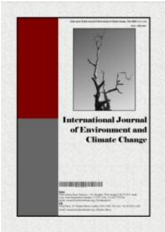

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Effect of Exogenous Application of Auxin on Leaf Cuttings of Mexican Snow Ball (*Echeveria elegans* Rose)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Succulents are on the rising trend of popularity due to its compromising behaviour with watering and durability indoors, creating a peaceful and healthy living condition. Thus it is the need of the hour to find a suitable propagation method or use of exogenous substances with propagation to assist regenerating new plants.

Study Design: The experiment was laid out in randomized block design (RBD) with three replications.

Place and Duration of Study: The present investigation entitled Effect of IAA and IBA Application on leaf cuttings of Mexican Snow Ball (*Echeveria elegans*). Was conducted in Research Field, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during February, 2021 to April, 2021.

Methodology: The experiment was laid out in randomized block design (RBD) with three (IAA 100 ppm, IAA 300 ppm, IAA 500 ppm, IBA 100 ppm, IBA 300, IBA 500 ppm, IAA + IBA (100 ppm + 500 ppm), IAA + IBA (500 ppm + 100 ppm) and Control replications. The treatment in each replication was allotted randomly. Nine treatments having one variety were tried in the experimental design.

Results: The results revealed that among all the treatments, application of IAA + IBA (100 ppm + 500 ppm) in treatment (T_8) took minimum days to rooting (9.00), number of leaves (16.56), number of shoots (2.56), shoot height (15.56 mm), shoot diameter (16.44 mm), root length (29.00 mm) and

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in economic point of view treatment T_8 IAA + IBA (100 ppm + 500 ppm) was found to be most economically viable in terms of gross return (Rs. 17,000), net return (Rs. 11,100) and benefit cost ratio (2.88).

Conclusion: According to the present investigation it is concluded that treatment IAA + IBA (100 ppm + 500 ppm) was found most effective in terms of growth of Echevaria (*Echevaria elegan*).

Keywords: IAA; IBA; Mexican snow ball; propagation; leaf cuttings; growth.

1. INTRODUCTION

Succulents are plants that survive in arid climates with mucilaginous substances that retain water. The word “succulent” comes from the latin word *sucus* meaning juice, or sap. Echeveria is the largest genus of flowering plants of the family Crassulaceae and are native to remote mountainous terrain between 1,000 and 4,000 feet elevation. Many of the 150 recognized species have been crossed to make new cultivars, of which there are well over a thousand. Most *Echeverias* that are cabbage-like, ruffled, crinkly or bumpy are hybrids *Echeveria spp*. stem from thick-leaved rosettes. eye are the most beloved of succulents, and are described as everlasting flowers, for their colorful rosettes that resembles the tightly cupped petals of rose [1]. Mexican snow ball (*Echeveria elegans*) is a bluish-green succulent that takes on a pink hue in the corners when exposed to bright sunlight. They form a compact rosette pattern and fleshy spoon shaped leaves. The leaves are usually 6 cm long and 2 cm wide. It offsets freely and forms a dense carpet of rosettes over time. From late winter to midsummer it sends up slender pinkish stems up to 1 foot tall which bears pinkish red flowers tipped with yellow. The specific epithet “elegans” refers to its elegant appearance. The plants are also popular as it can be propagated from leaves [2]. Cutting is the most popular way of multiplication of ornamental shrubs [3], but rooting success rate through conventional method of hardwood cuttings is very low. However, treatment of cuttings with auxins has been reported to improve rooting in many woody and semi woody species. Various auxins such as Indole Acetic Acid (IAA), Indole Butyric Acid (IBA),Naphthalene Acetic Acid (NAA) and 2,4-Dichloropheoxy Acetic Acid (2,4-D) have been reported to promote rooting in cuttings of the most of the plant species. Each auxin’s concentration varies from plant to plant and type of the cuttings used. IBA or IAA or combination of both is mostly recommended for rooting of cuttings. The use of plant growth regulators to increase the efficacy of propagation in cutting and layering are now common and moreover, use of growth regulators has opened a new vista for nursery men for propagation of ornamental plants trees [4]. The treatment of cuttings with auxins (NAA or IBA) has been reported to improve rooting in many woody species including Bougainvillea alba [5]. Application of plant growth regulators increases fast regeneration, growth and development of shoot and roots resulting in easy, early and more roots in cuttings [6]. The present studies were, therefore, undertaken to standardize the growth regulator (IBA and IAA concentration) treatment for survival and improving the rooting of leaf cuttings in Mexican snow ball.

