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Impact of salicylic acid and jasmonic acid on keeping quality of rose (cv. 'Angelina') flowers

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ABSTRACT: The rose undoubtedly remains the queen of the cut flowers. Most of the commercial cut roses will easily last in a vase for 10 days. Unfortunately, many consumers consider roses to have a very short vase life. The signal molecules salicylic acid (SA), jasmonic acid (JA) and methyl jasmonate (MeJA) are endogenous plant growth substances that play key roles in plant growth and development, and responses to environmental stresses. In this study, effects of various postharvest treatments on postharvest quality and quantity parameters of rose (cv. 'Angelina') were evaluated. The present study was carried out in Department of Horticulture, Faculty of Agriculture, Islamic Azad University of Isfahan (Khorasgan) branch. Effects of different levels of jasmonic acid (JA) (0, 50, 100 and 150 ppm) and salicylic acid (SA) (0, 7, 14 and 21 ppm) on rose (cv. 'Angelina') quality were quantified. Completely Randomized Factorial Designs was applied to test the significance of treatments and means were compared using Duncan's multiple range test at P = 0.01. Results showed that foliar application of salicylic acid (SA) and jasmonic acid (JA) significantly affected number of flower, diameter of flower, diameter of stalk, stalk length, fresh weight and total chlorophyll contents. About of using salicylic acid (SA), the maximum number of flower, diameter of stalk and total chlorophyll contents obtained at 14 ppm and most of flower diameter, stalk length and fresh weight was obtain in 21 ppm. In jasmonic acid (JA) foliar application best dosage of each material was 50 ppm.

Keywords**:** jasmonic acid, rose, salicylic acid.

INTRODUCTION

Roses belong to family Rosaceae are recognized for, their high economic value, which are used in agro-based industry especially in cosmetics and perfumes. Additionally, roses play a vital role in the manufacturing of various products of medicinal and nutritional importance. However, the main idea of rose plant cultivation is to get the cut flowers, which greatly deals with the floricultural business (Zamani ., 2011).

Salicylic acid is a monohydroxybenzoic acid, a type of phenolic acid and a beta hydroxy acid. This colorless crystalline organic acid is widely used in organic synthesis and functions as a plant hormone. It is derived from the metabolism of salicin. Application of salicylic acid to plants induces a large variety of responses, among them flowering and tuberization. Foliar applications of salicylic acid have been shown to affect flower induction and flower numbers in several species. In addition to possible involvement in flowering, the knowledge of the role of salicylic acid in systemic acquired resistance and pest resistance has recently been advanced. Earlier experiments carried out by Ezhilmathi (2001), showed that 5-sulfosalicylic acid as salicylate derivatives in vase solution was most effective in extending flower vase life of cut gladiolus. Salicylates increased vase life by increasing ROS scavenging activity of the gladiolus cut flowers (Ezhilmathi ., 2007).

Recent reviews have demonstrated that salicylic acid has a relevant role in the control of several physiological and biochemical processes in plants, and it is considered a phytohormone by some authors (Raskin 1992, 1995; Gross and Parthier, 1994). Among the morphogenetic processes affected by salicylic acid are flowering and tuberization; e.g., salicylic acid enhances flowering in Lemna (Khurama and Cleland, 1992) and induces tuberization in potato (Koda ., 1992).

Jasmonic acid (JA) is an endogenous plant growth regulator widely distributed in higher plants (Tizio 1996). The synthesis of jasmonic acid takes place via the octadecanoid pathway. The precursor of jasmonic acid is linolenic acid.

Jasmonates (jasmonic acid and its derivatives) are plant growth regulators that appear to be common in higher plants. They act on the transcriptional level, and responsive genes have been identified (Turner ., 2002; Devoto and Turner 2003). Many genes regulated by jasmonates participate in defense and stress responses (Gfeller and Farmer 2004; Pozo ., 2005). Application of jasmonates and analysis of mutants indicate that jasmonates also have a significant role in various developmental processes (Devoto and Turner 2005). Jasmonates influence storage organ formation. Exogenously applied jasmonates induce or promote tuber formation in potato (Bazabakana ., 2003), and orchid (Debeljak ., 2002), as well as bulb formation in garlic (Ravnikar ., 1993) and narcissus (Santos and Salema 2000). The putative role of jasmonates in storage organ formation has been corroborated by reports on increased endogenous levels of jasmonates in bulb- and tuber-forming plants (Helder ., 1993). These finding are of particular importance for agriculture. The natural growth regulator jasmonic acid and its derivative methyl jasmonate (MJ) are postulated to induce plant defense responses (Reymond and Farmer, 1998), and to increase shelf life of various commodities (Buta and Moline, 1998; Droby ., 1999).

