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Response of Carnation (*Dianthus caryophyllus*) Cultivars to Different Postharvest Preservatives

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Abstract: Experiments were conducted to assess the effect of selected pulsing solutions on the days to flower bud shrinkage, leaf wilting and petal edge drying occurrence of carnation cultivars (Green-Go and Galy). The pulsing solutions used for this investigation were Silver Thiosulfate (STS) (0.2, 0.6, 1 mM) and also ethanol (6, 8, 10%), both received equal amount of sucrose (10%). Besides, to simulate the actual practice of the farm (0.4 mM Silver Thiosulfate (STS) plus 0.3 mM T.O.G®) was used as a standard control. Senescence symptoms such as flower bud shrinkage, petal edge drying and leaf wilting were monitored. The results obtained showed that 1 mM STS plus 25 g sucrose achieved rapid petal edge drying for Green-Go cultivar. On the other hand, positive effects were also observed in days to flower bud shrinkage extended by 6 mM Silver Thiosulfate (STS) plus 25 g sucrose and being in par with 8% ethanol plus 25 g sucrose for Green-Go cultivar. Subsequently, the standard control, 0.6 mM Silver Thiosulfate (STS) plus 25 g sucrose and 8% ethanol plus 25 g sucrose attended comparable increment on the days to leaf wilting occurrences.

Key words: Flower bud shrinkage, leaf wilting, petal edge drying

INTRODUCTION

Cut flowers are one of the huge income generators of fresh commodities in Global market (Da Silva, 2003). The vase life of cut flowers is one of the most important characteristics that determine their ornamental value and their ability to satisfy consumer preferences (Kazemi and Ameri, 2012a). The decline of the ornamental value of cut flowers after harvest may depend on many reasons (Kazemi *et al*., 2011a). For instance, postharvest senescence of flower has been attributed mainly to ethylene (Chutichudet *et al*., 2010). Carnation (*Dianthus caryophyllus* L.) is one of the main floricultural crops in worldwide (Tabassum *et al*., 2002). The senescence of a climacteric flowers, such as carnations, is associated with a climacteric rise of respiration, loss of membrane fluidity (Larsen *et al*., 1993; Tang *et al*., 1994), reduction of endogenous sugar (Zuliana *et al*., 2008) and production of ethylene autocatalytically (Kazemi *et al*., 2012a). In addition, carnation is highly sensitive to ethylene (Kazemi *et al*., 2012c). Hence, cut carnation flowers reduce its quality and market value due to petal enrolling (Song *et al*., 2007), petal discoloration (Zuliana *et al*., 2008) and leaf wilting and discoloration (Kazemi and Ameri, 2012b). Consequently, it hastens flower senescence and reduction of flower vase life span (Chutichudet *et al*., 2011; Kazemi *et al*., 2012b).

The outcome of ethylene can be overcome by using ethylene antagonists which inhibit ethylene biosynthesis or by inhibitors of ethylene action (Wu *et al*., 1991; Kazemi *et al*., 2012c). Silver Thiosulfate (STS) pulsing delays the commencement of flower senescence by suppressing climacteric respiration and ethylene production without affecting basal level of ACC (Buffer *et al*., 1980; Wu *et al*., 1991). In addition, Ethanol pulsing also reduced the accumulation of ACC and completely by inhibiting the activity of the EFE (ACC oxidase) (Pun *et al*., 2001).

Postharvest senescence is also affected by 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; Kazemi *et al*., 2011b). Similarly, Kazemi *et al*. (2012c) suggested that, sucrose prolongs vase life of cut carnation flowers. In addition, it has been suggested that, vase life of *Dendrobium heang* Beauty inflorescences treated with a combination of sugar and ethylene inhibitor prolonged significantly (Zuliana *et al*., 2008). Pulsing solutions containing Silver Thiosulfate (STS) is 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

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Tuberose flowers was also improved greatly by pulsing in Silver Thiosulfate (STS). However, Silver Thiosulfate (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). Therefore, it was important to find an alternative pulsing solution which is safe for health and the environment. Thus, this study was initiated to assess the effect of selected pulsing solutions on the days to flower bud shrinkage, leaf wilting and petal edge drying occurrence of carnation cultivars (Green-Go and Galy).

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 petal edge drying, flower bud shrinkage and leaf wilting were recorded.

