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Effects of Plant Growth Regulators (IBA) and Soil Media on Success, Growth and Survival of Stem Cutting of Assam Lemon (*Citrus lemon (L) Burm*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An investigation was carried out to study of the " Effects of plant growth regulators (IBA) and soil media on success, growth and survival on rooting of stem cutting in Assam Lemon (*Citrus lemon (L) Burm*)." was successfully carried out in the year 2021-2022 in naturally polyhouse of experimental farm ,under (KVK),Central Agriculture University, Selesih, Aizawl, Mizoram. The experiment was carried out using Factorial Completely Randomized Design (FCRD) with replicated thrice. The cuttings were treated with five different doses of IBA and four different soil media and then planted in raised bed polyhouse. From the experiment, T5M2 (IBA 800ppm+Soil + Sand + vermicompost + Cocopeat (1:1:1:1)) was the best treatment in all the parameters for rooting of stem cutting in Assam lemon and over all the treatment gave the significant response in respect to all the parameters i.e. Date to first new leaf initiation (16.33), Number of leaf per plant (13.50), Plant height (21.43 cm), Shoot length (6.59 cm) , Stem diameter(2.37 cm) , Number of branches (6.08), Length of tap root (7.92 cm), Root spread (8.42 cm), Fresh weight of root (0.54 g), Dry weight of root(0.34 g), Survival percentage of cuttings (1.00), during the observation period in the foot hills of Mizoram.

Keywords: Assam lemon; stem cuttings; soil media; plant growth.

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1. INTRODUCTION

Lemon [*Citrus limon* (L.) Burm.] is one of the most popular fruits in citrus group in India and around the world as well. Lemon is the leading acid citrus fruit and the third most favoured citrus species next to orange and mandarin, owing to its appealing color, aroma and flavor [1]. The most common commercial citrus species are oranges, mandarins, pomelos, grapefruit, lemons, limes, and citrons. These plants are among the first cultivated fruit crops, having evolved in tropical and subtropical Southeast Asia [2,3]. There are a number of diverse forms of lemon which may slightly differ from each other. It has wide adaptability which makes it one of the most promising fruit crops in the world. Assam lemon, an important variety of lemon is widely grown in the north-eastern parts of India which is a dwarf cultivar and suitable for high density planting [4]. Assam lemon is the most important lemon cultivar of Assam and other parts of Northeast region of India. It is locally known as 'kazi nemu' in Assam, 'pat nimboo' in Western India and 'seville lemon' in Andhra Pradesh [5]. It is also found in the other north eastern states like Arunachal Pradesh, Nagaland and Meghalaya [6]. its inception is traced back to as chance seedling which was later propagated by vegetative means as a clonal variety and designated as Assam lemon [7].

It is an evergreen plant with dark green leaves; leaf lamina is lanceolate in shape having 70.2 mm in length and 30.2 mm in width with brevipetiolate attachment and dentate margin. Leaf petiole is 8.6mm in length and its wings are absent, iindividual flowers are large, hermaphrodite and purple-tinged in the bud and on the lower surface of petals. anthers are also yellow in colour [4]. Many flowers are staminate (sterile male) because of pistil abortion, the incidence of which varies greatly from bloom to bloom and season to season [8]. Assam lemon is found to be comparatively bigger in size than the normally grown lemon and hence, contain higher amount of juice. the fruit, zest, roots, leaves and juice are widely used in culinary, beverages, industries and medicines [9]. Assam lemon has the character of being able to bear fruits in many flushes making it available throughout the year with two peak season (February-March and September-October). It is a dwarf cultivar and suitable for high density planting [4]. Therefore, it is essential to maximize the production and keeping in mind about its good demand, production of genuine and quality planting material is a pre-requisite. It is always important for the fruit growers to have the best quality planting material. Therefore, the experiment was conducted with a goal to produce quality planting material for distribution to fruit growers. There is a necessity to find out a rapid method for multiplying the planting material which is required to obtain good quality plants and to meet its demand in the market. Although the studies on the effect of PGRs on rooting of stem cuttings in citrus have been investigated over the years, the studies on the effect of plant growth regulators and soil media on stem cuttings in citrus especially in Assam lemon in particular is scarce. Hence the present study was undertaken to find out the optimum concentration of IBA and suitable rooting media for rooting and survival of cutting and the best combination of IBA and rooting media on rooting success and survival of cuttings.

