

1 **Effect of exogenous application of auxin on leaf**
2 **cuttings of Mexican Snow Ball (*Echeveria***
3 ***elegans* Rose)**

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7 **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 (T₈) 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 in economic point of view treatment T₈ 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 (100ppm + 500 ppm) was found most effective in terms of growth of Echevaria (*Echevaria elegan*).

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9 **Keywords:** IAA, IBA, Mexican snow ball, propagation, leaf cuttings, growth

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11 **1. INTRODUCTION**

12 Succulents are plants that survive in arid climates with mucilaginous substances that retain water. The
13 word "succulent" comes from the latin word *sucus* meaning juice, or sap. Echeveria is the

14 largest genus of flowering plants of the family Crassulaceae and are native to remote mountainous terrain
15 between 1,000 and 4,000 feet elevation. Many of the 150 recognized species have been crossed to make new
16 cultivars, of which there are well over a thousand. Most *Echeverias* that are cabbage-like, ruffled, crinkly or
17 bumpy are hybrids *Echeveria spp.* stem from thick-leaved rosettes. eye are the most beloved of succulents,
18 and are described as everlasting flowers, for their colorful rosettes that resembles the tightly cupped petals of
19 rose (Kapitany, 2007). Mexican snow ball (*Echeveria elegans*) is a bluish-green succulent that takes on a pink
20 hue in the corners when exposed to bright sunlight. They form a compact rosette pattern and fleshy spoon
21 shaped leaves. The leaves are usually 6 cm long and 2 cm wide. It offsets freely and forms a dense carpet of
22 rosettes over time. From late winter to midsummer it sends up slender pinkish stems up to 1 foot tall which
23 bears pinkish red flowers tipped with yellow. The specific epithet “elegans” refers to its elegant appearance.
24 The plants are also popular as it can be propagated from leaves (Raju and Mann, 1970). Cutting is the most
25 popular way of multiplication of ornamental shrubs (Bose *et al*, 1977), but rooting success rate through
26 conventional method of hardwood cuttings is very low. However, treatment of cuttings with auxins has been
27 reported to improve rooting in many woody and semi woody species. Various auxins such as Indole Acetic
28 Acid (IAA), Indole Butyric Acid (IBA),Naphthalene Acetic Acid (NAA) and 2,4- Dichloropheoxy Acetic Acid (2,4-
29 D) have been reported to promote rooting in cuttings of the most of the plant species. Each auxin’s
30 concentration varies from plant to plant and type of the cuttings used. IBA or IAA or combination of both is
31 mostly recommended for rooting of cuttings. The use of plant growth regulators to increase the efficacy of
32 propagation in cutting and layering are now common and moreover, use of growth regulators has opened a
33 new vista for nursery men for propagation of ornamental plants trees (Baghel *et al.*, 2016). The treatment of
34 cuttings with auxins (NAA or IBA) has been reported to improve rooting in many woody species including
35 Bougainvillea alba (Singh *et al.*, 2017). Application of plant growth regulators increases fast regeneration,
36 growth and development of shoot and roots resulting in easy, early and more roots in cuttings. The present
37 studies were, therefore, undertaken to standardize the growth regulator (IBA and IAA concentration) treatment
38 for survival and improving the rooting of leaf cuttings in Mexican snow ball.

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40 **2. MATERIAL AND METHODS**

41 A field experiment was carried out at Horticulture experimental field, Department of Horticulture, Naini
42 Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS),
43 Prayagraj (U.P.) in the month of February to April, 2021-2022 for studying the effect of auxins (IAA and IBA)
44 application on leaf cuttings of mexican snow ball (*Echeveria elegans*). The treatments consisted were T₁
45 (Control), T₂ (IAA- 100 ppm), T₃ (IAA-300 ppm), T₄ (IAA- 500 ppm), T₅ (IBA-100 ppm), T₆ (IBA-300 ppm), T₇
46 (IBA-500 ppm), T₈ (IAA+ IBA- 100 ppm + 500 ppm), T₉ (IAA+ IBA- 500 ppm + 100 ppm). The experiment was
47 laid out in randomized block design (RBD) with three replications. The treatment in each replication was
48 allotted randomly. Nine treatments having one variety were tried in the experimental design.The experiment

