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RESPONSE OF ROSE STEM CUTTINGS TO INDOLE-3-BUTYRIC ACID FOR ROOT FORMATION AND GROWTH TRAITS

I. MOHAMMED[1*], H. KARRAR[1], D.K.A. AL-TAEY[1], G. LI[2], R. YONGLIN[2*], and M.F. ALSAFFAR[3]

[1]Faculty of Agriculture, Al-Qasim Green University, Iraq
[2]College of Environmental and Life Sciences, Murdoch University, Australia
[3]Medical Laboratories, AL-Mustaqbal University, Hillah, Babil, Iraq
*Corresponding authors' emails: mohammed.muhi@agre.uoqasim.edu.iq, y.ren@murdoch.edu.au
Email addresses of co-authors: karrar.abbas@agre.uoqasim.edu.iq, duraidaltaey@gmail.com, lgu68forever@gmail.com, marwaalsaffar@uomus.edu.iq

SUMMARY

In the floriculture industry, vegetative propagation is a widely use preserver of cultivar characteristics in roses. The latest study aimed to evaluate the effect of powder and gel forms of indole-3-butyric acid (IBA) on the adventitious root formation of two types of roses, i.e., Hybrid Tea Rose (Mr. Lincolin) and Floribunda (Iceberg). Both types of rose stem cuttings with lengths of 20, 25, 30, and 35 cm received evaluation with the application of Vapor Gard for one, two, and three weeks as an anti-desiccant. The rose cutting with a length of 30 cm treated for three weeks with Vapor Gard provided the maximum rooting percentages of 73%, 76%, 83%, and 83% for Hybrid Tea Rose and Floribunda, respectively. The Floribunda rose cuttings with IBA (gel form) resulted in the utmost percentage of rooted cuttings (93%), root length (15.7 cm), root number (21 per cutting), shoot number (four per cutting), shoot length (19.70 cm), number of leaves (20.0 leaf), and leaf area (19.6 cm^2). IBA powder treatment was not significantly different from the IBA gel treatment in the leaf area for Hybrid Tea Rose. However, IBA gel treatment proved to be superior in all other parameters. This method combined IBA applied as a gel with longer cuttings of rose to generate an improved protocol for better rooting in rose stem cuttings. The successful use of this method has enhanced rooting in rose stem cuttings and can be functional for other valuable ornamentals and floricultural species.

Keywords: Hybrid Tea Rose (Mr. Lincolin), Floribunda (Iceberg) rose, IBA gel and powder forms, stem cuttings, root formation, root traits

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Key findings: The current study indicated that the two rose types have responded differently to IBA applications in gel and powder form. The highest number of roots and their better growth were prominent in the stem cuttings of Floribunda rose type with IBA gel form (93%). Vapor Gard application for two weeks and IBA gel form in 30 cm stem cuttings significantly improved other parameters for both rose types.

INTRODUCTION

The term rose refers to several shrub species within the genus *Rosa* L., where thousands of cultivars and their hybrids are available. International marketing of roses as high-value cut flowers has global export values reaching USD 22.4 billion (International Trade Centre, 2022). Rose types, Hybrid Tea Rose and Floribunda, are the most valuable ornamental flowering shrubs with scents of flowers. These two rose types are considerably the basis of the rose for modern roses and are very popular in Australia (Folta and Gardiner, 2009; Ibrahim *et al*., 2018). Usually, cultivating roses occurs in homes and public gardens as commercial cut flowers and have industrial uses, such as *Rosa Hybrida* and *Rosa gallica* (Ibrahim *et al*., 2019; Guaita-Pradas *et al*., 2023).

Rose production increases yearly; however, propagation methods are the chief challenge in producing roses (Cardoso and Vendrame, 2022; Guaita-Pradas *et al*., 2023). Propagation of roses also depends upon the different techniques, including *in vitro* micro-propagation and employing stem cuttings. Propagation by vegetative means maintains the desirable cultivar characteristics, which is one of the most used in woody plant species like roses, as it has several benefits, such as time-saving and cost-efficiency (Kentelky *et al*., 2021; Akhtar *et al*., 2002). These methods allow the maintenance of the desirable characteristics in superior rose cultivars, specifically cuttings and grafting methods; however, these approaches can incur influences from genotypic differences for adventitious root formation (Nguyen *et al*., 2020). Other factors that affect the rose in the rooting system's success in stem cuttings are the length of cutting, hormone types applied, and infection by fungi because of high humidity.