2. MATERIALS AND METHODS

A field experiment was conducted at Krishi Vigyan Kedra(KVK), Central Agriculture University, Selesih, Aizawl, Mizoram during the year 2021. The experiment was started in September 17, 2021.

The experiment material consists of Assam Lemon (Citrus lemon (L) burm). The experiment was laid out in two Factorial Completely Randomized Design (FCRD) with three replications and twenty treatments and the treatment consisted of two factors i.e. five levels of IBA(100ppm, 200ppm, 400ppm, 600ppm, 800ppm) Factor 'A' and four levels of soil media (Soil + Sand + FYM + Cocopeat (1:1:1:1), Soil + Sand + vermicompost+ Cocopeat (1:1:1:1), Soil + Sand + FYM + Trichiderma + Cocopeat + Azotobacter(1:1:1:1), Soil + Sand + vermicompost+ Trichoderma + Cocopeat+ Azotobacter(1:1:1:1)Factor 'B'. Treatment details were given below:

Factor A

Level of IBA

- T_1 : IBA 100 ppm
- T_2 : IBA 200 ppm
- T_3 : IBA 400 ppm
- T_4 : IBA 600 ppm
- T_5 : IBA 800 ppm

Factor B

Soil Media

- M_1 : Soil + Sand + FYM + Cocopeat (1:1:1:1)
- M_2 : Soil + Sand + Vermicompost+ Cocopeat (1:1:1:1)
- M_3 : Soil + Sand + FYM + Trichiderma + Cocopeat + Azotobacter(1:1:1:1)
- M_4 : Soil + Sand + Vermicompost+ Trichoderma + Cocopeat+ Azotobacter (1:1:1:1)

The total number of polybag is 240 (20 treatments x 3 replication x 4 units), number of cuttings per bag is 1 and polybag dimention is 10x14"cm size black polybag, the polybags is 2kg quantity were used. In the bottom of poly bags 3-4 holes were made to ensure drainage. According to treatments, rooting media were prepared by thoroughly mixing of garden soil, sand, FYM, vermicompost, cocopeat, trichoderma, and azotobacter. It was sterilized by solarization method during hot summer months. Well mixed media were filled in poly bags. The prepared cuttings were treated with different doses of IBA solution and planted in the polybags in shade house. Irrigation channels were prepared according to layout.

Different levels of indole 3butyric acid (IBA) of 100 ppm(T_1) , 200ppm(T_2), 400ppm(T_3), 600ppm (T_4), 800ppm (T_5) solution were used. To prepare PGR solution, required quantity of IBA 3ml was dissolved in 20ml of absolute alcohol and stirred thoroughly until the power get dissolved completely. Latter the final volume was made up to1 liter by adding distilled water.

The cuttings were made in 18-21cm in length. The cutting were obtained from 1 year old shoot of 5-6 years old mother plant of Assam lemon. 20 cutting were treated in each replication and total 60 cutting were planted in each treatment. Therefore, total 240 cuttings were used for rooting of cuttings.

The prepared cuttings were ready for treatment and planting. One third basal portion of the cutting were dipped 20-30 minutes in aquaceous solution of IBA according to concentration and planted in the polythene bags by inserting two-third portion in poly bags. The planted cuttings were irrigated regularly depending upon soil moisture conditions.

3. RESULTS AND DISCUSSION

3.1 Date to First New Leaf Initiation

The result on date to first new leaves initiation are presented in Table 1. The data revealed that days taken for date to first new leaves initiation was found significant with the application of IBA concentration. The minimum number of days required (18.31) was observed in the application of IBA 800ppm. Whereas the maximum days taken for first new leaf initiation (35.92) was observed in the application of IBA 200ppm.

As regards, soil media the minimum number of days required (26.63) was observed under M_2 i.e., soil+sand+vermicompost+cocopeat(1:1:1:1). Whereas the maximum day taken (31.12) was noted under M_1 i.e., soil+ sand+ FYM+ cocopeat(1:1:1:1).

The interaction of different concentrations of IBA and soil media showed significant on the effect date to first new leaf initiation. The minimum number of days taken (16.33) was recorded under IBA 800ppm+Soil + Sand + vermicompost+ Cocopeat (1:1:1:1)(T5M2). whereas the maximum days taken (41.25) was noted under IBA 200ppm+Soil + Sand + vermicompost+ Trichoderma + Cocopeat+ AZB (1:1:1:1) (T2M4).