49 was carried out by initially by leaf propagation from mother plants of *Echeveria*. Mother plants were provided
 50 by the Department of Horticulture, SHUATS, Prayagraj. A total of 25 mother plants were utilized to pluck
 51 mature leaves (pups) and 200 leaves were plucked and kept for propagating in a well-drained potting media.
 52 Potting mixture were prepared by using combination of cocopeat, vermicompost and perlite (2:1:1) for each
 53 treatment considering the size of pot 12 cm x 12 cm. For the preparation of IBA and IAA solutions standard
 54 amount of growth regulators was weighted. These amounts of growth regulators, then dissolved in small
 55 amount of alcohol containing few drops of ammonium hydroxide and finally diluted with distilled water. The
 56 final volume of each solution was maintained 250 ml. Quick dip method was adopted for treatment of the
 57 cuttings with IBA and IAA solutions. The basal 1.5-2.0 cm portion of the pups was dipped in growth regulator
 58 formulation for 2 minutes and immediately planted in medium to a depth of 1 cm. Pups were propagated two
 59 months before in individual paper cups and afterwards transplanted into terracotta pots on 6th February 2021.
 60 The plants were placed carefully and given slight irrigation immediately. The pots were kept under 25 per cent
 61 green shade net. Standard cultural practices recommended for *Echiveria* was followed uniformly for all the
 62 experimental plots. The data obtained were analyzed statistically as per method described by Gomez and
 63 Gomez (1984) and were tested at 5% level of significance ($p=0.05$).

64 **Table 1 . Analysis of variance (ANOVA) for six chacters in auxin treated leaf cutting in Mexican snow**
 65 **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	90 DAT	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

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67 3. RESULTS AND DISCUSSION

68 The data presented in Table 2 reveals that in general, different rooting hormone treatments produced
 69 significant effect on rooting at various stages. Least number of days (9.00) taken to rooting was recorded in the
 70 treatment T₈ i.e. IAA + IBA (100 ppm + 500 ppm), whereas, maximum days (19.22) was found in treatment T₁ .
 71 (control). The results indicate the positive effect of auxins in *Echiveri* root initiation. Auxins are known to
 72 increase the cell division by increasing the level of endogenous cytokinins resulting in induction of more number
 73 of root primordial, exogenous application of auxins hastened the process of root initiation, similar findings also
 74 reported by Nanda and Kochhar (1985). Maximum concentration of IBA may have caused mobilization and
 75 utilization of carbohydrates and nitrogen fraction with the presence of co-factor at wound site which may have

76 helped in better root initiation (Baghel *et al.*, 2015). Similar trend of finding was also confirmed by Cabahug *et*
77 *al.*, (2016) in *Echeveria* and Renuka *et al.* (2014) in *Carnation*.

78 Results of the experiment showed that T₈ (IAA + IBA, 100 ppm + 500 ppm) had the highest leaves (5.67)
79 after 30 days after treatment, much more than any other treatment, followed by T₉, which was also significantly
80 more effective than the other treatments. However, T₁ had the lowest number of leaves (3.11). At 60 days post-
81 treatment, the treatment T₈ had the highest number of leaves (13.89) followed by the treatment T₉ (13.11), both
82 of which were significantly better than the other treatments. In contrast, the treatment T₁ (control), which had an
83 intermediate response, had the lowest number of leaves (6.78). The highest number of leaves (16.56) was
84 obtained in T₈ at 90 days after treatment, matching T₉ level (16.11). This could be caused by increased
85 enzymatic activity and faster hormone transfer along the path of cell division and elongation (Debnath and Maiti,
86 1990). This might be because the roots began to form earlier, there were more roots, and the roots were longer,
87 allowing them to absorb more water and nutrients, leading to more leaves after planting (Baghel *et al.*, 2015).
88 Zepa *et al.* (2011) in *calendula* and Bhatt and Chouhan (2012) in *african marigold* reported similar outcomes.

89 In the present investigation, various rooting hormone treatments had a considerable impact on the quantity
90 of shoots at different stages. At 30 days after treatment, T₈ had the highest number of shoots (1.11), and T₁ had the
91 lowest number of shoots (0.22). Maximum number of shoots was reported in T₈ (1.89) and T₉ (1.56) at 60 days
92 following treatment, both of which were noticeably better than other treatments. The bare minimum number of
93 shoots noticed for T₁ treatment (0.22). At 90 days post-treatment, T₈ had the most shoots reported (2.56), which
94 was significantly higher than other treatments. The greater number of shoots in IBA-treated cuttings may be
95 attributable to the higher concentration of IBA stimulating early root initiation and faster root growth, more roots,
96 longer roots, and other factors that improved the absorption of water and nutrients and improved shoot growth
97 (Tyagi and Patel, 2004). Auxin increased protein synthesis, cell development and cell division, which may have
98 contributed to increased vegetative growth (Evans, 1973). Similar results were reported by Zepa *et al.* (2011) he in
99 *Calendula* and Bhatt and Chouhan (2012) in *African marigolds*.

