Trends in Horticultural Research

ISSN 1996-0735

Academic Journals Inc.

www.academicjournals.com

Trends in Horticultural Research 2 (1): 8-13, 2012
ISSN 1996-0735 / DOI: 10.3923/thr.2012.8.13

Effect of Pulsing Solution on Postharvest Performance of Carnation (*Dianthus caryophyllus* L.) Cultivars

Biniam Adugna, Derbew Belew and Negussie Kassa
Jimma University College of Agriculture and Veterinary Medicine, P.O. Box 307, Jimma, Ethiopia

Corresponding Author: Biniam Adugna, P.O. Box 90172, Addis Ababa, Ethiopia Tel: +251911694848

ABSTRACT

Carnation (*Dianthus caryophyllus* L.) is very sensitive to external and self generated ethylene. Pulsing with silver thiosulfate (STS) solutions is now widely used commercially. However, silver thiosulfate (STS) solutions contains silver ion which is a potent environmental pollutant. On the other hand, ethanol solution pulsing has been found to be effective in inhibiting ethylene biosynthesis and environmentally safe. Thus, this study was conducted to assess the effect of selected pulsing solutions on the days to bent neck, complete flower bud opening, and flower bud shrinkage occurrence of carnation cultivars (Green-Go and Galy) at Addis Alem, Schecter Yosef Flower Farm and Central Ethiopia. The experiment was laid out in a factorial arrangement with a Complete Randomized Design (CRD) consisting of three replications. The pulsing solutions used for this investigation were silver thiosulfate (STS) (0.2, 0.6 and 1 mM) for 6 h and ethanol (6, 8 and 10 %) for 3 h, both received equal amount of sucrose (10%). In addition, existing practice of the farm (0.4 mM silver thiosulfate (STS) plus 0.3 mM T.O.G®) was used as a standard control. The recorded trials included complete flower bud opening, flower bud shrinkage and bent Neck. Accordingly, the days to complete flower bud opening was prolonged by 0.6 mM silver thiosulfate (STS) plus 25 g sucrose (8.47 days). The days to flower bud shrinkage extended by 0.6 mM silver thiosulfate (STS) plus 25 g sucrose (26.42 days) and being in par with 8% ethanol plus 25 g sucrose (25.39 days) for Green-Go cultivar. Furthermore, days to complete flower bud opening showed a direct association with days to flower bud shrinkage occurrence.

Key words: Bent neck, complete flower bud opening, flower bud shrinkage

INTRODUCTION

Postharvest senescence is an integral part of normal developmental cycle of plants and it is highly regulated process that involves structural, biochemical and molecular changes in the plant tissue (Shahri, 2011). Postharvest senescence of flower has been attributed mainly to ethylene (Chutichudet *et al*., 2010; Kazemi *et al*., 2011). Carnation is the most important flower on an international market as cut flower (Tabassum *et al*, 2002). In the presence of ethylene, cut carnation flowers have limitation for their successful marketing due to petal inrolling (Song *et al*., 2007) and discoloration (Zuliana *et al*., 2008). Finally, it led to flower senescence and shortening of vase life (Chutichudet *et al*., 2011).

Ethylene is a naturally occurring plant hormone that enhances the senescence and shortens the vase life of many flowers (Bhowmik *et al*., 2002). Similarly, cut carnations are very sensitive

to ethylene injury (Wawrzynczak and Goszczynska, 2003; Yangkhamman *et al*., 2005). However, 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) delays the onset of flower senescence (Wu *et al*., 1991).

Accordingly, STS not only delays the onset of flower senescence but also suppresses climacteric respiration and ethylene production (Buffer *et al*., 1980; Wu *et al*., 1991), without affecting basal level of ACC in the petals (Buffer *et al*., 1980). On the other hand, Wu *et al*. (1992) suggested that, ethanol pulsing has been found to be effective on increasing the vase life of carnation flowers by inhibiting ethylene biosynthesis. In addition, Ethanol pulsing reduced the accumulation of ACC and completely inhibited activity of the EFE (ACC oxidase) (Pun *et al*., 2001).