In roses, the length of stem cutting is a crucial factor that affects its rooting success, and a higher percentage of successfully rooted rose cuttings appeared with longer cuttings (Bredmose *et al*., 2004). However, the optimal length of stem cuttings is imperative to determine. Moreover, the stem cutting length of miniature roses (*Rosa hybrida* L.) plants affects root formation and has a high percentage of successful cuttings. Past findings also showed that 20 cm cuttings length had a better rooting efficiency in hardwood stem cuttings of two rose genotypes (Ercisli *et al*., 2004). Past findings also mentioned the stem-cutting lengths of 15–25 cm as more optimal for roses (Bredmose *et al*., 2004; Ercisli *et al*., 2004). Several studies have run to test different auxins for promoting adventitious roots in rose cuttings, notably by applying IBA, which is more stable than other auxins. However, no work existed on hormone application in gel form and on the stem cutting length of more than 25 cm.

In the successful propagation of roses, the desiccation and pathogen infection in cuttings are the foremost constraints. Less or more irrigation water also causes bacterial and fungal infections. Vapor Gard (Miller Chemicals, Pennsylvania, USA) is an anti-transpirant and anti-desiccant terpene polymer-based product developed as a full-coverage spray to reduce water evapotranspiration in plants under water-stress conditions. In addition, previous uses of Vapor Gard have helped to increase the vase's life after application by reducing the infection of bacteria and fungi and lowering respiration (Nell *et al*., 1985). Another study also showed that applying Vapor Gard (1% solution) significantly improved the physiological state of the photosynthetic apparatus of Actinidia (kiwifruit) plants and their tolerance to water-stress conditions (Latocha *et al*., 2009).

Plants naturally produce plant hormones, known as plant growth regulators, and synthetically by chemicals. Auxins, a class of plant hormones that includes the synthetic auxins naphthalene acetic acid (NAA) and the naturally occurring auxins indole-3-butyric acid (IBA), are essential to plant development (Ullah *et al*., 2013). The commonly used auxins include Indole-3-acetic acid (IAA, which exists naturally), Indole-3-butyric acid (IBA, occurs naturally as a derivative of IAA and is chemically synthesized), and 1-Naphthaleneacetic acid (NAA, chemically synthesized) in horticultural production. Past studies established that applying auxins (IBA) mostly induced adventitious root formation in rose stem cuttings. Different concentrations of IBA significantly enhanced the rooting percentage of live cuttings (Blythe, 2012). The IBA is the most widely used auxin for promoting root formation in stem cuttings. Moreover, treatments with different IBA concentrations are widely applicable in commercial plant propagation to increase rooting percentages in plants, hasten root initiation, and enhance the number and quality of roots (Cox, 2018).

Materials used for propagating roses are hard and soft stem cuttings, and treating these cuttings with rooting hormones should occur before planting. Rose cuttings treated with IBA generate roots initially with miniature rose genotypes at a high rate of 89.3% (Ahmadi, 2011). A recent study by Traversari *et al*. (2022) demonstrated that applying IBA in stem cuttings of rose cultivars Michelangelo and Cosmos significantly increased the number and length of roots. Another study by Susaj *et al*. (2012) also showed that 1000 ppm IBA enhanced the shoot length and other growth parameters in rose cultivars Christopher Columbus and Vay Vicend. Besides IBA application, other factors like stem cutting length also affect root formation. These factors' scrutiny can be by optimizing the lengths of stem cuttings and applying Vapor Gard to reduce water loss and infection of fungi. Thus, the presented study sought to evaluate the effectiveness of IBA (gel and powder form) in stem cuttings of two rose cultivars, Hybrid Tea and Floribunda, in inducing adventitious roots, the number and length of roots and shoots, and leaf area.

MATERIALS AND METHODS

Plant material

The experiment transpired on stem cuttings of two rose types, Hybrid Tea Rose (Mr. Lincolin) and Floribunda (Iceberg). The stem cuttings came from the five-year-old healthy mother stock at the beginning of the growing season at the end of March 2018 from Roworth's Rose Nursery, Perth, Western Australia. The stem cuttings' planting commenced in a temperature-controlled glasshouse at Murdoch University, Perth, Western Australia. During the experiment period, the average temperature ranged from 20 °C ± 2 °C to 28 °C ± 2 °C during the night and day, respectively. In the glasshouse, the relative humidity ranged between 65% ± 2% and 75% ± 2% during the night and day, respectively. Dipping the rose stem cuttings up to about 5 cm continued for a few seconds in 1,000-ppm powder of Indole-3-Butyric Acid (IBA), removing the excess powder by shaking off and lightly tapping the cuttings against the edge of the pot, then planting individually in appropriate trays (Susaj *et al*., 2012). The procurement of IBA powder (98% purity, CAS Number: 60096-23-3) was from Sigma-Aldrich (Castle Hill, NSW, Australia). The IBA in gel form (Clone) came from Hydroponic Xpress (Code: 9313656614189; Perth, Western Australia, Australia).

