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INFLUENCE OF TYPE OF CUTTINGS AND PLANT GROWTH REGULATORS ON ADVENTITIOUS ROOT FORMATION AND GROWTH OF IVY GOURD (*COCCINIA GRANDIS* L.) CUTTINGS

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ABSTRACT

The present study was aimed to investigate the effect of different types of cuttings and different concentrations of auxins on sprouting, rooting and growth of ivy gourd. The different types of cuttings i.e., hardwood, semi-hardwood and softwood cuttings were dipped in 250 ppm, 500 ppm, 1000 ppm, 1500 ppm, 2000 ppm of IBA and 100 ppm, 150 ppm of NAA and planted in polybags. The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. The data revealed that, the days to first bud initiation, sprouting percentage and growth of the cuttings were significantly influenced by types of cuttings and different concentrations of plant growth regulators. Hardwood cuttings (C_3) took minimum days to first bud initiation (9.75 days) and shown maximum sprouting percentage (94.22 %), number of shoots (4.2), length of primary shoot (75.88 cm), number of leaves (58.48), number of primary roots (19.4) and fresh weight of roots (4.17 g). Cuttings treated with 1500 ppm IBA (G_4) took minimum days to first bud initiation (9.44 days) and maximum sprouting percentage (81.41 %), number of shoots (4.2), length of primary shoot (85.22 cm), number of leaves (52.89) and number of primary roots (19.2). Among the interaction between the types of cutting and different auxin concentrations, the treatment combination (C_3G_4) recorded significantly maximum number of leaves (69.50), length of primary shoot (106.33) and number of primary roots (23.8). The minimum days to first bud initiation (9 days) and maximum fresh weight of roots (9.57 g) were noticed in C_3G_3.

Key words: Ivy gourd propagation, type of cuttings, Sprouting, IBA, NAA, shoot and root characteristics

Introduction

Ivy gourd (*Coccinia grandis* L.) is an under-exploited and dioecious vegetable crop that belongs to the family of Cucurbitaceae. The ivy gourd (2n=24) is native to India. The fruits of ivy gourd provide a beneficial source of carbohydrates, proteins and vitamins A and C. These fruits are composed of 92.3% water, 2% protein, 0.3% fat, 0.5% mineral matter, 3% fiber, 1.9% carbohydrates and 0.04% phosphorus and they are also rich in minerals. *Coccinia grandis* has a rich history of traditional use as herbal medicine to treat various ailments such as diabetes, hypertension and jaundice and to gain body strength (Ayyanar and Ignacimuthu, 2011)

Due to its dioecious nature, stem cuttings are frequently used for propagation. Since 50% of plants produced through seed propagation are male and not productive, growers do not particularly favour this method. These crop's potential is undervalued and underutilized as a result of ignorance and lack of awareness. Tissue culture provides the advantage of mass production and the ability to generate clonal seedlings, but it demands modern laboratory infrastructure. So vegetative propagation using stem cuttings is extensively utilized for commercial crops. Although stem cutting is a known technique for propagation, it is currently unknown what kind of cutting and what kind of plant growth regulator to employ at what dosage (Jagdale *et al.*, 2023).

The propagation of plants by cuttings with the use of plant growth regulators is widely followed practice now. Among the plant growth regulators auxin plays an important role in stimulation and initiation of roots in cuttings (Dhale *et al.*, 2018). Plants produce natural auxin in their branches and young leaves, but synthetic auxin should be applied for better rooting. Natural auxins are more sensitive to catabolism enzymes than the synthetic auxins (Stenfanic and Vodnik, 2007). Indole-3-butyric acid (IBA) and 1-Naphthalene acetic acid (NAA) are the two important plant growth regulators used widely for propagation. This experiment was conducted to determine the ideal concentration of plant growth regulator and the type of cutting needed for ivy gourd propagation.