The senescence of cut flowers is closely related to a considerable reduction of the energy needed for synthesis reactions (Pramanik *et al*., 2004; Song *et al*., 2007). Therefore, Supplying cut flowers with exogenous sucrose pulsing maintain mitochondrial structure and functions, plus it improve osmotic potential (Emongor, 2004) and inhibits the ethylene production (Zuliana *et al*., 2008). Thus, it has been proven to prolong vase life in many cultivars such as rose, carnations and orchids (Zuliana *et al*., 2008; Kazemi *et al*., 2011). Many studies have reported the effectiveness of treatments containing a combination of sugars and ethylene inhibitors in extending vase life of flowers. Maximum increase in the vase life of Dendrobium Heang Beauty inflorences treated with a combination of sugar and AOA. The vase life of cut roses was also prolonged with the treatment of sucrose pulse followed by pulsing with STS (Zuliana *et al*., 2008).

Pulsing solutions containing STS is now widely used commercially to inhibit the acceleration of carnation senescence by ethylene (Wu *et al*., 1991). Similarly, Bakhsh *et al*. (1999) reported that, the vase life of cut Tuberose flowers was also improved greatly by pulsing in silver thiosulfate (STS). However, STS contains silver ion, still the agricultural use of silver has been criticized because of its cost and negative impact on the environment. Therefore, alternative techniques for extending the life of cut carnation flowers are commercial interest (Wu *et al*., 1991; Serek *et al*., 1995).

MATERIALS AND METHODS

Flower stems of two greenhouse grown standard type cultivars of carnation (*Dianthus caryophyllus*) Green-Go and Galy were used for this investigation being obtained from Schecter Yosef Flower Farm, which is located at Addis Alem, central Ethiopia. The experiment was started on January 2011 in the grading hall with an average daily air temperature of 20°C and relative humidity of 65 %. In addition, 12 h room illumination was given. Immediately after harvest the flowers stems were recut to 50 cm and transferred to pre-cooling room 4°C for 6 h. Subsequently, pulsed with 0.5, 0.6 and 1 mM STS solutions for 6 h and also ethanol solutions used for this experiment were 6, 8 and 10 % for 3 h (Wu *et al*., 1992) and also both cultivars pulsed for 3 h in the standard control (0.4 mM STS plus 0.3 mM T.O.G®). In addition, all pulsing treatments except for the standard control received equal amount of sucrose (10%) during the experiment. Generally, throughout the entire period of investigation tap water was used for all of the treatments. The pH of the tap water used in this experiment was adjusted to 4 pH. Finally, the two carnation cultivars were placed in to clean glass vases containing 250 mL tap water and the water changed every three days interval until the end of experiment. Parameters including days to complete opening of flower bud, flower bud shrinkage and bent neck were recorded.

Complete opening of flower bud: Complete opening period is the number of days required for complete blooming of the flowers (Satoh *et al*., 2005). The number of days taken from the start of the experiment up to complete blooming of the flower bud has been recorded.

Lower bud shrinkage: The Flower bud Shrinkage of carnation cut flowers was defined by the petals of the flower bud shriveled or shrieked inward. It was recorded in a number of days when the flowers has showed the above mentioned characteristics (VBN, 2005).

Bent neck: The number of days taken for the appearance of bent neck was counted when the peduncle was bent perpendicular towards to the stem (VBN, 2005; Floral Solutions, 2006).

Statistical analysis: The data of all parameters considered in the study were subjected to the Analysis of Variance (ANOVA) using SAS version 9.2. (SAS, 1998). The mean separation was conducted by LSD ($p<0.05$) in the same software. Correlation between response variables was also determined.

