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Response of Orthotropic and Plagiotropic Sucker Cuttings to Growth Promoters in Coffee (*Coffea canephora* L.)

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ABSTRACT

Coffee cultivation relies on effective propagation methods to sustain and expand plantations. Clonal propagation is crucial technique, ensuring the consistent reproduction of elite coffee plants. Furthermore, the periodic manual removal of suckers not only maintains the coffee plants but also provides potential explants for vegetative propagation. Thus, an experiment was conducted to study the response of orthotropic and plagiotropic sucker cuttings of robusta coffee (*Coffea canephora* L.) at Adi nursery, Suntikoppa, Kodagu. The experiment consisted of 16 treatments comprising of two factors namely shoot cuttings (at two levels S_1- orthotropic and S_2- plagiotropic cuttings) and growth promoters (at eight levels G_1-control, G_2-IBA@1000 ppm, G_3-IBA@2000 ppm, G_4-NAA@200 ppm, G_5-NAA@400 ppm, G_6-*Azospirillum* @10g/bag, G_7-*VAM* @5g/bag and G_8-*Azospirillum* @10g + *VAM* @5g /bag). Across all parameters, orthotropic cuttings consistently outperformed plagiotropic cuttings. G_8 (*Azospirillum* @10g + *VAM* @5g /bag) found to be the most effective growth promoter for sprouting and shoot growth. Meanwhile, G_3 (IBA @ 2000 ppm) showed superior results for root growth. Among the interactions, S_1G_8 (orthotropic + *Azospirillum*@ 10g/bag+*VAM* @5g/bag) recorded highest values for shoot and sprouting parameters *i.e.*, per cent sprouting, shoot length, number of leaves, leaf area and collar girth. On the other hand, S_1G_3 (orthotropic + IBA @ 2000 ppm) recorded highest values for root parameters *i.e.,* longest roots, primary and secondary roots, root volume, and rooting percentage.

Key words: *Azospirillum, VAM, Growth promoters, Orthotropic suckers, Plagiotropic cuttings*

Introduction

Coffee is a tropical evergreen shrub grown for its seeds or beans, which are used to make the revitalizing drink known as 'coffee'. Arabica coffee is renowned for its superior quality and value, grown in cooler, elevated tropics, while Robusta coffee grown in warmer, lower elevations, offers lower quality and lower prices (Mangal, 2015). Coffee is commercially propagated by seeds, but it can also be propagated vegetatively through stem cuttings or grafting. Plants propagated by cutting are more produc-

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tive than plants propagated by seeds (Junqueira *et al*., 2006 and Partelli *et al*., 2006). Vegetative propagation of coffee by stem cutting maintains uniformity since it preserves the genetic make-up of the planting materials, whereas, seed propagation results in genetic variability due to heterozygosity (Kumar *et al*., 2006).

Coffee produces two types of shoots namely lateral (plagiotropic) and vertical (orthotropic). Only the orthotropic shoots, elongated branches (suckers) can be used to produce a shrub with a normal habit. Cuttings from plagiotropic produce abnormal, low, creeping with a shrubby habit (Mangal, 2015). Thus, orthotropic suckers are preferred for clonal propagation over plagiotropic suckers as it maintains lateral growth, resulting in a bushy canopy.

Coffee growers have recently made an effort to raise coffee plants using plagiotropic shoots, but these efforts have not been scientifically validated. Plagiotropic propagation can lead to reduced plant height, more branches and thus more fruit-bearing nodes on the coffee plant. The impact of growth regulators on coffee cutting rooting has not been extensively studied. For the better understanding of the response of various clonal propagules (orthotropic and plagiotropic shoots) to growth promoters, the current investigation was proposed with the objectives to study the effect of growth promoters on sprouting and shoot growth of orthotropic and plagiotropic cuttings in nursery and to know the effect of growth promoters on rooting of orthotropic and plagiotropic cuttings in nursery.

Materials and Methods

The present investigation entitled "response of orthotropic and plagiotropic sucker cuttings to growth promoters in coffee (*Coffea canephora* L.)" was carried out during 2022-2023 at Adi nursery, Suntikoppa, Kodagu, Karnataka. The experiment was laid out under a net shade house. The polybags with cuttings were arranged according to treatments and placed inside a low polythene tunnel. The statistical design adapted was factorial RCBD with sixteen treatments and replicated thrice.