Materials and Methods

This experiment was conducted at Department of vegetable science Dr. YSRHU-College of Horticulture, Anantharajupeta during the year 2024-25. The experiment was laid out in factorial randomized block design with two factors and three replications. Factor one comprised of different types of cutting i.e. hardwood (C_1), semi-hardwood (C_2) and softwood cuttings (C_3), whereas factor two comprised of different concentrations of auxins i.e. 250 ppm (G_1), 500 ppm (G_2), 1000 ppm (G_3), 1500 ppm (G_4), 2000 ppm of IBA (G_5) and 100 ppm (G_6), 150 ppm of NAA (G_7) along with control (G_8). Thirty cuttings were planted per treatment.

Planting material

The healthy, disease free and vigorous one-year old ivy gourd plants were collected from farmers field, Endiyur village, Tamil Nadu.

Preparation of cuttings

Vines were cut into three-node segments and classified by position from where it collected from plant: hardwood (lower third, 25–30 cm length, 20 mm diameter), semi-hardwood (middle third, 20–25 cm, 10 mm) and softwood (upper third, 15–20 cm, 5 mm). A slanting cut was made 2–3 cm below the basal node, and the basal 2.5 cm of each cutting was dipped in IBA or NAA solutions of varying concentrations.

Preparation of plant growth regulators

A stock solution of 250, 500, 1000, 1500, 2000 ppm of IBA (250, 500, 1000, 1500 and 2000 mg in 1000 ml water respectively) and 100, 150 ppm of NAA (100 and 150 mg in 1000 ml water respectively) was prepared separately. IBA and NAA was prepared by dissolving the chemical first in small quantity of 80% ethyl alcohol and later the volume was made up to 1000 ml by adding distilled water.

Planting of cuttings and after care

Cuttings were dipped in PGR solutions for varying durations (30 min for 250 ppm IBA, 100 ppm NAA, 150 ppm NAA; 20 min for 500 ppm IBA; 10 min for 1000 ppm IBA; 5 min for 1500 ppm IBA; 1 min for 2000 ppm IBA; and 30 min in water for control). They were then planted at a slanting position in polythene bags containing soil, farmyard manure, and cocopeat (2:1:1) under shade net conditions. The media around the cutting was pressed gently after planting the cuttings and bags were watered immediately after planting and watered regularly as per the requirement. After 30 DAP, the sprouted plants were transplanted to open field condition. The observations on days to first bud initiation, sprouting percentage, number of shoots, length of primary shoot, number of leaves per cutting at 45 and 60 DAP and number of primary roots and fresh weight of roots per cutting at 30 and 60 DAP were recorded.

Statistical analysis

Statistical analysis was conducted using the standard procedure of Panse and Sukhatme (1985) under Factorial Randomized Block Design (FRBD). Treatment differences were evaluated using the F-test and when significant, treatment means were compared using the critical difference (C.D.) at a 5% probability level with the corresponding standard error.

Results

Days to first bud initiation

It is clear from the data depicted in table 1 that, the number of days required for first bud initiation of ivy gourd were significantly influenced by different concentrations of PGRs, types of cutting and their interactions also.

The hardwood cuttings (C_3) recorded minimum number of days (9.75 days) to first bud initiation which was on par with semi-hardwood cuttings (C_2) (10.17 days). Whereas maximum number of days required to first bud initiation was observed in soft-wood cuttings (12.21 days).

The minimum number of days (9.44) was observed in G_4 (1500 ppm IBA), which was statistically on par with G_2 (500 ppm IBA) (10.0 days) and G_3 (1000 ppm IBA) (10.33 days). On the other hand, maximum days were taken in G_8 (control) with 12.56.

Table 1: Effect of plant growth regulators and type of cuttings on days taken for first bud initiation of ivy gourd.