Rose stem cuttings in the control treatment received double distilled water, similar to the IBA treatment: dipping cuttings up to about 5 cm for a few seconds in double distilled water. Planting treated cuttings into seedling trays (Figure 1) contained a soil mix consisting of vermiculite and coarse sand in equal measures (1:1 v/v) obtained from Richgro Industries (Perth, Western Australia). After two months, recording the number and length of roots ensued. The rooted stem cuttings continued to transfer to individual 16 cm × 16 cm pots consisting of composted pine bark, coarse river sand, and coco peat (2:2:1

Figure 1. Rose cuttings planted in seedling trays.

v/v). The rooted stem cuttings received automatic watering by a sprinkler system that applied water for five minutes every three hours. The cutting tray arrangement was a factorial based on a completely randomized design with two rose types, two IBA treatments, four rose stem cutting lengths, and three replicates for each variant.

Cuttings length and Vapor Gard measurements

Healthy rose stem cuttings (uninfected, undamaged, and sturdy stems) of two different rose types (Hybrid Tea Rose and Floribunda) with 20, 25, 30, and 35 cm lengths, had 4-6, 6-8, 8-10, and 10-12 nodes, respectively. Stem cuttings at 10 cm × 10 cm space and 10 cm within rows achieved planting in soil of 20 cm in depth under irrigation system and other conditions as mentioned earlier in the plant material and treatments. After two months, the percentage of rooted cuttings evaluation for both rose types commenced. Another experiment continued to evaluate the cuttings' lengths. The stem cuttings with 30 cm length obtained Vapor Gard treatment one week after planting. The rose stem cuttings with 30-cm length were specimens and sustained treatment with a 1% solution of Vapor Gard (Miller Chemical and Fertilizer Corporation, Pennsylvania), ensuring the solution covered all cuttings. Ten ml of Vapor Gard dissolved in one liter of distilled water used two-liter sprayers. The Vapor Gard application had three applications, i.e., applied one week, two weeks, and three weeks after the planting of cuttings. The measurement of the rooting percentage of two rose types progressed. The high rooting percentage, obtained from the best cutting length and best Vapor Gard application time, also served for subsequent experiments.

Rooting measurements

Recording the root formation and development measurement for each treatment with IBA applied as a gel and powder form, and cutting length ensued after two months of growth (Susaj *et al*., 2012). The measurements were for the number of roots and lengths of roots for each cutting. Counting the number of roots emerging in 10 rose seedlings helped calculate the average number. Measuring the lengths of emerged roots from 10 sampled cuttings took place in each replicate and then averaged. Measurements evaluation was according to their percentage, with the rooting success expressed as the percentage of rooting success of the rose stem cuttings rooted in each treatment. However, the rooting failure also resulted in the mean of cuttings that rotted in each treatment. The root fresh weight (RFW) also incurred assessment. Drying the roots at 75 °C for two days proceeded to measure the root dry weight (RDW).

Shooting and leaf area measurements

The length of shoots of 10 samples of growing rose stem cuttings gained measuring from the formation point to the tip using a linear meter and averaged. The average number of shoots also attained counting for each variant in each replication. The leaf area measurement had five leaves from each rose seedling plucked from different positions and lengths. Then, all the removed leaves from ten seedlings underwent measuring, with the leaf area determined using a portable laser leaf area meter (C1-202, CID Bio-Sciences Inc. USA). Evaluating the shoot's fresh weight (SFW) materialized; afterward, the shoots were at 75 °C for two days to measure their dry weight (SDW).

Statistical analysis

The analysis of all the collected data ran through a one-way analysis of variance by using the GenStat statistical software.The study applied the least significant differences ($LSD_{0.05}$) test to compare and separate treatment means.

RESULTS

Evaluation of cutting length on root percentage

In rose stem cuttings, cutting length has considerably affected the rooting percentage for both rose types (Figure 2). However, the differences among the cutting lengths had a nonsignificant effect from the rose type. The results indicated that increasing root percentages of 70%–72% and 73%–76% emerged in cutting lengths of 30 and 35 cm in Floribunda and Hybrid Tea Rose, respectively. However, no significant differences appeared between these two stems' cutting lengths, and thus, 30 cm for further study and confirmation. In contrast, a substantial effect occurred on rooting percentage for the stem cutting lengths of 20 and 25 cm, recorded with rooting percentages of 53%–60% and 43%–56% for Floribunda and Hybrid Tea roses, respectively.