Orthotropic and plagiotropic shoots of robusta coffee were collected from six months old shoots of healthy plants. Semi-hard wood cuttings of 15 cm long, pencil thickness (Fig. 1) with single node were prepared and all the leaves were removed. The cuttings were planted in the poly bags of 8×6" size filled with forest soil as rooting media. IBA concentrations at 1000 and 2000 ppm were prepared by dissolving 1 g and 2 g in small quantity of ethanol, and NAA concentrations at 200 and 400 ppm were prepared by dissolving 0.2 g and 0.4 g in small quantity of NaOH for complete dissolution and addition of distilled water to make volume of 1000 ml. Basal portions of the cuttings were treated with IBA and NAA solutions for 60 seconds, then air dried. Talc based *Azospirillum* and VAM were applied to polybags at 10g/bag and 5g/bag, respectively, by making 1 inch circular depth.

Recording observations was done for sprouting, shoot growth and rooting parameters *viz*. sprouting (%), shoot length (cm), number of leaves, leaf area (cm^2/cutting), collar girth (mm), length of roots (cm), number of primary and secondary roots, root volume (cc) and rooting (%).

Results and Discussion

Sprouting and shoot parameters

The study revealed notable findings: the highest sprouting occurred at 60 days after planting (DAP). Whereas, maximum values for shoot length of new sprout, number of leaves, leaf area, collar girth at 150 DAP (Table 1) was observed in orthotropic suckers. This might be attributed to the stored energy and nutrient reserves in orthotropic suckers, supporting rapid shoot growth compared to cuttings without such reserves. Among growth promoters G_8 (*Azospirillum* @ 10g/bag+*VAM* @ 5g/bag) showed maximum sprouting, shoot length, number of leaves, leaf area and collar girth, while the control had the minimum values (Table 1). This might be due to association with synthesis of growth hormone, enhanced nutrition and water absorption facilitated by AMF and PGPR. These findings align with previous studies in sneeze wort vine (Sandhya *et al*., 2013) and black pepper (Kandiannan *et al*., 2000). The treatment combination S_1G_8 (orthotropic suckers+ *Azospirillum* @ 10g/bag+*VAM* @ 5g/bag) exhibited the highest values for sprouting (98.89%), shoot length (19.11 cm), number of leaves (13.76), leaf area (1122.83 cm^2/cutting) and collar girth (7.45 mm) (Table 1). This variation might be attributed to the synergistic effect of the cutting source and combined microbial treatment, promoting superior growth in the cuttings, as also seen in similar results reported by Ganesh (2023) in pepper orthotropic cuttings.

Table 1. Effect of source of cuttings and growth promoters on sprouting, shoot length, leaf number and area and collar girth of robusta coffee cuttings

Parameters		G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	Mean	CD at 5%		
											S	G	S X G
Sprouting percentage(30 DAP)	S_1	46.67	52.22	50.00	53.33	55.56	54.44	55.56	62.22	53.75	1.25	2.51	3.58
	S_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
	Mean	23.33	26.11	25.00	26.67	27.78	27.22	27.78	31.11	-			
Sprouting percentage(60 DAP)	S_1	88.89	96.67	95.56	95.56	96.67	95.56	92.22	98.89	95.00	1.31	2.62	3.71
	S_2	86.67	94.44	96.67	91.11	92.22	91.11	95.56	97.78	93.19			
	Mean	87.78	95.56	96.11	93.33	94.44	93.33	93.89	98.33	-			
Length of new shoot (cm)	S_1	14.42	15.00	16.39	15.91	15.65	17.74	17.92	19.11	16.52	0.47	0.95	1.34
	S_2	12.60	12.88	14.26	14.09	12.55	13.17	14.12	15.00	13.58			
	Mean	13.51	13.94	15.33	15.00	14.10	15.46	16.02	17.06	-			
Numberof leaves	S_1	12.24	11.87	12.52	12.19	12.31	12.23	12.56	13.76	12.46	0.37	0.73	1.04
	S_2	11.84	11.69	12.10	10.51	10.83	9.82	10.73	11.03	11.07			
	Mean	12.04	11.78	11.52	12.14	11.57	11.03	11.65	12.39	-			
Leaf area (cm^2)	S_1	762.94	829.39	898.86	877.23	989.84	976.42	953.92	1122.83	926.43	38.28	76.56	108.28
	S_2	731.11	775.55	798.04	543.65	553.53	558.63	612.99	718.34	661.48			
	Mean	747.02	802.47	848.45	710.44	771.69	767.53	783.45	920.58	-			
Collar girth (mm)	S_1	5.90	5.58	6.42	5.83	5.90	7.09	7.18	7.45	6.42	0.21	0.42	0.60
	S_2	4.83	5.60	4.39	5.33	5.23	4.57	4.57	5.70	5.03			
	Mean	5.37	5.59	5.40	5.58	5.56	5.83	5.87	6.58	-			

Note: S_1-Orthotropic suckers; S_2- Plagiotropic suckers; G_1- Control; G_2- IBA@1000 ppm; G_3- IBA@2000 ppm; G_4- NAA@ 200ppm; G_5- NAA@ 400ppm; G_6- Azospirillum@ 10g/bag; G_7- VAM@ 5g/bag; G_8- Azospirillum@ 10g + VAM@ 5g per bag; DAP- Days after planting