2. MATERIALS AND METHODS

A field experiment was carried out at Horticulture experimental field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) in the month of February to April, 2021-2022 for studying the effect of auxins (IAA and IBA) application on leaf cuttings of mexican snow ball (*Echeveria elegans*). The treatments consisted were T_1 (Control), T_2 (IAA- 100 ppm), T_3 (IAA-300 ppm), T_4 (IAA- 500 ppm), T_5 (IBA-100 ppm), T_6 (IBA-300 ppm), T_7 (IBA-500 ppm), T_8 (IAA+ IBA-100 ppm + 500 ppm), T_9 (IAA+ IBA- 500 ppm + 100 ppm). The experiment was laid out in randomized block design (RBD) with three replications. The treatment in each replication was allotted randomly. Nine treatments having one variety were tried in the experimental design.The experiment was carried out by initially by leaf propagation from mother plants of Echeveria. Mother plants were provided by the Department of Horticulture, SHUATS, Prayagraj. A total of 25 mother plants were utilized to pluck mature leaves (pups) and 200 leaves were plucked and kept for propagating in a well-drained potting media. Potting mixture were prepared by using combination of cocopeat, vermicompost and perlite (2:1:1) for each treatment considering the size of pot 12 cm x 12 cm. For the preparation of IBA and IAA solutions standard amount of growth regulators was weighted. These amounts of growth regulators, then dissolved in small amount of alcohol containing few drops of ammonium hydroxide and finally diluted with distilled water. The final volume of each solution was maintained 250 ml. Quick dip method was adopted for treatment of the cuttings with IBA and IAA solutions. The basal 1.5-2.0 cm portion of the pups was dipped in growth regulator formulation for 2 minutes and immediately planted in medium to a depth of 1 cm. Pups were propagated two months before in individual paper cups and afterwards transplanted into terracotta pots on 6^{th} February 2021. The plants were placed carefully and given slight irrigation immediately. The pots were kept under 25 per cent green shade net. Standard cultural practices recommended for *Echiveria* was followed uniformly for all the experimental plots. The data obtained were analyzed statistically as per method described by Gomez and Gomez [7] and were tested at 5% level of significance (*p*=0.05).

3. RESULTS AND DISCUSSION

The data presented in Table 2 reveals that in general, different rooting hormone treatments produced significant effect on rooting at various stages. Least number of days (9.00) taken to rooting was recorded in the treatment T_8 i.e. IAA + IBA (100 ppm + 500 ppm), whereas, maximum days (19.22) was found in treatment T_1 (control). The results indicate the positive effect of auxins in *Echiveri* root initiation. Auxins are known to increase the cell division by increasing the level of endogenous cytokinins resulting in induction of more number of root primordial, exogenous application of auxins hastened the process of root initiation, similar findings also reported by Nanda and Kochhar [8]. Maximum concentration of IBA may have caused mobilization and utilization of carbohydrates and nitrogen fraction with the presence of co-factor at wound site which may have helped in better root initiation [9]. Similar trend of finding was also confirmed by Cabahug et al. [10] in Echeveria and Renuka et al. [11] in Carnation.

Results of the experiment showed that T_8 (IAA + IBA, 100 ppm + 500 ppm) had the highest leaves (5.67) after 30 days after treatment, much more than any other treatment, followed by T_9, which was also significantly more effective than the other treatments. However, T_1 had the lowest number of leaves (3.11). At 60 days post-treatment, the treatment T_8 had the highest number of leaves (13.89) followed by the treatment T_9 (13.11), both of which were significantly better than the other treatments. In contrast, the treatment T_1 (control), which had an intermediate response, had the lowest number of leaves (6.78). The highest number of leaves (16.56) was obtained in T_8 at 90 days after treatment, matching T_9 level (16.11). This could be caused by increased enzymatic activity and faster hormone transfer along the path of cell division and elongation [12]. This might be because the roots began to form earlier, there were more roots, and the roots were longer, allowing them to absorb more water and nutrients, leading to more leaves after planting [9]. Zepa et al. [13] in calendula and Bhatt and Chouhan [14] in african marigold reported similar outcomes.

