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Effect of different IBA concentration and rooting media on *Zamioculcas zamiifolia* L

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Abstract
Zamioculcas zamiifolia mainly propagated by division–simply separating or cutting the plant roots into two clumps and replanting them. The best part of growing plants in water is that pest and disease issues are reduced and if changed frequently, will not spread disease abundantly. Unfortunately, availability of scientific literatures has filled a lacuna on water as well as other soilless rooting media too. Looking to the importance of as pot plant, the study was carried out on *Zamioculcas zamiifolia* to determine the impact of different concentration of IBA, rooting media and its interaction on rooting and survival. Twelve treatment combinations comprising four levels of IBA concentration *i.e.* I_1: Control, I_2: 250 ppm, I_3: 500 ppm and I_4: 750 ppm with three different rooting media *i.e.*, M_1: Water, M_2: Cocopeat + vermicompost (3:1 v/v) and M_3: Sand + vermicompost (3:1 v/v) were used in experiment. When compared to all treatments, leaflet cutting treated with 750 ppm IBA and placed in water media (I_4M_1) produced maximum number of roots, longest root length, root diameter, rooting, fresh and dry weight of root and number of sprouts on callus and survival at 75 days after placing of cutting for rooting. Whereas, callus diameter, fresh and dry weight of callus were recorded higher in I_4M_3-750 ppm IBA with sand + vermicompost @ 3:1 v/v. At 90 days after transplanting in black polythene bags, maximum number of leaves per plant and total number of leaflets per plant were noted in I_4M_1. According to the aforementioned results, propagation of *Zamioculcas zamiifolia* through one pair of leaflets cutting along with rachis dipped in IBA @ 500 ppm for 30 minutes and placed in water media produced better callus, roots and biomass for getting higher survival and establishment.

Keywords: *Zamioculcas zamiifolia*, rooting media, growth regulator, IBA, vegetative propagation, rooting

Introduction

A perennial plant, *Zamioculcas zamiifolia* L. commonly known as Zee zee plant, Zanzibar gem, Zuzu plant or Emerald palm which is appears to be used in the floriculture industry. *Zamioculcas* is a genus of flowering plant in the family Araceae, containing the single species *Zamioculcas zamiifolia* thrives best over in humid native to eastern Africa (Seneviratne *et al.*, 2013) [21]. Zee plant was first mentioned in a publication of plants released in 1829, placed in the genus *Caladium zamiifolium*. This was eventually changed to *Zamioculcas* in 1856, but given its current name of *Zamioculcas zamiifolia* in 1905. Before 1996 around, plant was probably not known to anyone outside the continent of Africa, but has now become one of the most popular indoor and office plants around. Growers in Florida were the first to venture into mass scale production of *Zamioculcas zamiifolia* as an ornamental in the year 1999 (Jakkula Archana, 2019) [6]. Since then, it has emerged as an important foliage plant for interiorscaping and a fascinating decorative plant (Brown, 2000) [3]. Within three years from its first introduction, this plant has become so popular that it was named as the 'plant of the year' in 2002 by the Florida Nurserymen's and Growers Association (Harrison, 2009) [5].

According to Chinese feng shui, *Zamioculcas zamiifolia* known as zz plant, symbolism and to associate with dedication, steady, growth, balance and enhancement. It is a stem-less herbaceous, monocotyledonous plant can grow up to 90 cm tall, from a stout underground, succulent rhizome. It is normally evergreen, surviving in drought due to the large potato-like rhizome that stores water until rainfall resumes. The pinnately compound leaves, up to 90 cm long, with 10-15 pairs of leaflets with 7-15 centimetres in length (2.8" to 5.9") are smooth, shiny and dark green. The flowers are produced in mid-summer to early autumn with a small bright yellow to brown or bronze spadix 5-7 cm and partly covered by the spathe.

