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Effect of different concentrations of indole-3-butyric acid (IBA) on rooting of rosemary (*Rosmarinus officinalis*) under mist house environment

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Abstract
The investigation was carried out in Medicinal and Aromatic Plants Unit, Saidapur farm, Department of Horticulture, University of Agricultural Sciences, Dharwad, Karnataka to study the effect of different concentrations of Indole-3-butyric acid (IBA) on rooting of rosemary (*Rosmarinus officinalis*) under mist house environment during the year 2015-16 and 2016-17. Two types of cuttings (Tip cutting and Median cutting) were treated with different concentrations of Indole-3-butyric acid (IBA) (250, 500, 750 and 1000 ppm) by quick dip method. The cuttings treated with IBA were planted in polybags (containing red soil and FYM in equal proportion) and placed under mist house environment. There were 12 treatment combinations *viz*., T_1- Tip cutting + water dipping (open), T_2- Tip cutting + water dipping, T_3- Tip cutting + IBA 250 ppm, T_4- Tip cutting + IBA 500 ppm, T_5- Tip cutting + IBA 750 ppm, T_6- Tip cutting + IBA 1000 ppm, T_7- Median cutting + water dipping (open), T_8- Median cutting + water dipping, T_9- Median cutting + IBA 250 ppm, T_{10}- Median cutting + IBA 500 ppm, T_{11}- Median cutting + IBA 750 ppm, T_{12}- Median cutting + IBA 1000 ppm. Each treatment was represented by 100 cuttings replicated thrice. The experiment was laid out in two factorial randomised block design. It was observed that the rooting response of rosemary varied with type of cuttings and different concentrations of Indole-3-butyric acid (IBA). Highest number of roots (41.83), length of longest root (19.76 cm) and per cent rooting (98.78 %) were recorded under tip cuttings treated with IBA 500 ppm followed by tip cuttings treated with IBA 750 and 1000 ppm which was placed under mist house environment. Hence, Indole-3-butyric acid (IBA) 500 ppm was found to be the best for mass multiplication of this plant under mist chamber condition

Keywords: Rosemary, rooting, IBA, cuttings, mist house environment

Introduction
Among horticulture crops, medicinal and aromatic plants form one of the important groups which have a unique role in sustaining pharmaceutical, perfumery and cosmetic industries in India (Raviprasad Sajjan and Venugopal, 2017) [9]. Out of thousands of aromatic plants, few have attained the status of commercial crops which are being cultivated on large scale. Rosemary is one such aromatic plant which is being cultivated in India.

Rosemary (*Rosmarinus officinalis*) belongs to the family lamiaceae (labiatae) and is native to north and south coasts of the Mediterranean Sea and northwestern Spain. It is widely distributed in Europe and South-Eastern Asia (Barata *et al*., 2016) [1]. Rosemary is a woody, perennial herb with fragrant evergreen needle-like leaves and a lovely fragrance. It has opposite, simple, entire, evergreen leaves that are a shiny green on top and whitish below. The plant begins to bloom in the late spring and continues through the summer. Flowers are usually blue although there are cultivars with pink or white blooms (Kiuru *et al*., 2015) [5].

In recent past decades, an increasing evidence indicates the positive role of traditional medicinal plants in the prevention or control of some metabolic disorders like diabetes, heart diseases and certain types of cancers. Among the herbal extracts reported to have antioxidant activity, rosemary is one of the most widely commercialized plant extracts; it is used as a culinary herb for flavoring and as an antioxidant in processed foods and cosmetics (Paradikovic *et al*., 2013) [8].

Rosemary is commonly used as a spice and flavoring agent in food processing. The plant has been used extensively as a culinary spice in a variety of contexts. Leaves are finely chopped and used to flavour dishes. Rosemary leaves flavor soups and beverages in India. Finely minced leaves can enhance stews, casseroles, fish, potatoes, salads, pasta and breads such as focaccia. Rosemary and its extracts also are used as food preservatives and enhancers of sensory and functional properties (Louay *et al*., 2014) [7].

Rosemary propagation is done through either seed or stem cutting. Seeds of rosemary are rarely used in propagation as they are slow to germinate, taking 3–4 weeks before emergence with a poor germination rate of 10–20 %. Cutting is a well-known common and relatively cheap method used in the propagation of many ornamental plant species. It overcomes the difficulties of propagation by plant seeds Elhaak *et al*. (2015) [3]. Propagation of plants from cuttings enables a large percentage of the cuttings to produce roots quickly. Therefore, propagation of rosemary by cuttings was tried in the present study.

