Floriculture and Ornamental Biotechnology ©2008 Global Science Books

Effects of Cultivar, Harvesting Date and Chemical Treatments on the Quality and Soluble Carbohydrate Contents in Rose (*Rosa hybrida*)

Naser Alemzadeh Ansari* • Mozhgan Zangeneh

Department of Horticulture, Faculty of Agriculture, Shahid Chamran University, Ahwaz, 61357-14891, Iran

***Corresponding author*: * ansari_n@scu.ac.ir**

ABSTRACT

Cut rose flower quality decreases after 3-4 days from harvest. To reduce postharvest losses, this experiment was conducted on two rose cultivars ('Ilona' and 'Noblesse'), which grow under subtropical climatic conditions in Khuzestan province of Iran. Each rose cultivar was harvested on three dates two years apart. Chemical treatments included benzyladenine (BA) (10, 20 and 30 mg l^{-1}) and silver thiosulfate solution (STS) (0.2, 0.4 and 0.6 mM) with a combination of 300 mg l^{-1} 8-hydroxyquinoline citrate and 2% sucrose for 24 h. The effect of these treatments on vase life and flower quality of cut rose flowers was evaluated daily. The effects of chemical treatments were investigated by a pulsing method. Vase life, flower diameter, bud opening, concentration of leaf and petal soluble carbohydrate content of cut rose flowers treated with STS and BA increased, and bent neck decreased. Maximum and minimum vase life and quality were in the first and third harvesting date, respectively. Vase life and quality of cv. 'Noblesse' was better than 'Ilona'.

Keywords: bent neck, benzyladenine, silver thiosulfate, vase life

INTRODUCTION

Rose is the most popular cut flower in Iran and thoughout the world. The Khuzestan province is an important area of agriculture production. Cut rose flowers are produced there for over three months a year for export to other provinces of Iran and to other countries. Vase life is one of the most important factors to assess the quality of cut flowers. The longevity of cut rose flowers varied among various cultivars (Bhattacharjee and Pal 1999). The vase life of 'First Red' and 'Saphir' is much longer than 'Red Velvet' and 'Sonia' (Kim and Lee 2002a). Often bent neck is a symptom of the end of the vase life. Cultivars with a short vase life have lower water contents of neck, upper stem and lower stem than those with a longer vase life, also these with a longer vase life have high total sugar contents at and after harvest (Kim and Lee 2002). Cultivars with a short vase life showed frequent bent neck, whereas those with a longer vase life did not show bent neck during senescence (Lee and Kim 2002). The harvest stage is very important because flowers harvested at earlier stages have a weak neck strength, which caused flower necks to bend earlier (Lee and Kim 2001). The bending of the flower neck is considered to be caused by vascular occlusion, which inhibits water supply to the flowers (de Stigter 1980; van Doorn 1997; reviewed extensively by Balas *et al*. 2006). The nature of the occlusion in the stems, however, is not clear. Vascular occlusion is caused by multiplication of bacteria (Zagory and Reid 1986; van Doorn *et al*. 1989; Jones and Hill 1993), air emboli or physiological responses in the stem that are induced by cutting. When 8-hydroxyquinoline citrate (HQC) was added to the vase water, hydraulic conductance of stem segments was higher than in controls. HQC is known to inhibit ethylene at the cut surface of rose stems (van Doorn *et al*. 1989).

Cut rose flowers are often harvested before full development. The formation of a mature flower depends on carbohydrate supply. Before harvesting, flowers are supplied with carbohydrates by photosynthesis that occurs in the green organs of the plant. Postharvest light intensity is usually low and therefore the production of carbohydrates by photosynthesis in cut flowers generally is negligible. A lack of carbohydrates can cause the bud of a cut rose flower not to open (van Doorm *et al*. 1996). Sugar can be use to compensate for lack of carbohydrates solution (Ichimura and Hiraya 1999), but sucrose alone has not been usually used because sugar treatment without germicides promotes bacterial proliferation, leading to shortening of the vase life. Silver thiosulphate (STS) treatment has been recommended for maintaining the vase life of several cut flowers. This material in low amounts inhibits ethylene production and acts as an antimicrobial agent in the vase solution. For example, Mor *et al.* (1989) found that STS-treated cut rose flowers had better quality than the water controls. In addition, Ichimura *et al*. (1998) reported that STS and sucrose treatment in cut rose flower had better quality than the water controls.

