Kharrazi *et al.*, 2011). A few of its cultivars are utilized for window boxes, bedding, pots and rock gardens. In addition to its aesthetic appeal, carnation flowers are thought to have nervine, alexiteric, cardiac tonic and diaphoretic properties (Chopra *et al.*, 1956). Given that carnations are currently one of the most popular cut flowers, it's critical to prolong their vase life. Cut flower vase life and postharvest performance are influenced by a number of factors (Ichimura *et al.*, 2002).

Biocides are an important class of chemicals that have been used in the past to extend the vase life of carnation flowers. Postharvest treatment is essential to delay the flower's aging process and extend its vase life because the flower's ageing process quickens as it separates from its mother plant (Tsegaw *et al.*, 2011). Biocides are required in the vase solution if sugars are introduced, as the sugars themselves will encourage bacterial development, which leads to xylem occlusion. Biocides inhibit microbial growth in the solution and prevent microorganisms from blocking xylem (Pun *et al.*, 2005).

When flowers are purchased, customers are drawn to them because of their attractiveness, scent and longevity in various floral arrangements. This encourages them to purchase flowers again. Therefore, it is necessary to investigate the possibility of employing various biocides solutions to extend the vase life (Tsegaw *et al.*, 2011). The current study, "Studies on the effect of ethylene inhibitors on extension of vase life of carnation cut flower (*Dianthus caryophyllus* L.) cv. Dona under ambient conditions," was conducted with consideration for the whole range of market demands and constraints.

Materials and Methods

The present investigation was carried out in the Floriculture lab, College of Horticulture, Mojerla, Telangana. The study was taken up in a completely randomized design with 13 treatments replicated thrice. The treatments consisted of T_1 (Cobalt chloride @ 100 ppm), T_2 (Cobalt chloride @ 200 ppm), T_3 (Cobalt chloride @ 300 ppm), T_4 (Salicylic acid @ 100 ppm), T_5 (Salicylic acid @ 200 ppm), T_6 (Salicylic acid @ 300 ppm), T_7 (Malic acid @ 100 ppm), T_8 (Malic acid @ 200 ppm), T_9 (Malic acid @ 300 ppm), T_{10} (Citric acid @ 100 ppm), T_{11} (Citric acid @ 200 ppm), T_{12} (Citric acid @ 300 ppm) and T_{13} (Control Deionised water + sucrose 4%). Carnation (*Dianthus caryophyllus* L.) cv. Dona flowers free from diseases and pests obtained from Floriculture Research Station, Hyderabad were used for the experimentation (Plate 1). The basal three pairs of leaves were removed and the stalks were re-cut to a uniform length of 40 cm using distilled water. Each of the 500 ml conical flasks holding the 300 ml treatments' liquids has four flowers in it (Plate 2). Every container and solution, both with and without flowers had its weight measured once every two days. At the same time that the weights were being recorded, the base of the floral stems roughly 0.5 cm was chopped off. On different days, the floral observations were noted.

Plate 1 : FRS, Rajendranagar, Hyderabad.

Plate 2 : Floriculture lab, College of Horticulture, Mojerla.

Water uptake (WU), Transpirational loss of water (TLW), Water balance (WB) was observed and expressed as gram per flower (g flower^{-1}) and fresh weight change (FWC) was recorded as percentage of initial weight. Optical density of vase solution was measured at every alternate day using spectrophotometer at 480 nm and vase life was observed and expressed in days.

Results and Discussion

The amount of water that carnation cut flowers cv. Dona kept in different preservative solutions varied significantly. Of all the treatments, the flowers kept in T_1 treatment (cobalt chloride @ 100 ppm+ sucrose 4%) recorded the highest amount of water (11.92 g flower^{-1}) from the second to the tenth day (11.04 g flower^{-1}) of the vase life period, while the control group (T_{13}) on preservative solution recorded the lowest amount of water (4.72 g flower^{-1}) on the second day of the vase life period (Table 1). The combined effects of sucrose and cobalt chloride may be the cause of the highest WU in T_1 (cobalt chloride at 100 ppm + sugar at 4%). Kuiper *et al.* (1995) state that tissues on the verge of deprivation from carbohydrates utilize sucrose as a source of sustenance. Auxins, cytokinin activity and ethylene synthesis are all somewhat inhibited by cobalt. Furthermore, it somewhat induced stomatal closure and raised the water potential of cut flowers (Reddy, 1988). Similar outcomes were also attained by Mukhopadhyay (1982), Balakrishna *et al.* (1989), Gowda (1990), Lol *et al.* (1990) in gladiolus, and Bhaskar *et al.* (1999) in tuberose. Aslmoshtaghi *et al.* (2014) also obtained similar findings in roses.