Treat-ments	DTFBI				SP			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
G_1	12.00	9.67	10.00	**10.56**	27.89	76.22	90.00	**64.70**
G_2	10.00	10.00	10.00	**10.00**	46.22	66.22	93.11	**68.52**
G_3	12.00	10.00	9.00	**10.33**	33.11	83.11	98.00	**71.41**
G_4	9.67	9.67	9.00	**9.44**	60.00	86.22	98.00	**81.41**
G_5	12.00	11.00	9.00	**10.67**	28.56	83.11	95.56	**69.07**
G_6	14.00	10.00	10.33	**11.44**	37.15	60.00	97.67	**64.94**
G_7	13.00	10.00	9.00	**10.67**	50.00	80.00	98.33	**76.11**
G_8	15.00	11.00	11.67	**12.56**	26.22	56.22	83.11	**55.19**
Mean	**12.21**	**10.17**	**9.75**		**38.64**	**73.89**	**94.22**	
Factors	**SE (m) ±**		**C.D. at 5%**		**SE (m) ±**		**C.D. at 5%**	
Factor (C)	0.20		0.58		0.90		2.55	
Factor (G)	0.33		0.94		1.46		4.16	
C × G	0.57		1.63		2.53		7.20	

DTFBI: Days taken for first bud initiation; **SP:** Sprouting percentage

Among the interactions, the earliest bud initiation (9.0 days) was recorded in the treatment combinations of C_3G_4 (hardwood cutting with 1500 ppm IBA), C_3G_3 (hardwood cutting with 1000 ppm IBA), C_3G_5 (hardwood cutting with 2000 ppm IBA) and C_3G_7 (hardwood cutting with 150 ppm NAA). The most delayed bud initiation (15.0 days) was noticed in C_1G_8 (softwood cuttings under control).

Hardwood cuttings exhibited earlier sprouting, which may be attributed to their higher accumulation of stored metabolites, particularly carbohydrates, along with nitrogen and other essential nutrients. These reserves provide the necessary energy and substrates for enhanced metabolic activity, thereby promoting rapid cell division and differentiation, leading to faster sprouting. (Chandramouli, 2001). The early sprouting of cuttings may be attributed to the exogenous application of auxins, which enhance the hydrolysis of stored starch into soluble sugars, providing readily available energy for bud initiation and growth. Additionally, auxins may inhibit the downward translocation of carbohydrates, leading to their accumulation at the site of bud initiation, while also increasing endogenous auxin levels. This localized concentration of sugars and hormones creates a favourable physiological environment that promotes rapid sprouting (Dhrubajyoti *et al*., 2023). Similar findings were reported by Bhardwaj *et al*., (2017) in ivy gourd and Padekar *et al*., (2018) in kartoli.

Sprouting percentage

The information regarding the impact of cutting types and plant growth regulators on the sprouting percentage of ivy gourd is presented in Table 1 and Fig. 1.

The type of cuttings had a substantial impact on the sprouting percentage. Hardwood cuttings (C_3) had the greatest mean sprouting percentage of any cutting type, at 94.22%, while semi-hardwood cuttings (C_2) came in second at 73.89%. Softwood cuttings (C_1) had the lowest sprouting percentage (38.64%).

Plant growth regulators also had a significant influence on sprouting percentage. The maximum mean sprouting percentage (81.41%) was obtained in G_4 (IBA @ 1500 ppm), followed by G_7 (NAA @ 150 ppm) (76.11%), which was significantly superior over all other treatments. The minimum sprouting percentage (55.19%) was observed in control (G_8).

The interaction effect between type of cuttings and growth regulators was significant. The highest sprouting percentage (98.33%) was recorded in hardwood cuttings treated with NAA @ 150 ppm (C_3G_7) and was statistically on par with C_3G_6 (hardwood cuttings treated with NAA @ 100 ppm) (97.67%), C_3G_4 (hardwood cuttings treated with IBA @ 1500 ppm) (98%) and C_3G_3 (hardwood cuttings treated with IBA @ 1000 ppm) (98%), C_3G_5 (hardwood cuttings treated with IBA @ 2000 ppm) (95.56%) and C_3G_2 (hardwood cuttings treated with IBA @ 500 ppm) (93.11%). On the other hand, the lowest sprouting percentage (26.22%) was observed in softwood cuttings under control (C_1G_8).

