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Effects of different plant growth regulators as the foliar application on growth and flower quality of potted rose (*Rosa chinensis* Jacq. cv. Nhung)

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ABSTRACT

This study was conducted to evaluate the different concentrations of Naphthalene acetic acid (NAA), Benzyladenine (BA) and Gibberellic acid (GA_3) as foliar applications on growth and flower quality of potted rose Nhung (Rosa chinensis Jacq. cv. Nhung). The experiment was constructed in a completely randomized design, that included seven treatments, such as control (sprayed water), NAA, BA and GA_3 at two different concentrations of 25 and 50 ppm, in six replications, with one plant/pot for each replication. The chemical solutions were applied three times at an interval of fifteen days. The results revealed that some plant growth regulators increased the growth and flowering time of rose cv. Nhung. Using pre-harvest foliar sprays of NAA and BA at 25 and 50 ppm concentrations showed maximum bud diameter, flower diameter and flowering duration as compared with the control treatment. The concentration of GA_3 foliar application at 25 ppm increased plant growth (the height of flowering branches and Spad values) without affecting flower quality values and the flowering duration in comparison with the control treatment.

1. INTRODUCTION

Rose Nhung (*Rosa chinensis* Jacq. cv. Nhung) belongs to the *Rosaceae* familly that is widely grown in most parts of Viet Nam as potted, cutting flowers or ornamental plants (Helgi and Rolfe, 2005). There are different flora forms and petal colors of roses that are used for decoration, medicine, make-up products and for the perfume industry (David, 2006; Younis et al., 2006; Nariman et al., 2011). Among some potted varieties of rose, rose Nhung is very popular in the South of Viet Nam because of its large diameter and typical dark red color; however, the number of flowers are often limited to 1-3 flowers/tree and the blooming time is quiet short. Many reports have shown that several plant growth regulators (PGRs) are implicated in regulating petal senescence and the flower lifespan. In many rose species, cytokinins reduction, ethylene production and sensitivity are the primary coordinators of petal senescence (Saffari et al., 2004; Zmani et al., 2011; Younis et al., 2013). Spraying plant hormones such as auxins, gibberellins and cytokinins could delay senescence in floral tissues, enhance the flower diameter, and prolong the flowering time (Saffari et al., 2004; Leiv and Hans, 2005; Kumar, 2008; Nybon, 2009; Younis et al., 2013). However, few studies have investigated the physiological effects of plant growth regulators on selected ornamental plants especially on potted roses in Viet Nam. Thus, the aim of this study was to assess the plant growth, flower development and flower quality of potted rose Nhung sprayed with differentPGRs as foliar applications.

2. MATERIALS AND METHOD

The experiment was conducted in July 2020. The research was conducted for 60 days in a rose garden at Nguyen De Street, Can Tho city, Viet Nam from May to July 2020. During that period, the daily average temperature and average humidity were recorded as 29-30ºC and 70-88%, respectively. The cultivar used was rose Nhung (*Rosa chinensis* Jacq. cv. Nhung). The plants were propagated by air layering at the same time one year ago. Single plants were grown in a black plastic pot (DS4 - 26 cm top diameter x 23 cm bottom diameter x 22 cm height). The pot was filled with 2 kg standard growing media based on straw compost + coconut fiber + rice husk ash with the ratio of 1:2:1. Each plant had 3 to 4 branches on the main stem. The branches were pruned and 4 buds/branch were maintained by cutting at a 45 degree angle at the experiment time.

The 42 pots were arranged in a completely randomized design in the yard. They included seven treatments, including the control (sprayed water), and sprayed with NAA, BA and GA_3 at two different concentrations of 25 and 50 ppm with six replications for each treatment. One replication comprised one plant per pot. Each chemical solution wasapplied to selected rose plants by using a mist sprayer (1.000 mL). The whole plant received 100 mL of solution through spraying, while the controls were sprayed with distilled water. The solutions were applied three times at an interval of fifteen days and the first application was performed 15 days after pruning.