This might be due to presence of endogenous auxins in cuttings might have brought early breakage of bud dormancy and results in early bud sprouting as explained by Iqbal et al. [10]. Chandramouli [11] found that the increase in the concentration of IBA significantly decreased the number of days to first sprouting of cuttings and earliness In sprouting might be due to better utilization of stored carbohydrates, nitrogen and other factors with the help of growth regulators. similar findings were reported by Srivastava et al. [12] In kiwifruit, Akshay [13] in *Piper nigrum* and Sivaji et al. [14].

3.2 Number of Leaf per Plant

The data revealed that number of leaf was found significantly with the application of IBA concentration. The highest number of leaves (12.19) was observed in the application of IBA 800ppm . Whereas the minimum number of leaf (10.46) was observed in the application of IBA 100 ppm.

As regards, Soil media the maximum number of leaf (11.43) was noted under observed (M2) (Soil+Sand+vermicompost+cocopeat(1:1:1:1). Whereas the minimum number of leaf (10.67) was noted under (M1) Soil+ sand+ FYM+ cocopeat (1:1:1:1)

The interaction of different concentrations of IBA and soil media showed significant on number of leaf. The maximum number of leaf (13.50) was recorded under IBA 800ppm+Soil + Sand + vermicompost+ Cocopeat (1:1:1:1)(T5M2). whereas the minimum number of leaf (8.25) was noted under IBA 100ppm+Soil + Sand + FYM+cocopeat (T1M1).

The maximum number of leaf it may be due to modification in physiological process of plants and formation of more number of roots resulting in the increase in number of sproutsof leaf. These findings are supported with the results reported by Singh [15], Maurya et al. [16], Rymbai and Reddy [17], and Tomar et al. [18].

3.3 Plant Height

The plant height was found significantly with the application of IBA concentration. The maximum plant height (19.48) was observed in the application of IBA 800ppm. Whereas the minimum plant height (18.62) was observed in the application of IBA 100ppm.

As regards, Soil media the maximum plant height (11.43) was noted under observed (M2) (Soil+ Sand+ vermicompost+ cocopeat (1:1:1:1). Whereas the minimum plant height (18.62) was noted under (M3) (Soil+ sand+ FYM+ trichoderma+ azotobacter+ cocopeat(1:1:1:1).

The interaction of different concentrations of IBA and soil media showed significant on plant height. The maximum plant height (21.43) was recorded under IBA 800ppm+Soil + Sand+vermicompost+ Cocopeat (1:1:1:1)(T5M2). whereas the minimum plant height (18.09) was recorded under IBA100 ppm+ (Soil+ Sand+ FYM+ trichoderma+ azotobacter+ cocopeat) (1:1:1:1) (T1M3).

The better response of 1000 ppm IBA in plant height might be attributed to the fact that cuttings treated with this concentration had improved root system thus absorbed more amount of nutrients which helped in better stem growth, similar explanation had been suggested by Chauhan and Maheshwari [19].

3.4 Shoot Length

The length of shoot was found in significant. Revealed that shoot length was found significantly with the application of IBA concentration. The maximum shoot length (4.75) was observed in the application of IBA 800ppm . Whereas the minimum shoot length (3.92) was observed in the application of IBA 100ppm.

As regards, Soil media the maximum shoot length (4.58) was noted under observed (M2) (soil+ sand+ vermicompost+ cocopea t(1:1:1:1). Whereas the minimum shoot length (4.15) was noted under (M1) (soil+ sand+ FYM+ cocopeat (1:1:1:1).

The interaction of different concentrations of IBA and soil media showed significant on shoot length. The maximum shoot length (6.59) was recorded under IBA 800ppm+soil + sand + vermicompost+ cocopeat (1:1:1:1)(T5M2). whereas the minimum shoot length (2.54) was recorded under IBA 100ppm+ soil + Sand + FYM+ trichoderma+ azotobacter+ cocopeat (1:1:1:1) (T1M3).

They pointed out that the increase in shoot length is related to better rooting performance. The cuttings treated with IBA 4000 ppm gave more rooting which facilitated the enhanced nutrient uptake and ultimately increased the shoot length. Alam et al., [20] also reported maximum shoot diameter with the treatment IBA 4000 ppm.

