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Potential of Plant Growth Regulators on Modulating Rooting of *Rosa centifolia*

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Abstract

***Rosa centifolia* is grown for its flowers which are used for essential oil extraction. It is vegetatively propagated through its cuttings which are difficult to root. This study was designed to increase the rooting percentage of cuttings by applying plant growth regulators (PGRs) with different levels. In total 31 treatments with different concentrations (450 ppm, 700 ppm and 950 ppm) of indole butyric acid (IBA), indole acetic acid (IAA), naphthalene acetic acid (NAA) alone, in combination and with same concentrations of 6-benzylamino purine (BAP) were used. Healthy similar sized cutting of *R. centifolia* was treated in solution of PGRs by quick dip method and planted in polythene bags. The data for shoot length, shoot dry weight, number of roots, root length and root dry weight were recorded. All three levels (450 ppm, 700 ppm and 950 ppm) of IBA alone produced maximum results in case of all parameters as compared to all other treatments. Among three levels of IBA, 450 ppm concentration produced maximum shoot length (10.67 cm), shoot dry weight (3.02 g), number of roots (14.00), root length (11.90 cm) and root dry weight (0.50 g). Lower concentrations of plant growth regulators produced better results as compared to higher concentrations.**

Keywords

Growth Regulator, *Rosa centifolia*, Auxins, Rooting, Shooting

1. Introduction

Rose is a significant floriculture crop in the world [1] and belongs to the family Rosaceae, which is made up of

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about 200 species and 1800 cultivars [2]. *Rosa centifolia* is an important oil producing species of roses [3] in the world, which has pink fragrant flowers with many petals. It was originally grown in Bulgaria where it spread to Turkey [4] and other countries. Now many countries (Bulgaria, Israel, Italy, United States, Japan, Turkey, Iran, India, Pakistan and France) are growing it but most commonly in Morocco, France and Egypt [5]. In Pakistan it is famous as a high-value nontraditional crop, which is famous among farmers. This species is grown at Rosa project, at the Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan, for many years and used for extraction of rose oil and water, for making rose jam, eye drops and perfumes, because in Pakistan it produced recurrent flowering throughout the year including warm summer season. Rose oil is one of the most expensive oils in the world [6], which contains more than 500 volatiles with higher percentage of monoterpene alcohols including citronellol, nerol, geraniol, linalool, and phenylethyl alcohol, which are very significant for perfume [7]. Its oils can be extracted by various methods like supercritical fluid extraction, solvent extraction, steam distillation, cold pressing and hot pressing [8]. The Rosa project is extracting its oil by using steam distillation [9], Soxhlet extractor and super critical fluid extraction method.

Roses are usually propagated by asexual methods like rooted cuttings or grafting [10] and seeds are used for the propagation of species and rootstock [11]. Cuttings are mostly used for propagation of roses, but main problems are less multiplication and less rooting percentage [12]. There is a need to use different plant growth regulators for effective rooting of cuttings to fulfill the demand of *R. centifolia* plants.

Cutting is the primary method of propagation of a variety of wood ornamental plants [13], but differences exist in rooting ability of different genotypes [14]. Differences are present in both angiosperms and gymnosperms for root and shoot growth from cuttings [15]. Many researchers have confirmed that differences in rooting within the genotypes growing in one location are due to the natural genetic factors [16]. *R. centifolia* found in Pakistan shows different characters like recurrent flowering round the year including higher summer conditions, but its success rate is very low in the field due to less rooting ability. Induction of rooting at early stage enables cuttings to establish by absorbing water and nutrients from the soil [17] while delay or absence of rooting causes death of cuttings and decreases survival rate [18].

A variety of plant growth regulators are used to increase number of axillary buds, induce lateral bud break, promote axillary shoot formation, and delay leaf chlorosis of cut flowers [19] [20]. Auxin and cytokinin are two important classes of plant growth regulators, which regulate plant growth and organize plant development [21]. Sometimes combinations of two or more plant growth regulators are required for growth regulation [21]. Auxin causes cell growth expansion, cell wall modification and initiation of cell division, promotes vascular differentiation and plays a main role in root promotion [22] [23]. Now there is a need for standardization of the plant growth regulator with effective concentration for better growth of cuttings of *R. centifolia*.

