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Yield and quality management of rose (*Rosa hybrida* cv. Poison) with plant growth regulators

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Abstract

This study was done to evaluate effects of different levels of salicylic acid (SA) (50, 100, 150 and 200 mg l^{-1}), gibberellic acid (GA_3) (150, 200, 250 and 300 mg l^{-1}), and cycocel (CCC) (500, 1000, 1500 and 2000 mg l^{-1}) at pre-harvest stage on the quality, yield and vase life of cut rose (*Rosa hybrida* 'Poison'). Results showed that the effects of plant growth regulators on bud length, vase life and yield were significant ($P \leq 0.05$). The effect of regulators has also been significant at $P \leq 0.01$ level on fresh weight and flower height. The highest record of flower yield was obtained by application of 200 mg l^{-1} GA_3 with 192 cut flowers per year per m^{-2}. The highest vase life (12.67 days) was obtained when 150 mg l^{-1} SA applied to cut flowers. The best treatment to increase the stem flower length was application of 300 mg l^{-1} GA_3 which produced longest cm stems (49.33).

Keywords: Gibberellin, Salisylic acid, Cycocel, *Rosa hybrida*, Quality, Yield
Abbreviations: PGRs; Plant growth regulators, GA; Gibberellic acid, SA; Salicylic acid, CCC; Cycocel

Introduction

Rose is one of the most popular flowers that used in pot and as cut flower. Yield and quality improvement are important aims of florists. Low yield and low quality are two problems in Iran compared to other countries such as the Netherlands, Colombia, Kenya and USA. These problems can be rectified by optimizing the production conditions and utilization of plant growth regulators (PGRs). Good quality production is usually achieved by manipulating growth factors such as light and temperature. These physical factors are very difficult to control and perhaps expensive. Plant flowering and growth very depended on PGRs equilibrium and plants quickly respond to change of hormonal balance (Khangoli, 2001). Plant growth retardants are the most effective PGRs which exceedingly applied in ornamental plants. These compounds delay cell division and growth in the beneath apex, but they do not have any effect on meristem (Hedayat, 2001). They supposedly reduce plant growth without affecting morphological change on leaves and shoot numbers. These compounds may increase yield and quality of cut flower via controlling plant height, acceleration of flowering and increasing of flower primordia (Khangoli, 2001; Hedayat, 2001). Gibberellins, especially gibberellic acid (GA_3) plays an important role in the growth and development of plants. Gibberellins are classified as diverse group of plant hormones that enhance some physiological or biochemical pathways in plants. The use of GA_3 for boosting the growth and vigor of various horticultural plants is very old known and well documented (Gul et al., 2006). GA_3 improves yield and quality of ornamental plants via plant growth incitation and stem elongation (Fathipour and Esmaellpour, 2000). Arun et al. (2000) studied the effects of different levels of GA_3 on growth and flowering of rose "First red" and found that GA_3 could improves plant and flower neck height, as well flowering stalk. They observed that all treatments increased bud length, flower diameter and produced the most cut flowers in unit area. GA_3 enhances plant growth and internode length by increasing the cell division and enlargement. It also increases cell size, stem height, stem thickness and number of leaves. Other studies on the effect of GA_3 on ornamental plants showed that, GA_3 accelerated flowering and enhanced plant height (Gul et al., 2006).

Abdi et al. (2009) showed that the salicylic acid causes a significant increase on the plant density and dry weight of root and shoot. Spraying maize plants 'Single hybrid 10' with SA increased dry weight of stem, leaves and whole plant (Abdi et al., 2009). Application of SA has increased the quantity of most amino acids, except methionine, in plants (Latimer and Beden, 1994). SA plays an important role in resistance of old leaves against pathogens, and acts as an induction signal for specific defense responses of plants. SA normally operates by producing low weight proteins with some interesting role in the resistance (Fathipour and Esmaellpour, 2000; Simons, 1991).