The plant has air purifying qualities for the indoor environment. A study from Department of Plant and Environmental Air Purification given the facts that the plant has been used externally in traditional medicine, is a very common office plant and is cultivated on a large scale, it is safe to assume as not toxic. *Zamioculcas zamiifolia* do best in bright to moderate, indirect light but will do fine in extremely low levels of light. This plant makes an ideal plant for a window-less office or bathroom where it will receive only small quantity of artificial light. ZZ plant has been reported to be an efficient plant for the removal of non-polar air borne pollutants such as 80% benzene, 76% toluene, 75% ethylbenzene and 73% xylene (BTEX) within 24 hrs. *Zamioculcas zamiifolia* mainly propagated by division – simply separating or cutting the plant roots into two clumps and replanting them. It is possible to propagate either by single leaflet, apical leaflet section, basal leaflet section, rachis cutting and whole leaf, single leaflet (Seneviratne *et al.*, 2013) [21], apical leaflet section, basal leaflet section or rachis cutting (Lopez *et al.*, 2009) [14] leaf cuttings or leaflets. Moreover, it can also be propagated by rhizome division or whole leaf cutting along with rachis under bench temperature of 24-30 ºC and relative humidity of 60-90%.

Exogenous auxins are commonly used to improve rooting efficiency and quality of cuttings. Auxin has an effect on quicker and higher percentage of rooting. Both, IBA (indole-3-butyric acid) and NAA (1-naphthaleneacetic acid) stimulate adventitious rooting. Application of IBA and NAA encourage vegetative propagation methods for enhancing rooting which provides healthy planting material (Shadparvar *et al.*, 2011) [22]. IBA has strong roles in various aspects of root development including regulation of root apical, meristem size, root hair elongation, lateral root development and formation of adventitious roots. IBA significantly increased the rate of root emergence in single noded leafy stem cutting. IBA inhibits primary root elongation and stimulates lateral root formation as well as found most effective on promoting adventitious root initiation (Nasri *et al.*, 2015) [17]. The rooting effects of auxins are commercially utilized in nursery industries for horticultural crops especially in the floriculture sector.

Rooting media play a vital role for plant propagation but soil alone as a rooting medium does not fulfil all requirements for obtaining better quality planting material. Rooting media are essential for improvement in rooting percentage and hence the standardize media combination assumes greater significance for success in vegetative propagation. Now a day in nursery, common available soilless media such as cocopeat, sand, vermicompost, perlite, vermiculite *etc*. and their combinations are utilized. Various type of rooting medium determines the nature of roots produced in the cutting to some extent (Renuka and Shekhar, 2015) [20]. A mixture should be loose, well drained and have plenty of oxygen movement for newly forming roots. For proper growth, a rooting media must provide four functions *viz.*, supply nutrients, hold moisture, permit gaseous exchange and provide support to the plant (Kumar *et al.*, 2019) [11]. Except solid media, water is also use as best medium for rooting in herbs and some ornamental plants like *viz.*, pothos, tradescantia, fiddle leaf fig, baby's tears, coleus, zz plant, begonia, lucky bamboo and spider plant etc. The best part of growing plants in water is that pest and disease issues are reduced and if changed frequently, will not spread disease abundantly. Unfortunately, availability of scientific literatures has filled a lacuna on water as well as other soilless rooting media too.

Materials and Methods

Present study entitled "Effect of different IBA concentration and rooting media on *Zamioculcas zamiifolia* L." was conducted during September, 2021 to February, 2022 at Advanced Technology Centre of Soilless System for Production of Various Crops, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari with objective to find out the different concentration of IBA, rooting media and its interaction effect on rooting and survival of *Zamioculcas zamiifolia* L. The experiment was laid out in Completely Randomized Design with Factorial concept (FCRD) and three repetitions. There were twelve treatment combinations comprising four levels of IBA concentration *i.e.* I_1: Control, I_2: 250 ppm, I_3: 500 ppm and I_4: 750 ppm with three different rooting media *i.e.*, M_1: Water, M_2: Cocopeat + vermicompost (3:1 v/v) and M_3: Sand + vermicompost (3:1 v/v). One pair of fresh, healthy and uniform sized leaflets along with rachis (5.00 cm length with near around 1.00 cm diameter of basal end) were taken for experiment. Leaflet cuttings were dipped for 30 minutes in different concentrations of IBA solution *i.e.*, 250 ppm, 500 ppm, 750 ppm.