Evaluation of Vapor Gard on rooting percentage

Vapor Gard application from one to three weeks in both rose types improved and increased the rooting percentage. The rooting percentage in the first week of the experiment revealed a gradual enhancement up to three weeks of application (83%) in both rose types. However, the rooting percentage decreased in control and the Vapor Gard treatments for one week in Hybrid Tea and Floribunda roses to 46%–50% and 60%–63%, respectively (Figure 3). The Vapor Gard treatment notably boosted the rooting percentage (Figure 3). Analysis of all treated cuttings revealed significant ($P \leq 0.01$) differences between tested rose cultivars for rooting percentage. Hybrid Tea Rose responded best to applying Vapor Gard for three weeks. Floribunda rose had nonsignificant differences for two and three weeks of Vapor Gard application (76% and 83%, respectively). Therefore, two weeks of application of Vapor Gard was for Floribunda Rose, while three weeks of Vapor Gard application used for Hybrid Tea Rose showed better results.

Effect of hormone on rooting percentage

Root initiation was visible after 2–4 weeks from treatment. Results indicated that applying IBA (gel and powder form) significantly promoted the growth and development of roots of rose stem cuttings, as reflected by the rooting percentage. The two rose types showed significant ($P \leq 0.05$) differences in rooting percentage (Figure 4). However, the most notable effect was apparent in the rooting percentage after treating stem cuttings with the IBA gel (93% and 89%) in Floribunda and Hybrid Tea roses, respectively. The stem cuttings treated with IBA (powder form) showed a low rooting percentage compared with the gel form. The maximum rooting percentage (93%) was successful with the IBA gel application in Floribunda rose stem cuttings. However, the minimum rooting emerged in the Hybrid Tea Rose (46%) from the control treatment.

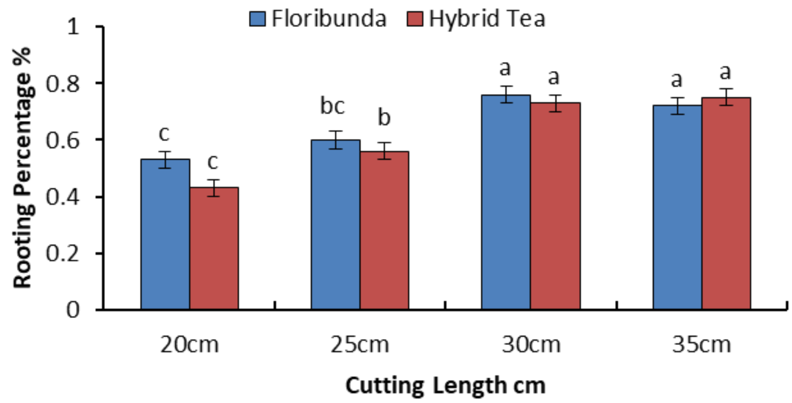

Figure 2. Rooting percentages of two rose types, according to the length of cuttings. Error bars represent Standard Error (SE). Different letters in the figure indicate the level of significant difference (n=3).

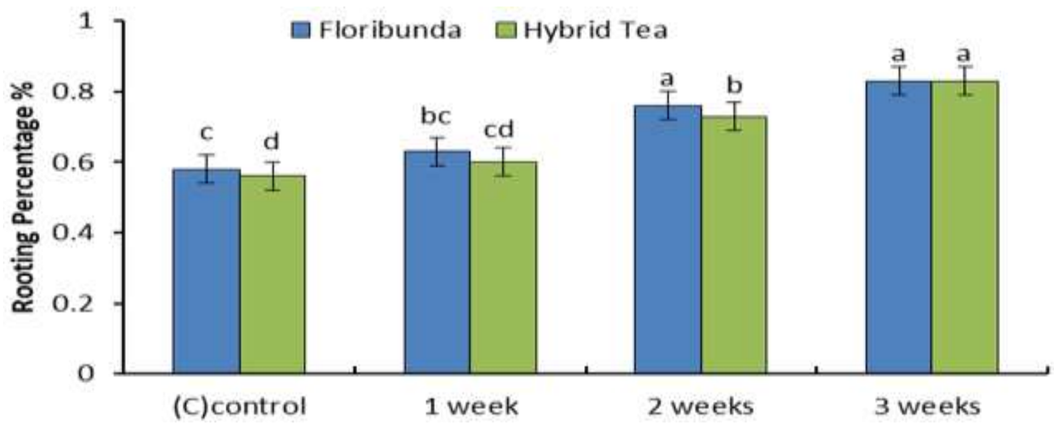

Figure 3. Rooting percentage of two rose types, according to application of Vapor Gard® after 1, 2, and 3 weeks from planting. Error bars represent Standard Error (SE). Different letters in the figure indicate the level of significant difference (n=3).

