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Influence of type of cuttings and growth regulators on rooting in Indian Borage (*Coleus aromaticus* L.)

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Abstract
The experiment was conducted at Horticulture College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2016-2017 to assess the influence of the type of cuttings and growth regulators on Indian Borage (*Coleus aromaticus* L.). The experiment was laid out in a Factorial Completely Randomized Block Design (FCRD) with fifteen treatment combinations and replicated thrice. Higher rooting (94.86 %), survival percentage (94.87 %), days taken for shoot initiation (4.13 days) and days taken for root initiation (5.03) was recorded in softwood cuttings when compared to semi-hardwood and hardwood cuttings. Among the growth regulators, IBA @ 200 ppm enhanced rooting percentage(67.10 %) and survival percentage (69.01) besides improving the characters *viz*., days taken for root initiation (8.62 days), number of leaves sprouted (10.35), number of roots (30.90)and length of roots (15.49cm). Early sprouting (6.03 days) was observed in 1AA @ 200 ppm. The interaction effect of cuttings and growth regulators indicated that softwood cutting treated with IBA at 200 ppm was efficient to induce better sprouting and rooting than semi-hardwood and hardwood cuttings.

Keywords: cuttings and growth regulators, rooting in Indian Borage

Introduction
Coleus aromaticus Benth. (Syn. *Plectranthus amboinicus* Lour. Spreng; *Plectranthus aromaticus* Roxb. *Coleus amboinicus* Lour) is a small bushy herb growing to a height of 30-90 cm. The stem is hairy fleshy, leaves are 2.50- 5.08 cm in length, roundish, dentate, hairy, thick and fleshy resembling heart shape. The flowers are small, blue or purplish in colour with four petals. The species is well known in India and more relished by people asa medicinal species for preventive health care. The plant is easy to grow, aromatic, decorative and amenable to pot culture as well as home gardens. It is grown in different parts of India *viz*., Tamil Nadu, Karnataka, Northeastern states mainly West Bengal, Manipur, and Assam. The leaves possess antibacterial effect and preferred as home grown plant as aremedy against the common cold, throat inflammation and cough (Nadkarni *et al*., 2002) [1]. It is commonly known as 'country borage' or 'Indian borage' or '*pathorchur*' or '*ajwainpatta*' or '*Karpooravalli*'. It is recorded in the Indian system of medicine as one of the sources of *Pashanabheda* (Chopra *et al*., 1956) [2]. *Coleus aromaticus* is used for seasoning meat dishes and in food products, while a decoction of its leaves is administered in cases of chronic cough and *asthma*. It is considered to be an antispasmodic, stimulant and stomachic and is used for the treatment of headache, fever, epilepsy and dyspepsia. It is used to treat conditions such as indigestion, diarrhoea, nervous tension, insect bites, toothache, earache, rheumatism, whooping cough, and bronchitis (Warrier and Nambier 1996) [3]. The leaf juice is a powerful aromatic decoction which is used in digestive disorders in children. The expressed juice is applied round the orbit to relieve the pain in conjunctivitis. It is widely used in making native medicines (Ayurveda, Homeopathy, Unani and Siddha). This herb is traditionally used for burns and insect bites as an external application, while internally it is used as a carminative and to control *asthma*. Although *Coleus aromaticus* is grown mainly as a home garden medicinal plant, there is adequate scope for introduction of this species as a commercial crop in the near future due to the growing need for its raw material (whole plant). Under such scenario, it is pertinent to investigate methods to improve the productivity of the crop for the benefit of farmers and the AYUSH industry.

Of all parameters, quality planting material is considered vital to ensuring uniformity in field establishment as well quality of the produce. Offering suitable agro-techniques and promoting cultivation of this economically important plant is the best option for meeting the demand and for sustainable utilization. Hence, the present study was conducted to standardize the propagation method in *coleus aromaticus.*

Material and Methods

The experiment was conducted to standardize the propagation techniques in Indian Borage (*Coleus aromaticus* L.) at the Department of Medicinal and Aromatic Crops, Horticultural College & Research Institute, Tamil Nadu Agricultural University, Coimbatore during the year, 2016-17.The experiment consisted of 15 treatments laid out in Factorial Completely Randomized Design (FCRD) inside the mist chamber. Each treatment was replicated thrice and in each treatment, 30 cuttings were planted. The experiment involves three types of cuttings (C) *viz.,* softwood cutting, Semi-hardwood cutting and Hardwood cutting as main treatments and five different doses of growth regulators as sub-treatments *viz.,* IBA (200 ppm), IBA (300 ppm), IAA (200 ppm), IAA (300 ppm) and Control.

