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Research Article

The Effect of Salicylic acid Preharvest Treatment on Qualitative Traits and Yield of Rose Cut Flowers (*Rosa hybrida* L.) CV. Angelina

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ABSTRACT

The rose certainly remains the queen of the cut flowers. This research was carried out in the research greenhouse of Islamic Azad University, Isfahan (Khorasgan) branch, to investigate the effect of salicylic acid preharvest treatment on quality, quantity and nutrient uptake of rose flower (cv. Angelina). The experimental design was completely randomized, using different concentrations salicylic acid (0, 50, 100 and 150 ppm) with 3 replications. Average temperature of day and night were 28°C and 18°C, respectively and relative humidity in greenhouse was 60-70 percent during the growth period. The plants were sprayed manually on a once every two weeks. The some properties of rose such as leaf area, length of flowering stem, plant yield, chlorophyll content (a, b and total), anthocyanin of petal, total nitrogen, potassium and phosphor were determined at after the late-stage of salicylic acid spray. The results indicated that foliar application of salicylic acid significantly affected chlorophyll (a, b and total), anthocyanin of petal, total nitrogen, potassium and phosphor. However, statistical analysis showed leaf area, length of flowering stem and plant yield of rose were far greater in 50 and 100 ppm salicylic acid compared to 0 and 150 ppm salicylic acid. Based on these results, it is suggested that salicylic acid pre harvest application improved quality of cut rose flowers.

Key words: Salicylic acid, Rose cut flowers, Pre harvest, Chlorophyll, Anthocyanin

INTRODUCTION

Rose (*Rosa* spp.) belongs to the family Rosaceae and is one of the most popular flowers and economically important genuses of aromatic, ornamental and medicinal plants widely distributed all over the world (Ritz *et al.*, 2005; Castilon *et al*., 2006). This flower is favoured for its beauty and many other uses like production of petals, rose honey, rose crystallized petals, extraction of perfumes, and extraction of ascorbic acid from hips and for sale as cut flowers (Khan and Khan, 1991). Applying of preharvest growth regulators, such as salicylic acid on plants could be useful in terms of both quality of and quantity of maintaining and improving plant is producing flowers, However, easy to use, non-toxic, and inexpensive compounds is always crucial in this respect for large-scale applications. Salicylic acid has been considered a novel potential alternative for this purpose and has been discovered to affect several biochemical and physiological functions in plants (Métraux, 2002). Salicylic acid or ortho-hydroxy benzoic acid and other salicylates are known to affect various physiological and biochemical activities of plants and may play a key role in regulating their growth and productivity (Hayat *et al*., 2010). It is an internal growth regulator of phenolic compounds which influences different physiological processes. Flower induction, growth and development, ethylene synthesis and respiration are among several vital functions of salicylic acid (Rajjou *et al*., 2006). Also, the role of salicylic acid as a natural phenolic secondary metabolite, in different aspects of vital processes like stomatal regulation, ethylene biosynthesis, respiration, senescence and the activation of defense systems against different pathogens is well documented (Miura *et al*., 2010; An *et al*., 2011; Loutfy *et al*., 2012). In addition, a potential role of salicylic acid in response to stresses has been demonstrated (Buchanan-Wollaston *et al*., 2003). Flowering is another important parameter that is directly

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related to yield and productivity of plants. Different plant species including ornamental plant *Sinningia speciosa* flowered much earlier as compared to the untreated control, when they received an exogenous foliar spray of salicylic acid (Martin-max *et al*., 2005). Some researches indicated that salicylic acid increased membrane permeability would facilitate absorbtion and utilization of mineral nutrients and transport of assimilates (Javaheri *et al*., 2012). Recent evidence has shown that hormones participate in the control of these regulatory networks. Conversely, mineral nutrient conditions influence hormone biosynthesis, further supporting close interrelation between hormonal stimuli and nutritional homeostasis, and salicylic acid has an essential function in regulating plant developmental processes that affect nutrient uptake and their status (Rubio *et al*., 2009).

However, very little is known about the effect of salicylic acid applied to foliage on plant growth and development. The present research was undertaken to improve our understanding of the effect of the various concentrations of salicylic acid applied as foliar spray to evaluate the effect of salicylic acid on quantitative and qualitative traits and nutrient uptake of rose cut flowers (cv. 'Angelina').