Because hardwood cuttings have larger stores of carbohydrates and minerals, they are better able to offer the energy needed for bud break and early growth, which may explain their higher sprouting percentage performance. IBA is known to enhance carbohydrate mobilization and promote protein synthesis, which provide energy and building blocks for bud break and sprouting (Hartman *et al*., 2014). Jagdale *et al*., (2023) observed the same in ivy gourd and Vanitha *et al*., (2023) in guava.

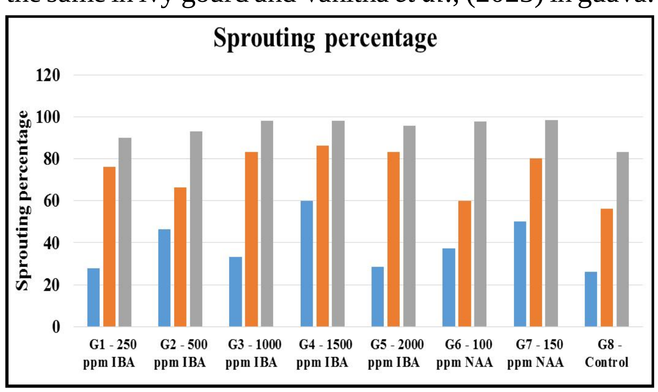

Fig. 1: Sprouting percentage of cuttings influenced by type of cuttings and plant growth regulators.

Table 2: Effect of plant growth regulators and type of cuttings on number of shoots per cutting of ivy gourd.

Treatments	Number of shoots per cutting							
	45 DAP				60 DAP			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
G_1	2.3	2.3	2.7	**2.4**	2.5	3.2	4.0	**3.2**
G_2	1.8	2.2	3.2	**2.4**	2.8	3.2	4.2	**3.4**
G_3	2.3	3.0	4.2	**3.2**	2.8	4.0	4.3	**3.7**
G_4	3.5	3.7	4.5	**3.9**	3.7	3.8	5.0	**4.2**
G_5	2.3	2.5	3.2	**2.7**	3.0	3.7	3.5	**3.4**
G_6	1.7	2.7	3.2	**2.5**	2.7	3.2	4.0	**3.3**
G_7	2.8	3.2	4.7	**3.6**	3.3	3.0	5.3	**3.9**
G_8	2.0	1.8	2.3	**2.1**	2.5	2.7	3.3	**2.8**
Mean	2.4	2.7	3.5		2.9	3.3	4.2	
Factors	**SE (m) ±**		**C.D. at 5%**		**SE (m) ±**		**C.D. at 5%**	
Factor (C)	0.1		0.4		0.1		0.4	
Factor (G)	0.2		0.6		0.2		0.6	
C × G	0.4		NS		0.4		NS	

Table 3: Effect of plant growth regulators and type of cuttings on number of leaves per cutting of ivy gourd.

Treatments	Number of leaves per cutting							
	45 DAP				60 DAP			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
G_1	19.33	24.17	31.00	**24.83**	33.00	45.83	51.00	**43.28**
G_2	19.33	23.83	33.00	**25.39**	26.67	46.00	55.00	**42.56**
G_3	18.33	30.17	34.33	**27.61**	36.00	43.83	64.83	**48.22**
G_4	27.33	32.67	41.50	**33.83**	36.50	52.67	69.50	**52.89**
G_5	14.33	26.00	32.67	**24.33**	29.00	44.33	57.00	**43.44**
G_6	12.67	21.33	38.67	**24.22**	29.17	42.33	62.83	**44.78**
G_7	24.00	25.50	37.83	**29.11**	29.17	53.83	60.50	**47.83**
G_8	14.50	21.83	28.67	**21.67**	24.33	40.50	47.17	**37.33**
Mean	**18.73**	**25.69**	**34.71**		**30.48**	**46.17**	**58.48**	
Factors	**SE (m) ±**		**C.D. at 5%**		**SE (m) ±**		**C.D. at 5%**	
Factor (C)	0.75		2.12		0.91		2.57	
Factor (G)	1.22		3.46		1.48		4.20	
C × G	2.11		NS		2.56		7.28	