Exogenous ethylene inhibits floral opening in cut rose flower, and promotes opening bud in cv. 'Samantha', but ethylene production rate differs depending on the cultivar (Tan *et al*. 2006). Gibberellic acid (GA_3) was effective in extending vase life of cut roses by delaying the onset of tepal fading and wilting and delaying senescence-associated proteolysis (Eason 2002) and benzyladenine (BA) caused protein levels to increase in petals and ovaries of water-held roses (Lukaszewska 1986).

The objective of this study was to evaluate the quali- and quantitative characters of two cultivars of *Rosa hybrida* grown in Khuzestan province, Iran at harvesting date and supplemented with various levels of STS and BA in holding solutions.

MATERIALS AND METHODS

Research was conducted on two cut rose (*Rosa hybrida* L.) cultivars, 'Ilona' and 'Noblesse', grown in Khuzestan province of Iran.

Received: 10 May, 2008. Accepted: 23 June, 2008.

Original Research Paper

The mature buds were harvested for selling in markets at the normal harvest time in December 3, 2005, January 3, and February 3, 2006 and were immediately carried to the Physiology Lab. of the Horticulture Department, Shahid Chamran University, Ahwaz, Iran. At first, the flower stems were trimmed to 60 cm and all leaves except for the upper leaves were removed. For every replication, four cut flowers were placed in 500 ml beakers with 250 ml of preservative solutions containing STS (0.2, 0.4 and 0.6 mM) and BA (10, 20 and 30 mg l^{-1}) supplemented with 2% sucrose and 300 mg l^{-1} HQC and tap water as the control. The cut flowers were kept at 23 ± 2°C under 70% RH and a 12 h photoperiod. The pulse treatment of each solution was kept for 24 h and then transferred to tap water. In this study, several parameters were evaluated to select the suitability of cultivars, harvest date, and levels of STS and BA to determine the best solution. The vase life and the degree of flower opening, based on the standards by Pearson-Mims (1990) was recorded daily (score 4, fully open flowers, score 3, 50% of petals opened, score 2, 20% of petals opened, score 1, one or two petals opened, score 0, tight floral buds wilted). Flower diameter, percentage of bent neck, and concentration of leaf and petal soluble carbohydrate pretreatment were examined after 3 and 6 days. The experiment was conducted in a factorial experiment design completely randomized with three replications; the results were tested for significant differences by Duncan's Multiple Range Test, at a probability of 5%. Data were analyzed statistically with MSTATC.

RESULTS AND DISCUSSION

Results of this experiment showed that cultivar, harvesting date, BA, STS and the interaction effects of cultivar and harvesting date impacted the vase life of cut rose flowers, bud opening, percentage bent neck, flower diameter, and petal and leaf soluble carbohydrate concentration (p = 0.05). Others interactions and factors did not show a significant effect.

Vase life

The vase life of cv. 'Noblesse' was longer than that of 'Ilona' (**Table 1**). This result is supported by another study (Ichimura *et al*. 2002) which showed that the shortest vase life is in cv. 'Bridal Pink' (3.8 days) and the longest in cv. 'Calibra' (14.5 days) when vase water was supplemented with 200 mg l^{-1} 8-hydroxyquinoline sulfate (HQS) and 20 g l^{-1} sucrose. Variation between cultivars may be due to their ability to produce ethylene, stress after harvesting and the cultivar-specific reaction to these compounds. BA increased vase life more than the control (**Table 1**). BA led to a delay in the decrease of chlorophylls, while the vase life of cut rose flowers increased (Jordi *et al*. 1994, 1996). At the third harvesting date, the general vase life of cut rose flowers was half that of the first harvesting date. The temperate environment in early autumn caused carbohydrates to accumulate in the stem, leaves, and petals but in a relative cold environment in the middle of winter and decreased sunlight hours, carbohydrate levels and vase life decreased. Maximum and minimum vase life was observed for cv. 'Ilona' harvested in December and February, respectively (**Fig. 1**). Cv. 'Ilona' could not tolerate changes in the environment as well as cv. 'Noblesse' and was less firm. Monteiro *et al*. (2001) also showed the effects of cultivar and harvesting date on vase life: cv. 'Meijikatar' miniature rose flowers harvested in spring and summer had a longer vase life then those harvested in autumn and winter.