The objective of this research was to increase the success rate of cutting by increasing rooting percentage through application of different concentrations of plant growth regulators, and to observe their effects on growth of cuttings.

2. Materials and Methods

Present research work was conducted in the Rosa project, University of Agriculture, Faisalabad, Pakistan in 2012. Different types of cuttings including leaf cuttings, leaf-bud cuttings, root cuttings and hardwood, semi-hardwood and softwood stem cuttings [24] are available for plant propagation but healthy semi hard wood cuttings [25] of *R. centifolia* were taken from one year old branches of 7 - 8 years old plants, grown in the field of Rosa project, which were regularly pruned every year in month of November. Each cutting had at least three buds. Three different (450 ppm, 700 ppm and 950 ppm) levels of three auxins IBA, IAA and NAA were used as alone and in combination. BAP was also used in combination with all three auxins in similar concentration. All the solutions were made in distilled water. Cuttings were placed in the polythene bags after giving a slanting cut at lower portion and treating with plant growth regulator solution by quick dip method [26] [27]. Polythene bags with cuttings were placed in the green house for further growth because direct planting of cuttings causes decrease in success rate [28].

Data for shoot length, shoot dry weight, number of roots, root length and root dry weight were recorded after 7 - 8 weeks. Shoot length and root lengths were measured in cm, while their dry weights were measured in grams after oven dry.

The total of 31 treatments were used and each treatment had three replications, which was made up of three cuttings. Data was statistically analyzed by using Complete Randomized Design (CRD) and differences among

treatments were compared by using Duncan's Multiple Range (DMR) test.

3. Results

3.1. Shoot Length

According to the **Table 1**, maximum shoot length (10.67 cm) was observed from 450 ppm concentration of IBA followed by 700 ppm and 950 ppm of IBA which produced 5.80 cm and 5.57 cm shoot length, respectively. Combination of similar concentrations (450 ppm, 700 ppm and 950 ppm) of IBA and IAA also produced satisfactory results by producing 5.00 cm, 4.97 cm and 4.50 cm shoot lengths respectively. Minimum shoot length (0.93 cm) was observed from plant grown without application of plant growth regulators. NAA at 450 ppm, 700 ppm and 950 ppm concentrations also produced plant with least shoot length (1.87 cm, 1.83 cm and 1.80 cm respectively) as compared other treatments.

Table 1. Effect of different levels of plant growth regulators on growth of cuttings of *Rosa centifolia*.