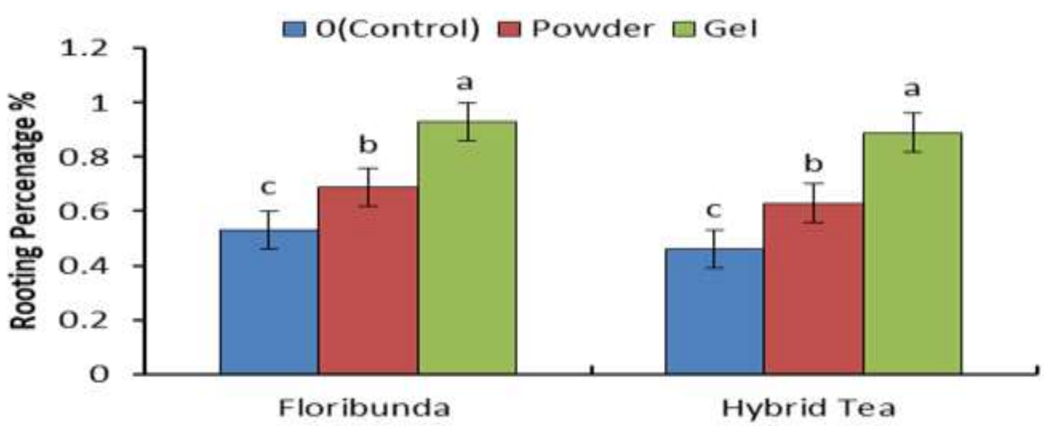

Figure 4. Effect of various IBA forms (gel and powder) on rooting percentage (%) on two roses (Floribunda and Hybrid Tea). Error bars represent Standard Error (SE), and the same letters mean no significant differences (n=3).

Effect of IBA (gel and powder) on root traits

The IBA application significantly influenced the rooting traits of stem cuttings, such as root length (cm), roots per cutting, root fresh (RFW), and dry weight (RDW). Results indicated that IBA treatment affected all the root trait measurements (Figure 5A). Nonsignificant differences appeared between the IBA gel and powder forms in both rose types for root number. However, both IBA treatments substantially increased the number of roots in Floribunda and Hybrid Tea Rose, with values of 21.0 and 16.3 per plant, respectively. However, the control treatment resulted in significantly fewer roots per stem cutting, 10.7 and 9.7/cutting for Floribunda and Hybrid Tea roses, respectively.

The treatments of IBA (in gel and powder forms) had varied effects on the root length (Figure 5B). The significantly longer root length was visible with the IBA (gel) at 15.7 and 12.3 cm, followed by the IBA (powder) at 13.0 and 9.0 cm, in stem cuttings of Floribunda and Hybrid Tea, respectively. However, no significant differences occurred between the IBA (powder) and the control treatment for root length in the Hybrid Tea Rose plants. The maximum fresh and dry weight of roots was prominent with the IBA (gel) treatment, i.e., 12.7 and 10.8 g and 0.22 and 0.19 g in Floribunda and Hybrid Tea Rose stem cuttings, respectively (Figures 5C and 5D). The lowest root fresh and dry weights resulted in the control treatment, i.e., 9.0 and 8.4 g and 0.13 and 0.12 g, in Floribunda and Hybrid Tea Rose, respectively. Results further showed nonsignificant differences between the IBA (gel) and IBA (powder) forms on the root fresh and dry weights in the stem cuttings of Hybrid Tea roses (Figures 5C and 5D).

Effect of hormones on growth traits

A higher number of shoots per cutting (4.0) than the control treatment (1.67) surfaced In Floribunda rose with the IBA (gel) (Figure 6A). In contrast, the Hybrid Tea Rose responded to both forms of the IBA. Results further indicated nonsignificant differences between the two IBA forms (gel and powder), giving 2.67 and 2.33 shoots per cutting, respectively (Figure 6A). Both forms of the IBA (gel and powder) also generated the same shoot length, with 19.0 and 16.67 cm and 14.67 and 13.0 cm, in the Floribunda and Hybrid Tea Rose, respectively (Figure 6B). Shoot fresh and dry weights increased with the treatment of IBA (gel), especially with the Floribunda stem cuttings compared with the IBA (powder) and the control treatment (Figures 6C and D).

The results demonstrated higher values for fresh (20.91 g) and dry (1.17 g) weights when applying the IBA (gel) in Floribunda rose. In contrast, the control treatment had the lowest shoot fresh and dry weights, i.e., 16.19 and 0.62 g in Floribunda rose, respectively (Figures 6C and 6 D). However, the Hybrid Tea Rose responded differently than the Floribunda rose for shoot fresh and dry weights. No significant differences appeared between the IBA (gel and powder) for shoot fresh weight (18.31 and 17.01 g) and dry weight (0.77 and 0.72 g), respectively. The control treatment showed the minimum values, i.e., 14.90 and 0.50 g, for shoot fresh and dry weights, respectively.