Bud opening

Cv. 'Noblesse' had a better bud opening score than cv. 'Ilona'. Ichimura *et al*. (2002) indicated that the cut flowers of various rose cultivars had different bud opening scores. For example, some cultivars showed very early bud opening while in others the bud remained closed, and were eventually rejected. At first harvesting date the bud opening score was higher than later harvesting. Kanok *et al*. (2004) also indicated that at the suitable time for growth (spring and summer), cut flowers had more carbohydrates and were of better quality than those harvested from an unsuitable time for growth (autumn and winter). The interaction effect of cultivar and harvesting date showed that cv. 'Noblesse' harvested in December and cv. 'Ilona' harvested in February showed the maximum and minimum bud opening score, respectively (**Fig. 2**).

Bent neck percentage

Cv. 'Ilona' had a higher percentage bent neck than cv. 'Noblesse'. Minimum and maximum bent neck percentages were observed in December and February, respectively (**Table 1**). After harvest, in general, the percentage bent neck increased when the storage period was increased (**Fig. 3**). Using STS in pretreatment solutions prevented vascular occlusion through its bactericidal affect and BA led to a decrease in the percentage bent neck. Lee and Kim (2001) and Kim and Lee (2003) indicated that by using bactericide material in holding solutions resulted in stronger flower necks and decreased the percentage of bent neck.

Flower diameter

Cv. 'Noblesse' had a higher flower diameter than cv. 'Ilona'. Flower diameter flower is affected by genotype (Ichimura *et*

Table 1 Mean simple effect of cultivars, harvesting date, benzyl adenine, and silver thiosulfate on some of morphological, and biochemical characters rose at postharvesting stage.

Treatment	Vase life (days)	Opening bud (scoring)	Neck bent (%)	Flower diameter (cm)	Leaf carbohydrate (mg/g)	Petal carbohydrate (mg/g)
Cultivars						
Noblesse	7.54 ± 0.20a*	3.08 ± 0.05a	29.03 ± 1.00a	6.78 ± 0.31a	3.78 ± 0.03a	2.45 ± 0.13a
Ilona	6.64 ± 0.25b	3.00 ± 0.05b	33.23 ± 1.16b	6.14 ± 0.11b	3.54 ± 0.03b	2.12 ± 0.21b
Harvesting date						
December	9.88 ± 0.23a	3.13 ± 0.04a	18.91 ± 0.99c	7.46 ± 0.11a	4.13 ± 0.03a	2.80 ± 0.05a
January	6.56 ± 0.16b	2.42 ± 0.09b	33.70 ± 1.29b	6.21 ± 0.12b	4.08 ± 0.03b	2.73 ± 0.12b
February	4.82 ± 0.08c	2.04 ± 0.1c	40.78 ± 1.47a	5.71 ± 0.12c	3.07 ± 0.23c	1.72 ± 0.11c
Benzyl adenine (mg l^{-1})						
0	6.77 ± 0.31b	2.60 ± 0.10a	34.17 ± 1.70a	5.65 ± 0.11c	3.66 ± 0.33c	2.32 ± 0.16d
10	7.55 ± 0.37a	2.65 ± 0.11a	33.13 ± 1.59b	6.50 ± 0.12b	3.76 ± 0.23b	2.42 ± 0.12c
20	6.94 ± 0.27b	2.60 ± 0.11a	28.75 ± 1.39c	6.73 ± 0.13ab	3.77 ± 0.13b	2.45 ± 0.10b
30	7.10 ± 0.37b	2.32 ± 0.11a	28.47 ± 1.47c	6.99 ± 0.19a	3.86 ± 0.02a	2.53 ± 0.06a
Silver thiosulfate (mM)						
0	6.36 ± 0.26b	2.60 ± 0.11a	44.65 ± 1.74a	5.74 ± 0.15c	3.38 ± 0.12d	2.08 ± 0.03d
0.2	7.25 ± 0.35a	2.65 ± 0.10a	31.25 ± 1.32b	6.19 ± 0.14b	3.70 ± 0.14c	2.36 ± 0.12c
0.4	7.45 ± 0.32a	2.60 ± 0.10a	30.76 ± 1.55b	6.84 ± 0.14a	3.91 ± 0.13b	2.58 ± 0.11b
0.6	7.29 ± 0.35a	2.32 ± 0.12b	17.85 ± 1.12c	7.09 ± 0.16a	4.05 ± 0.02a	2.71 ± 0.10a