3.5 Stem Diameter (cm)

Stem diameter was found significantly with the application of IBA concentration. The maximum stem diameter (1.51) was observed in the application of IBA 800ppm. Whereas the minimum stem diameter (1.28) was observed in the application of IBA 200 ppm.

As regards, the application of Soil media. The maximum stem diameter (1.57) was noted under observed (M2) (Soil+ Sand+ vermicompost+ cocopeat (1:1:1:1). Whereas the minimum stem diameter (1.28) was recorded under (M3) (Soil+ sand + FYM+ trichoderma + azotobacter+ cocopeat (1:1:1:1).

The interaction of different concentrations of IBA and soil media showed significant on stem diameter. The maximum shoot length (2.37) was recorded under IBA 800 ppm+ Soil + Sand +

vermicompost+ Cocopeat (1:1:1:1) (T5M2). whereas the minimum stem diameter (1.18) was recorded under IBA200 ppm+ Soil+ Sand+ FYM +trichoderma+ azotobacter+ cocopeat (1:1:1:1) (T2M3).

Further they stated that the increase in shoot diameter in kiwifruit cuttings might be due to more number of leaves and vigorous root system as a consequence of better carbohydrates production and assimilation. The results are also in partial conformity with the findings of Singh et al. [21].

3.6 Number of Branches

The number of branches was found significantly with the application of IBA concentration. The maximum number of branches (4.96) was observed in the application of IBA 800ppm. Whereas the minimum number of branches (3.83) was observed in the application of IBA 400ppm.

As regards, the application of Soil media. The maximum number of branches (4.52) was noted under observed (M2) (Soil+ Sand+ vermicompost+ cocopeat (1:1:1:1). Whereas the minimum number of branches (3.87) was recorded under (M3) (Soil+ sand+ FYM+ trichoderma+ azotobacter+ cocopeat (1:1:1:1).

The interaction of different concentrations of IBA and soil media showed significant on number of branches. The maximum number of branches (6.08) was recorded under IBA 800ppm+Soil + Sand + vermicompost+ Cocopeat (1:1:1:1) (T5M2). whereas the minimum number of branches (3.17) was recorded under IBA 100ppm+Soil + Sand + FYM+ trichoderma+ azotobacter+ cocopeat (1:1:1:1) (T1M3).

The maximum number of branches due to higher number of roots if there will be more number of food materials and other necessary minerals will be higher in this way plant will take higher growth which results more number of branches. These findings are in accordance with the results reported by Rymbai et al. [22], Maurya et al. [23], Rymbai and Reddy [24] and Singh et al. [25].

3.7 Length of Tap Root (cm)

Length of tap root was found significantly with the application of IBA concentration. The maximum length of tap root (6.16) was observed in the application of IBA 800ppm. Whereas the minimum length of tap root (4.82) was observed in the application of IBA 400ppm.

As regards, the application of soil media. The maximum length of tap root (5.69) was noted under observed (M4) (Soil+ Sand+ vermicompost+ trichoderma+ azotobecter+ cocopeat. Whereas the minimum length of tap root (4.96) was recorded under (M1) (Soil+ sand+ FYM+ cocopeat (1:1:1:1).

The interaction of different concentrations of IBA and soil media showed significant on length of tap root. The maximum length of tap root (7.92) was recorded under IBA 800 ppm+ Soil + Sand + vermicompost+ Cocopeat (1:1:1:1) (T5M2). whereas the minimum length of tap root (3.34) was recorded under IBA 200ppm+Soil + Sand +vermicompost+cocopeat(1:1:1:1) (T2M2).

The maximum length of tap root, it may be due to hormonal effect and accumulation of other internal substances and their basipetal movement as well as accumulation of other internal substances and their downward movements. The difference in root system due to different hormones might have been due to their varying molecular structure and configuration. The higher concentration of IBA stimulated faster growth of roots resulting in maximum length as reported by Tyagi and Patel [26].

3.8 Root Spread

The data revealed that root spread was found significantly with the application of IBA concentration. The maximum that root spread (7.00) was observed in the application of IBA 800ppm . Whereas the minimum that root spread (5.00) was observed in the application of IBA 100ppm.