RESULTS AND DISCUSSION

Complete flower bud opening period: The mean separation for the influence of pulsing treatments on complete flower bud opening revealed that, PS 2 (0.6 mM STS plus 25 g sucrose) recorded the highest number of days (8.47 days) to completely open the flower buds (Table 1). Whereas, the shortest day to complete flower bud opening was achieved by PS 6 (10% ethanol plus 25 g sucrose) (5.52 days), however, it was at par with PS 3 (1 mM STS plus 25 g sucrose) (5.69 days) (Table 1). The result might be due to degradation of various polysaccharides enhance the climacteric respiration pick and consequently lead to production of ethylene, which is responsible hormone for hastening flower bud opening period. Meanwhile, the best level of concentration of STS plus sucrose pulsing could retard the depletion of carbohydrate and also simultaneously inhibit ethylene production in petals as a result the days to complete flower bud opening could be extended. Furthermore, Green-Go recorded significantly higher complete flower bud opening period (6.96 days) than Galy (6.78 days), which might be attributed to their genetic makeup. The correlation coefficients among response variables revealed that, the complete flower bud opening period of carnation cultivars was highly significant and positively associated with flower bud shrinkage. This showed that, as the days to complete flower bud opening period

Table 1: Effect of different pulsing solutions on complete flower bud opening (CFBO) and bent neck (BN) of two carnation cultivars

Pulsing solution (+)	CFBO±SE	BN±SE
PS 1: 0.2 mM STS 25 g sucrose	6.38±0.11^{d}	44.95 ±0.68^{d}
PS 2: 0.6 mM STS 25 g sucrose	8.47±0.11^{a}	48.72 ±0.68^{c}
PS 3: 1 mM STS 25 g sucrose	5.69±0.11^{e}	50.12 ±0.68^{bc}
PS 4: 6% Ethanol 25 g sucrose	6.93±0.11^{c}	46.44±0.68^{d}
PS 5: 8% Ethanol 25 g sucrose	7.90±0.11^{b}	48.65±0.68^{c}
PS 6: 10% Ethanol 25 g sucrose	5.52±0.11^{e}	51.61 ±0.68^{b}
PS 7: T.O.G® 0.3 mM and 0.4 mM STS (Control)	7.22±0.11^{c}	53.93±0.68^{a}
Cultivars		
Green-Go	6.96±0.059^{a}	48.59±0.36^{b}
Galy	6.78±0.059^{b}	49.81±0.36^{a}
CV (%)	3.98	3.42

Means followed by different letters per column differ significantly ($p<0.05$) as established by LSD test, CV: Coefficient of variation

Table 2: Correlation coefficient of the parameters considered

	CFBOP	FBS	BN
CFBOP	-		
FBS	0.51**		
BN	-0.12^{ns}	- 0.03^{ns}	-

**Significantly different at 0.001 probability level, respectively, ns: Non significant, CFBOP: Complete flower bud opening period, FBS: Flower bud shrinkage, BN: Bent neck

increment enhance the number of day's extension flower bud shrinkage. On the other hand, the complete flower bud opening period demonstrated non-significant association with bent neck occurrence (Table 2). Serek *et al.* (1994) also suggested that, the opening and senescence of Gladiolus (*Gladiolus* sp.) florets were dependant on gladiolus varieties, whereas the pulse treatment of the spikes with STS and sucrose improved flower bud opening. Similarly, Hutchinson *et al.* (2003) reported that, inclusion of the ethylene antagonist, STS, in the vase solution resulted in the greatest improvement of vase life and floret opening of cut Tuberose (*Polianthes tuberosa* L.) flowers.

Bent neck: The mean separation revealed that, standard control (53.93 days) extend the days to bent neck occurrence than other pulsing treatments. However, the number of days taken for bent neck occurrence hastened by PS 1 (0.2 mM STS plus 25 g sucrose) (44.95 days). The result was not significantly different with PS 4 (6% ethanol plus 25 g sucrose) (46.44 days) (Table 1). On the other hand, the flower bud shrinkage demonstrated non-significant association with bent neck occurrence (Table 2). The outcome might be caused by xylem blockage. Consequently, this lead to imbalance of water status in the stem and caused bent neck to the carnation flowers. In this study; the standard control had T.O.G® combination, which was helpful for combating microorganisms and preventing xylem blockage. The finding of this investigation is supported by He *et al.* (2006), on Grevillea cultivar '*Crimson* Yul-lo'. On the other side, T.O.G® contains 8-HQ as a main component which is very expensive and most harmful preservative for human causing irritating to skin, eyes and respiratory tract infections (Shanan *et al.*, 2010).