*Means ± standard deviations followed by the same letter do not differ significantly by Duncan's Multiple Range Test, *P*=0.05.

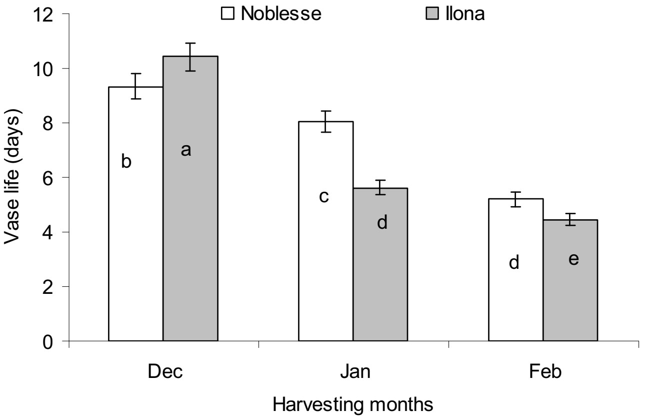

Fig. 1 Interaction effect of harvesting date and cultivar on vase life of cut rose flower at postharvesting stage.

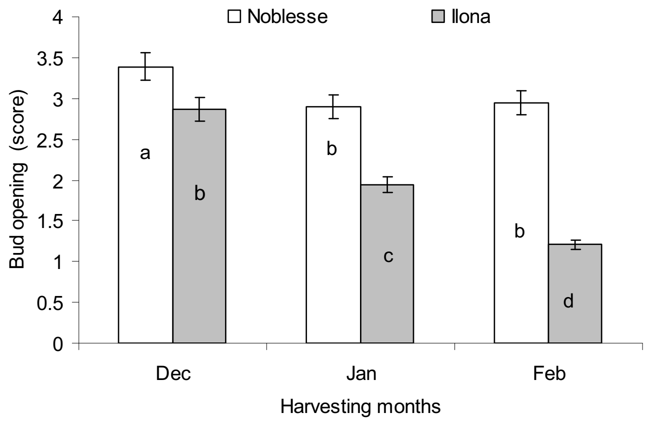

Fig. 2 Interaction effect of harvesting date and cultivar on bud opening of cut rose flower at postharvesting stage.

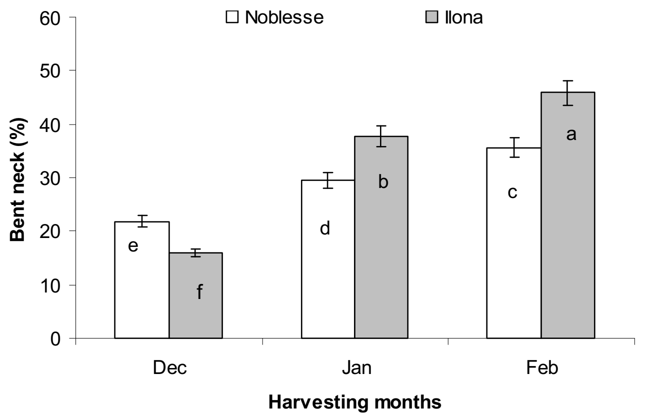

Fig. 3 Interaction effect of harvesting date and cultivar on percentage of bent neck of cut rose flower at postharvesting stage.