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

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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	
T₁ : 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
T₂ : 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
T₃ : 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
T₄ : 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
T₅ : 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
T₆ : 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
T₇ : 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
T₈ : IAA + IBA (100ppm + 500ppm)	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
T₉ : IAA + IBA (500ppm + 100ppm)	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

102 The Different rooting hormone treatments produced a significant effect on shoot height per plant throughout
103 the experimental period (Table 2). On 30 days after treatment, the maximum shoot height recorded in T₈ (7.89 mm)
104 and the minimum shoot height in T₁ (4.44 mm). On the 60th day after treatment, the maximum shoot height recorded
105 in T₈ (13.11 mm), followed by T₉ (13.00 mm) which was significantly higher than the rest of the treatments. The
106 minimum shoot height was recorded in T₁ (6.33 mm). At 90 days after treatment, maximum shoot height was
107 recorded for T₈ (15.56 mm), significantly superior to the rest of the treatments. We found that the minimum shoot
108 height in T₁ (7.89mm). This may be due to the fact that external application of auxin promoted growth and increased
109 germination of dormant shoots on cuttings, resulting in the formation of more shoots per cutting. It was also observed
110 that treating more roots per cut increased nutrient and water uptake and increased shoot production compared to all
111 other treatments (Sandesh *et al.*, 2018). Similar results were reported by Zepa *et al.* (2011) he in *Calendula* and
112 Bhatt and Chouhan (2012) in African marigolds.

113 Different rooting hormone treatments had significant effects on shoot diameter per plant throughout the
114 experimental period. At 30 days post-treatment, the maximum shoot diameter was recorded in T₈ (14.78 mm), with a
115 significant increase in shoot diameter over all other treatments, followed by treatment T₉ (13.02 mm) for the
116 remaining was more significant than treatment. The minimum shoot diameter in the treatment was found in T₁ (5.33
117 mm). At 60 days after treatment, the maximum shoot diameter was recorded at T₈ (15.87 mm) followed by T₉ (13.76
118 mm), which was significantly superior to the rest of the treatments. The least shoot diameter recorded in T₁ (5.96
119 mm). At 90 days after treatment, maximum shoot diameter was recorded for treatments T₈ (16.44 mm) and T₉ (14.89
120 mm), which were significantly superior to the rest of the treatments. Minimum shoot diameters turned into observed in
121 T₁ (6.44 mm). Application of auxin encouraged cuttings in a few approaches which include growing the basis number,
122 root length; cause or provoke the manufacturing of root-selling chemical substances which include radiocarbon with
123 inside the roots and for this reason growing shoot diameter. Optimal concentrations of IBA ought to result in the
124 mobilization and usage of carbohydrates, nitrogen fraction, water and mineral nutrient absorption (Shahzad *et al.*,
125 2019). This result is in good agreement with that of Kumar *et al.* (2020) they noted that IBA was more beneficial in his
126 Nerium shoot diameter.

127 The highest root length was noticed in T₈(29.00 mm), with a significant increase in root length over all other
128 treatments, followed by T₉ (26.78 mm), which had a higher root length than the rest of the treatments. The minimum
129 root length was found in T₁ (14.89 mm). The characteristic property of auxins was their action in stimulating the
130 length of cells in their relevant growth stage. It appears likely that auxins initiate synthesis of structural enzyme
131 proteins in the formation of adventitious root thus increasing the root length through the process of acidification
132 (Audus,1972). The number of roots are increases by the application of auxin is a common feature in many
133 herbaceous perennial crops (Hartmann *et al.*, 2002). Similar finding have been obtained by Sidhu and Singh
134 (2002) and Pratibha (2012) in *Chrysanthemum*, Singh *et al.*(2013) in Night Queen.

135

136 4. CONCLUSION

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

142 COMPETINGINTERESTS

143 Authors have declared that no competing interests exist.

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