Number of shoots per cutting at 45 and 60 DAP

In Table 2, the effect of cutting types and plant growth regulators on the number of shoots per cutting at 45 and 60 DAP of ivy gourd are given.

With respect to the impact of cutting types on the number of shoots per cutting, hardwood cuttings (C_3) recorded the highest number of shoots per cutting at 45 and 60 DAP (3.5 and 4.2, respectively), followed by semi-hardwood cuttings (C_2) with 2.7 and 3.3 and softwood cuttings (C_1) with 2.4 and 2.9 at the same intervals.

Out of all the growth regulator treatments, G_4 (IBA @ 1500 ppm) produced the most shoots, with 3.9 and 4.2 at 45 and 60 DAP, respectively. G_8 (control) had the fewest shoots, recording 2.1 at 45 DAP and 2.8 at 60 DAP.

Among the interaction between types of cutting and growth regulators, no significant differences were obtained from the data collected pertaining to the number of shoots at 45 and 60 DAP.

In comparison to semi-hard and soft-wood cuttings, hardwood cuttings produced significantly more sprouts per cutting. This suggests that because of its larger carbohydrate reserves, the cutting produces more shoots (Hartmann and Kester, 1990 and Jan, 2001).

The more number of shoot formation with the growth regulators might be due to the vigorous root system which might have increased the nutrient uptake under the influence of IBA. It might also be due to the more number of roots and vigorous growth of the plant (Shinde *et al.*, 2024). Similar results were obtained by Modi *et al.*, (2019) and Bhardwaj *et al.*, (2017) in ivy gourd and Padekar *et al.*, (2018) in *Momordica dioica*.

Length of primary shoot at 45 and 60 DAP

The effect of cutting types and plant growth regulators on length of the primary shoot at 45 and 60 DAP of ivy gourd is shown in Table 3.

The effect of type of cuttings on length of primary shoot at 45 and 60 DAP was significant. Among the effect of types of cuttings on the length of the primary shoot, hardwood cuttings (C_3) recorded significantly maximum shoot length of 59.23, and 75.88 cm at 45 and 60 DAP respectively, followed by semi-hardwood cuttings (C_2) with 54.54, and 66.63 cm, while the minimum shoot length was observed in softwood cuttings (C_1) with 40.38, and 51.17 cm at the corresponding intervals.

G_4 (1500 ppm IBA) was the plant growth regulator treatment that produced the most notable maximum shoot lengths, measuring 61.00, and 85.22 cm at 45, and 60 DAP, respectively. G_8 (control) showed lowest shoot length, measuring 40.38 and 55.39 cm at the corresponding intervals.

Among the interaction between types of cutting and plant growth regulators, no significant differences were obtained from the data collected pertaining to length of the primary shoot at 45 DAP. At 60 DAP, the interaction effect showed that hardwood cuttings treated with 1500 ppm IBA (C_3G_4) attained the highest shoot length (106.33 cm) which is followed by C_2G_4 (84 cm), C_3G_3 (83.17 cm), C_3G_1 (76.33 cm), C_2G_3 (74.17 cm), C_3G_5 (74 cm), whereas

Table 4: Effect of plant growth regulators and type of cuttings on length of primary shoot of ivy gourd.