MATERIALS AND METHODS

This research was conducted in the research greenhouse of Islamic Azad University, Isfahan (Khorasgan) branch. Cuttings of rose cultivar Angelina were taken from biennial mother plants of rose. The experimental design was completely randomized, with different concentrations salicylic acid in 4 levels (0, 50, 100 and 150 ppm) with 3 replications. Plants were grown during 3-4 months in hydroponic growing media. Then, the plants were sprayed by using hand sprayer on a once every two weeks during 45 days. Average temperature of day and night were 28 °C and 18 °C, respectively and relative humidity in greenhouse was 60- 70 percent during the growth period. The some properties of rose such as leaf area, length of flowering stem, plant yield, chlorophyll (a, b and total), anthocyanin of petal, total nitrogen, potassium and phosphor were determined at the after the late-stage of salicylic acid spray.

Measurement of chlorophyll content

Chlorophyll content was determined in 80% acetone extract. Total chlorophyll as well as chlorophyll a and b concentrations were calculated according to Arnon (1949).

Measurement of anthocyanin

The anthocyanin of petals was determined according to modified Wagner (1979).

Measurement of Total N, K and P in leaf

Total N (Kjeldahl method), K (flame photometry method) and P (spectrophotometrically method) was determined after wet digestion (Isaac and Kerber, 1971).

Statistical analyses

The effects of salicylic acid on the quantitative and qualitative traits of rose cut flowers were carried out by one-way analysis of variance (ANOVA). Statistical procedures were performed using the Statistical Analysis System (SAS), version 9.1 (SAS Institute, Cary, NC, USA). Differences between the treatments were determined using Least Significant Difference (LSD) test at $P<0.05$.

RESULTS AND DISCUSSION

Leaf area

Statistical analysis showed that the leaf area was far greater in plants treated with salicylic acid compared to control. However, there were not significant differences between salicylic acid 150 ppm and control (Fig. 1). These results are agreed with the findings of Alaey *et al*. (2011) who found that different levels of salicylic acid increased leaf area of rose cut flowers compared to control. It was reported that salicylic acid application promoted cell division and cell enlargement (Hayat *et al*., 2005). The effect of salicylic acid on the physiology of cut flowers has been already reported (Gerailoo *et al*., 2011; Zamani *et al*. 2011; Hajireza *et al*., 2013). Salicylic acid effects on leaf structure. Previous studies also found that salicylic acid is an important regulator of photosynthesis because it affects leaf structure (Uzunova and Popova, 2000) and stomatal closure (Mateo *et al*., 2004; Melotto *et al*., 2006).

Length of flowering stem

The results indicated that 50 and 100 ppm levels of salicylic acid increased length of flowering stem compared to control (Fig. 2). Alaey *et al*. (2011) also investigated on effects of salicylic acid pre and postharvest on cut rose and found that stem height were higher in salicylic acid sprayed plants and increased consistently with increasing salicylic acid concentration. Arun *et al*. (2000) indicated that salicylic acid increased length of floral bud in rose 'First red'. However, Ghazijahani *et al*. (2014) demonstrated that salicylic acid reduced the plant height and thickened the stem of sweet basil (*Ocimum basilicum* L.).

Yield of rose

The result suggests that application of 50 and 100 ppm concentrations of salicylic acid has positive effect of yield of rose. The yield of rose was greater in these treatments compared with salicylic acid 150 ppm and control (Fig. 3). Flowering-inducing activity of salicylic acid and the contribution of salicylic acid to flowering regulation has been well known for a long time (Rivas-San Vicente and Plasencia, 2011). According to Shakirova *et al*. (2007) the positive effect of salicylic acid on growth and yield can be due to its influence on other plant hormons. Increasing of yield under foliar application of salicylic acid could be ascribed to the well-known roles of salicylic acid on photosynthetic parameters and plant water relations. Fariduddin *et al*. (2003) reported that exogenous application of salicylic acid enhanced the net photosynthetic rate, internal CO_2 concentration and water use efficiency in Brassica juncea. The effectiveness of this compound can be due to water relations enhancement, prevent vascular occlusion due to antimicrobial effect, anti-ethylene effect which reduces respiration rate of cut flowers and increased dry matter percent (Gast, 1997).