As regards, the application of Soil media. The maximum that root spread (7.03) was recorded under (M4) (Soil+ Sand+ vermicompost+ trichoderma+ azotobecter+ cocopeat (1:1:1:1). Whereas the minimum that root spread (5.88) was recorded under (M1) Soil+ sand+ FYM+ cocopeat (1:1:1:1).

The interaction of different concentrations of IBA and soil media showed significant on that root spread. The maximum that root spread (8.42) was recorded under IBA 800 ppm+Soil + Sand + vermicompost+ Cocopeat (1:1:1:1) (T5M2). Whereas the minimum that root spread (3.50) was recorded under IBA 100ppm+Soil + Sand +

FYM+ trichoderma+ azotobacter+ cocopeat (1:1:1:1) (T1M3).

The optimum concentration of IBA must have caused the mobilization and utilization of carbohydrate and nitrogen fraction with the presence of cofactor at wounding portion which help better root initiation number of roots. These results indicates the response of IBA with increasing concentration might be due to the activity of auxin at cambial may be adequate for initiation root primordial as reported by Bhagat et al. [27]. These results indicates the response of media (M5) increase in success number of root spread , might be due to attributing to proper aeration, good nutrient availability and high water holding capacity. These findings are in accordance with the results reported by Rymbai et al. [22], Maurya et al. [23], Rymbai and Reddy [24] and Singh et al. [25].

3.9 Fresh Weight of Root (G)

The data revealed that fresh weight of root was found significantly with the application of IBA concentration. The maximum that fresh weight of root (0.48) was observed in the application of IBA 800ppm . Whereas the minimum that fresh weight of root (0.40) was observed in the application of IBA 100ppm.

As regards, the application of Soil media. The maximum that fresh weight of root (0.45) was recorded under (M2) (Soil+ Sand+ vermicompost+ cocopeat) (1:1:1:1). Whereas the minimum that fresh weight of root (0.43) was recorded under (M1) Soil+sand+ FYM+ cocopeat (1:1:1:1).

The interaction of different concentrations of IBA and soil media showed significant on that fresh weight of root. The maximum that fresh weight of root (0.54) was recorded under IBA 800 ppm+Soil + Sand + vermicompost+ Cocopeat (1:1:1:1) (T5M2). Whereas the minimum that fresh weight of root (0.37) was recorded under IBA 100 ppm+Soil + Sand +FYM +cocopeat (1:1:1:1) (T1M1).

It was reported by Audus [28] that cuttings treated with IBA @ 1000 ppm increased the fresh weight and roots per cutting. This infers that an increased in the metabolic activity with an increased in sugar, starch, C:N ratio in the cuttings treated with IBA might have helped in producing good quality root system.

3.10 Dry Weight of Root (g)

The data revealed that dry weight of root was found significantly with the application of IBA concentration. The maximum that dry weight of root (0.28) was observed in the application of IBA 800ppm. Whereas the minimum that dry weight of root (0.24) was observed in the application of IBA 100ppm, 200ppm, 600ppm.

As regards, the application of Soil media. The maximum that dry weight of root (0.26) was recorded under (M2) (Soil+ Sand+ vermicompost+ cocopeat) (1:1:1:1). Whereas the minimum that dry weight of root (0.23) was recorded under (M4) Soil+ sand+ vermicompost+ trichoderma +cocopeat (1:1:1:1).

The interaction of different concentrations of IBA and soil media showed significant on that dry weight of root. The maximum that dry weight of root (0.34) was recorded under IBA 800 ppm+Soil + Sand + vermicompost+ Cocopeat (1:1:1:1) (T5M2). Whereas the minimum that dry weight of root (0.19) was recorded under the effect of different concentration of IBA 100 + soil+sand+vermicompost+trichoderma+cocopeat (T1M4).

This meight be due to better mobilization of primary metabolites for better root formation with the help of growth regulators. IBA increases the number of roots resulting in higher accumulation of dry matter of roots. The results are in agreement with the earlier findings of Kaur et al. [29] in grapevine, Deb et al. [30] in lemon.

3.11 Survival Percentage (%)

The data revealed that survival percentage was found significantly with the application of IBA concentration. The maximum that survival percentage (0.96) was observed in the application of IBA 800ppm. Whereas the minimum survival percentage (0.29) was observed in the application of IBA 100ppm.