Flower bud shrinkage: The interaction effect of cultivars and pulsing treatments revealed their respective days to attain flower bud shrinkage. Hence, cultivar Green-Go treated with PS 2 (0.6 mM STS plus 25 g sucrose) (26.42 days) and PS 5 (8% ethanol plus 25 g sucrose) (25.39 days) exhibited similarity on extending the number of days taken to flower bud shrinkage occurrence. On other hand, Galy (19.16 days) pulsed in PS 4 (6% ethanol plus 25 g sucrose) showed a rapid flower bud shrinkage, in par with cultivar Green-Go (19.56 days) pulsed with the same treatment. The result was similar with Green-Go (20.28 days) pulsed in the Standard control and Galy (20.39 days) pulsed in PS 6 (10% ethanol plus 25 g sucrose) (Fig. 1). The extension of days to flower bud shrinkage could be due to the pulsing solution of ethanol which inhibits ACC oxidase and pulsing solutions which contain STS block the ethylene receptor site on the membrane delays the onset of flower bud shrinkage caused by ethylene. Furthermore, In accordance with this investigation, Wu *et al.* (1992), stated that, carnation (*D. caryophyllus* L.) cultivar 'White Sim' pulsed with 8% ethanol inhibited ethylene as result it significantly extended the vase life.

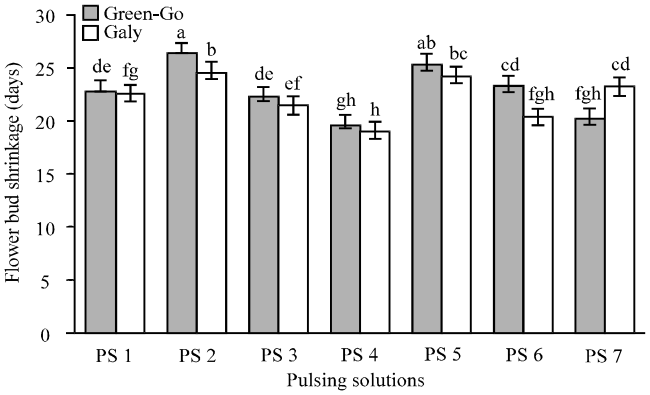

Fig. 1: Interaction effects of cultivars and pulsing solutions on flower bud shrinkage (SE±0.48) Means followed by different letters per column differ significantly ($p<0.05$) as established by LSD test, PS: Pulsing solutions

CONCLUSION

This study showed that, 0.6 mM silver thiosulfate (STS) plus 25 g sucrose and/or 8% ethanol plus 25 g sucrose could be used as the best pulsing solutions on extending time of occurrence of flower bud shrinkage for Green-Go cultivar. STS pulsing solution was effective on extending the days to complete opening period of the two cultivars. However, the standard control extended time of bent neck occurrence.

REFERENCES

Bakhsh, A., M.A. Khan, C.M. Ayyub, M.A. Shah and M. Afzal, 1999. Effect of various chemicals on vase life and quality of cut tuberose flowers. Pak. J. Biol. Sci., 2: 914-916.

Bhowmik, P.K., T. Matsui, H. Suzuki and Y. Kosugi. 2002. A harvest-induced ACC oxidase gene from tips of harvested asparagus spears and its expression during storage. Asian J. Plant Sci., 1: 390-394.

Buffer, G., Y. Mor, M. Reid and S. Yang, 1980. Changes in 1-aminocyclopropane-l-earboxylic-acid content of cut carnation flowers in relation to their senescence. Planta, 50: 439-442.

Chutichudet, P., B. Chutichudet and K. Boontiang, 2010. Effect of 1-MCP fumigation on vase life and other postharvest qualities of siam tulip (*Curcuma aeruqinosa* Roxb.) cv. Laddawan. Int. J. Agric. Res., 5: 1-10.

Chutichudet, P., B. Chutichudet and K. Boontiang, 2011. Effect of 1-MCP on vase life and other postharvest qualities of patumma (*Curcuma alismatifolia*) cv. Chiang mai pink. Int. J. Agric. Res., 1: 1-11.

Emongor, V.E., 2004. Effects of gibberellic acid on postharvest quality and vaselife life of gerbera cut flowers (*Gerbera jamesonii*). J. Agro., 3: 191-195.