Results

The data on a number of days for sprout initiation in cuttings was significantly influenced by different types of cuttings as well as growth regulators (Table 1). Among the type of cuttings, softwood cuttings sprouted earlier (4.13 days) than hardwood cuttings (9.25 days). Among the growth regulators, IAA at 200 ppm took a minimum number of days (6.02) for sprout initiation, while in control (7.93) is being observed. The interaction effect between the type of cuttings and the growth regulators showed significant influence. Softwood cuttings which were treated with IBA 200ppm sprouted in 3.93 days while hardwood cuttings took 10.60 days. The data on a number of days for root initiation was significant for various types of cuttings, growth regulators as well as the interaction effect (Table 1). Among the three cuttings used, softwood cuttings rooted earlier (5.03 days) while hardwood cuttings took (12.93 days). Among the growth regulators, IBA at 200 ppm influenced early root initiation (8.62 days) while in control (9.64 days) was observed. The two-way interaction between the factors showed significant result wherein, softwood cuttings treated with IBA 200 ppm sprouted early (4.66 days) while hardwood cuttings with no growth regulator treatment took (14.13 days).

Significant variation was observed with respect to total number of leaves among the three types of cutting, growth regulator treatments and their interaction (Table 2). Softwood cuttings recorded a higher number of leaves (11.11) than semi-hardwood cuttings (8.69) and hardwood cuttings (8.48). In case of growth regulators, IAA @300ppm registered more number of leaves (10.57), while IAA at 200ppmrecorded fewer number (8.24).In the case of two-way interaction, significant variation was observed in which softwood cuttings treated with 300 ppm produced more number of leaves (12.73) than rest of the treatment combinations.

The data on length of roots among different types of cutting, growth regulator treatments and their interaction was significant (Table 3). Between the three types of cuttings, softwood cutting was significantly superior by striking longer roots (18.42 cm). Among the growth regulators used, higher root length (15.49) was registered in IBA while the length (12.72 cm) was lowest in control. The interaction effect revealed that softwood cuttings treated with 200 ppm produced longer roots (19.33 cm) than rest of the treatment combinations. In control, the length of roots was lowest (8.74 cm).Significant result was obtained due to the different types of cutting, growth regulators and their interaction which was revealed on the data on number of roots per cutting (Table 2). Among the cuttings, softwood cutting registered higher number of roots (44.94) and was superior to the other two cuttings *viz.,* semi hardwood cuttings (23.47) and hardwood cuttings (19.50). Among the growth regulators tried, IAA at 300ppm recorded a higher number of roots at 60 days after planting (32.60) while in control (22.26). Among the interaction, softwood cutting with IBA at 200ppm recorded the highest number of roots (50.80) than rest of the combinations while the lowest number was recorded in control (13.06 roots).

The rooting percentage was significantly influenced by types of cuttings, growth regulators and their interactions (Table 4). Highest rooting percentage (94.86%) was recorded in softwood cuttings and was significantly higher than in semi-hardwood cuttings and hardwood cuttings which registered (47.14 %) and (49.86%) respectively. Among the growth regulators, IBA at 200ppm exhibited higher rooting percentage (67.10%) while in control (60.20 %).Among the interaction treatments, softwood cutting with IBA at 200ppm registered the highest rooting percentage (97.40 %) while semi hardwood cuttings which received no growth regulator treatment registered the lowest percentage (42.20).

The data on survival percentage of cuttings showed significance among the types of cuttings and the growth regulators while the interaction effect was not significant. Among the cuttings, softwood cutting exhibited significantly higher survival percentage (94.87%) than semi-hardwood cuttings (49.14%) and hardwood cuttings (52.14%) (Table 4). Among the growth regulators, the survival percent was more (69.06 %) in IBA while it was the lowest (60.20%) in control. Even though the data on interaction effect was not significant, the highest survival percent (97.40 %) was recorded in softwood cuttings treated with IBA 200ppm while semi-hardwood cuttings without any growth regulator treatment recorded the lowest (42.20%).

Table 1. Effect of growth regulators and type of cuttings on number of days taken for sprout and shoot initiation.