Root parameters

Orthotropic suckers exhibited maximum root length, primary and secondary roots, root volume and rooting at 150 DAP(Table 2). This might be due to orthotopes are often better at nutrient transport because they connected to main vascular system.In case of growth promoters, G_3 (IBA @ 2000 ppm) showed the most significant impact, resulting in the highest primary roots (Table 2), comparable to G_2 (IBA @ 1000 ppm). Notably, treatment G_3 (IBA @ 2000 ppm) recorded highest values for longest root, root volume, secondary rootsand rooting per cent. Conversely, the control group had the lowest values. This entails that treating or exposing stem cuttings to plant growth substances may improve the percentage of rooting, root initiation and root number (Davis and Hassig, 1990; Leakey *et al*., 1982; Leakey, 1990). Collaborated with the studies of Yeshiwas *et al*. (2015) in rose, Bharmal*et al*. (2004) and Ranpise*et al*. (2004) in chrysanthemum.Among the interaction, S_1G_3 (orthotropic suckers+IBA @ 2000 ppm) yielded the best results, with attributes like root length (15.99 cm), primary roots (10.73), secondary roots (202.87), root volume (4.27 cc) and rooting (91.11%) reaching their highest levels. Theapplication of IBA to coffee cuttings might stimulate development of adventitious root from the nodes of the cuttings.

Conclusion

The study highlights the efficacy of growth promoters for enhancing coffee cuttings growth, with orthotropic cuttings consistently outperforming plagiotropic cuttings. *Azospirillum*@ 10g and *VAM*@ 5g per bag (G_8) showed the best outcomes for sprouting and shoot development, followed closely by *VAM* at 5g/bag (G_7). For root growth, IBA @ 2000 ppm (G_3) performed better than IBA @1000 ppm (G_2). Among interactions, S_1G_8 (orthotropic + *Azospirillum* @10g/

Table 2. Effect of source of cuttings and growth promoters on root number, root length, root volume and per cent rooting of robusta coffee cuttings

Parameters		G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	Mean	CD at 5%		
											S	G	S X G
Number of primary roots	S_1	8.20	10.60	10.73	9.20	9.73	9.33	9.40	9.67	9.61	0.19	0.38	0.54
	S_2	7.13	8.13	8.73	7.53	8.07	7.87	7.80	7.93	7.90			
	Mean	7.67	9.37	9.73	8.37	8.90	8.60	8.60	8.80	-			
Number of secondary roots	S_1	133.00	186.13	202.87	156.80	179.67	166.13	163.87	172.73	170.15	4.34	8.67	12.27
	S_2	128.20	162.47	184.53	155.93	153.60	147.93	140.80	150.40	152.98			
	Mean	130.60	174.30	193.70	156.37	166.63	157.03	152.33	161.57	-			
Length of longest roots (cm)	S_1	12.00	14.75	15.99	13.51	13.52	13.32	13.29	14.00	13.80	0.19	0.37	0.53
	S_2	11.15	13.07	14.36	12.73	13.05	12.74	11.59	12.41	12.64			
	Mean	11.58	13.91	15.17	13.12	13.29	13.03	12.44	13.20	-			
Root volume(cc)	S_1	2.17	4.01	4.27	3.19	3.41	2.55	3.08	3.15	3.23	0.09	0.18	0.25
	S_2	2.11	3.85	4.04	2.51	2.86	2.82	2.83	3.26	3.04			
	Mean	2.14	3.93	4.16	2.85	3.14	2.69	2.95	3.21	-			
Rooting percentage	S_1	75.56	81.11	91.11	76.67	78.89	77.78	82.22	84.44	80.97	NS	4.33	6.12
	S_2	70.00	85.56	87.78	80.00	73.33	80.00	74.44	83.33	79.31			
	Mean	72.78	83.33	89.44	78.33	76.11	78.89	78.33	83.89	-			

Note: S_1-Orthotropic suckers; S_2- Plagiotropic suckers; G_1- Control; G2- IBA@1000 ppm; G_3- IBA@2000 ppm; G_4- NAA@ 200ppm; G_5- NAA@ 400ppm; G_6- Azospirillum@ 10g/bag; G_7- VAM@ 5g/bag; G_8- Azospirillum@ 10g + VAM@ 5g per bag;

bag +*VAM* @ 5g/bag) and S_1G_7 (orthotropic + *VAM*@ 5g/bag) exhibited superior shoot and sprouting parameters, while S_1G_3 (orthotropic + IBA@ 2000 ppm) and S_1G_2 (orthotropic + IBA @ 1000 ppm) showed better root parameters.

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Conflict of interest

The authors declare that no conflict of interest exists.

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