The flowers kept in T_1 (cobalt chloride @ 100 ppm+ sucrose 4%) had the highest transpirational loss of water (8.05 g flower^{-1}) from the second to the tenth day (8. 09 g flower^{-1}), while the control (T_{13}) had the lowest transpirational loss of water (3.38 g flower^{-1}) over the course of the vase life period (Table 1). Due to appropriate and controlled TLW in response to increased WU, the T1 treatment (cobalt chloride @ 100 ppm+ sucrose 4%) had the highest TLW (Halevy *et al.*, 1978).

Water balance varied greatly between treatments; flowers in T_1 treatment (cobalt chloride @ 100 ppm+ sucrose 4%) had the highest water balance (5.87 g flower^{-1}) from the second to the tenth day (4.95 g flower^{-1}) of the vase life period, while flowers in control (T_{13}) on preservative solution on the second day of the vase

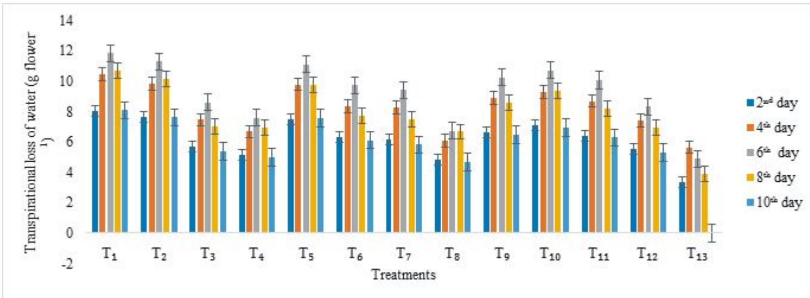

Fig. 1 : Effect of different treatments on Transpirational loss of water.

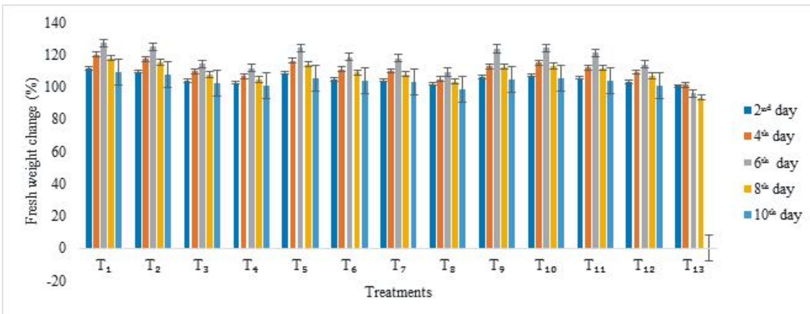

Fig. 2 : Effect of different treatments on fresh weight change.

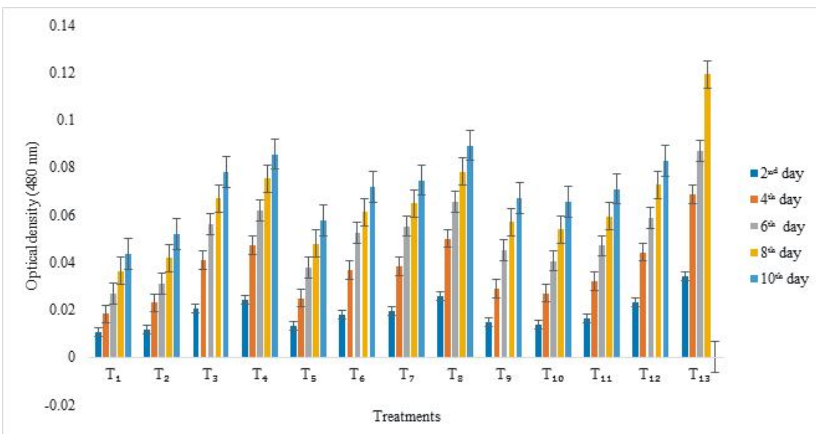

Fig. 3 : Effect of different treatment on Optical density.