Treatments	Length of primary shoot (cm)							
	45 DAP				60 DAP			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
G_1	35.00	48.33	61.50	**48.28**	50.33	58.50	76.33	**61.72**
G_2	47.17	51.17	56.33	**51.56**	57.83	59.00	69.50	**62.11**
G_3	43.00	59.67	58.00	**53.56**	58.00	74.17	83.17	**71.78**
G_4	51.67	62.83	68.50	**61.00**	65.33	84.00	106.33	**85.22**
G_5	33.67	50.50	67.67	**50.61**	39.67	60.33	74.00	**58.00**
G_6	41.50	56.17	51.67	**49.78**	44.50	68.17	67.83	**60.17**
G_7	46.00	62.67	58.50	**55.72**	57.00	70.00	68.17	**65.06**
G_8	25.00	45.00	51.67	**40.56**	36.67	58.83	61.67	**52.39**
Mean	40.38	54.54	59.23		51.17	66.63	75.88	
Factors	SE (m) ±		C.D. at 5%		SE (m) ±		C.D. at 5%	
Factor (C)	1.79		5.10		1.60		4.54	
Factor (G)	2.93		8.33		2.61		7.41	
C × G	5.08		NS		4.51		12.83	

Table 5: Effect of plant growth regulators and type of cuttings on number of primary roots of ivy gourd.

Treatments	Number of primary roots							
	30 DAP				60 DAP			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
G_1	10.0	12.0	15.0	**12.3**	8.6	16.1	18.9	**14.5**
G_2	9.3	11.7	13.0	**11.3**	9.7	16.2	16.7	**14.2**
G_3	5.7	13.0	20.0	**12.9**	12.1	18.4	22.3	**17.6**
G_4	13.0	15.0	20.3	**16.1**	16.4	17.3	23.8	**19.2**
G_5	7.3	11.7	16.3	**11.8**	11.3	12.5	21.9	**15.2**
G_6	7.7	5.3	18.0	**10.3**	12.2	16.5	17.2	**15.3**
G_7	8.0	15.3	17.0	**13.4**	13.8	16.3	21.3	**17.1**
G_8	5.0	5.3	6.7	**5.7**	7.8	11.5	13.2	**10.8**
Mean	**8.3**	**11.2**	**15.8**		**11.5**	**15.6**	**19.4**	
Factors	SE (m) ±		C.D. at 5%		SE (m) ±		C.D. at 5%	
Factor (C)	0.7		1.9		0.3		0.9	
Factor (G)	1.1		3.2		0.5		1.5	
C × G	1.9		NS		0.9		2.6	

the shortest shoot length (36.67 cm) was noted in softwood cuttings under control (C_1G_8).

The significantly increased length of the primary shoot of hardwood cuttings could be the result of more roots per cutting and active root growth, which increases the uptake of nutrients and water. Auxin enhanced cell division and cell enlargement, promotion of protein synthesis which might have resulted in enhanced vegetative growth. Auxins are known to promote stem cell elongation, which results in enhanced linear growth of the stem (Maneesha *et al.*, 2024). Patro and Reddy (2010) observed that kakrol cuttings treated with 1500 ppm IBA gave maximum length of the shoot. Padekar *et al.*, (2018) also observed similar results in *Momordica dioica*.

Number of leaves per cutting at 45 and 60 DAP

The impact of plant growth regulators and cutting types on the number of leaves per cutting at 45 and 60 DAP of ivy gourd is presented in Table 4.

Type of cuttings had a significant effect on the number of leaves per cutting at 45 and 60 DAP. Softwood cuttings (C_1) produced the lowest number of leaves, with 18.73 and 30.48 at 45 and 60 DAP, while hardwood cuttings (C_3) consistently produced the highest number of leaves, with 34.71 and 58.48 at 45 and 60 DAP, respectively. Semi-hardwood cuttings (C_2) came in next with 25.69 and 46.17.