Results and Discussion

Influence of IBA concentrations

Data of several root, callus parameters along with chlorophyl content in leaves indicated a considerable impact of leaflet cutting of *Zamioculcas zamiifolia* cutting treated with IBA @ 750 ppm at 75 days after treatment (Table 1). This treatment recorded maximum number of roots (18.98), longest root length (17.92 cm), diameter of longest root (2.08 mm), rooting (82.78%), diameter of callus (19.67 mm), fresh (1.17 g) and dry (0.173 g) weight of roots, fresh (4.64 g) and dry (0.677 g) weight of callus, number of sprouts (5.44) on callus and survival (81.11%) which was statistically at par with 500 ppm IBA (I3) concentration. Moreover, chlorophyll-a, chlorophyll-b and total chlorophyll (0.51 mg/100 g, 0.33 mg/100 g & 0.84 mg/100 g, respectively) were found significantly maximum in IBA @ 750 ppm.

The findings (Table 2) showed that at 90 days after transplanting in black polythene bags, the maximum plant height (19.20 cm), number of leaves (2.82) per plant, number of leaflets per rachis (7.52), total number of leaflet (17.28) per plant, weight of rhizome (28.03 g) and diameter of rhizome (52.38 mm) were obtained in IBA @ 750 ppm concentration which was on the same bar with 500 ppm IBA (I3). Furthermore, chlorophyll-a, chlorophyll-b and total chlorophyll (0.54 mg/100 g, 0.35 mg/100 g & 0.89 mg/100 g, respectively) were found significant in cutting treated with IBA @ 750 ppm.

The increased number of roots on the *Zamioculcas zamiifolia* might be resulted due to auxin application may leads the adventitious root formation by their ability to promote the initiation of lateral roots and also enhanced the transportation of carbohydrates to the basal end of cuttings (Prince *et al.*, 2017) [19]. Moreover, IBA treatment affects the plasticity of cell which accelerates cell division, stimulates callus development and root growth. Increased length of roots per cutting might be due to early initiation of roots at optimum concentrations of IBA and more utilization of food materials during root elongation (Mallika Sindha, 2022) [16]. The Greater metabolic activity and maximum utilization of sugar and starch after hydrolysis at stem base resulted increased auxin concentration which enhanced the diameter of root (Shadparvar *et al.* 2011) [22]. Increased rooting might be due to acceleration of the root initiation and genesis of root primordia that resulted root formation in auxin treated cuttings. Auxin solutions might have supplemented at the base of cuttings, which helps to generated the adventitious roots in plants. The plants with better response to exogenous auxins and transportation of carbohydrates towards roots may augmented higher fresh as well as dry weight of roots. Increased diameter of callus might be due to application of auxin which promote cell division and cell expansion of callus. Cuttings showed greater ability to callogenesis which might be the reason of greater diameter of callus (Singh, 2012) [2]. Increased fresh and dry weight of callus Increased fresh and dry weight of callus be due the stored food material present in the cutting was mobilized with help of auxin and hastened the sprouting, thereby enhancing the utilization of carbohydrates and adsorb at the base of cuttings and better utilization of photosynthesis which increase the volume of sink. Exogenous application of IBA increases the endogenous level of auxin which resulted the cell elongation may leads for encouraging the new sprouts on callus. Moreover, mobilization and utilization of the stored carbohydrates from source to sink may increase the number of sprouts (Kumari Anuja *et al.* 2013) [13]. In case of chlorophyll content, the effect of growth regulator enhance translocation of metabolites and carbohydrate enhance the chlorophyll and greenness of leaves which produced sufficient food materials through active photosynthates (Khandaker *et al.* 2022) [9].

Increase in plant height might be due to cuttings submerged in water which resulted more number of adventitious roots and maintain appropriate amount of chlorophyll in leaflets. Moreover, stored sugars and high concentrations of internal carbohydrates in callus encourage maximum plant height (JunGae *et al.,* 2003) [7]. This higher rooting strength absorb more amount of nutrient which may be the most plausible reason for obtaining better plant height. More number of leaves observed in *Zamioculcas zamiifolia* plant might be due to cuttings submerged in water media which provide congenial condition to induce more number of adventitious roots and number of sprouts on callus. Auxin the rooting hormone enhanced the cell division, cell enlargement and promotion of protein synthesis which may be the responsible for better vegetative growth of the plants. Ultimately, appropriate amount of IBA may enhance the early emergence of leaf with higher number of leaflets per longest rachis. Appropriate IBA concentration may encourage the more number of roots and sprouting on callus which resulted better vegetative growth with respect to more plant height, number of leaves and leaflet (Jakkula Archana, 2019) [6]. In case of chlorophyll content, the effect of growth regulator enhance translocation of metabolites and carbohydrate enhance the chlorophyll and greenness of leaves which produced sufficient food materials through active photosynthates. Exogenous application of auxin promoted cell division and enlargement for better rooting with superior vegetative growth which is responsible for higher rate of photosynthesis and augmented carbohydrate fixation in to plant (Seneviratne *et al.,* 2013) [21]. Which might have resulted in increase the diameter of rhizome in zee zee plant. Enhancing the fresh biomass of plant depends upon the rooting and vegetative growth parameter *viz*. plant height, average number of shoots, number of leaves which is directly influenced by auxin through cell elongation, enlargement and multiplication (Jakkula Archana, 2019) [6]. Thus, fresh biomass accumulation resulted more photosynthesis or hydrolysis of starch utilized through source to sink relationship and enhanced the fresh weight of rhizome.