In the present investigation, various rooting hormone treatments had a considerable impact on the quantity of shoots at different stages. At 30 days after treatment, T_8 had the highest number of shoots (1.11), and T_1 had the lowest number of shoots (0.22). Maximum number of shoots was reported in T_8 (1.89) and T_9 (1.56) at 60 days following treatment, both of which were noticeably better than other treatments. The bare minimum number of shoots noticed for T_1 treatment (0.22). At 90 days post-treatment, T_8 had the most shoots reported (2.56), which was significantly higher than other treatments. The greater number of shoots in IBA-treated cuttings may be attributable to the higher concentration of IBA stimulating early root initiation and faster root growth, more roots, longer roots, and other factors that improved the absorption of water and nutrients and improved shoot growth [15]. Auxin increased protein synthesis, cell development and cell division, which may have contributed to increased vegetative growth [16]. Similar results were reported by Zepa et al. [13] he in Calendula and Bhatt and Chouhan [14] in African marigolds.

The Different rooting hormone treatments produced a significant effect on shoot height per plant throughout the experimental period (Table 2). On 30 days after treatment, the maximum shoot height recorded in T_8 (7.89 mm) and the minimum shoot height in T_1 (4.44 mm). On the 60^{th} day after treatment, the maximum shoot height recorded in T_8 (13.11 mm), followed by T_9 (13.00 mm) which was significantly higher than the rest of the treatments. The minimum shoot height was recorded in T_1 (6.33 mm). At 90 days after treatment, maximum shoot height was recorded for T_8 (15.56 mm), significantly superior to the rest of the treatments. We found that the minimum shoot height in T_1 (7.89 mm).

Table 1. Analysis of variance (ANOVA) for six chacters in auxin treated leaf cutting in mexican snow ball

Source of variation	df	Number of days to rooting	Number of leaves			Number of shoots			Shoot height			Shoot diameter			Root length
			30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90DAT	30 DAT	60 DAT	90 DAT	90 DAT
Treatment	8	38.12	1.71	22.00	20.49	0.28	0.94	1.41	4.19	18.18	19.46	26.60	29.95	33.16	78.09
Error	16	0.52	0.19	1.36	1.12	0.04	0.04	0.09	0.21	0.76	0.66	0.28	0.22	0.54	1.80
Total	**26**	**315.41**	**17.09**	**198.67**	**183.81**	**2.89**	**8.16**	**13.02**	**36.89**	**158.03**	**167.07**	**218.01**	**243.96**	**273.97**	**671.69**

Table 2. Effect of auxins in rooting and growth parameters in *Echeveria elegans* leaf cuttings