The signal molecules salicylic acid (SA), jasmonic acid (JA) and methyl jasmonate (MeJA) are endogenous plant growth substances that play key roles in plant growth and development, and responses to environmental stresses. These signal molecules are involved in some signal transduction systems, which induce particular enzymes catalyzing biosynthetic reactions to form defense compounds such as polyphenols, alkaloids or pathogenesis-related (PR) proteins (Creelman and Mullet, 1995; Tamari ., 1995; Van Loon, 1995).

MATERIALS AND METHODS

The experiment was carried out to evaluate the effects of different salicylic acid and jasmonic acid levels on the rose (cv. 'Angelina') morphological properties. Rose cut flowers were obtained from local commercial greenhouses (Isfahan, Iran). Plants were grown under standard greenhouse conditions with 22 and 16°C day and night temperatures, respectively. A factorial experiment was established, including salicylic acid at 0.0, 7, 14 and 21 ppm and jasmonic acid at 0.0, 50, 100 and 150 ppm effect on rose (cv. 'Angelina') cut flowers morphological properties. The cut flowers were harvested in the early morning and transported with appropriate cover (in plastic packages) immediately to laboratory. Sucrose at 4% was added to all treatments as a base solution. The flowers were kept in a controlled room at 19±2°C, 70±5% relative humidity and 12 μmol m^{-2} s^{-1} light intensity (cool-white fluorescence lamps) under a daily light period of 12 h. Fresh weight, number of flower, diameter of flower, diameter of stalk and stalk length were recorded. The flowers were checked once a day for signs of deterioration. Total chlorophyll content was determined (2 days intervals) by chlorophyll meter (SPAD-502 Konica, Minolta, Tokyo), which is presented by SPAD values. Average of 3 measurements from different spots of a single leave was considered (Kazemi and Ameri, 2012). The data were statistically processed by analysis of variance according to a randomized complete block design and means with standard errors were calculated using the program Statistical Analysis System, version 9.1 (SAS Institute, Cary, NC, USA). Differences between the treatments were determined using Duncan's test.

RESULTS AND DISCUSSION

Salicylic acid

The significant differences ($p<0.01$) were revealed among the salicylic acid treatments for number of flower, that the control treatment had the lowest number and 14 ppm salicylic acid treatment had the highest number of flower after harvest (figure 1). With respect to the results, using salicylic acid increased significantly the number of flower, as compared to control treatment during experiment.

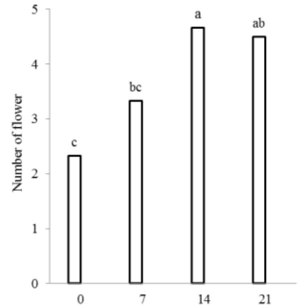

Figure 1. Effect of salicylic acid treatments on number of rose (cv. ‘Angelina’) flower
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05

As shown in figure 2, fresh weight increased significantly during the experiment. Similar patterns of changes were also reported for cut rose flowers (Lu ., 2010; Alaey ., 2011). A variation in terms of fresh weight was observed among the treatments and the differences were statistically significant (p<0.01). The fresh weight was affected by salicylic acid treatments, since control cut flowers had significantly lower fresh weight during experiment, while the highest levels were obtained with 21 ppm salicylic acid treatment (figure 2). Kazemi and Ameri (2012) showed that the treated cut gerbera flowers with salicylic acid had the highest levels of relative fresh weight during vase period. The decrease in fresh weight of cut flowers during the days after harvest could be due to the decrease in water uptake (Serek ., 1995). Alaey . (2011) reported that the highest fresh weight of cut rose flowers was observed in vase solutions which showed the greatest water uptake.

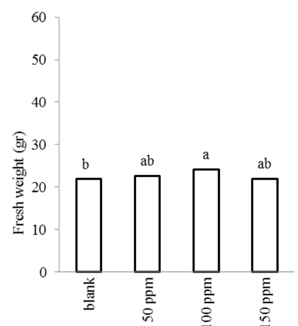

Figure 2. Effect of salicylic acid treatments on fresh weight of rose (cv. ‘Angelina’)
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05

Figure 3 shows considerable differences between flower diameter on different concentrations of salicylic acid at p≤ 0.05. The lowest flower diameter were obtained with 0 ppm salicylic acid (control) and the highest rate were seen with 21 ppm salicylic acid treatment.