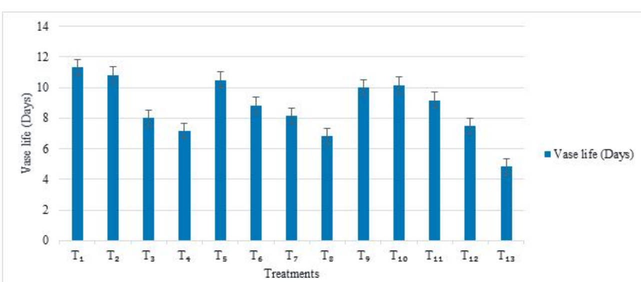

Fig. 4 : Effect of different treatment on vase life.

life period had the lowest water balance (3.35 g flower^{-1}) (Table 2). It could be because, in comparison to other treatments, the identical treatment registered the highest WU and TLW. Cobalt chloride, according to Lu *et al.* (2010), enhanced the water balance in roses via controlling the stomatal aperture. Aslmoshtaghi *et al.* (2014) have obtained similar results with rose blooms.

The flowers kept in T_1 treatment (cobalt chloride @ 100 ppm + sucrose 4%) had the largest fresh weight change (111.57%) from the second to the tenth day (109.54%), while the control group had the lowest fresh weight change (100.53%) on the second day of vase life. Higher fresh weight change (FWC) in T_1 treatment (cobalt chloride @ 100 ppm + 4 % sucrose) (Table 2) was caused by harvesting the flowers at paintbrush stage and the synergistic effect of sucrose and cobalt chloride. The improvement in the flower's water retention may have also contributed to the high fresh weight change. These results are consistent with the research conducted in carnation by Kazemi *et al.* (2012), who found that Co2 + reduces vascular occlusion and limits microbial growth, leading to an increase in fresh weight.

The flowers kept in T_1 treatment (cobalt chloride @ 100 ppm + 4 percent sucrose) had the lowest optical density of vase solution (0.010) on the second day to the tenth day (0.043), while the flowers kept in T_{13} Control had the highest optical density of vase solution (0.034) on the second day (Table 3). The treatment with the lowest ODVS value, T_1 (cobalt chloride @ 100 ppm + sucrose 4%), may have had a lower bacterial count because it showed higher WU, TLW, WB and FWC values than the other treatments. According to Van Doorn *et al.* (1989), there was a positive link between the number of bacteria and water conductivity in the stem of the cut flower. The study conducted by Kazemi *et al.* (2012) in Carnation revealed that Co2+ reduces vascular occlusion and limits microbial development, leading to the lowest value.

Varying biocide treatments resulted in drastically varying vase lives for cut carnations. Vase life has increased dramatically with all treatments compared to control. When compared to other treatments, the flowers held in treatment T_1 (cobalt chloride @ 100 ppm + 4 percent sucrose) recorded the highest value (11.33 days), while treatment T_{13} (control) recorded the lowest value (4.83 days). The reason the T_1 treatment (cobalt chloride @ 100 ppm + 4% sucrose) had the longest vase life (Plates 3 and 4) was because it also had the greatest figures WU, TLW, WB, FWC and lowest ODVS compared to the other treatments. These findings are

Table 1 : Effect of ethylene inhibitors on water uptake (g flower^{-1}) and transpirational loss of water (g flower^{-1}) during postharvest vase life of cut carnation cv. Dona under ambient conditions.