Treatments	Concentrations (ppm)	Shoot length (cm)	Shoot dry weight (g)	Number of roots	Root length (cm)	Root dry weight (g)
Control		0.93e	0.06c	1.67d	3.17e	0.02e
IBA	450	10.67a	3.02a	14.00a	11.90a	0.50a
IBA	700	5.80b	2.38ab	10.33ab	11.10ab	0.41ab
IBA	950	5.57be	1.05bc	9.00abc	10.00abc	0.36abc
NAA	450	1.87de	0.08c	2.33d	6.10abcde	0.11cde
NAA	700	1.83de	0.06c	2.33d	5.29abcde	0.03e
NAA	950	1.80de	0.06c	1.67d	3.23de	0.03e
IAA	450	3.60bcde	0.80c	3.67cd	7.13abcde	0.17bcde
IAA	700	3.33bcde	0.76c	3.67cd	7.13abcde	0.15bcde
IAA	950	2.03cde	0.68c	3.33cd	7.10abcde	0.12bcde
IBA + NAA	450 + 450	2.63bcde	0.41c	3.67d	7.23abcde	0.03e
IBA + NAA	700 + 700	2.50bcde	0.41c	3.00d	5.13bcde	0.05e
IBA + NAA	950 + 950	2.47bcde	0.30c	2.00d	4.87bcde	0.03e
IBA + IAA	450 + 450	5.00bcd	1.03bc	7.33cd	9.90abcd	0.35abc
IBA + IAA	700 + 700	4.97bcd	0.99c	6.00bcd	9.67abcde	0.34abcd
IBA + IAA	950 + 950	4.50bcde	0.93c	6.00bcd	9.57abcde	0.28abcde
NAA + IAA	450 + 450	2.78bcde	0.29c	3.33cd	5.23abcde	0.23abcde
NAA + IAA	700 + 700	2.53bcde	0.22c	2.00d	4.17cde	0.07cde
NAA + IAA	950 + 950	2.83bcde	0.21c	2.00d	3.87cde	0.03e
IBA + NAA + IAA	450 + 450 + 450	4.17bcde	0.62c	5.67bcd	9.47abcde	0.25abcde
IBA + NAA + IAA	700 + 700 + 700	4.00bcde	0.56c	5.67bcd	9.10abcde	0.19bcde
IBA + NAA + IAA	950 + 950 + 950	3.80bcde	0.48c	5.33bcd	9.00abcde	0.17bcde
IBA + BAP	450 + 450	3.07bcde	0.44c	3.67cd	8.70abcde	0.03e
IBA + BAP	700 + 700	2.96bcde	0.43c	3.67cd	8.67abcde	0.03e
IBA + BAP	950 + 950	2.78bcde	0.41c	4.67bcd	8.63abcde	0.15bcde
NAA + BAP	450 + 450	2.13cde	0.11c	2.67d	3.60cde	0.03e
NAA + BAP	700 + 700	1.97cde	0.18c	2.67d	4.58bcde	0.04e
NAA + BAP	950 + 950	2.20bcde	0.31c	2.67d	7.73abcde	0.03e
IAA + BAP	450 + 450	2.07cde	0.34c	2.33bcd	6.53abcde	0.09cde
IAA + BAP	700 + 700	2.20bcde	0.34c	2.33d	5.93abcde	0.05e
IAA + BAP	950 + 950	2.63bcde	0.36c	2.33d	4.30cde	0.05de
LSD value at 5%		3.66	1.37	5.87	6.73	0.29

Treatments means sharing similar letter do not differ significantly by DMR test ($P < 0.05$).

3.2. Shoot Dry Weight

Three different levels of IBA 450 ppm, 700 ppm and 950 ppm produced maximum shoot dry weight 3.02 g, 2.38 g and 1.05 g respectively as shown in the **Table 1**. 450 ppm, 700 ppm and 950 ppm concentrations of IBA in combination with same concentrations of IAA produced satisfactory results by increasing 1.03 g, 0.99 g and 0.93 g shoot weights, respectively, followed by three levels 450 ppm, 700 ppm and 950 ppm of IAA, which produced 0.80 g, 0.76 g and 0.68 g, respectively. Minimum shoot dry weight (0.06) was observed in the plant grown without application of any growth regulator as shown in the **Table 1**. NAA alone at 450 ppm, 700 ppm and 950 ppm concentrations proved least effective by producing 0.08 g, 0.06 g and 0.06 g shoot length respectively.

3.3. Number of Roots

Maximum numbers of roots 14.00, 10.33 and 9.00 were recorded in three levels 450 ppm, 700 ppm and 950 ppm of IBA respectively as shown in the **Table 1** and visually shown in **Figure 1**. Combination of similar levels (450 ppm, 700 ppm and 950 ppm) of IBA and IAA also produced effective number of roots (7.33, 6.00 and 6.00 respectively) after IBA alone. According to the **Table 1** cuttings without plant growth regulators application produced least number of roots (1.67) followed by NAA at concentration of 950 ppm by producing same number of roots.

3.4. Root Length

According to the data presented in **Table 1** 450 ppm, 700 ppm and 950 ppm concentrations of IBA produced maximum 11.90 cm, 11.10 cm and 10.00 cm root length respectively. Three concentrations (450 ppm, 700 ppm and 950 ppm) of IBA in combination of IAA in same concentrations produced satisfactory 9.90 cm, 9.67 cm and 9.57 cm shoot length, followed by combination of similar concentrations (450 ppm, 700 ppm and 950 ppm) of three growth regulators IBA, NAA and IAA which produced 9.47 cm, 9.10 cm and 9.00 cm root length respectively. Plants grown without application of any growth regulator produced least root length (3.17 cm) followed by 950 ppm NAA, which produced 3.23 cm shoot length.