Type of cuttings	Number of days taken for sprout initiation						Number of days taken for root initiation					
	H_1	**H_2**	**H_3**	**H_4**	**H_5**	**Mean**	**H_1**	**H_2**	**H_3**	**H_4**	**H_5**	**Mean**
C_1	3.93	4.00	4.20	3.94	4.60	4.13	4.66	5.06	5.00	5.33	5.13	5.03
C_2	5.96	5.66	5.53	6.73	8.60	6.49	8.73	8.53	9.26	9.26	9.66	9.08
C_3	8.80	9.00	8.53	9.33	10.60	9.25	12.46	12.66	12.80	12.60	14.13	12.93
Grand mean	6.23	6.28	6.02	6.66	7.93	6.62	8.62	8.75	9.02	9.06	9.64	9.01
Interaction	C		H		C*H		C		H		C*H	
SE (d)	0.06		0.08		0.14		0.12		0.16		0.28	
CD	0.13**		0.17**		0.29**		0.26**		0.33**		0.58**	
NS- Non Significant, * Significant, ** Highly Significant												

Table 2. Effect of growth regulators and type of cuttings on number of leaves and number of roots.

Type of cuttings	Number of leaves						Number of roots					
	H_1	**H_2**	**H_3**	**H_4**	**H_5**	**Mean**	**H_1**	**H_2**	**H_3**	**H_4**	**H_5**	**Mean**
C_1	10.73	12.73	9.26	12.06	10.80	11.11	50.80	48.40	41.83	46.26	37.43	44.94
C_2	10.60	8.26	7.13	8.93	8.53	8.69	23.46	25.33	27.40	24.90	16.30	23.47
C_3	9.66	7.66	8.33	10.73	6.20	8.48	18.43	18.30	21.20	26.63	13.06	19.50
Grand mean	10.35	9.55	8.24	10.57	8.51	9.44	30.90	30.67	30.14	32.60	22.26	29.31
Interaction	C		H		C*H		C		H		C*H	
SE (d)	0.26		0.34		0.59		0.89		1.15		1.99	
CD	0.54**		0.69**		1.20**		1.82**		2.35*		4.07**	
NS- Non Significant, * Significant, ** Highly Significant												

Table 3: Effect of growth regulators and type of cuttings on length of roots (cm)

Type of cuttings	Length of roots (cm)					
	H_1	**H_2**	**H_3**	**H_4**	**H_5**	**Mean**
C_1	19.33	15.00	18.93	19.20	19.20	18.42
C_2	12.98	12.16	12.76	9.17	8.74	11.16
C_3	14.16	11.68	13.70	11.40	9.52	12.09
Grand mean	15.49	12.95	15.13	13.26	12.72	13.91
Interactions	C		H		C*H	
SE (d)	0.37		0.47		0.82	
CD	0.75**		0.97**		1.69**	
NS- Non Significant, * Significant, ** Highly Significant						

H_1- IBA@200ppm H_2- IBA @300 ppm H_3- IAA @200 ppm H_4- IAA @300 ppm H_5- Control	C_1- Softwood cutting C_2- Semi-hardwood cutting C_3- Hardwood cutting

Table 4: Effect of growth regulators and type of cuttings on rooting and survival per cent

Type of cuttings	Rooting percent						Survival percent					
	H_1	**H_2**	**H_3**	**H_4**	**H_5**	**Mean**	**H_1**	**H_2**	**H_3**	**H_4**	**H_5**	**Mean**
C_1	97.40	94.10	95.20	94.30	93.30	94.86	97.40	94.10	95.20	94.36	93.30	94.87
C_2	50.30	46.80	50.30	46.10	42.20	47.14	52.50	48.50	53.30	49.30	42.20	49.14
C_3	53.61	52.30	49.80	48.50	45.10	49.86	57.30	54.50	52.50	51.30	45.10	52.14
Grand mean	67.10	64.40	65.10	62.96	60.20	63.90	69.06	65.70	67.00	64.95	60.20	65.83
Interaction	C		H		C*H		C		H		C*H	
SE (d)	0.50		0.65		1.12		1.11		1.44		2.50	
CD	1.02**		1.32**		2.30*		2.28 **		2.95 **		5.11 NS	
NS- Non Significant, * Significant, ** Highly Significant												