Treatments	Water uptake (g flower^{-1})					Transpirational loss of water (g flower^{-1})				
	Days (D)					Days (D)				
	2	4	6	8	10	2	4	6	8	10
T_1-Cobalt chloride @ 100 ppm	11.92	14.07	15.36	13.85	11.04	8.05	10.46	11.83	10.72	8.09
T_2- Cobalt chloride @ 200 ppm	10.92	12.98	14.18	12.75	10.12	7.62	9.85	11.28	10.13	7.62
T_3- Cobalt chloride @ 300 ppm	7.73	9.38	10.24	8.55	6.72	5.67	7.46	8.59	7.02	5.39
T_4-Salicylic acid @ 100 ppm	6.78	8.14	8.95	6.88	4.59	5.15	6.68	7.58	6.92	4.99
T_5- Salicylic acid @ 200 ppm	10.68	12.74	13.93	12.31	9.75	7.47	9.78	11.09	9.78	7.58
T_6- Salicylic acid @ 300 ppm	8.81	10.60	11.84	9.70	7.75	6.33	8.35	9.75	7.74	6.12
T_7-Malic acid @ 100 ppm	8.42	10.22	11.28	9.28	7.30	6.19	8.26	9.42	7.50	5.83
T_8-Malic acid @ 200 ppm	6.37	7.45	7.97	6.37	4.20	4.87	6.09	6.74	6.67	4.67
T_9-Malic acid @ 300 ppm	9.64	11.52	12.77	10.95	8.60	6.66	8.88	10.26	8.60	6.48
T_{10}-Citric acid @ 100 ppm	10.22	12.12	13.35	11.70	9.10	7.13	9.29	10.72	9.33	6.95
T_{11}-Citric acid @ 200 ppm	9.30	11.17	12.43	10.35	8.03	6.39	8.70	10.07	8.22	6.30
T_{12}- Citric acid @ 300 ppm	7.42	9.12	9.86	8.31	5.03	5.57	7.42	8.32	6.93	5.31
T_{13}-Control (Deionised water)	4.72	5.49	4.70	3.61	-	3.38	5.65	4.89	3.92	-
Mean	8.68	10.38	11.29	9.58	7.68	6.19	8.22	9.27	7.96	6.28
SEm±	0.03	0.03	0.04	0.05	0.04	0.05	0.06	0.05	0.05	0.05
CD at 5 % or (p = 0.05)	0.11	0.11	0.13	0.16	0.12	0.16	0.17	0.14	0.15	0.15

Note: Sucrose (4%) is substrate for all above treatments.

Table 2 : Effect of ethylene inhibitors on water balance (g flower^{-1}) and fresh weight change (%) during postharvest vase life of cut carnation cv. Dona under ambient conditions.

Treatments	Water balance (g flower^{-1})					Fresh weight change (g flower^{-1})				
	Days (D)					Days (D)				
	2	4	6	8	10	2	4	6	8	10
T_1-Cobalt chloride @ 100 ppm	5.87	5.61	5.53	5.12	4.95	111.57	120.04	127.27	117.87	109.54
T_2- Cobalt chloride @ 200 ppm	5.30	5.13	4.90	4.62	4.51	109.48	117.49	125.14	115.38	107.94
T_3- Cobalt chloride @ 300 ppm	4.06	3.92	3.65	3.52	3.33	103.80	109.64	114.43	107.54	102.38
T_4-Salicylic acid @ 100 ppm	3.63	3.46	3.37	1.96	1.67	102.62	106.84	111.64	104.60	100.91
T_5- Salicylic acid @ 200 ppm	5.21	4.96	4.84	4.53	4.17	108.79	116.36	124.35	114.07	105.74
T_6- Salicylic acid @ 300 ppm	4.48	4.25	4.08	3.96	3.63	104.61	110.99	118.65	108.98	103.60
T_7-Malic acid @ 100 ppm	4.22	3.97	3.86	3.77	3.48	104.06	110.06	117.78	108.10	103.10
T_8-Malic acid @ 200 ppm	3.50	3.36	3.23	1.70	1.60	101.86	104.92	109.24	103.52	98.82
T_9-Malic acid @ 300 ppm	4.98	4.63	4.51	4.25	4.05	106.18	112.90	123.74	112.54	104.87
T_{10}-Citric acid @ 100 ppm	5.08	4.83	4.63	4.37	4.15	107.31	115.25	124.18	113.04	105.20
T_{11}-Citric acid @ 200 ppm	4.91	4.47	4.37	4.12	3.73	105.68	112.22	121.10	111.89	104.22
T_{12}- Citric acid @ 300 ppm	3.85	3.71	3.53	3.38	1.63	103.15	109.28	113.96	106.79	101.10
T_{13}-Control (Deionised water)	3.34	1.84	1.82	1.69	-	100.53	101.32	96.08	93.55	-
Mean	4.49	4.16	4.02	3.62	3.42	105.36	111.33	117.50	109.07	103.95
SEm ±	0.03	0.05	0.03	0.04	0.05	0.32	0.42	0.42	0.33	0.44
CD at 5% or (p = 0.05)	0.01	0.15	0.95	0.13	0.16	0.95	1.24	1.24	0.95	1.29

Note: Sucrose (4%) is substrate for all above treatments.

Table 3 : Effect of ethylene inhibitors on optical density of vase solution (ODVS) (at 480 nm) during postharvest vase life of cut carnation cv. Dona under ambient conditions.