Plants were kept under natural photoperiod with natural light and each received the same amount of water and fertilizer. Plants were watered manually daily to container capacity with about 500 mL of tap water per pot. Every fifteen days, organic fertilizer Japon 3.5.3 (Japan, 73% organic) was applied at a concentration of 1 g/pot. When the young leaves were fully developed, Emamectin Benzoate (MIKMIRE 7.9EC) at the recommended dosage was foliar applied once.

The determination of growth, total chlorophyll content and quality of flowers were described following the methods of Mondal and Sarkar (2018) (Table 1):

Table 1. Some qualitative and quantitative factors in the experiment

Criteria	Methods
Growth parameters	Recorded the number of branches and flowers per plant (count), the number of leaves/shoot, shoot length (cm) and the flowers/shoot ratio.
Spad values	Recorded the values by using Minolta chlorophyll meter SPAD-502Plus (Konika, Japan). SPAD values were measured at the midpoint of the leaf next to the main leaf vein at three different times (15, 30 and 45 days after pruning).
Measurement of bud initiation and flowering parameters	The height and size of buds and diameter of flowers (cm); days from bud emergence to flower abscission (days); days from flower initiation to flower abscission (days).
Petal color	Using ColorPix sofware to identify RGB values (Red Green Blue) and R values were compared.

For statistical analysis of the data, analysis of variance (Anova) and mean separation were performed by using Duncan's multiple range test at the $p < 0.05$ level. statistical analysis was performed using SPSS (SPSS Inc., Chicago, USA).

3. RESULTS AND DISCUSSION

3.1. Effects of different plant growth regulators on selected growth parameters of potted rose Nhung

The influence of all treatments on shoot initiation was observed throughout the experiment. The results showed that there was no significant effect of the different PGRs treatments on the number of new branches. The number of new branches fluctuated from 5.40 to 6.00 branches per rose plant. The average number of flowers per plant ranged from 2.40 to 3.80, but significantly the maximum number of flower (3.80 flower/plant) was recorded when the plants were treated with BA 50 ppm. The control treatment and the two concentration of NAA treatments significantly produced the lowest number of flowers (< 3). Data revealed that the number of flower initiation per plant was higher after spraying some GA_3 and BA concentrations than in the control treatment (Table 2). It is clear from the data presented in Table 2 that the treatments of BA 25 ppm, GA_3 at 25 or 50 ppm exhibited maximum length of branches (over 26 cm) and minimum length of branch was reported in the control treatment (25.3 cm).

Some plant growth regulators belonging to the group of auxins, cytokinins and gibberellins cause stem elongation, flower induction and flower quality in many ornamental plants (Saffari et al., 2004; Zmani et al., 2011; Younis et al., 2013; Sardoei, 2014). In Viet Nam, induction of flowering by using BA or GA_3 have also been reported in potted lily and chrysanthemum (Siddiqui, 2006). From the below results, some NAA concentrations didn't show the best results on some growth parameters as highlighted in the studies of Jiang et al. (2010) or Saffari et al. (2004).

In potted rose Nhung, adding plant growth regulators at different concentrations had no effect on the quantity of new branches; however, they affected the number of flowering branches per plants. The treatments showed the number of new branches at approximately 5.6-6.0 branches/plant and number of flowering branches at 2.4-3.8 branches/plant. Among them, the treatment of BA 50 ppm showed more flowers than other treatments of NAA and water control (lower than 3 flowers/plant). Moreover, all treatments showed different lengths of flowering branches, but no difference in the number of leaves per branch (Table 2). The results also showed that adding BA at 25 ppm, GA_3 at 25 ppm and 50 ppm, increased the length of flowering branches of rose plants cv. Nhung (branch length acquired >26 cm), compared with that of the water control (25.3 cm).

Results of this research are in line to several reported roles of chemical compounds belongs to auxin, cytokinins and gibberellins on increasing the length of flowering branches, quantity of flowers and flower quality in several ornamental species (Saffari et al., 2004; Sardoei, 2014). Our results showed all experimental concentrations of NAA had no effect on increasing flower quantity on rose plants, compared with that of water control, although NAA was suggested to apply and enhanced flower forming in several ornamental species (Jiang et al., 2010; Saffari et al., 2004).

