RESEARCH ARTICLE

EFFECT OF LOW TEMPERATURE WET STORAGE ON VASE LIFE OF CUT CARNATION (*DIANTHUS CARYOPHYLLUS* L.) FLOWERS

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Abstract: Studies were conducted to find out the effect of wet storage on vase life of cut carnation (*Dianthus caryophyllus* L.) flowers. Wet storage of cut flower for different durations significantly reduced flower diameter, flower appearance, consumption of holding solution, RWC, membrane stability and vase life as compared to un-stored conditions. Among different storage durations vase life was found maximum when cut flowers were stored in wet storage for 4 days. Maintenance of higher water status in holding solution containing serotonin seems to be the most important characteristic and have positive effect on flower diameter, membrane stability and vase life in cut carnation flowers.

Keywords: Vase life, Holding solutions, Wet storage

INTRODUCTION

Carnation *(Dianthus caryophyllus* L.) is one of the most popular cut flower and of highest economic importance in the floriculture industry. It ranks second among the cut flower after rose in global floriculture trade. The modern cut flower cultivar of carnation have been selected on the basis of flower size, petal number, stem length, resistance in various disease and insect pest as well as postharvest longevity (Satoh *et al.,* 2005). Storage of cut flowers is an essential part of the floriculture industry for orderly marketing in times when production exceeds demand. It enables in extending the season and delaying marketing especially during overproduction. Low temperature storage along with maintenance of high humidity helps to keep the flower in good condition for longer duration. A temperature range of 1 to 4ºC is usually maintained for most cut flower storage rooms with >90% relative humidity to reduce water loss (Armitage and Laushman 2003). Both dry and wet storage methods are prevalent for storage of cut carnations. For dry storage 0 to 1°C and for wet storage 4°C temperature was found optimum for carnation (Singh *et al.,* 2013). At lower temperature carnation cut flower can be stored successfully up to 3-4 weeks (Dole *et al.,* 2017). Under such conditions, it is very crucial to identify the optimum storage duration for wet storage method in cut carnation flowers.

An important factor for quality deterioration in cut carnation is higher transpiration comparison to water absorption which leads to water deficit and wilting (Halevy and Mayak, 1981 He *et al.,* 2006) of flowers. Low water uptake can be due to occlusions located mainly in the basal end of stem (He *et al.,* 2006). Chemical products of microorganisms also plug the cut ends and drastically reduce the water absorption. Antimicrobial agents are being used in cut flowers vase solutions to improve water uptake in cut flowers. Such germicides like silver nitrate, aluminium sulphate and 8-hydroxyquinoline sulphate are hazardous to environment and it is important to replace these chemicals with suitable alternative eco friendly natural products like essential oils, melatonin and serotonin.

MATERIALS AND METHODS

The studies were carried out at Hi-Tech Centre of Department of Floriculture and Landscaping, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan during 2019-2020. All the recommended package of practices was followed for crop duration. Harvested cut flower stems of carnation were reduced to a uniform length of 30 cm by giving a slanting cut at the basal portion. The basal leaves of these stems were detached up to a length of 15 cm before using them for different experiments. The basal 2-3 cm portions of the stems were re-cut again before keeping them in vases containing holding solutions. Experiment was conducted using CRD design (factorial) with three replications.

Cut stem blooms were stored at 4°C for 0, 4, 8 and 12 days duration under wet storage conditions. During storage individual flower stalk was placed in 50 ml test tube containing 25 ml of distilled water. The relative humidity of cold room was maintained between 85-90%. After completion of storage period basal 2-3 cm portion of the stems were re-cut and flowers were transferred to three holding solutions namely T 1: Control (distilled water), T 2: As per university recommendations (Sucrose 2% +8HQC (150ppm) +BA (5ppm), T 4: Serotonin 300 µM for estimation of vase life .

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RESULTS AND DISCUSSION

Days taken to flower opening:
Time taken to flower opening was recorded highest (4.25 days) under un-stored conditions compared to wet storage. Wet storage of different durations significantly decreases the time taken to flower opening. Among different storage durations at 4 ^{0}C, minimum time taken for flower opening (2.18 days) was recorded when the cut flower stems were stored for longest duration of 12 days while, maximum time taken for flower opening was recorded when cut flowers were stored for 4 days (3.26 days). Such early opening under wet storage conditions can be due to the reason that metabolic activities continues at a slower rate. Thus, wet stored flowers are placed in different holding solutions took less time to open. Among different holding solutions, cut flowers placed in H_3 (Serotonin, 300 µM) solution recorded minimum time for flower opening (2.76 days) and it was found at par with H_2. In contrast, holding solution containing distilled water ($H_{1)}$ took significantly higher time for flower opening (3.68 days).

Flower diameter (cm):
Flower diameter of carnations cut flower differed significantly due to storage durations and holding solutions. Highest flower diameter of 7.24 cm was recorded when cut flowers were not stored in wet storage. Among different storage durations, maximum flower diameter of 6.64 cm was recorded when cut flowers were stored for 4 days. In contrast, minimum flower diameter of 5.40 cm was recorded with the longest storage duration of 12 days. In wet storage depletion of stored food continues in cut flowers. Thus, shorter duration stored flowers provide higher level of energy for higher flower diameter. The effect of different holding solutions on flower diameter revealed that holding solution namely H_3 (Serotonin, 300 µM) resulted in significantly maximum flower diameter (6.97 cm) and it was found at par with H_2.