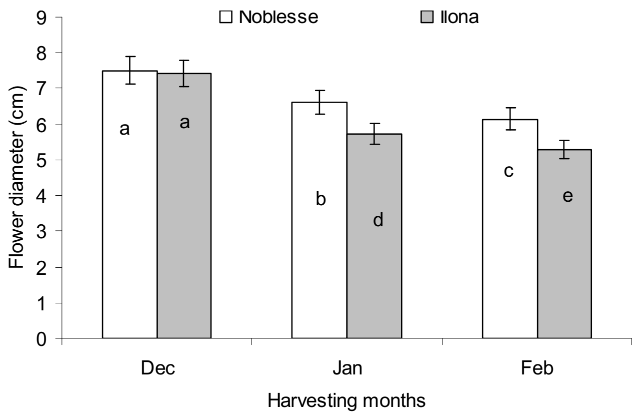

Fig. 4 Interaction effect of harvesting date and cultivar on flower diameter cut rose flower at postharvesting stage.

al. 2002). Minimum and maximum flower diameter occurred in December and February, respectively (**Table 1**). Grossi *et al*. (2004) observed that many characters changed seasonally: if developmental changes were rapid, then measured characters were smaller, i.e. smaller flower diameter, more compact growth, and smaller leaf area. Our results show that flower diameter increased by increasing BA and STS in holding solution (**Table 1**). Liao *et al*. (2000) showed that the diameter of cut rose flowers increased by using a pulse treatment of STS at 0.2 mM for 2 h. Flower diameter was not significantly different between cultivars when harvested in December, but at other harvesting dates the flower diameter of cv. 'Noblesse' was greater than that of cv. 'Ilona' (**Fig. 4**).

Petal and leaf soluble carbohydrate concentration

Cv. 'Noblesse' had more petal and leaf soluble carbohydrates than cv. 'Ilona', with minimum and maximum concentrations being recorded in December and February harvests, respectively (**Table 1**). In a cold environment, soluble carbohydrate accumulation decreases in petals and leaves, but this depends on the cultivar. Adachi *et al*. (2000) showed that changes in the temperature of the environment caused changes in the carbohydrate content in capitula, stems, and leaves of cut chrysanthemum Kitamura 'Seiun' plants. In general, by increasing STS and BA in holding solutions petal and leaf soluble carbohydrate concentration increased. Tjosvold *et al*. (1994) showed that a combined BA and STS treatment greatly improved the postproduction quality of rose plant.

ACKNOWLEDGEMENTS

The authors wish to thank Shahid Chamran University of Ahwaz, Iran for supporting this work.

REFERENCES

Balas J, Coronado PAG, Teixeira da Silva JA, Jayatilleke MP (2006) Supporting post-harvest performance of cut-flowers using fresh-flower-refreshments and other vase-water-additives. In: Teixeira da Silva JA (Ed) *Floriculture, Ornamental and Plant Biotechnology: Advances and Topical Issues* (1st Edn, Vol IV), Global Science Books, Isleworth, UK, pp 612-629

Bhattacharjee SK, Pal M (1999) Post-harvest life, quality and respiration rate of rose cultivars. *Journal of Maharashtra Agricultural Universities* **24**, 28-30

Chikkasubbanna V, Yogitha N (2003) Extension of vase life of cut roses cultivars Cream Prophyta and Sacha. *Horticultural Abstracts* **73**, 410

De Stigter HCM (1981) Water-balance aspects of cut and intact Sonia rose plants, and effects of glucose, 8-hydroxyquinoline sulfate and aluminium sulfate. *Acta Horticulturae* **113**, 97-108

Eason JR (2002) Sandersonia aurantiaca: An evaluation of postharvest pulsing solutions to maximise cut flower quality. *New Zealand Journal of Crop and Horticultural Science* **30**, 273-279

Grossi, JAS, Pemberton HB, Lang HB (2004) Influence of cultivar and seasonal growing environment on growth and postharvest characteristics of single-shoot pot rose plants. *HortScience* **39**, 138-141

Ichimura K, Hiraya T (1999) Effect of silver thiosulfate complex (STS) in combination with sucrose on the vase life of cut sweet pea flowers. *Journal of the Japanese Society for Horticultural Science* **68**, 23-27