Table 2. Effect of NAA, BA and GA_3 on growth of potted rose Nhung (*Rosa chinensis* Jacq. cv. Nhung) cultivar at 45 days after pruning

Treatment	Growth parameters			
	Number of branches	**Number of flowers**	**Length of branch**	**Number of leaves/branch**
Distilled water	5.40	2.40 c	25.33 c	6.60
NAA 25 ppm	5.60	2.80 bc	26.32 bc	6.60
NAA 50 ppm	5.60	2.80 bc	26.41 bc	6.60
BA 25 ppm	5.60	3.60 ab	26.73 ab	6.80
BA 50 ppm	5.60	3.80 a	26.34 bc	6.80
GA_3 25 ppm	6.00	3.20 ab	27.01 ab	6.40
GA_3 50 ppm	5.80	3.20 ab	27.82 a	6.60
F significance	ns	*	**	ns
CV (%)	11.00	22.20	3,35	8.80

Note: values followed by the same letters in the same column it means no significantly different in Duncan

Results on leaf chlorophyll content through SPAD index showed that various kinds and concentrations of chemicals affected chlorophyll index during three observation time points at 15, 30 and 45 days (Table 3).

The treatment of BA 50 ppm remained higher chlorophyll content than the water control during three observation time intervals. Moreover, the roses treated with GA_3 25 ppm acquired a higher SPAD index, compared to that of water control, at day 15 and 45. The SPAD index is usually applied to evaluate chlorophyll content on leaves, and this index is parallel to surveyed chlorophyll content (Markwell et al., 1995). Adding exogenous cytokinins, especially BA, plays a crucial role on remain chlorophyll concentration of plants by an increase of chlorophyll production and protection of chloroplast membrane (Saffari et al., 2004; Mikos-Bielak, 2005; He et al., 2018). In rose plants, an application of BA kept and increased chlorophyll colour of rose leaves, compared with one of GA_3 and water control (Mondal and Sarkar, 2018).

Table 3. Effect of NAA, BA and GA_3 on chlorophyll index (SPAD index) of potted rose Nhung (*Rosa chinensis* Jacq. cv. Nhung) cultivar

Treatments	Chlorophyll index (SPAD)		
	15 days	30 days	45 days
Distilled water	39.43 bc	41.03 bc	40.09b
NAA 25 ppm	40.24 abc	41.62 ab	40.85 b
NAA 50 ppm	39.91 abc	41.14 abc	40.82 ab
BA 25 ppm	40.53 ab	42.14 ab	41.67 a
BA 50 ppm	40.73 a	42.32 a	41.85 a
GA_3 25 ppm	40.82 a	41.61 ab	41.62 a
GA_3 50 ppm	39.21 bc	40.12 c	40.08 ab
F significance	*	*	**
CV (%)	2.12	2.17	1.97

Note: values followed by the same letters in the same column mean no significantly different in Duncan (p<0.05).

3.2. Effect of several plant growth regulators on characteristics of bud, flower and flower life span

Treating various kinds and concentrations of plant growth regulators affected the diameter of buds, flowers and the percentage of flower/total new branches (Table 4). On shape characteristics of rose buds, treatments of NAA and BA at various concentrations improved height and parameter of rose buds. Adding NAA and BA at a concentration of 25 ppm could increase rose bud diameter, compared with that of water control. However, kinds and concentrations of different chemicals had no effect on forming flowering branches per total new branches during a period of rose bud forming.