Petal edge drying: Petal edge drying is the number of days in which the peripheral part of petals starts to show brownish color. It was recorded in number of days when the outer five petals developed the above mentioned symptom (VBN, 2005).

Flower 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).

Leaf wilting: The number of days taken to attained 50% from total number of leaves lose their turgidity and faced horizontally down ward to the stem has been recorded as leaf wilting date (VBN, 2005).

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. Similarly, the bivariate correlation between responses variables were also determined.

RESULTS AND DISCUSSION

Petal edge drying: The interaction effect indicated that, cultivar Galy treated with PS 5 (8% ethanol plus 25 g sucrose) took the longest number of days (20.50 days) for petal edge drying. However, the result was not significantly different from cultivar Green-Go (20.08 days) pulsed with PS5 (8% ethanol plus 25 g sucrose) and Galy cultivar pulsed with PS2 (0.6 mM STS plus 25 g sucrose) (19.72 days) and standard control (19.39 days). On the other hand, PS 3 (1 mM STS plus 25 g sucrose) (11.92 days) achieved rapid petal edge drying for Green-Go cultivar. This might be attributed due to high concentration level of STS pulsing solutions leads to toxicity in the petals, consequently, it reduces the days to petal edge drying. Generally, in any of the pulsing treatments and cultivar combinations, Galy was found to be tolerant to petal edge drying as compare to Green-Go (Fig. 1). Subsequently, the days to petal edge drying showed highly significant positive relationship with flower bud shrinkage occurrence. However, petal edge drying had non-significant association with leaf wilting date (Table 1). The investigation result is in line with the finding of Watanabe *et al.* (1998), who reported that pulsing with high concentration of STS, reported as it accelerate the discoloration of cut sweet pea flower petals (*Lathyrus odoratus* L. "Diana"). Furthermore, the finding of Hossain *et al.* (2007), affirmed the beneficial effects of ethanol on prolonging days to petal edge drying in *Bougainvillea* flower. Result of the present work is also in line with works of Hossain and Boyce (2008), who reported a significant delay of petal edge drying of Bougainvillea flowers due to ethanol pulsing.

Table 1: Correlation coefficient of the parameters considered

	PED	FBS	LW
PED			
FBS	0.56**		
LW	0.10^{ns}	0.34*	

*,**Significant difference at 0.05 and 0.001 probability level, respectively, ns: Non significantly different

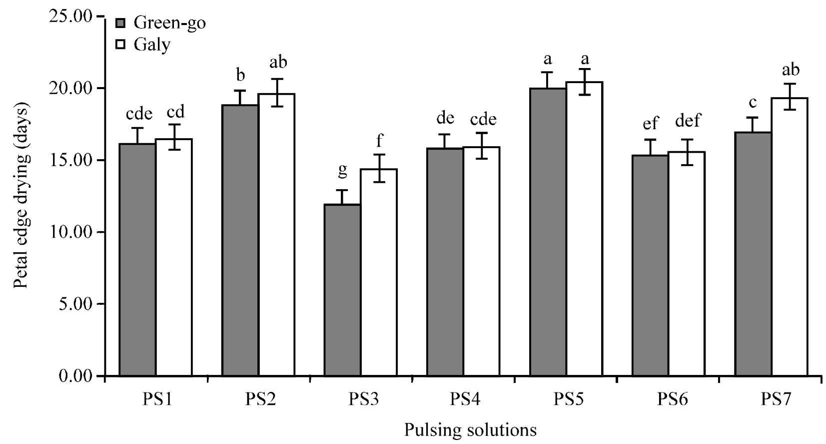

Fig. 1: Interaction effects of cultivars and pulsing treatments on petal edge drying (SE+0.48), Means followed by different letters differ significantly (p<0.05) as established by LSD test