It has been widely documented that auxins eg. Indole-3-butyric acid promotes adventitious root development of stem cuttings through their ability to promote the initiation of lateral roots primordia and to enhance transport of carbohydrates to the cutting base needed for root growth. The purpose of treating cuttings with auxins is to increase the percentage of rooting, root initiation, number and uniformity of rooting.

Keeping these points in view, the present experiment was conducted to study the effect of different concentrations of IBA on rooting of rosemary (*Rosmarinus officinalis*) under mist house environment.

2. Materials and Methods

The investigation was carried out in Medicinal and Aromatic Plants Unit, Saidapur farm, Department of Horticulture, University of Agricultural Sciences, Dharwad, Karnataka to study the effect of different concentrations of Indole-3-butyric acid (IBA) on rooting of rosemary (*Rosmarinus officinalis*) under mist house environment. Apical stem cuttings with 4-5 buds (12-15 cm) from rosemary plants were collected in the morning hours and trimmed properly by retaining sufficient apical leaves on the cuttings.

The different types of cuttings (Tip cutting and Median cutting) were treated with different concentrations of IBA (250, 500, 750 and 1000 ppm) by quick dip method. The cuttings treated with IBA were planted in black polythene polybags of size $3^{1/2} \times 5$ inch (containing red soil and Farm Yard Manure in equal proportion) and placed under mist house environment. There were 12 treatment combinations *viz*., T_1- Tip cutting + water dipping (open), T_2- Tip cutting + water dipping, T_3- Tip cutting + IBA 250 ppm, T_4- Tip cutting + IBA 500 ppm, T_5- Tip cutting + IBA 750 ppm, T_6- Tip cutting + IBA 1000 ppm, T_7- Median cutting + water dipping (open), T_8- Median cutting + water dipping, T_9- Median cutting + IBA 250 ppm, T_{10}- Median cutting + IBA 500 ppm, T_{11}- Median cutting + IBA 750 ppm, T_{12}- Median cutting + IBA 1000 ppm. Each treatment was represented by 100 cuttings replicated thrice. The experiment was laid out in two factorial randomized block design. Five representative plants in each treatment and in each replication were randomly selected, tagged and observations on root characters *viz*., number of roots per cutting, length of longest root and per cent rooting were recorded after 45 days of initiation of experiment and their mean values were recorded. The data were subjected to statistical analysis.

3. Results and Discussion

The data pertaining to various root parameters as influenced by treating the rosemary cuttings by different concentrations of IBA treatments under mist house environment are presented in Table 1. The experiment was conducted for two years and pooled data is presented herewith. The different concentrations of growth regulator (IBA) treatments had a significant effect on different root parameters. There was a significant influence of treatments on rooting parameters such as per cent rooting, number of roots per cutting and length of the longest root.

Among different concentrations of IBA treatments, higher rooting (98.78 %) was recorded in the tip cuttings treated with 500 ppm IBA followed by tip cuttings treated with 1000 ppm IBA (96.55 %) which were significantly superior over other treatments. This effect may be due to the action of IBA, which has caused enhanced hydrolysis and translocation of carbohydrates and nitrogenous substances at the base of cuttings and resulted in accelerated cell elongation and cell division in suitable environment (Elhaak *et al*., 2015) [3]. Growth regulators play tremendous role in increasing rooting and apical bud dominance (Kiuru *et al*., 2015) [5]. These results of the present investigation are in close agreement with the findings of Venugopal *et al*. (2008) [11] and Liljana *et al*. (2017) [6].

The number of roots per cutting was significantly higher in the tip cuttings treated with 500 ppm IBA (41.83) followed by tip cuttings treated with 750 ppm IBA (40.76). The higher number of roots may be attributed to auxin application which is a common feature in many herbaceous perennial crops. The increased number of roots to optimum concentration of IBA may be also due to increased rate of respiration, accumulation of higher level of amino acids at their bases. This pattern is continued with nitrogenous substances accumulating in basal part of treated cuttings, apparently mobilized in the upper part and translocated as aspargine and also higher partitioning of photosynthates towards root development (Yashaswini Sharma *et al*., 2011) [12]. These findings are well corroborated with the findings of Beemnet and Solomon (2012) [2], Ingle and Venugopal (2009) [4] and Taleb and Ahmad (2013) [10].