Plant growth retardants are the biggest group of PGRs in floriculture industry. Bhattacharjee and Singh (1995) evaluated the effect of daminozide and CCC on rose 'Raktagandha var.' and observed that these compounds had significant effect on vegetative growth and flowering caused to hasten first bud manifestation, increasing bud length, flower diameter and yield of cut flowers up to 9%. Hisamatsu et al. (1998) controlled the height of *Pyracantha coccinea* 'Kasan' and 'Lalande' by CCC. On other hand, paclobotrazol and CCC, two plant growth retardants, caused less carbohydrate consumption for shoot

Table 1. Mean comparison of bud lenght, fresh weight of flower and vase life

Traits / Treatments (mg l^{-1})	Bud length (cm)	Fresh weight of flower (g)	Vase life (days)
Control	3.476 cde*	43.33 ab	9.667 bc
GA (150)	3.990 ab	47.35 a	11 ab
GA (200)	4.050 ab	46.46 a	10 bc
GA (250)	3.820 abc	45.46 a	11 ab
GA (300)	3.310 de	33.45 cde	9.500 bc
SA (50)	3.150 e	36.30 e	10 bc
SA (100)	3.840 abc	35.21 bcde	11 ab
SA (150)	3.797 abc	42.79 abc	12.670 a
SA (200)	3.633 bcde	37.73 abcd	9.500 bc
CCC (500)	3.600 bcde	31.53 de	11.50 ab
CCC (1000)	3.727 abcd	38.83 abcd	11 ab
CCC (1500)	4.157 a	35.56 bcde	11.3 ab
CCC (2000)	3.717 abcd	39.90 abcd	8.500 c

Values in each row followed by the same letter are not significantly different by LSD *

growth of pelargonium 'Red elite' (White and Warrington, 1984b).

This experiment was carried out for the first time in order to evaluate different levels of GA_3, SA and CCC on the quality and yield performance of rose cv. 'Poison'.

Materials and methods

Plant materials and spraying method

Two-year-old rose variety 'Poison' were planted in 70% cocopeat and 30% perlite (v/v). They were pruned (Khalighi, 2001) 5 times and sprayed in 30–40 day intervals with PGRs. This experiment carried out in greenhouse pot hydroponic system in 20-25^{o}C, 50-70% Relative Humidity (RH) and natural photoperiod. Fertigation was done according Rosen-tantau® Co. using crystalon fertilizer and drop irrigation (Figure 1).

Preparation of solutions

One liter PGRs solutions were prepared for 30 plants and sprayed in 5 stages of foliage. The trial conducted using randomized complete block design with GA_3 (150, 200, 250 and 300 mg l^{-1}), CCC (500, 1000, 1500 and 2000 mg l^{-1}), SA (50, 100, 150 and 200 mg l^{-1}) and control (distilled water) in 3 replications. GA_3, SA, and CCC were dissolved in ethanol 70%, distilled water (30^{o}C) and distilled water, respectively.

Measurement of traits

Traits were measured as following: production or yield by number of flowers per square meter per annum, bud length and flower stem height by ruler, fresh weight by careful scale (0.01g) and vase life (days to wilting) by holding plants in the preservative solution of 250 mg l^{-1} 8-Hydroxy quinoline citrate (8-HQC), 2% sucrose and 0.4 mM STS.

Fig 1. Fertigation of pruned stocks

Statistical analysis

Statistical analysis of data was carried out by MSTATC and SPSS package, by comparing mean values using LSD test.

Results and discussion

The effect of PGRs on bud length was significant ($P \leq 0.05$). The results revealed that the highest bud length (4.16 cm) was obtained using 1500 mg l^{-1} CCC, followed by 150, 200 and 250 mg l^{-1} GA_3, while the differences among them were not significant (Table 1).