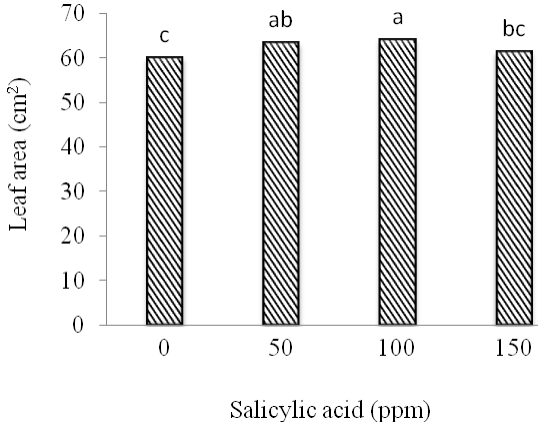

Fig. 1: The effects salicylic acid on leaf area of rose (cv. 'Angelina'). Means followed by the same letter are not significantly different at P<0.05 by LSD test (LSD=2.41).

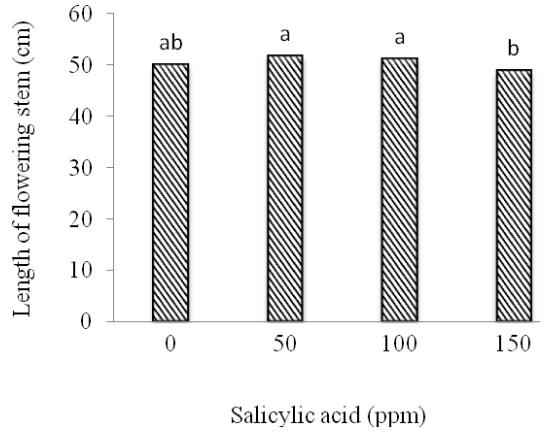

Fig. 2: The effects salicylic acid on length of flowering stem of rose (cv. 'Angelina'). Means followed by the same letter are not significantly different at P<0.05 by LSD test (LSD=1.96).

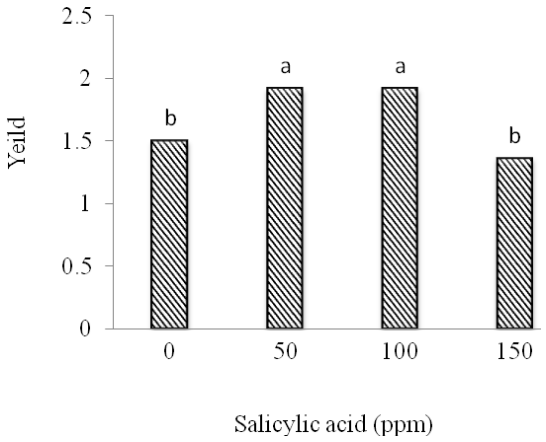

Fig. 3: The effects salicylic acid on yield of rose (cv. 'Angelina'). Means followed by the same letter are not significantly different at P<0.05 by LSD test (LSD=0.29).

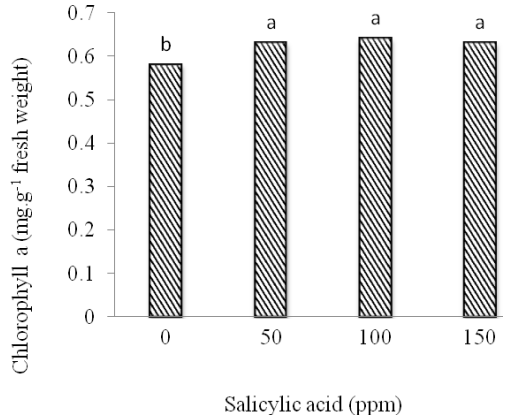

Fig. 4: The effects salicylic acid on chlorophyll a of rose (cv. 'Angelina'). Means followed by the same letter are not significantly different at P<0.05 by LSD test (LSD=0.015).

Alaey *et al*. (2011) investigated on effects of salicylic acid on vase life of cut rose (*Rosa hybrida* cv. 'Black Magic') and stated that salicylic acid extends vase life by disrupting catalase activity and regulation water relations. Roodbaraky *et al*. (2012) evaluated effect of different concentrations of salicylic acid on vase life of cut Carnation and found that salicylic acid at the concentrations of 50, 100 and 150 ppm enhanced water uptake, dry matter and vase life compared the control. Hajireza *et al*. (2013) obtained that salicylic acid increased vase life, water absorption, flower diameter and flower quality and delayed the effective weight loss of fresh of rose (*Rosa hybrida* L.) cut flower.