Maximum length of the root was obtained in the tip cuttings treated with 1000 ppm IBA (19.81 cm) followed by tip cuttings treated with 500 ppm IBA (19.76 cm). Auxins accelerate the translocation of nutrients from upper part of the cuttings to their basal ends by increasing the activity of enzymes. This increases hydrolysis of carbohydrates for providing enough energy in rooting respond of the cells. It may also be attributed to slow translocation or slow destruction property by auxin destroying enzyme system (Louay *et al*., 2014) [7] and (Paradikovic *et al*., 2013) [8]. As reported by Beemnet and Solomon (2012) [2] occasionally IBA treatment seems to stimulate cell division in the ray cells between the primary bundles which improves root length and increased uniformity of rooting. These findings are in conformity with the findings of Liljana *et al*. (2017) [6] and Elhaak *et al*. (2015) [3].

Among different types of cuttings, highest number of roots, length of longest root and per cent rooting was recorded in tip cuttings than median cuttings. For many years propagation ability has been known to vary between cuttings from different parts of the same plant and this was correlated with structure of the stem or difference in chemical composition of the plant along the stem. This significance increase in tip cuttings could be due to high concentration of endogenous root promoting substances in the tip cuttings which arise from the terminal buds and also “more cells” which are capable of becoming meristematic and resulted in accelerated cell elongation and cell division. The median cuttings could have more maturity of stem, less number of leaves and low meristematic activity to develop roots than the tip cuttings (Beemnet and Solomon, 2012) [2]. The difference in rooting due to cutting position can be related to the difference in the chemical composition of the shoots. These results of the present investigation are in close agreement with the findings of Venugopal *et al*. (2008) [11] and Liljana *et al*. (2017) [6].

Table 1: Effect of different concentrations of IBA on rooting of rosemary under mist environment

S. No.	Treatments	2015-16			2016-17			Pooled		
		No. of roots per cutting	Length of longest root (cm)	Per cent rooting (%)	No. of roots per cutting	Length of longest root (cm)	Per cent rooting (%)	No. of roots per cutting	Length of longest root (cm)	Per cent rooting (%)
T_1	Tip cutting + water dipping (open)	21.58	7.21	35.00	24.15	9.57	39.00	22.75	8.33	37.10
T_2	Tip cutting + water dipping	33.51	12.38	91.67	36.17	15.19	88.15	34.78	13.55	89.77
T_3	Tip cutting + 250 ppm IBA	33.13	13.07	91.67	37.58	16.18	90.55	35.19	14.80	90.79
T_4	Tip cutting + 500 ppm IBA	39.47	18.51	98.33	43.18	21.55	99.38	41.83	19.76	98.78
T_5	Tip cutting + 750 ppm IBA	39.20	17.25	95.00	42.57	19.18	96.75	40.76	18.33	96.15
T_6	Tip cutting +1000 ppm IBA	34.53	18.12	95.00	38.53	21.20	97.13	36.33	19.81	96.55
T_7	Median cutting + water dipping (open)	13.00	8.10	5.00	18.35	11.83	22.00	15.78	10.20	13.19
T_8	Median cutting + water dipping	9.20	8.87	46.67	17.80	12.78	50.57	14.81	10.81	48.76
T_9	Median cutting + 250 ppm IBA	32.67	9.85	58.33	29.10	13.35	62.15	31.37	11.77	60.60
T_{10}	Median cutting + 500 ppm IBA	40.93	10.07	45.00	31.56	14.07	49.88	36.51	12.28	47.68
T_{11}	Median cutting + 750 ppm IBA	40.40	9.05	65.00	32.85	12.38	68.17	37.19	10.99	66.98
T_{12}	Median cutting + 1000 ppm IBA	39.93	9.70	66.67	34.90	12.89	71.53	36.87	11.23	69.13
	SEm±	4.188	1.685	7.444	4.57	1.72	7.81	4.08	1.70	7.39
	CD @ 5%	12.282	4.941	21.829	13.07	5.24	23.18	12.12	5.19	22.09

4. Conclusion

Thus, based on the study it can be concluded that for mass multiplication of rosemary, the tip cuttings treated with IBA 500 ppm under mist house environment is found suitable for getting higher per cent rooting, number of roots per cutting and length of the longest root.

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