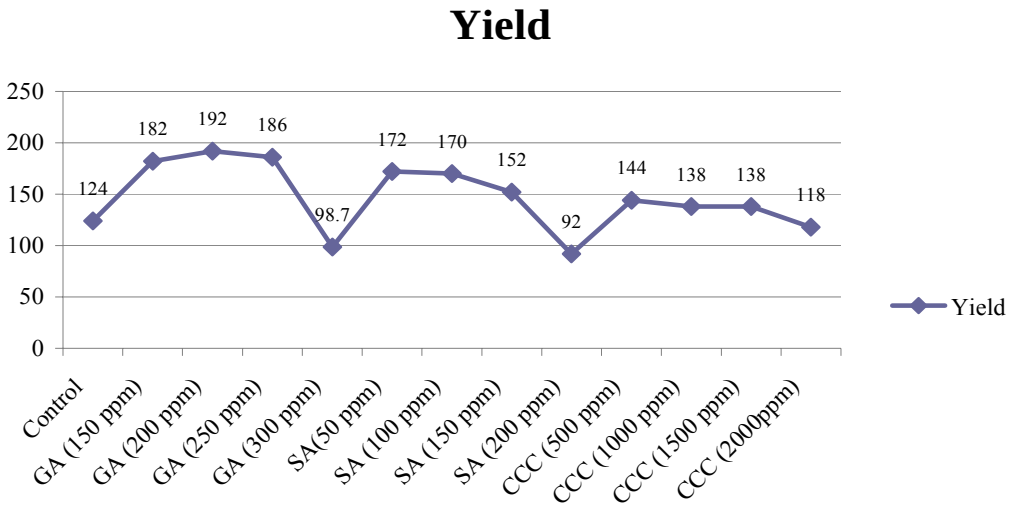

Fig 2. Effect of plant growth regulators in yield of cut flowers in *Rosa hybrida* 'Poison'

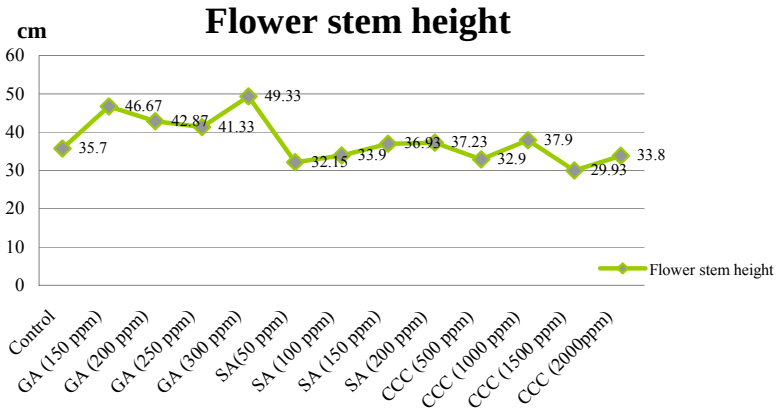

Fig 3. Effect of plant growth regulators on yield on flowers stem height of *Rosa hybrida* 'Poison'

Arun et al. (2000) reported that GA_3 and SA increased length of floral bud in rose 'First red'. Also, Bhattacharjee and Singh (1995) reported the bud length was increased significantly using 1000 mg l^{-1} CCC on rose 'Ractagandha' (Fathipour and Esmaellpour, 2000; Bhattacharjee and Singh, 1995). These findings confirmed our results. Gul et al. (2006) applied 0, 100, 200 and 300 mg l^{-1} GA_3 on *Araucaria heterophylla* and showed that the internode length was significantly ($P \leq 0.001$) affected by GA_3 concentrations. Maximum internode length (8.6 cm) was found at 300 mg l^{-1} GA3, followed by 200 mg l^{-1} GA_3 (6.6 cm), while minimum of that was recorded (2.9 cm) in control plants.