Ichimura K, Kawabata Y, Kishimoto M, Goto R, Yamada K (2002) Variation with the cultivar in the vase life of cut rose flowers. *Bulletin of the National Institute for Floricultural Science* **2**, 9-20

Ichimura K, Mukasa M, Fujiwara T, Kohata K, Suto K (1998) Improvement of postharvest life and changes in sugar concentrations by sucrose treatment in bud cut sweet pea. *Bulletin of the National Research Institute for Vegetable and Ornamental Plants and Tea* **13**, 41-49

Jones RB, Hill M (1993) The effect of germicides on the longevity of cut flowers. *Journal of the American Society for Horticultural Science* **118**, 350-354

Jordi W, Pot CS, Stoopen GM, Schapendonk AHCM (1994) Effect of light and gibberellic acid on photosynthesis during leaf senescence of *Alstroemeria* cut flowers. *Physiologia Plantarum* **90**, 293-298

Jordi W, Stoppen GM, Argiroudi I, In't-Velt E, Heinen P, van Toll H (1996) Accumulation of a 50-Kda protein during leaf senescence of *Alstroemeria* cut flowering stems. *Physiologia Plantarum* **98**, 819-823

Kanok BA, Saichol K, van Doorn WG (2004) Postharvest physiology of *Cur-*

cuma alismatifolia flowers. *Postharvest Biology and Technology* **34**, 219-226

Kim YA, Lee JS (2002) Changes in cell wall components and carbohydrates as affected by bent neck and senescence of cut rose flowers. *Journal of the Korean Society for Horticultural Science* **43**, 213-220

Lee JS, Kim YA (2001) Effects of harvesting stages and holding solutions on quality and vase life of cut 'Madelon' rose flowers. *Journal of the Korean Society for Horticultural Science* **42**, 743-747

Lee JS, Kim YA (2002) Changes in bent neck, water balance, and vase life of cut rose cultivars as affected by preservative solution. *Journal of the Korean Society for Horticultural Science* **43**, 201-207

Liao JL, Lin YH, Kuang LH, Chen WS, Cheng YM (2000) Postharvest life of cut rose flowers as affected by silver thiosulfate and sucrose. *Botanical Bulletin of Academia Sinica (Taipei)* **41**, 299-303

Lukaszewska AJ (1986) The effect of benzyladenine and ethephon on soluble protein content and invertase activity in wilting cut rose cv. Carina. *Acta Horticulturae* **181**, 87-92

Monteiro JA, Nell TA, Barrett JE (2002) Effects of exogenous sucrose on carbohydrate levels, flower respiration and longevity of potted miniature rose (*Rosa hybrida*) flowers during postproduction. *Postharvest Biology and Technology* **26**, 221-229

Mor Y, Johnson F, Faragher JD (1989) Preserving the quality of cold stored rose flowers with ethylene ontagonis. *HortScience* **24**, 640-641

Pearson-Mims CH, Lohr VI (1990) Fluoride injury to cut `Samantha' roses may be reduced by pulsing with calcium nitrate. *HortScience* **25**, 1270-1271

Tan H, Lio X, Ma N, Xue J, Lu W, Bai J, Gao J (2006) Ethylene-influenced flower opening and expression of genes encoding *Etrs*, *Ctrs*, and *Ein3s* in two cut rose cultivars. *Postharvest Biology and Technology* **40**, 97-105

Tjosvold SA, Wu MJ, Reid MS (1994) Reduction of postproduction quality loss in potted miniature roses. *HortScience* **29**, 230-340

van Doorn WG, Vojinovic A (1996) Petal abscission in rose flowers: Effects of water potential, light intensity and light quality. *Annals of Botany* **78**, 619-623

van Doorn WG, Schurer K, de Witte Y (1989) Role of endogenous bacteria in vascular blockage of cut rose flowers. *Journal of Plant Physiology* **134**, 375-381

van Doorn WG (1997) Water relations of cut flowers. *Horticultural Reviews* **18**, 1-85

Zagory D, Reid MS (1986) Role of vase solution microorganisms in the life of cut flowers. *Journal of the American Society for Horticultural Science* **111**, 154-158