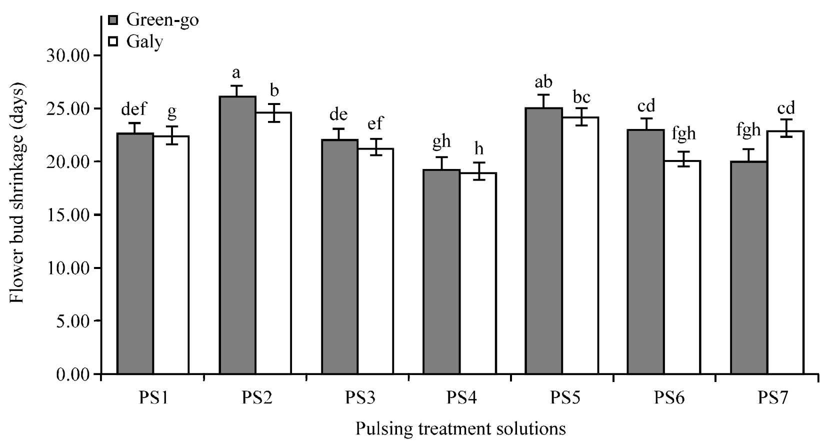

Fig. 2: Interaction effects of cultivars and pulsing treatments on flower bud shrinkage (SE+0.48), Means followed by different letters per column differ significantly (p<0.05) as established by LSD test

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. 2). Although, the number of days taken for flower bud Shrinkage showed moderate association with days to leaf wilting occurrence (Table 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 (*Dianthus caryophyllus* L.) cultivar 'White Sim' pulsed with 8% ethanol inhibited ethylene as result it significantly extended the days to attain flower bud shrinkage.

Leaf wilting date: Hence, the standard control (48.06 days) significantly delayed leaf wilting date correspondingly with PS2 (0.6 mM STS plus 25 g sucrose) (47.23 days), PS 3 (1 mM STS plus 25 g sucrose) (47.07 days), PS 6 (10% ethanol plus 25 g sucrose)

Table 2: Effect of different pulsing solutions on leaf wilting (LW) of two carnation cultivars

Pulsing solutions		LW(Days±SE)
PS1	(0.2 mM STS plus 25 g sucrose)	39.55±1.20[b]
PS2	(0.6 mM STS plus 25 g sucrose)	47.23±1.20[a]
PS3	(1 mM STS plus 25 g sucrose)	47.07±1.20[a]
PS4	(6% Ethanol plus 25 g sucrose)	38.66±1.20[b]
PS5	(8% Ethanol plus 25 g sucrose)	45.37±1.20[a]
PS6	(10% Ethanol plus 25 g sucrose)	46.99±1.20[a]
PS7	(T.O.G® 0.3 mM and 0.4 mM STS) (control)	48.06±1.20[a]
Cultivars		
Green-Go		45.21±0.64[a]
Galy		44.20±0.64[a]
CV (%)		6.61±0.00

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

(46.99 days) and PS 5 (8% ethanol plus 25 g sucrose) (45.37 days). On the other hand, carnation cultivars pulsed in PS 4 (6% ethanol plus 25 g sucrose) (38.66 days) and PS 1 (0.2 mM STS plus 25 g sucrose) (39.55 days) exhibited the lowest leaf wilting date values. This might be attributed due to the lowest concentration levels of both STS and ethanol. In the present study, the delay of the leaf wilting days by the standard control could be due to the combined effect T.O.G® and STS. Meanwhile, T.O.G® had 8-HQ as a main component which was helpful for the reduction of microbial population and it could reduce xylem blockage. Consequently, it might help to keep the water balance in plant, as well the STS was supportive for combating leaf senescence caused by ethylene at the same time retard the wilting of the leaf tissue. In agreement with the above result, Li *et al.* (2010) suggested that, 8-HQ had a strong antibacterial and activity in the vase. Van Doorn *et al.* (1991) reported that, the time to wilting of the leaves (usually called fronds) fern (*Adiantum raddianum Presl.*) could be significantly delayed by 8-HQ pulsing (Table 2).

CONCLUSION

From the results of the present study, it can be concluded that, 0.6 mM Silver Thiosulfate (STS) plus 25 g sucrose and 8% ethanol plus 25 g sucrose had similarities with regard to extend days to attained leaf wilting. Similarly, Green-Go cultivar pulsed with these two pulsing treatments compatibly achieved longer number of days, in the same way, cultivar Galy delayed the incidence of petal edge drying and flower bud shrinkage. Therefore, 0.6 mM Silver Thiosulfate (STS) plus 25 g sucrose and/or 8 percent ethanol plus 25 g sucrose) could be used as the best pulsing solutions. Since, they revealed best performance in many of the measured parameters.

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