Floral Solutions, 2006. Protocol for Cut Flower Vaselife Tests. Pokon and Chrysal International, Naarden, The Netherlands, pp: 1-20.

He, S., D.C. Joyce and D.E. Irving, 2006. Competition for water between inflorescences and leaves in Cut flowering stems of *Grevillea* `crimson yul-lo. Acta Horticulturae, 63: 120-130.

Hutchinson, M.J., D.K. Chebet and V.E. Emongor, 2003. Effect of accel, sucrose and STS on the water relation and postharvest physiology of cut Tuberose (*Polianthes tuberose* L.) flowers. Afr. crop Sci. J., 4: 279-287.

Kazemi, M., S. Zamani and M. Aran, 2011. Effect of some treatment chemicals on keeping quality and vase-life of cut flowers. Am. J. Plant Physiol., 6: 99-105.

Pramanik, B.K., T. Matsui, H. Suzuki and Y. Kosugi, 2004. Changes in acid invertase activity and sugar distribution during postharvest senescence in broccoli. Pak. J. Biol. Sci., 7: 679-684.

Pun, U.K., J.S. Rowarth, M.F. Barnes and J.A. Heyes, 2001. The role of ethanol or acetaldehyde in the biosynthesis of ethylene in carnation (*Dianthus caryophyllus* L.) cv. yellow candy. Postharvest Biol. Technol., 21: 235-239.

SAS, 1998. SAS/STAT® 9.2 User's Guide. SAS Institute Inc., North Carolina, USA., pp: 1831-1891.

Satoh, S., H. Nukui and T. Inokuma, 2005. A method for determining the vase life of cut spray carnation flowers. J. Applied. Hortic., 7: 8-10.

Serek M., E. Sisler and M.S. Reid, 1995. Effect of 1-MCP on the vaselife and ethylene response of cut flowers. Plant Growth Regulation, 16: 93-97.

Serek, M., E.C. Sisler and M.S. Reid, 1994. Novel gaseous ethylene binding inhibitor prevents ethylene effects in potted flowering plants. J. Am. Soc. Horticult. Sci., 119: 1230-1233.

Shahri, W., 2011. Senescence: Concepts and synonyms. Asian J. Plant Sci., 10: 24-28.

Shanan, T.N., K.S. Emara and S.O. Barakat, 2010. Prolonging vaselife of carnation flowers using natural essential oils and its impact on microbial profile of vase solutions. Australian J. Basic Appl. Sci., 4: 3559-3574.

Song, L., Y. Wang, W. Lu, G. Wu, Y. Jiang and H. Gao, 2007. Differential expressions of expansin and xyloglucan endotransglucosylase genes by adenosine triphosphate of cut carnation flowers during senescence. Int. J. Agric. Res., 2: 945-951.

Tabassum, R., A. Ghaffoor, K. Waseem and M.A. Nadeem, 2002. Evaluation of rose cultivars as cut flower production. Asian J. Plant Sci., 1: 668-669.

VBN, 2005. Product specification. Vereniging Van Bloemenveilingen in Nederland.

Wawrzynczak, A. and D.M. Goszczynska, 2003. Effect of ethylene inhibiters on longevity of cut carnation (*Dianthus caryophyllus* L.) and ethylene production by flowers. J. Fruit Ornamental Plant Res., 11: 89-98.

Wu, M.J., L. Zacarias, M.E. Saltveit and M.S. Reid, 1992. Alcohols and carnation senescence. HortScience, 27: 136-138.

Wu, M.J., W.G. van Doom and M.S. Reid, 1991. Variation in the senescence of carnation (*Dianthus caryophyllus* L.) cultivars. I. Comparison of flower life, respiration and ethylene biosynthesis. Sci. Hortic., 48: 99-107.

Yangkhamman , P., S. Fukai and K. Ichimura, 2005. Ethylene production and vase life of cut carnation flowers under high temperature conditions. J. Jap. Soc. Hortic. Sci., 74: 337-341.

Zuliana, R., A.N. Boyce, H. Nair and S. Chandran, 2008. Effects of aminooxyacetic acid and sugar on the longevity of pollinated *Dendrobium pompadour*. Asian J. Plant Sci., 7: 654-659.