Treatments	No. of days to rooting	Number of leaves			Number of shoots			Shoot height (mm)			Shoot diameter (mm)			Root length (mm)
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	
T_1 : Control	19.22	3.11	6.78	9.56	0.22	0.22	0.44	4.44	6.33	7.89	5.33	5.96	6.44	14.89
T_2 : IAA (100 ppm)	17.89	3.44	7.00	9.89	0.33	0.33	0.78	4.67	6.56	9.78	7.00	7.33	7.88	15.67
T_3 : IAA (300 ppm)	16.33	3.56	7.67	11.33	0.44	0.56	1.33	5.56	7.67	10.33	8.44	8.94	9.00	16.78
T_4 : IAA (500 ppm)	13.56	3.67	8.11	13.78	0.56	0.78	1.44	6.56	9.11	12.22	8.89	9.23	9.92	18.89
T_5 : IBA (100 ppm)	12.67	3.89	9.56	14.11	0.67	0.89	1.56	6.78	9.22	12.44	9.99	10.60	11.39	20.89
T_6 : IBA (300 ppm)	11.22	4.11	10.67	14.22	0.78	1.00	1.78	6.89	9.67	13.11	10.71	11.44	12.01	21.11
T_7 : IBA (500 ppm)	10.89	4.22	12.22	15.56	0.89	1.33	2.00	7.00	10.44	13.33	12.01	12.76	13.77	25.78
T_8 : IAA + IBA (100 ppm + 500 ppm)	9.00	5.67	13.89	16.56	1.11	1.89	2.56	7.89	13.11	15.56	14.78	15.87	16.44	29.00
T_9 : IAA + IBA (500 ppm + 100 ppm)	10.56	4.56	13.11	16.11	1.00	1.56	2.33	7.22	13.00	15.44	13.02	13.76	14.89	26.78
S.E.d (±)	0.59	0.35	0.95	0.86	0.15	0.17	0.24	0.37	0.71	0.66	0.43	0.38	0.60	1.09
C.D. (p=0.05)	1.25	0.75	2.02	1.83	0.33	0.35	0.51	0.79	1.50	1.41	0.92	0.81	1.27	2.32
CV (%)	5.37	10.72	11.72	7.86	29.26	21.34	18.55	7.18	9.19	6.65	5.31	4.37	6.51	6.36

This may be due to the fact that external application of auxin promoted growth and increased germination of dormant shoots on cuttings, resulting in the formation of more shoots per cutting. It was also observed that treating more roots per cut increased nutrient and water uptake and increased shoot production compared to all other treatments [17]. Similar results were reported by Zepa et al. [13] he in Calendula and Bhatt and Chouhan [14] in African marigolds.

Different rooting hormone treatments had significant effects on shoot diameter per plant throughout the experimental period. At 30 days post-treatment, the maximum shoot diameter was recorded in T_8 (14.78 mm), with a significant increase in shoot diameter over all other treatments, followed by treatment T_9 (13.02 mm) for the remaining was more significant than treatment. The minimum shoot diameter in the treatment was found in T_1 (5.33 mm). At 60 days after treatment, the maximum shoot diameter was recorded at T_8 (15.87 mm) followed by T_9 (13.76 mm), which was significantly superior to the rest of the treatments. The least shoot diameter recorded in T_1 (5.96 mm). At 90 days after treatment, maximum shoot diameter was recorded for treatments T_8 (16.44 mm) and T_9 (14.89 mm), which were significantly superior to the rest of the treatments. Minimum shoot diameters turned into observed in T_1 (6.44 mm). Application of auxin encouraged cuttings in a few approaches which include growing the basis number, root length; cause or provoke the manufacturing of root-selling chemical substances which include radiocarbon with inside the roots and for this reason growing shoot diameter. Optimal concentrations of IBA ought to result in the mobilization and usage of carbohydrates, nitrogen fraction, water and mineral nutrient absorption [18]. This result is in good agreement with that of Kumar et al. [19] they noted that IBA was more beneficial in his Nerium shoot diameter.

The highest root length was noticed in T_8 (29.00 mm), with a significant increase in root length over all other treatments, followed by T_9 (26.78 mm), which had a higher root length than the rest of the treatments. The minimum root length was found in T_1 (14.89 mm). The characteristic property of auxins was their action in stimulating the length of cells in their relevant growth stage. It appears likely that auxins initiate synthesis of structural enzyme proteins in the formation of adventitious root thus increasing the root length through the process of acidification [20]. The number of roots are increases by the application of auxin is a common feature in many herbaceous perennial crops [21]. Similar finding have been obtained by Sidhu and Singh [22] and Pratibha [23] in Chrysanthemum, Singh et al. [24] in Night Queen.

4. CONCLUSION

On the basis of the results obtained and discussion given above, it can be concluded that as compare to non-treated leaf cutting, IBA and IAA treated leaf cutting is capable not only increasing the number of produced roots, but also improving the other shoots characters in mexican snow ball. Among the different IBA and IAA concentrations, IAA + IBA (100 ppm + 500 ppm) was found most effective in terms of growth of Echevaria (*Echevaria elegan*) and may be used for easy and faster multiplication.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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