At 45 and 60 DAP, G_4 (IBA @ 1500 ppm) recorded significantly maximum number of leaves, i.e., 33.83 and 52.89 followed by G_7 (29.11 and 47.83) and G_3 (27.61 and 48.22), while the minimum number of leaves was observed in G_8 (control) with 21.67 and 37.33 at the corresponding intervals.

Among the interaction between types of cutting and growth regulators, no significant differences were obtained from the data collected pertaining to the number of leaves per cutting at 45 DAP. Hardwood cuttings treated with IBA @ 1500 ppm (C_3G_4) had the most leaves (69.50) in the interaction effect, which was on par with C_3G_3 (hardwood cuttings treated with IBA @ 1000 ppm) (64.83) and C_3G_6 (hardwood cuttings treated with NAA @ 100 ppm) (62.83). Softwood cuttings treated with 100 ppm of NAA showed the lowest number of leaves (24.33) (C_1G_6).

Early sprouting and more food stored in the hardwood cuttings are the reasons for the higher number of leaves in the hardwood cuttings. On average, hardwood cuttings with more roots displayed the most leaves.

Increase in number of leaves in shoot might be due to vigorous growth and early initiation of root induced by the application of growth regulator which helps to absorb more nutrients and thereby producing more leaves (Stancato *et al.*, 2003). Similar findings were also reported by Maneesha *et al.*, (2024) in pointed gourd and Bharadwaj *et al.*, (2017) in ivy gourd.

Number of primary roots at 30 and 60 DAP

The influence of various PGRs and types of cuttings

Table 6: Effect of plant growth regulators and type of cuttings on fresh weight of roots of ivy gourd.

Treatments	Fresh weight of roots (g)							
	30 DAP				60 DAP			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
G_1	0.09	0.13	0.29	**0.17**	1.65	2.96	1.90	**2.17**
G_2	0.13	0.09	0.32	**0.18**	4.54	3.41	1.30	**3.08**
G_3	0.10	0.12	0.47	**0.23**	1.08	1.68	9.57	**4.11**
G_4	0.16	0.18	0.59	**0.31**	1.92	4.52	5.81	**4.08**
G_5	0.08	0.18	0.29	**0.18**	0.68	4.71	4.65	**3.34**
G_6	0.10	0.08	0.31	**0.16**	1.02	2.90	4.14	**2.69**
G_7	0.20	0.19	0.20	**0.20**	4.23	3.10	4.39	**3.91**
G_8	0.11	0.09	0.14	**0.11**	0.55	1.64	1.58	**1.25**
Mean	**0.12**	**0.13**	**0.33**		**1.96**	**3.12**	**4.17**	
Factors	**SE (m) ±**		**C.D. at 5%**		**SE (m) ±**		**C.D. at 5%**	
Factor (C)	0.04		0.12		0.04		0.11	
Factor (G)	0.07		NS		0.06		0.18	
C × G	0.12		NS		0.11		0.31	

on number of primary roots of ivy gourd at 30 and 60 DAP is presented in Table 5.

At 30 and 60 DAP, the amount of primary roots per cutting was significantly impacted by the type of cuttings. In terms of the effect of cutting type, hardwood cuttings (C_3) had the most primary roots (15.8 and 19.4 at 30 and 60 DAP, respectively), followed by semi-hardwood cuttings (C_2) with 11.2 and 15.6, and softwood cuttings (C_1) with 8.3 and 11.5 at the same intervals.

Different concentrations of plant growth regulators also exerted a significant effect on the number of primary roots at 30 and 60 DAP. Among the plant growth regulator treatments, 1500 ppm IBA (G_4) recorded the highest number of primary roots with 16.1 and 19.2 at 30 and 60 DAP, respectively. At 30 DAP, it G_4 was on par with 150 ppm NAA (G_7) (13.4), while the minimum number of roots was observed in the control (G_8) (5.7). By 60 DAP, G_4 was followed by 1000 ppm IBA (G_3) (17.6) and 150 ppm NAA (G_7) (17.1), whereas the lowest number of roots was again recorded in the control (G_8) (10.8).