Influence of different rooting media

According to the data shown in Table 3, maximum number of roots (22.8), longest root length (20.75 cm), diameter of longest root (2.06 mm), rooting (86.04%), survival (85.42%), fresh and dry weight of root (1.30 g & 0.179 g, respectively) with number of sprouts (5.31) on callus were noted in water (M_1) containing rooting media. Whereas, callus diameter (19.90 mm), fresh (5.88 g) and dry (0.853 g) weight of callus were obtained in rooting media consisting sand + vermicompost @ 3:1 v/v (M_3). Moreover, chlorophyll-a, chlorophyll-b and total chlorophyll (0.51 mg/100 g, 0.30 mg/100 g & 0.81 mg/100 g, respectively) were reported maximum at 75 days after placing of leaflet cutting for rooting in cocopeat + vermicompost @ 3:1 v/v media (M_2) which was statistically at par with water (M_1) media.

Maximum plant height (18.66 cm), number of leaves (2.5) per plant, number of leaflets per rachis (6.97), total number of leaflet (17.07) per plant were found maximum in water (M_1) rooting media. Among them number of leaflets per rachis statistically at par with M_2 (cocopeat + vermicompost @ 3:1 v/v media) and total number of leaflets per plant on the same bar with M_3 (sand + vermicompost @ 3:1 v/v media). Furthermore, the highest weight (28.51 g) and diameter (52.40 mm) of rhizome obtained in M_3-sand + vermicompost @ 3:1 v/v media. In case of chlorophyll-a, chlorophyll-b and total chlorophyll (0.52 mg/100 g, 0.32 mg/100 g & 0.84 mg/100 g, respectively) were found significant at 90 days after when transplanted in black polythene bags having media cocopeat + vermicompost @ 3:1 v/v media (M_2) which was statistically at par with water (M_1) media (Table 4).

Increased in number of roots on cuttings of *Zamioculcas zamiifolia* might be attributed due to submerged condition through water media, which slows down the diffusion rates and traps gases during submerging tissue of cutting. Longest root is might be due to submergence of cutting (water media) for prolonged period of time, adventitious roots formed at the base due to stimulated by ethylene production (Lorbiecke and Sauter, 1999) [15] which leads to breakdown of starch and provide energy substance for forming new cell and root elongation (Abts *et al.,* 2017) [1]. The submergence condition in water which induced ethylene synthesis that stimulates breakdown of starch and cytokinins (CTK) by slow down the regulation of ABA action and providing energy substance for forming new cells for increased rooting behaviour and strength might be the reason for increased in diameter (Wang and Pan 2006) [25]. Increased rooting percentage might be due to ethylene biosynthesis process occurs when cuttings submerged in water which responsible for induction of more adventitious roots by loosening cell wall through regulation of apoplastic pH or regulation of expansion genes (Phukan *et al.,* 2015) [18]. Higher numerical rooting strength of *Zamioculcas zamiifolia* attributed when leaflet cuttings placed in water resulted increased the fresh and dry weight of root because of congenial conditions provide by water media. This may be the most possible reason for enhance the number and higher weight of root. Diameter of callus may enlarged due to media composition of sand + vermicompost which provides proper aeration, drainage as well as major and micro nutrients resulted in increased the photosynthetic activity and chlorophyll formation in the plants which improving the diameter of callus through source to sink relationship (Seneviratne *et al.*, 2013) [21]. Fresh weight of callus was noted in sand + vermicompost media might be due to the better aeration and proper drainage as well as the neutral pH and low water holding capacity of media promoted higher callus expansion compared to rest of the media. Moreover, vermicompost media which provide nutrient to the cuttings which stored in callus resulted increase the fresh and dry weight of callus. Increased in number of sprouts is might be due to that water media create an anaerobic condition which produce more adventitious roots and also helps to cell elongation for new sprouts. Higher survival rate observed in cuttings placed in water might be due to submerged conditions may favor induction of more adventitious roots with appropriate size of callus. Even nature of plant especially in high precipitation, which induced more adventitious roots that obtained nutrient from media and photosynthates (chlorophyll). Ultimately, higher rooting strength increased the survival rate of plants (Lorbiecke and Sauter, 1999 [15] as well as Phukan *et al.*, 2015) [18]. Increased in chlorophyl content is might be due to media containing cocopeat and vermicompost favours proper aeration, appropriate water holding capacity and sufficient nutrient content resulted increases the chlorophyll content of leaves. Moreover, supplementary nutrients *viz* N, P, K, Fe, Mg and Cu present in vermicompost.