As regards, the application of Soil media. The maximum survival percentage (0.78) was recorded under (M4) (Soil+ Sand+ vermicompost+ trichoderma+ azotobacter+ cocopeat) (1:1:1:1). Whereas the minimum that survival percentage (0.45) was recorded under (M1) Soil+ sand+ FYM+ cocopeat (1:1:1:1).

Table 1. Effects of plant growth regulators (IBA), soil media and their interaction on growth of Assam lemon

Treatment	Date to first new leaf	No of leaf per plant	Plant height	Shoot length	Stem diameter	No of branches	Length of tap root	Root spread	Fresh weight of root	Dry weight of root	Survival %
IBA @ 100 PPM	32.44	10.46	18.62	3.92	1.32	3.94	5.05	5.00	0.40	0.24	0.29
IBA @ 200 PPM	35.92	11.29	18.72	4.31	1.28	3.92	4.99	6.44	0.42	0.24	0.46
IBA @ 400 PPM	31.85	10.83	19.06	4.42	1.32	3.83	4.82	6.50	0.44	0.25	0.77
IBA @ 600 PPM	23.87	11.00	19.03	4.27	1.32	3.96	5.42	6.42	0.45	0.24	0.77
IBA @ 800 PPM	18.31	12.19	19.48	4.75	1.51	4.96	6.16	7.00	0.48	0.28	0.96
SEd(±)	1.01	0.18	0.14	0.13	0.06	0.17	0.18	0.34	0.004	0.007	0.03
CD at 5%	2.89	0.51	0.30	0.37	0.17	0.48	0.51	0.99	0.01	0.02	0.01
Soil+Sand+FYM+Cocopeat	31.12	10.67	18.84	4.15	1.32	3.93	4.96	5.88	0.43	0.26	0.45
Soil+Sand+Vermicompost+Cocopeat	26.63	11.43	19.35	4.58	1.57	4.52	5.24	7.03	0.45	0.26	0.70
Soil+Sand+FYM+Cocopeat+Trichoderma+Azotobacter	28.00	11.13	18.62	4.19	1.28	3.87	5.26	6.02	0.44	0.25	0.67
Soil+Sand+Vermicompost+Cocopeat+Trichoderma+Azotobacter	28.17	11.38	19.11	4.42	1.30	4.17	5.69	6.16	0.44	0.23	0.78
SEd(±)	0.90	0.16	0.12	0.11	0.05	0.15	0.16	0.31	0.003	0.006	0.03
CD at 5%	2.58	0.46	0.36	0.33	0.15	0.43	0.46	0.88	0.01	0.02	0.09
IBA 100 ppm + Soil + Sand + Cocopeat + FYM (1:1:1:1)	31.08	8.25	18.84	4.09	1.29	3.50	4.92	4.67	0.37	0.26	0.00
IBA 100 ppm + Soil + Sand + Cocopeat + vermicompost (1:1:1:1)	32.50	11.08	18.52	4.02	1.40	4.83	4.74	5.25	0.41	0.25	0.50
IBA 100 ppm + Soil + Sand + FYM + Trichoderma + Cocopeat + AZB	33.08	10.83	18.09	2.54	1.27	3.17	5.23	3.50	0.41	0.26	0.17
IBA 100 ppm + Soil + Sand + vermicompost+ Trichoderma +	33.08	11.67	19.04	5.02	1.31	4.25	5.32	6.58	0.41	0.19	0.50