At 30 DAP, no noticeable differences were seen in the interactions between cutting types and plant growth regulators. At 60 DAP, there was a significant interaction between cutting types and plant growth regulators. The highest number of primary roots (23.8) was reported from the hardwood cuttings and 1500 ppm IBA combination (C_3G_4), which is on par with C_3G_3 (22.3), C_3G_5, (21.9), and C_3G_7 (21.3). Softwood cuttings in the control group (C_1G_8) showed the lowest roots (7.8).

Hardwood cuttings are usually more mature and have accumulated with more carbohydrates and nutrients. These reserves serve as energy sources that support root initiation and growth.

IBA influences cell wall plasticity, thereby facilitating enhanced cell division, stimulating callus formation, and promoting root initiation and development. As a result, cuttings treated with IBA produced the highest number of roots compared to untreated ones. Results of present findings agree with the findings of Maneesha *et al.*, (2024) in pointed gourd and Tanuja *et al.*, (2017) in pomegranate.

Fresh weight of roots per cutting at 30 and 60 DAP

Table 6 details the influence of various PGRs and types of cutting on the fresh weight of roots of ivy gourd at 30 and 60 DAP.

Among the type of cuttings, hardwood cuttings (C_3) recorded the highest fresh weight of roots with 0.33 g plant^{-1} and 4.17 g plant^{-1} at 30 DAP and 60 DAP respectively, followed by semi-hardwood cuttings (C_2) with 0.13 g plant^{-1} and 3.12 g plant^{-1}, while the minimum root weight was observed in softwood cuttings (C_1) with 0.12 g plant^{-1} and 1.96 g plant^{-1} at the respective intervals.

Among the various growth regulators, no significant differences were obtained at 30 DAP. But at 60 DAP, cuttings treated with 1000 ppm of IBA (G_3) (4.11 g plant^{-1}) produced maximum fresh root weight, which is on par with 1500 ppm IBA (G_4) (4.08 g plant^{-1}). Whereas, the control (G_8) exhibited the minimum fresh root weight (1.25 g plant^{-1}).

Among the interaction between types of cutting and plant growth regulators, no significant differences were obtained at 30 DAP. Considering the interaction effect at 60 DAP, C_3G_3 (hardwood cutting with 1000 ppm IBA) recorded the maximum fresh root weight (9.57 g plant^{-1}), which was followed by C_3G_4 (hardwood cutting with 1500 ppm IBA) (5.81 g plant^{-1}), whereas the minimum value (0.55 g plant^{-1}) was recorded in C_1G_8 (softwood cutting under control).

The fresh weight of roots is closely related to the number of roots produced per cutting. An increase in the number of roots per cutting likely contributed to a corresponding rise in root fresh weight.

IBA is effective in enhancing rooting percentage; root length thus ultimately causes enhanced root biomass in plants (Sabatino *et al.*, 2014; Madhavan *et al.*, 2021). Similar results were reported by Tanuja *et al.*, (2017) in pomegranate and Anamika *et al.*, (2022) in guava.

Conclusions

The study demonstrated that plant growth regulator treatments on ivy gourd cuttings significantly influenced the sprouting and growth compared to untreated controls. Hardwood cuttings took minimum days to first bud initiation and shown maximum sprouting percentage, number of shoots, length of primary shoot, number of leaves, number of primary roots, fresh weight of roots and dry weight of the roots than semi-hardwood and softwood cuttings. Cuttings treated with 1500 ppm IBA took minimum days to first bud initiation and maximum sprouting percentage, number of shoots, length of primary shoot, number of leaves, number of primary roots and dry weight of the roots. Hardwood cuttings treated with 1500 ppm of IBA has showed the best impact for the rooting ability and growth of the cuttings of ivy gourd.

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