Increase in plant height and number of leaves might be due to cuttings submerged in water which resulted more number of adventitious roots and maintain appropriate amount of chlorophyll in leaflets. Moreover, stored sugars and high concentrations of internal carbohydrates in callus encourage maximum plant height and provide congenial condition to induce more number of adventitious roots and number of sprouts on callus which ultimately increase the number of leaves per plant. More number of adventitious roots may absorb more nutrient and minerals and utilization of reserved food material from callus which increase the earliness in number of sprouts and plant height which allow to bear more number of leaflets per rachis (Phukan *et al*., 2015) [18]. Media containing cocopeat and vermicompost favours proper aeration, appropriate water holding capacity and sufficient nutrient content resulted increases the chlorophyll content of leaves. Moreover, supplementary nutrients *viz* N, P, K, Fe, Mg and Cu present in vermicompost (Tanaka *et al.*, 1998) [24]. Increased diameter of rhizome may be due to media composition of sand + vermicompost which provides proper aeration, drainage as well as major and micro nutrients resulted in increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism in the plants which improving the diameter of rhizome. Weight of rhizome was noted in sand + vermicompost media might be due to the better aeration and proper drainage as well as the neutral pH and low water holding capacity of media promoted better rhizome formation compared to rest of the media. Moreover, vermicompost provides supplementary nutrients for the betterment of plants (Sonam Dawa *et al.*, 2012) [23] which stored as reserved food material in rhizome.

Interaction effect of (I x M)

Data presented in Table 5 showed that at 75 days after placing of cutting for rooting, maximum number of roots (27.2), longest root length (24.53 cm), root diameter (2.46 mm), rooting (93.33%), fresh and dry weight of root (1.60 g and 0.269 g, respectively) and number of sprout (7.20) on callus and survival (93.33%) were obtained when cuttings treated with 750 ppm IBA and placed in water media (I_4M_1) which was statistically at par with I_3M_1 (500 ppm IBA + water media). Whereas, callus diameter (22.02 mm), fresh (6.58 g) and dry (0.960 g) weight of callus were recorded higher in I_4M_3-750 ppm IBA with sand + vermicompost @ 3:1 v/v at 90 days after transplanting in black polythene bags which was statistically at par with I_3M_3-750 ppm IBA with sand + vermicompost @ 3:1 v/v.

According to data presented in Table 6, maximum number of leaves (3.67) per plant and total number of leaflets per plant (19.56) in I_4M_1 which was statistically on the same bar with I_3M_1. Certain parameters like *viz.* chlorophyll content, plant height, number of leaflets per rachis, diameter of rhizome, weight of rhizome and survival of plants after transplanting were found non-significant.

Table 1: Effect of different IBA concentration on roots and callus parameter of cutting in *Zamioculcas zamiifolia* L.