Treatment	Date to first new leaf	No of leaf per plant	Plant height	Shoot length	Stem diameter	No of branches	Length of tap root	Root spread	Fresh weight of root	Dry weight of root	Survival %
Cocopeat + AZB											
IBA 200 ppm + Soil + Sand + Cocopeat + FYM (1:1:1:1)	37.08	11.17	18.52	4.89	1.38	4.17	5.49	5.67	0.42	0.25	0.08
IBA 200 ppm + Soil + Sand + Cocopeat + vermicompost (1:1:1:1)	32.58	10.92	18.47	3.77	1.29	4.00	3.34	7.50	0.43	0.24	0.50
IBA 200 ppm + Soil + Sand + FYM + Trchiderma + Cocopeat + AZB	32.75	11.58	18.57	4.71	1.18	3.33	5.07	7.50	0.42	0.23	0.58
IBA 200 ppm + Soil + Sand + vermicompost+ Trichoderma + Cocopeat + AZB	41.25	11.50	19.31	3.86	1.28	4.17	6.05	5.08	0.43	0.24	0.67
IBA 400 ppm + Soil + Sand + Cocopeat + FYM (1:1:1:1)	33.75	10.75	19.18	4.52	1.26	3.25	4.12	7.42	0.42	0.25	0.67
IBA 400 ppm + Soil + Sand + vermicompost (1:1:1:1)	27.08	11.17	19.25	4.31	1.36	3.75	4.97	7.42	0.44	0.24	0.75
IBA 400 ppm + Soil + Sand + FYM + Trichiderma + Cocopeat + AZB	35.75	10.33	18.29	4.26	1.36	4.00	5.06	5.92	0.45	0.24	0.83
IBA 400 ppm + Soil + Sand + vermicompost+ Trichoderma + Cocopeat + AZB	30.83	11.08	19.53	4.58	1.32	4.33	5.13	5.27	0.45	0.26	0.83
IBA 600 ppm + Soil + Sand + Cocopeat + FYM (1:1:1:1)	31.25	11.00	18.59	3.53	1.31	3.75	5.42	5.50	0.45	0.26	0.67
IBA 600 ppm + Soil	24.67	10.50	19.08	4.20	1.41	3.92	5.22	6.58	0.45	0.24	0.75

Treatment	Date to first new leaf	No of leaf per plant	Plant height	Shoot length	Stem diameter	No of branches	Length of tap root	Root spread	Fresh weight of root	Dry weight of root	Survival %
+ Sand + vermicompost (1:1:1:1)											
IBA 600 ppm + Soil + Sand + FYM + Trichoderma + Cocopeat + AZB	21.92	11.25	19.58	4.86	1.27	4.00	5.38	6.33	0.46	0.23	0.75
IBA 600 ppm + Soil + Sand + vermicompost+ Trichoderma + Cocopeat + AZB	17.67	11.25	18.86	4.50	1.27	4.17	5.65	7.26	0.45	0.24	0.92
IBA 800 ppm + Soil + Sand + Cocopeat + FYM (1:1:1:1)	22.42	12.17	19.08	3.71	1.36	5.00	4.87	6.17	0.46	0.26	0.83
IBA 800 ppm + Soil + Sand + Cocopeat + vermicompost (1:1:1:1)	16.33	13.50	21.43	6.59	2.37	6.08	7.92	8.42	0.54	0.34	1.00
IBA 800 ppm + Soil + Sand + FYM + Trichoderma + Cocopeat + AZB	16.50	11.67	18.58	4.57	1.32	4.83	5.55	6.83	0.46	0.29	1.00
IBA 800 ppm + Soil + Sand + vermicompost+ Trichoderma + Cocopeat + AZB	18.00	11.42	18.83	4.12	1.32	3.92	6.31	6.58	0.46	0.25	1.00
SEd(±)	2.01	0.36	0.28	0.26	0.12	0.34	0.36	0.69	0.007	0.014	0.07
CD at 5%	5.78	1.03	0.70	0.74	0.33	0.96	1.02	1.97	0.02	0.04	0.19

The interaction of different concentrations of IBA and soil media showed significant on that survival percentage. The maximum survival percentage (1.00) was recorded under IBA 800 ppm+Soil + Sand + vermicompost+ Cocopeat (1:1:1:1) (T5M2). Whereas the minimum survival percentage (0.00) was recorded under the effect of different concentration of IBA 100 + Soil+ sand+ FYM+ cocopeat (1:1:1:1) (T1M1).

In addition to that when using growth regulator boosting the rooting can be attributed to the favorable condition like high temperature (30-350C) and high relative humidity (80-90%) with higher photosynthetic activity which promoted better rooting in cutting and survival percentage These result are in close conformity with of the earlier workers Saini et al., [31], Fraternaleet al., [2] and Chayanika et al., [3].

4. CONCLUSION

From the results of the study conducted, a combination of 800 ppm IBA + soil + sand + cocopeat + vermicompost (1:1:1:1) was found to be the best for rooting of stem cuttings and survival percentage of Assam lemon (*Citrus limon* L. Burm). Over all 800 ppm IBA gave the significant response in respect to all the parameters recorded i.e., days taken to first new leaf initiation, number of leaf per plant, plant height(cm), shoot length (cm) , stem diameter(cm), number of branches, length of tap root (cm), root spread (cm), fresh weight of root(g), dry weight of root(g), survival percentage of cuttings.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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