Content of leaf chlorophyll

According to the results this study (Fig. 4, Fig. 5 and Fig. 6), leaf chlorophyll content (a, b and total) was affected by application of salicylic acid. The results indicated that 50, 100 and 150 ppm levels of salicylic acid increased leaf chlorophyll content compared to control. However, there were no significant differences between salicylic acid treatments. Previous studies also suggest that salicylic acid is an important regulator of photosynthesis because it affects chloroplast structure (Uzunova and Popova, 2000) and chlorophyll contents (Fariduddin *et al*., 2003). However, these results are not in agreement with the findings of Mohammadi *et al*. (2014) who showed that increase in salicylic acid concentration resulted in reduction of chlorophyll content. Gerailoo *et al*. (2011) suggested that salicylic acid increases vase life of cut rose flowers by improving the antioxidant system and reducing oxidative stress damages.

The application salicylic acid caused an increase in chlorophyll total content. This might be inhibiting ethylene action and as a result, the vase life could be increased. These findings are similar to previous results of Zamani *et al*. (2011) who revealed that total chlorophyll content increased along with salicylic acid concentration in rose cut flower. Also Kazemi *et al*. (2011) observed that chlorophyll biosynthesis increased treatment with salicylic acid in the cut carnation flowers.

Anthocyanin of petal

Statistical analysis indicated that anthocyanin of petal was far greater in plants treated with salicylic acid compared to control (Fig. 7). Petals of a rose cut flower are the major ornamental parts. The turgidity of petals is

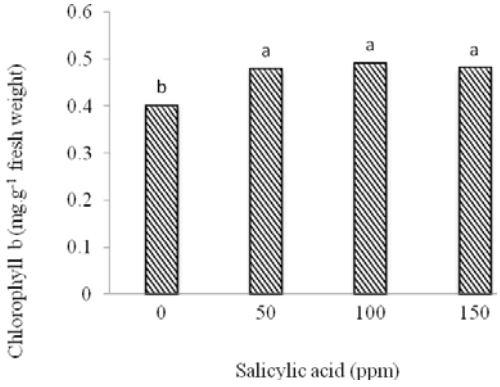

Fig. 5: The effects salicylic acid on chlorophyll b of rose (cv. 'Angelina'). Means followed by the same letter are not significantly different at P<0.05 by LSD test (LSD=0.03).

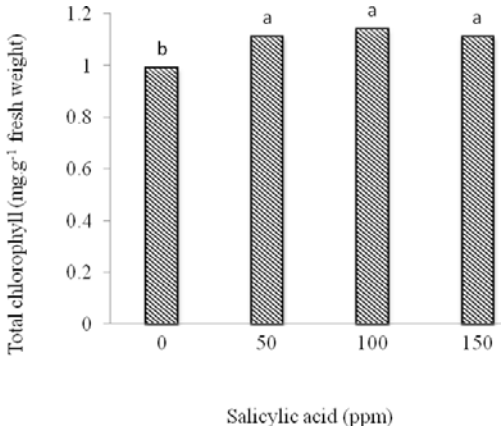

Fig. 6: The effects salicylic acid on total chlorophyll of rose (cv. 'Angelina'). Means followed by the same letter are not significantly different at P<0.05 by LSD test (LSD=0.05).

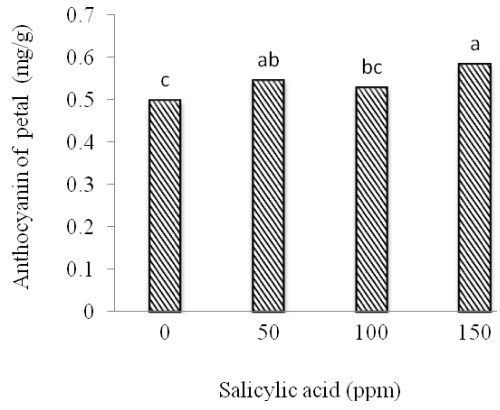

Fig. 7: The effects salicylic acid on anthocyanin of petal in rose (cv. 'Angelina'). Means followed by the same letter are not significantly different at P<0.05 by LSD test (LSD=0.04).