According to our results, application of 150, 200 and 250 mg l^{-1} GA_3 with 47.35, 46.46 and 45.46 g on flower stalk, respectively, have had better effect than other treatments ($P \leq 0.01$). Fresh weight of flowers has been decreased by applying all concentrations of CCC treatments compared to control (Table 1). Significant increase in fresh weight of flower is mainly happens due to promoting effect of GA_3 on vegetative growth. Also, different concentrations of SA, increased fresh weight, however this increasing was not significant (Table 1). Kumar and Singh (2003) showed spraying of 100 and 200 mg l^{-1} GA_3, increased flower weight in carnation 'Red corso'.

Latimer and Baden (1994) examined the different GA_3 levels on *Pelargonium* 'Ringo rose' and 'Ringo white' and found that the 150 mg l^{-1} CCC decreased shoot weight. In current study, all levels of CCC, diminished shoot weight, as well.

Flower stem height is also one of the most important qualitative factors, which was influenced by GA_3 and CCC. The least and highest flower stem height (length) were obtained by using 1500 mg l^{-1} CCC (29.93 cm) and 300 mg l^{-1} GA_3 (49.33 cm), respectively. The stem length was 35.7 cm in control plants (Fig 2). Our results showed a significant increase in stem length of flowers under GA_3 treatments and extremely decline under CCC application (Fig 2). Roberts et al. (1999) confirmed the effect of GA_3 on increasing of internode length. Also, Saffari et al. (2004) sprayed the *Rosa damascena* plants with 50 mg l^{-1} GA_3 and found that this compound could increase flower stem height (77.5 cm) compared to control (69.2 cm). They revealed that 3000 mg l^{-1} CCC decreased flower stem length about 5 cm relative to control. Plant growth retardants decreased the inter node length and eliminated the apical dominance (Khangoli, 2001; Lee et al., 1999).

Gul et al. (2006) evaluated application of 100, 200 and 300 mg l^{-1} GA_3 on *Araucaria heterophylla* and observed that maximum plant height (42.4cm) can be achieved at 300 mg l^{-1} GA_3 while minimum height (26.5 cm) was observed in control plants.

In our experiment, different levels of SA did not show any significant effect on flower stem length compared to control plants (Fig 1). The most vase life (12.67 days) was obtained at 150 mg l^{-1} SA ($P \leq 0.01$). Other levels of SA, GA_3 and CCC increased the vase life a little, compared to the control plants (9.67 days), but none of these elevations were significant (Table 1).

Obviously, application of SA could reduce the synthesis of ethylene and make the plant capable to blocks the synthesis of auxins (Gour and Chenulu, 1982; Shekari et al., 2003). As mentioned above, application of SA has increased the dry matter and consequently vase life of flowers (Chan et al., 2008). Also SA acts as an internal signal and causes a kind of systemic resistance in mature organs, so this resistance will be transported to the immature organs later (Simons, 1991). Salicylic acid also participates in signal regulation of gene expression in the course of leaf and petal senescence (Hussein et al., 2007).

GA_3, CCC and SA had significant effect on the number of cut flowers per unit area ($P \leq 0.05$). The highest yield was obtained at 200 and 250 mg l^{-1} of GA_3 concentrations with 192 and 186 cut flowers $m^{-2}y^{-1}$, respectively (56.8 and 50% increasing of yield compared to control). The concentration of 300 mg l^{-1} of GA_3 decreased the yield (Figure 3).

Barzegar Fallah (2006) applied 0, 10, 25 and 50 mg l^{-1} GA_3 on *Aquilegia* × *hybrida* and observed that the highest yield was obtained in 10 mg l^{-1} GA_3, while 50 mg l^{-1} GA_3 caused diminishing of cut flowers. Also, Bhattacharjee and Singh (Bhattacharjee and Singh, 1995) showed that 300 mg l^{-1} GA_3 decreased yield of rose 'Raktagandha' up to 11-20%. In current study, 300 mg l^{-1} GA_3 reduced yield of cut rose 'Poison'.

In conclusion, the highest yield, flower stalk height and fresh weight were achieved by using GA_3. The lowest flower stalk height, also the most bud length and the highest vase life were obtained by CCC and SA treatments, respectively.

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