Regarding the number of leaves per stem cutting, both Floribunda and Hybrid Tea Rose cuttings differed in results from treating with IBA forms (gel and powder) (Figure 7A). The IBA (gel) treatment induced 20.0 and 18.3 leaves per stem cutting in Floribunda and Hybrid Tea Rose, respectively. In contrast, no significant differences showed in the number of leaves between the IBA (powder) and the control treatment, i.e., 15.0 and 12.33 and 13.67 and 10.67 leaves in the Floribunda and Hybrid Tea stem cuttings, respectively. The higher average leaf area recording emerged with the IBA application (gel) (19.60 cm^2) in the Floribunda rose. Contrastingly, the minimum value for the leaf area (11.50 cm^2) was visible under the control treatment (Figure 7B). Hybrid Tea Rose stem cuttings treated with two IBA forms (gel and powder) provided the maximum values of leaf area with no significant difference, i.e., 17.27 and 15.50 cm^2, respectively. The Hybrid Tea Rose stem cutting with the control treatment showed the lowest value for leaf area (12.02 cm^2).

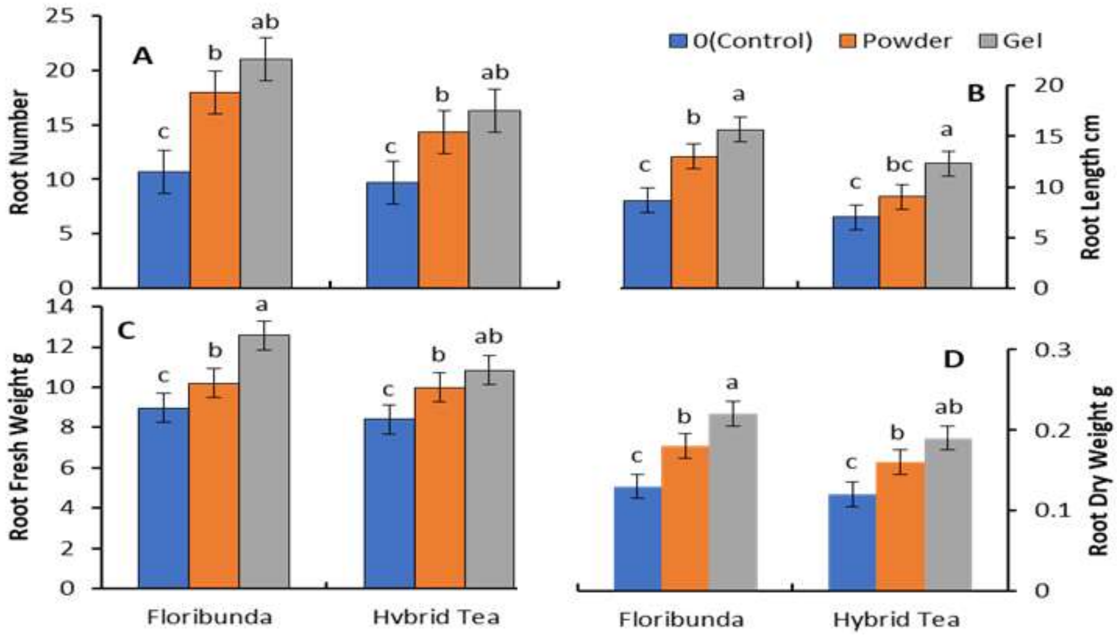

Figure 5. Effect of IBA in powder and gel form on various rose rooting parameters; (A) Root numbers, (B) Root length cm, (C) Root fresh weight g, (D) Root dry weight using two roses (Floribunda and Hybrid tea plants). Error bars represent Standard Error (SE). Different letters in the figure indicate the level of significant difference (n=3).