Treatments	Days				
	2	4	6	8	10
T_1-Cobalt chloride @ 100 ppm	0.010	0.018	0.027	0.036	0.043
T_2- Cobalt chloride @ 200 ppm	0.011	0.023	0.031	0.042	0.052
T_3- Cobalt chloride @ 300 ppm	0.020	0.041	0.056	0.067	0.078
T_4-Salicylic acid @ 100 ppm	0.024	0.047	0.061	0.075	0.085
T_5- Salicylic acid @ 200 ppm	0.013	0.025	0.037	0.048	0.057
T_6- Salicylic acid @ 300 ppm	0.018	0.036	0.052	0.061	0.072
T_7-Malic acid @ 100 ppm	0.019	0.038	0.055	0.065	0.074
T_8-Malic acid @ 200 ppm	0.025	0.05	0.065	0.078	0.089
T_9-Malic acid @ 300 ppm	0.015	0.029	0.045	0.057	0.067
T_{10}-Citric acid @ 100 ppm	0.013	0.027	0.040	0.054	0.065
T_{11}-Citric acid @ 200 ppm	0.016	0.032	0.047	0.059	0.071
T_{12}- Citric acid @ 300 ppm	0.023	0.044	0.058	0.072	0.082
T_{13}-Control (Deionised water)	0.034	0.068	0.087	0.119	-
Mean	0.018	0.036	0.051	0.064	0.069
SEm±	0.0004	0.0005	0.0004	0.0005	0.0004
CD at 5 % or (p = 0.05)	0.001	0.001	0.001	0.001	0.001

Note: Sucrose (4%) is substrate for all above treatments

Table 4 : Effect of ethylene inhibitors on vase life (days) of cut carnation cv. Dona under ambient conditions.

Treatments	Days (D)
T_1-Cobalt chloride @ 100 ppm	11.33
T_2- Cobalt chloride @ 200 ppm	10.83
T_3- Cobalt chloride @ 300 ppm	8.00
T_4-Salicylic acid @ 100 ppm	7.17
T_5- Salicylic acid @ 200 ppm	10.50
T_6- Salicylic acid @ 300 ppm	8.83
T_7-Malic acid @ 100 ppm	8.17
T_8-Malic acid @ 200 ppm	6.83
T_9-Malic acid @ 300 ppm	10.00
T_{10}-Citric acid @ 100 ppm	10.17
T_{11}-Citric acid @ 200 ppm	9.17
T_{12}- Citric acid@ 300 ppm	7.50
T_{13}-Control (Deionised water)	4.83
Mean	8.71
SEm±	0.16
CD at 5% or (p = 0.05)	0.46

Note: Sucrose (4%) is substrate for all above treatments.

consistent with those of Reddy (1988), who found that a longer vase life following cobalt treatment was linked to a flower's increased uptake of water, preservation of the water balance during opening, a delay in fresh weight loss, and a decreased risk of bent neck. Roses and other delicate flowers have a short vase life of a few weeks.

Plate 3 : Weight of flower.

Plate 4 : On 10th day.

The vase life can be doubled or tripled by selecting the appropriate preservatives and chemicals (Salehi-Salemi *et al.*, 2018).

Similar results were also reported by Murali and Reddy (1993) in gladiolus; Nagibol *et al.* (2006) in chrysanthemum; Mohammadi *et al.* (2012) in cut tuberose and Kazemi *et al.* (2012) in carnation.

Conclusion

It is possible to draw the conclusion from the study's findings that every chemical employed in it extended the vase life of the carnation flowers. According to the current study, adding 4% sucrose to the solution along with cobalt chloride at 100 ppm has increased water uptake, transpirational water loss, water balance, and fresh weight change while extending the vase life of flowers. In order to increase the vase life and postharvest quality of carnation cut flowers, cobalt chloride @ 100 ppm + sucrose 4% solution has the potential to be utilised as a commercial cut flower preservative solution.

Future scope

It is possible to replicate this investigation with different kinds. The vase life, quality, and biochemical parameters of the flowers may be examined with an increased quantity of preservative solutions. It is possible to examine how natural preservatives affect the flowers' biochemical characteristics, vase life, and quality. To prolong vase life, metallic nanoparticles possibly produced sustainably can be incorporated. Eco-friendly holding or pulse solutions made with creative methods that include the use of coconut water, lemon extract, etc.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be constructed as a potential conflict of interest.

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