Discussion

Coleus aromaticus is a succulent plant propagated by vegetative means. In this study on propagation using three different types of cutting, softwood cuttings rooted early with higher rooting per cent and shoot induction. The higher rooting percentage might be due to the presence of high level of endogenous auxins in vegetative shoots and also due to the inherent ability of the species to root. It is a well-established fact that exogenous treatment of growth regulators influences induction rooting in difficult to root crops or to enhance rooting in otherwise normal rooting plants in the vegetative propagation of horticultural crops. Auxin based growth regulators such as IBA, IAA and combination of IBA and IAA are extensively used for propagation of horticultural crops. Increase in percentage of rooting by growth regulators (IBA and NAA) was observed by earlier workers in Indian lavender (Somappa, 1979 and Chandramouli, 2001) [4, 5], in clerodendron, (Jamal *et al*., 2016 and Elhaak *et al*. 2015) [6, 7] and in patchouli (Kumar *et al*., 2014 and Sabathino *et al.*, 2014) [8]. In the present study, the survival percentage was highest in softwood cuttings treated with IBA 200 followed by IAA as supported by Debnanth and Maiti, (1990) [10] and Jamal *et al*. (2012) [11] who explained the basis for the establishment of plants rooted through auxin that it promotes early rooting and slow destruction by auxin destroying enzyme system. Regarding the number of roots, cuttings treated with IBA rooted better when compared to the control. It might be due to the enhanced hydrolysis of carbohydrates caused by auxin treatment (Rajarama, 1997) [12]. Further, Krishnamurthy (1981) opined that auxins would bring about various physiological changes, but the mechanism by which these changes are brought about is not fully understood except for the effect of auxin on cell elongation. The better response to the optimum concentration of IBA may beattributed to increased rate of respiration, accumulation of higher level of amino acids at their bases, than untreated cuttings. This pattern continued with nitrogenous substances accumulating in the basal part of treated cuttings, apparently mobilized in the upper part and trans located as asparagine (Strydom and Hartman, 1960) [14]. Kumar *et al.* (2014) [8] observed the same pattern in patchouli wherein the highest number of root was achieved due to IBA. Cuttings treated with IBA at 200 ppm performed better in inducing root growth which was evident by the length of root over other treatments. Somappa (1979) [4], Vijaykumar, (1973); Jayashankar *et al*. (1990), Singh, (2001), Kumar *et al*. (2014), Saglam *et al*. (2013) and Singh *et al*. (2003) supported this finding who correlated the root growth due to the action of auxin activity which might have caused hydrolysis and translocation of carbohydrate and nitrogenous substances at the base of cuttings and resulted in accelerated cell elongation and cell division in suitable environment. Another possible reason may be due to the early formation of roots and more utilization of reserved food materials of the treated cuttings under mist condition (Ghantnatti, 1997). Debanath and Maiti, (1990) [10] explained the cause for increase in dry weight of induced shoots through growth regulator treatment and that the dry weight was related with a number of roots and mean length of the roots. Auxin treatment induced higher number of primary and secondary roots which might have resulted in cell elongation of these roots through cell division. In present study, the root system as influenced by IBA 200 ppm may be due to enhancement of hydrolysis of nutrient reserves (mainly starch) by auxin treatments. According to Nanda *et al*, (1968) [22] enhanced hydrolysis activity in the presence of exogenous applied hormones was responsible for increased rooting in auxin treated cuttings. Chandramouli (2001) [5] also recorded early shooting, higher number of sprouts with IBA @ 200 ppm. Earliness in sprouting increases number of sprouts and greater sprout length which may be due to better utilization of stored carbohydrates, nitrogen and other factor with the of growth regulator. Further, stored food materials with the aid of growth regulator would have hastened the sprouting there by enhancing and utilization of carbohydrates, at the base of the cuttings through photosynthesis. Similar observation was made by Sevik *et al*. (2013). The number of leaves in cuttings were found to be higher when treated with IAA300 ppm when compared to other treatments. Chandramouli (2001) [5] attributed this factor to shoot growth which probably might have increased the number of nodes that led to development of more number of leaves under ambient condition. In patchouli, a similar work was published by Kumar *et al*. (2014) [8]. In addition to the growth regulator, rooting can be induced by favourable condition like higher temperature (30-350 C) and high relative humidity (85-90%) through intermittent misting. These factors attribute for reduced transpiration and respiration rate associated with higher photosynthetic activity which promotes better rooting in cutting (Hartmann and Kester, 1986) [26].

Conclusion

It can be concluded that softwood cutting treated with IBA at 200 ppm was efficient to induce better sprouting and rooting than semi-hardwood and hardwood cuttings.

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