Appearance of cut bloom (Score out of 5.00):
Flower appearance differed significantly due to storage durations and holding solutions. Flower appearance was highest (4.20) in un-stored cut flowers. Flower appearance deteriorates significantly under wet storage conditions of different durations. Among different storage durations, flowers appeared to be best when stored for 4 days with a score of 3.66. Appearance during storage of 8 and 12 days was found to be at par (3.38 and 3.26 respectively). This can be due to the reason that senescence process continues during cold storage of cut flowers and longer duration storage decreases the appearance. Holding solution namely H_3 (Serotonin, 300 µM) resulted in better appearance (3.86) and it was at par with H_2.

Vase life (days):
Vase life showed significant variation due to effect of storage durations, holding solutions and its interaction. Vase life was significantly higher (15.62), in un-stored treatment. Decrease in vase life was observed when cut flowers were placed in wet storage of different durations. Among different storage durations, 4 days wet storage of cut stems resulted in maximum vase life (13.16 days). In contrast, minimum vase life of 7.94 days was recorded with longest storage of 12 days. Rudnicki *et al.* (1989) also reported that storage of cut flowers reduces the vase life in comparison to un-stored flowers. ACC gets accumulated during low temperature storage of cut flowers which leads to higher rate of ethylene production when cut flowers taken out of storage shows reduction in vase life (Mayak and Faragher, 1986). Among different holding solutions, cut flowers showed maximum vase life (14.00 days) in a holding solution containing Serotonin, 300 µM.

Holding solution consumed (ml/stem):
The amount of holding solution consumed by cut flower stems of carnations differed significantly due to storage durations, holding solutions and their interactions. Cut flower shows highest consumption of holding solution under un-stored conditions and decreases under wet stored conditions. Shortest storage duration of 4 days showed maximum (22.60 ml/stem) and longest storage duration of 12 days showed minimum (14.90ml/stem) consumption of holding solution. The consumption of holding solutions can be linked with vase duration. Flowers with high vase life survive for longer duration and consume more holding solution and vice versa. Among different holding solutions, cut flowers placed in H_3 (Serotonin, 300 µM) solution consumed maximum amount of holding solution (24.90 ml/stem).

Relative Water Content (%):
RWC of cut flowers differed significantly due to storage durations and holding solutions. Highest RWC (80.36 %) was recorded when cut stems were not stored. Results revealed that RWC reduced significantly when cut flowers were kept in different wet storage durations. Among different storage durations, shortest storage duration showed highest (74.88 %) and longest storage duration showed lowest (64.41 %) RWC. Among different holding solutions, cut flowers placed in H_3 (Serotonin, 300 µM) solution showed highest RWC (77.11%).

Membrane stability (%):
Membrane stability of cut flower differed significantly due to storage durations, holding solutions and their interactions. It was recorded highest (70.51%) in un-stored treatment and was at par (68.61) with 4 days storage duration. Membrane stability decreases with further increase in storage duration. Among different holding solutions, cut flowers placed in H_3 (Serotonin, 300 µM) solution recorded maximum membrane stability (69.35 %).

Antimicrobial (Erland *et al.,* 2016) and senescence inhibiting (Kang *et al.,* 2009) effects of serotonin might have helped the cut flowers to exhibit higher uptake of holding solution which maintains higher flower water status, higher membrane stability and ultimately reflected in improved vase life.

Table 1. Effect of wet (4^0C) storage durations and holding solutions on Time to Flower opening, Flower diameter , Appearance of cut bloom , Vase life , Holding solution consumed , Relative Water Content and Membrane stability of cut carnation flowers cv. 'Bizet'.

Wet Storage durations (days) (D)	Days to flower opening	Flower diameter (cm)	Appearance of cut bloom (Score out of 5.00)	Vase life (days)	Holding solution consumed (ml/stem)	Relative Water Content (%)	Membrane stability (%)
0	4.25	7.24	4.20	15.62	30.91	80.36	70.51
4	3.26	6.64	3.66	13.16	22.60	74.88	68.61
8	2.74	5.93	3.38	8.96	17.06	68.24	60.30
12	2.18	5.40	3.26	7.94	14.90	64.41	57.69
Holding Solution (S)							
H_1	3.68	5.16	3.32	7.84	17.12	66.62	57.90
H_2	2.89	6.79	3.70	12.42	22.08	72.20	65.57
H_3	2. 76	6.97	3.86	14.00	24.90	77.11	69.35
$H_{1=}$ Control (Distilled water), **$H_{2=}$**[(Sucrose (2%) +8HQC (150ppm) +BA (5ppm)], **$H_{3=}$** Serotonin (300 µM)							
$CD_{0.05}$ for:							
D	0.40	0.39	0.21	0.88	1.59	2.03	2.26
S	0.34	0.34	0.18	0.76	1.38	1.76	1.96
D x S	NS	NS	NS	1.52	2.76	NS	3.92

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