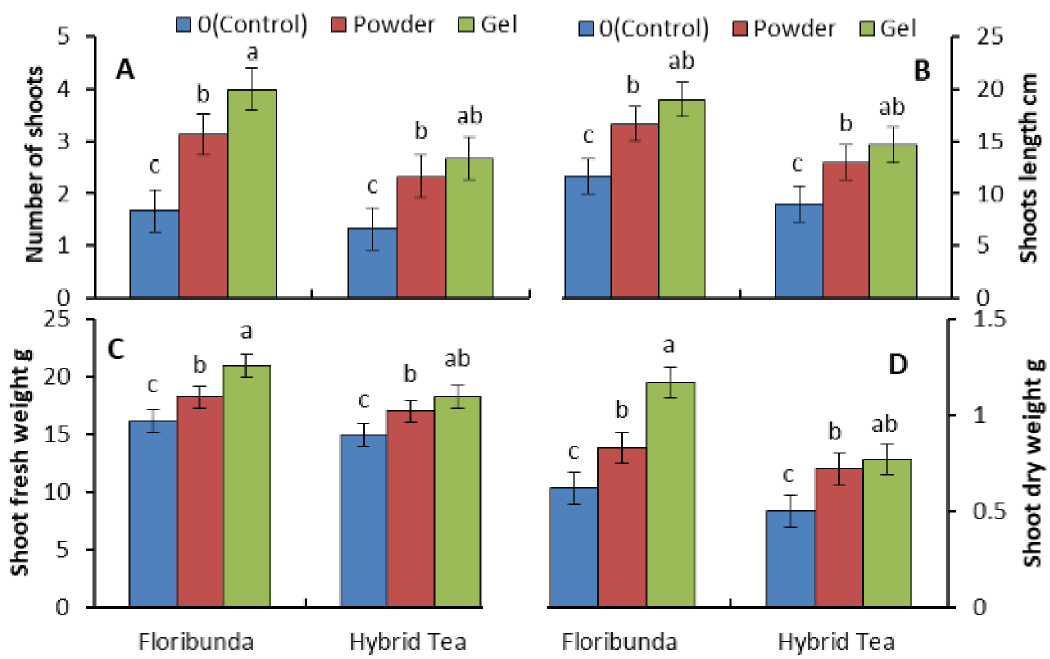

Figure 6. Effect of rooting hormones (0, powder, and gel) on various shoot parameters; (A) Number of shoot, (B) Shoot length cm, (C) Shoot fresh weight g, (D) Shoot dry weight using two roses (Floribunda and Hybrid Tea rose). Error bars represent Standard Error (SE). Different letters in the figure indicate the level of significant difference (n=3).

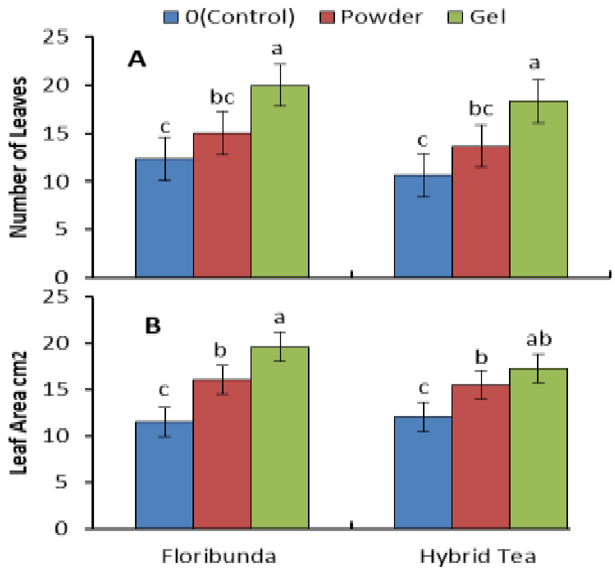

Figure 7. Effect of IBA gel and powder on (A) Number of leaves, (B) Leaf area cm^2 of two rose types (Floribunda and Hybrid Tea rose). Error bars represent Standard Error (SE). Different letters in the figure indicate the level of significant difference (n=3).

DISCUSSION

The rose has become the most valuable floriculture plant worldwide (Tanaka *et al*., 2005). Stem cuttings can propagate rose with a rooting percentage varying from zero to 100% (Nguyen *et al*., 2020). The presented results corresponded to previous research, which showed that the stem cutting length significantly affected the rooting efficiency; higher rooting efficiency (rooting percentage) appeared with a stem cutting length of 20 cm for miniature rose plants (Bredmose *et al*., 2004; Al-Mathidy *et al*., 2023). A higher rooting percentage emerged with 7 cm mini-rose bush cuttings, while the rooting percentage reduction used shorter cuttings (Pirola *et al*., 2016; Al-Musawi *et al*., 2023). Recently, utilizing the IBA (Vapor Gard) in research studies sought to protect plants from desiccation and fungal infections (Latocha *et al*., 2009). Before the current study, no work had proceeded on how the Vapor Gard application affects the rooting percentage in rose stem cuttings.

The latest study confirmed that applying IBA on rose stem cuttings induced adventitious root formation and were higher in number than the control treatment when treated with the IBA in Floribunda and Hybrid Tea roses. The results correspond with previous studies by Traversari *et al*. (2022), who showed that the IBA treatment on stem cuttings of two rose cultivars (Michelangelo and Cosmos) increased their rooting percentage, with a survival rate of 22% more than the control treatment. Root initiation incurs regulation from endogenous auxins and carbohydrates stored in the stem cuttings, and various elements react with each other to promote rooting ability (Davies, 2010). The effects of IBA delivery methods on initiating and forming roots in woody plants have limited studies. Before the current study, no such work transpired on how the IBA (in gel form) affects the root formation and development in stem rose cuttings.