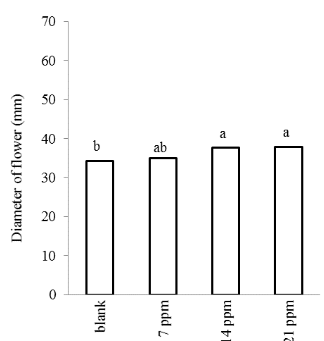

Figure 3. Effect of salicylic acid treatments on diameter of rose (cv. ‘Angelina’) flower
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05

The significant differences ($p<0.01$) were revealed among the salicylic acid treatments for stalk diameter, that the control treatment had the lowest stalk diameter and 7 ppm salicylic acid treatment had the highest diameter of stalk after harvest (figure 4). With respect to the results, using salicylic acid to 7 ppm increased significantly the diameter of stalk, as compared to control treatment during experiment.

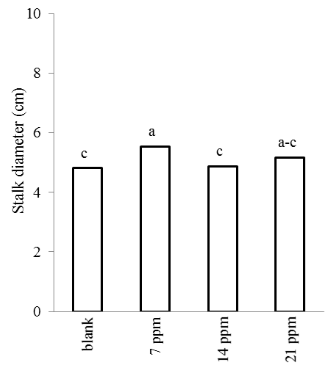

Figure 4. Effect of salicylic acid treatments on stalk diameter of rose (cv. 'Angelina')
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05

As shown in figure 5, flower stalk length increased significantly with increasing salicylic acid foliar application. A variation in terms of flower stalk length was observed among the treatments and the differences were statistically significant ($p<0.01$). The flower stalk length was affected by different salicylic acid, since control had significantly lower flower stalk length during experiment, while the highest levels were obtained with 21 ppm salicylic acid treatment (figure 5).

Figure 5. Effect of salicylic acid treatments on stalk length of rose (cv. 'Angelina')
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05.

According to results shown in figure 6, the total chlorophyll content, increased significantly during experiment, that the levels of total chlorophyll at the initial of the after harvest were lower than the end ones just. The results were in agreement with the findings reported by Ferrante . (2002). There were significant differences in the total chlorophyll content of the different treatments. The lowest and highest total chlorophyll values were observed in 0 and 14 ppm salicylic acid treatments, respectively (figure 6). Similar data were also reported for cut flowers of gerbera (Kazemi ., 2011 a), lily (Kazemi ., 2011 b) and rose (Zamani ., 2011).

Figure 6. Effect of salicylic acid treatments on total chlorophyll content of rose (cv. 'Angelina')
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05.

The maintenance of green colour in the leaves is an important quality properties in these economically significant ornamental plants. Previous study had revealed that the leaf yellowing of cut rose flowers is associated with chlorophyll breakdown and loss, thereby decreasing significant vase life (Ferrante ., 2002).

Jasmonic acid

Result of analysis of variance showed that there were significant difference among different levels jasmonic acid in the whole of traits.

The significant differences ($p<0.001$) were revealed among the treatments for number of flower, that the control treatment had the lowest number of flower and 100 ppm jasmonic acid treatment had the highest number of flower after harvest (figure 7). With respect to the results, using jasmonic acid increased significantly the number of flower, as compared to control treatment during experiment.

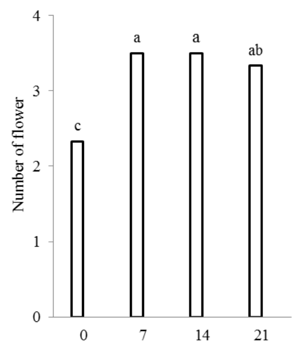

Figure 7. Effect of jasmonic acid treatments on number of rose (cv. 'Angelina') flower
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05

A variation in terms of fresh weight was observed among the jasmonic acid treatments and the differences were statistically significant (p<0.01). The fresh weight was affected by jasmonic acid treatments, since control cut flowers had significantly lower fresh weight during experiment, while the highest levels were obtained with 100 ppm jasmonic acid treatment (figure 8). Alaey . (2011) reported that the highest fresh weight of cut rose flowers was observed in vase solutions which showed the greatest water uptake.