Table 4. Effect of NAA, BA and GA_3 on flowering quality parameters of potted rose Nhung

Treatments	Flowering quality parameters			
	Height of rose buds (cm)	Diameter of rose buds (cm)	Diameter of flower (cm)	Percentage of flower/total new branches (%)
Distilled water	2.44 c	1.40 b	8.02 b	44.66
NAA 25 ppm	2.62 a	1.57 a	8.50 a	50.71
NAA 50 ppm	2.64 a	1.57 a	8.34 ab	50.67
BA 25 ppm	2.71 a	1.61 a	8.48 a	58.02
BA 50 ppm	2.60 ab	1.59 a	8.44 ab	61.28
GA_3 25 ppm	2.49 bc	1.41 b	8.08 ab	52.77
GA_3 50 ppm	2.41 c	1.39 b	8.10 ab	56.09
F significance	**	**	*	ns
CV (%)	3.71	4.20	3.54	25.11

Note: values followed by the same letters in the same column it means no significantly different in Duncan (p<0.05).

Applied chemicals affected petal colour, budding time and flowering time. Petal colour of treatments NAA 25 ppm and BA 50 ppm were lighter than those of the water control and GA_3 25 ppm, expressing by bigger diameter of rose petals, resulted in lighter rose petals when assessing parameter R on the RGB colour model of software Colorprix. Except two treatments of GA_3, other treatments of NAA and BA prolonged flower time from flowering to fading (> 20 days) and time from budding to fading (7.8-9.2 days), compared with those of water control (7.2 and 18.4 days, respectively) (Table 5).

Roles of auxins and cytokinins compounds on increasing the size of buds and flowers were reported in roses, carnations, marigolds, lilies and petunias (Chang et al., 2003; Saffari et al., 2004; Bairwa and Mishra, 2017; Kumari et al., 2017). Several studies have shown that wilt, senescence and drop of petals were caused by an increasing activity by endogenous ethylene, deterioration of cell wall components and an increasing activity of destroyed enzymes (Van Doorn, 2002; Wagstaff et al., 2003; Lerslerwong et al., 2009). A decrease in endogenous plant growth regulators could enhance the process of wilt and senescence (Lukaszewska et al., 1994: Ma et al., 2005). Therefore, an exogenous supply of these regulators could improve quality and flowering time in several ornamental plants (Saffari et al., 2004; Hoeberichts et al., 2007; Jiang et al., 2010; Sardoei, 2014; Mondal and Sarkar, 2018).

Table 5. Effect of NAA, BA and GA_3 on colour and life span of flower of rose flowers (*Rosa chinensis* Jacq. cv. Nhung)

Treatments	Colour parameter R on RGB colour model	Flower time from flowering to fading (day)	Time from budding to fading (day)
Distilled water	219.00 ab	6.80 d	18.73 d
NAA 25 ppm	195.00 c	7.80 bc	20.36 c
NAA 50 ppm	204.00 bc	8.40 ab	20.87 bc
BA 25 ppm	201.00 bc	8.80 a	21.76 ab
BA 50 ppm	196.00 c	9.20 a	22.33 a
GA_3 25 ppm	221.00 a	7.00 cd	19.02 d
GA_3 50 ppm	216.00 ab	7.20 cd	18.36 d
F significance	*	**	**
CV (%)	14.50	8.02	4.34

Note: values followed by the same letters in the same column it means no significantly different in Duncan (p<0.05).

4. CONCLUSIONS

4.1. Conclusions

Treatments of plant growth regulators showed a positive affect on growth, bud diameter, flower diameter, colour and flowering time in potted rose Nhung.

Sprays of NAA and BA at concentrations of 25 and 50 ppm increased te chlorophyll index, rosebud diameter, flower diameter, and prolonged flowering time reached over 20 days in potted rose cv. Nhung, compared with the water control. Application of BA 25 ppm increased the quality of flowering branches (>3 branches), branch height (> 26 cm), SPAD index at day 45 (>41), also enhanced size of buds and flowers (1.61 cm and 8.48 cm, respectively) and flowering time (> 21 days). Application of GA_3 25 ppm increased branch height (27 cm), as well as chlorophyll index (41.6), but no efficacy on flower quality and flowering time compared to the water control.

4.2. Suggestions

Apply NAA and BA at the concentration of 25 ppm on potted rose Nhung to improve the growth and flower quality

Continue to characterize the interaction of cultural techniques, fertilizers and plant growth regulators on the quality of potted rose Nhung.

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