considerable for a beautiful product of flower. Danaee *et al*. (2013) demonstrated that the rates of anthocyanin degradation during the experimental days were reduced by the application of salicylic acid. Zamani *et al*. (2011) found that salicylic acid caused significant decrease in anthocyanin leakage of rose cut flower compared to

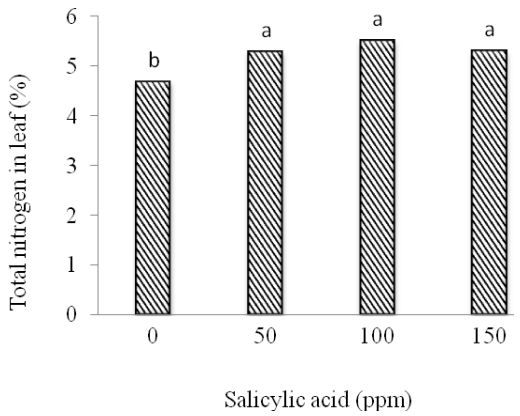

Fig. 8: The effects salicylic acid on total nitrogen of rose (cv. 'Angelina'). Means followed by the same letter are not significantly different at P<0.05 by LSD test (LSD=0.34).

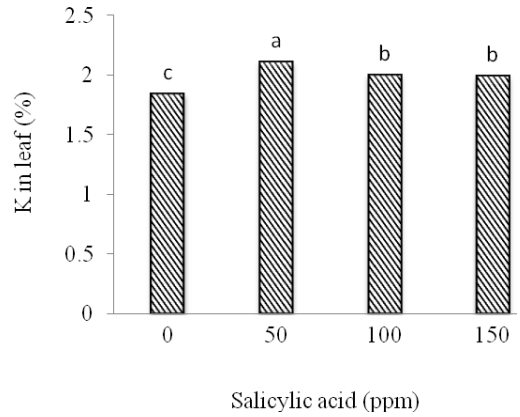

Fig. 9: The effects salicylic acid on potassium of rose (cv. 'Angelina'). Means followed by the same letter are not significantly different at P<0.05 by LSD test (LSD=0.11).

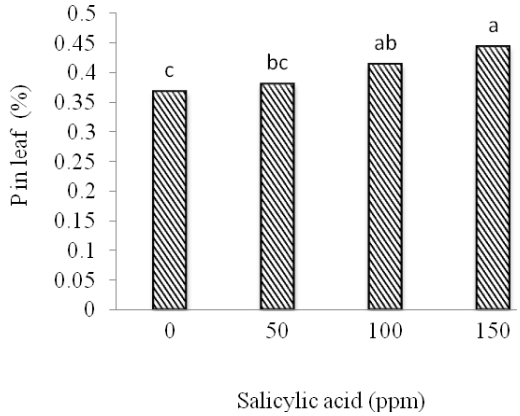

Fig. 10: The effects salicylic acid on phosphor of rose (cv. 'Angelina'). Means followed by the same letter are not significantly different at P<0.05 by LSD test (LSD=0.04).

control. Hussein and Orabi (2008) was also reported similar. Salicylic acid participates in signal regulation of gene expression during petal senescence (Hussein *et al*., 2007). This could be the reason for anthocyanins accumulation.

Total nitrogen

According to the results this study (Fig. 8), total nitrogen was affected by application of salicylic acid. The results indicated that 50, 100 and 150 ppm levels of salicylic acid increased total nitrogen compared to control however, there were no significant differences between salicylic acid treatments.

K concentration

The results indicated that the application of salicylic acid increased concentration of K compared to control (Fig. 9). Also, the salicylic acid at the 50 ppm concentration had highest K concentration among treatments. In contrast Ghazijahani *et al*. (2014) concluded that, there were no significant differences between salicylic acid treatments and control in K of sweet basil (*Ocimum basilicum* L.).

P concentration

As shown in Fig. 10, P concentration increased significantly with increasing salicylic acid application. However, Ghazijahani *et a*l. (2014) showed that, there were no significant differences between 1 mM salicylic acid and distilled water in P concentration of sweet basil (*Ocimum basilicum* L.).

Conclusions

The performance and suitability of salicylic acid on quantitative and qualitative traits of rose (cv. 'Angelina') cut flowers were studied in a greenhouse experiment. Based on the results of this study, the application of salicylic acid improved the quantitative, qualitative and nutrient uptake of rose cut flower.

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