3.5. Root Dry Weight

IBA at three different levels 450 ppm, 700 ppm and 950 ppm produced maximum root dry weights 0.50 g, 0.41 g and 0.35 g respectively, while minimum root dry weight 0.02 g was produced by control plant as shown in the **Table 1**. 450 ppm, 700 ppm and 950 ppm levels of IBA in combination with similar levels of IAA produced sa-

(a) (b)

Figure 1. Growth of cuttings of *Rosa centifolia*. (a) Shooting of *Rosa centifolia* cuttings grown in the polythene bags after plant growth regulator application; (b) Shooting of *Rosa centifolia* cuttings grown in the polythene bags after plant growth regulator application.

tisfactory by producing 0.35 g, 0.34 g and 0.28 g root dry weight respectively as compared to other treatments.

4. Discussion

In our research effect of different plant growth regulators especially auxin were noticed at different concentrations because they are very effective for better root formation at their specific quantity [29]. They proved very effective for effective rooting of *R. centifolia* because auxin played effective role in root initiation [30] and root primordia formation [31]. They also affect the cell wall, turgor and osmotic pressure and water permeability, which causes cell enlargement [32]. It has observed that auxin causes rooting due to stimulation of cell division [33]. They also enhance the growth of shoot buds and stimulate the substances present in the roots for their better development [34].

From our result IBA proved most effective among all plant growth regulators for producing maximum shoot length, shoot dry weight, number of roots, root length and root dry weight. Husen [35] found IBA effective for rooting of *Dalbergia sissoo* Roxb. Rana and Sood [17] found IBA better than IAA and NAA for producing maximum number of lateral roots, number of shoots, shoot length and number of leaves. All three levels of IBA produced better results as compared to the different levels of other used plant growth regulator. The increase in shoot length by IBA application may be due to the better utilization of carbohydrates, nitrogen and other nutrients, which play part in growth [36]. This increase of rooting by IBA application may be due to the translocation of carbohydrates from the leaves to contribute in root development [37] [38] although the increase in rooting by auxin application is a common feature in many herbaceous perennial pants [39]. It has been reported that IBA stimulates protein synthesis and RNA production [40] [41], enhances hydrolysis and translocation of carbohydrates and nitrogenous substances at the base of cuttings to increase cell division for enhancing rooting of plants [42]. Bagoury *et al.* [43] resulted increase in survival of cuttings after IBA application. Dirr [44]; Ruppert [27] reported that some species of plants produce rooting over a wide range of different concentration of IBA. Lower concentrations of IBA produced superior results than higher concentration [38] while their effectiveness decreases with higher concentration. Although IBA increases cell size and enlargement [32] and has higher ability to induce root formation [45] but higher concentration of IBA causes blockage in root formation by promoting higher level of degradative metabolites [46]. Haq *et al.* [47] had observed IBA as growth inhibitor at higher levels. Shin and Lee [48] also recorded inhibition in rooting and sprouting of chrysanthemum cutting by application of higher level of IBA. In case of other plant growth regulators lower concentration were also observed effective than higher.

Cuttings treated with different types of plant growth regulators found effective in case of both rooting and shooting as compared to control. These finding confirmed the effective role of plant growth regulators in growth and development of cuttings of *R. centifolia*. Plant growth regulators are needed for plant growth and development and respond the hormonal change in the plants [49].

5. Conclusion

In this study, effect of 30 different treatments of four (IBA, NAA, IAA and BAP) plant growth regulators in various combinations was observed on the growth of cuttings of *R. centifolia*. Maximum shoot length, shoot dry weight, number of roots, root length, root dry weight and root fresh weight were produced by 450 ppm IBA followed by 700 ppm and 950 ppm concentrations of IBA. All three concentrations of IBA alone produced better than combination with other growth regulators. Lower concentrations of growth regulators alone and in combination produced superior results as compared with higher concentrations. The finding of this experiment will be helpful to enhance propagation of *R. centifolia*, which will assist the business of essential oil extraction.

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