The two rose types behaved differently from each other when applied with the IBA (gel and powder forms). It demonstrated that the IBA (gel) delivery induced in the Floribunda rose a higher root number and root lengths. Applying the IBA on rose cuttings improved root traits and length compared with the control. Past studies revealed a positive correlation between the root number and IBA application in roses (Otiende *et al*., 2017). Research by Traversari *et al*. (2022) indicated that spreading the IBA hormone to stem cuttings of two rose types increased the number of roots and their length. The increase in root length might be due to the accumulation of rooting co-factors above the ringed portion by the IBA.

Considerably inducing longest roots under the IBA treatment in Rosa progressed (8.28 and 3.88 cm), followed by Natal briar (7.07 and 3.40 cm) (Otiende *et al*., 2017). The increase in the root length after treatment by the IBA might be due to plant hormonal effects and accumulation of other internal substances, such as abscisic acid, ethylene, gibberellins, cytokinins, potassium, and nitrogen, and their downward movement (Blythe *et al*., 2007). Treatment with the IBA may have direct and indirect influences by accelerating the translocation rate and carbohydrate mechanism and stimulating the rooting portion of stem cuttings, resulting in root formation (Krajnc *et al*., 2013). The highest fresh and dry weight of roots was prominent with the IBA (gel form). It may refer to the exogenous application of auxins, which generally stimulates the movement of natural auxin in a downward direction from leaves to shoot tips, resulting in roots formed with a higher fresh weight (Maurya *et al*., 2012). The promising results correspond with past findings that showed the treatment of guava cuttings with the IBA significantly increased the root fresh and dry weights (Rymbai and Reddy, 2010).

For the shoot number, the most significant effect emerged with the IBA application (gel form) in the Floribunda rose variety. However, IBA (gel and powder forms) treatments were more effective than the control treatment in both types of roses for shoot length in the growing stem cuttings. The reason is that diverse rose varieties responded differently to the IBA application. In addition, auxins, such as IBA, play a key role in plant life cycles and influence the physiological processes that occur in plants, including biochemical pathways and metabolic processes (Krajnc *et al*., 2013). The presented results correspond with other research conducted by Susaj *et al*. (2012), who reported that rose cultivars Christopher Columbus and Vay Vicend treated with the IBA (1000 ppm) increased the shoot length, number of shoots, and other growth parameters. The shoot length is crucial in cutting flowers for breeding purposes and positively impacts the number and quality of flowers (Blythe *et al*., 2007).

In this study, the leaf number significantly increased with the delivery of the IBA (gel form) in rose stem cuttings. The findings aligned with previous results of Pirola *et al*. (2016), who showed that mini-rose bush cuttings treated with the IBA increased the leaf number and area substantially. Yeshiwas *et al.* (2015) demonstrated that Rosa motor cuttings treated with the IBA (2000 ppm) had a broader leaf area. The differences between the two types of roses in leaf area may be because of the different characteristics of each variety. An explanation might be that the IBA significantly increased leaf area and aerial growth. The presented findings also agreed with past results on guava plants (Kumar and Syamal, 2005). Similarly, Baghel *et al*. (2016) demonstrated that a high average leaf area (30.3 cm^2) was notable after treating guava cuttings with the IBA.

Based on the above discussion, a question arises as to why the IBA in gel form was better than the IBA in powder form. An explanation was the Clonex gel contains other ingredients, such as anti-microbial agents, vitamins, and minerals. Moreover, the IBA increased the strike rate from the gel holding the active ingredient against the plant tissue. Clonex gel also has higher safety levels for workers since they are not breathing in talc and hormones. The gel seals the cut and stops air embolisms in the plant vascular tissue, preventing the cuttings from wilting, with the Clonex also considered an anti-desiccant.

CONCLUSIONS

The propagation of roses through stem cuttings is profitable because it maintains the unique phenotypical features of the cultivar. A cutting length of 30 cm and three weeks of Vapor Gard application provided a higher rooting percentage in both types of roses. The

Floribunda rose with the IBA (gel form) has shown improved rooting percentage, rooting parameters, and other growth parameters. The IBA treatment (gel) was superior to the IBA (powder) in generating roots for better growth parameters in both rose types. Consequently, the IBA (gel) can help improve root formation and percentage and further develop roots and shoots in rose and other floricultural plants. Thus, in the future, using the IBA in gel form can best increase the rooting and vegetative characteristics in different ornamental cuttings.

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