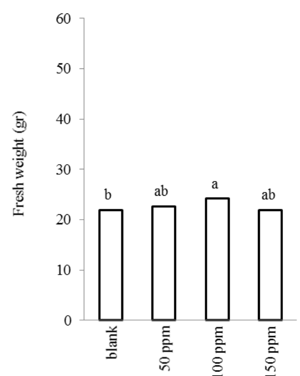

Figure 8. Effect of jasmonic acid treatments on fresh weight of rose (cv. 'Angelina')
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05

As shown in figure 9, flower diameter increased significantly during the experiment. A variation in flower diameter was observed among the treatments and the differences were statistically significant (p<0.001). The flower diameter was affected by jasmonic acid treatments, since control rose had significantly lower flower diameter during experiment, while the highest levels were obtained with 100 and 150 ppm flower diameter treatment (figure 9).

Jasmonic acid (JA) and its derivative methyl jasmonate (MeJA) are powerful promoters of leaf senescence upon exogenous application. Jasmonates (jasmonic acid and its derivatives) are plant growth regulators that appear to be common in higher plants.

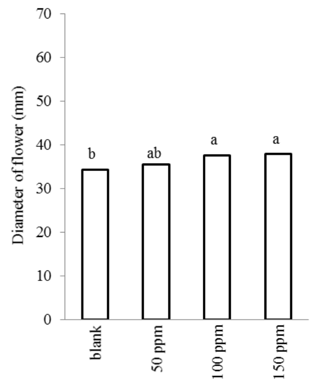

Figure 9. Effect of jasmonic acid treatments on diameter of rose (cv. ‘Angelina’) flower
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05

Figure 10 shows considerable differences between stalk diameter on different concentrations of jasmonic acid at $p \leq 0.001$. The significant differences ($p<0.001$) were revealed among the treatments for stalk diameter, that the control treatment had the lowest stalk diameter and 100 ppm jasmonic acid treatment had the highest stalk diameter after harvest (figure 10). With respect to the results, using jasmonic acid treatment increased significantly the stalk diameter, as compared to control treatment during experiment.

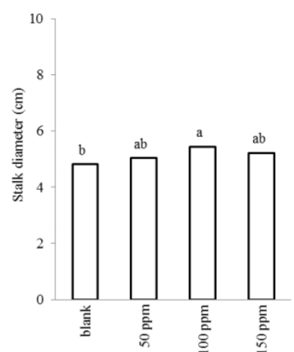

Figure 10. Effect of jasmonic acid treatments on stalk diameter of rose (cv. ‘Angelina’)
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05

As shown in figure 11, flower stalk length increased significantly with increasing salicylic acid foliar application to 50 ppm. A variation in terms of flower stalk length was observed among the treatments and the differences were statistically significant ($p<0.01$). The flower stalk length was affected by different jasmonic acid, since 150 ppm jasmonic acid had significantly lower flower stalk length during experiment, while the highest levels were obtained with 50 ppm jasmonic acid treatment (figure 11).

Figure 11. Effect of jasmonic acid treatments on stalk length of rose (cv. ‘Angelina’)
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05.

According to results shown in figure 12, the total chlorophyll content, increased significantly during experiment. The lowest and highest total chlorophyll values were observed in 50 and 0 ppm jasmonic acid treatments, respectively (figure 12).

Figure 12. Effect of jasmonic acid treatments on total chlorophyll content of rose (cv. ‘Angelina’)
*Values followed by the same small or capital letter are not significantly different within rows or columns at Duncan test P≤0.05

The naturally short vase life of the cut flowers is one of the most important problems. The using of different treatments is recommended to keeping quality and extending the vase life of cut flowers. In this study, influence of salicylic acid and jasmonic acid foliar applications on keeping quality and vase life of cut rose flowers during vase period were investigated. This research showed that the same behaviour in all measured factors after harvest for all treatments. The number of flower, diameter of flower, diameter of stalk, stalk length, fresh weight and total chlorophyll contents increased significantly during vase period. In addition, statistically significant differences were observed between control salicylic acid and jasmonic acid treatments in measured parameters. salicylic acid and jasmonic acid treatments are able to increase vase life of cut rose flowers by regulating the plant water and increasing total chlorophyll content. Thus, the data suggest that salicylic acid and jasmonic acid treatments has the potential to be used commercially to extend the vase life of cut rose flowers. However, further research is needed to investigate the effect of different plant hormone and environmental factors, such as temperature, drought, altitude and UV, on morphological properties of rose under experimental conditions.

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