	NR	LRL (cm)	DLR (mm)	R (%)	DC (mm)	FWR (g)	DWR (g)	FWC (g)	DWC (g)	NS	S (%)	Chl.-a (mg/100 g)	Chl.-b (mg/100 g)	TC (mg/100 g)
I_1	13.74	12.82	1.49	69.17	15.93	0.67	0.086	3.59	0.518	2.32	67.22	0.44	0.26	0.70
I_2	15.24	14.71	1.78	73.89	17.36	0.93	0.119	3.96	0.570	3.20	71.94	0.46	0.28	0.73
I_3	18.20	17.36	1.97	80.56	19.07	1.13	0.137	4.42	0.644	5.20	78.61	0.48	0.30	0.79
I_4	18.98	17.92	2.08	82.78	19.67	1.17	0.173	4.64	0.677	5.44	81.11	0.51	0.33	0.84
S. Em. ±	0.29	0.21	0.003	0.86	0.24	0.01	0.003	0.08	0.012	0.09	0.93	0.009	0.006	0.012
CD at 5%	0.84	0.62	0.09	2.50	0.69	0.04	0.007	0.23	0.035	0.26	2.72	0.027	0.016	0.036

Note: NR: Number of roots, LRL: Longest root length, DLR: Diameter of longest root, R: Rooting, DC: Diameter of callus, FWR: Fresh weight of roots, DWR: Fresh weight of roots, FWC: Fresh weight of callus, DWC: Dry weight of callus, NS: Number of sprouts, S: Survival, Chl-a: Chlorophyll-a, Chl-b: Chlorophyll-b, TC: Total chlorophyll

Table 2: Effect of different IBA concentration on vegetative parameter of cutting in *Zamioculcas zamiifolia* L.

	PH (cm)	NLP	NLR	TNLP	WR (g)	DR (mm)	Chl.-a (mg/100 g)	Chl.-b (mg/100 g)	TC (mg/100 g)
I_1	14.54	1.09	5.63	14.70	23.95	47.60	0.45	0.28	0.73
I_2	16.73	1.31	6.56	15.52	26.67	49.32	0.47	0.30	0.77
I_3	18.45	2.73	7.19	16.54	27.61	51.22	0.51	0.33	0.83
I_4	19.20	2.82	7.52	17.28	28.03	52.38	0.54	0.35	0.89
S. Em. ±	0.28	0.039	0.15	0.32	0.52	0.45	0.009	0.005	0.011
CD at 5%	0.81	0.112	0.43	0.94	0.51	1.32	0.026	0.015	0.033

Note: PH: Plant height, NLP: Number of leaves per plant, NLR: Number of leaflets per rachis, TNLP: Total number of leaflets per plant, WR: weight of rhizome, DR: Diameter of rhizome, Chl-a: Chlorophyll-a, Chl-b: Chlorophyll-b, TC: Total chlorophyll

Table 3: Effect of different IBA concentration on roots and callus parameter of cutting in *Zamioculcas zamiifolia* L.

	NR	LRL (cm)	DLR (mm)	R (%)	DC (mm)	FWR (g)	DWR (g)	FWC (g)	DWC (g)	NS	S (%)	Chl.-a (mg/100 g)	Chl.-b (mg/100 g)	TC (mg/100 g)
M_1	22.80	20.75	2.06	86.04	15.77	1.30	0.179	2.60	0.377	5.31	85.42	0.48	0.29	0.77
M_2	13.83	13.00	1.77	73.54	18.36	0.76	0.097	3.98	0.577	3.22	71.04	0.51	0.30	0.81
M_3	12.98	13.36	1.67	70.21	19.90	0.87	0.109	5.88	0.853	3.59	67.71	0.43	0.28	0.71
S. Em. ±	0.25	0.18	0.03	0.74	0.20	0.01	0.002	0.07	0.010	0.08	0.81	0.008	0.005	0.011
CD at 5%	0.72	0.53	0.08	2.16	0.59	0.04	0.006	0.20	0.031	0.23	2.36	0.024	0.014	0.031

Note: NR: Number of roots, LRL: Longest root length, DLR: Diameter of longest root, R: Rooting, DC: Diameter of callus, FWR: Fresh weight of roots, DWR: Fresh weight of roots, FWC: Fresh weight of callus, DWC: Dry weight of callus, NS: Number of sprouts, S: Survival, Chl-a: Chlorophyll-a, Chl-b: Chlorophyll-b, TC: Total chlorophyll

Table 4: Effect of different IBA concentration on vegetative parameter of cutting in *Zamioculcas zamiifolia* L.

	PH (cm)	NLP	NLR	TNLP	WR (g)	DR (mm)	Chl.-a (mg/100 g)	Chl.-b (mg/100 g)	TC (mg/100 g)
M_1	18.66	2.50	6.97	17.07	26.96	50.15	0.50	0.31	0.81
M_2	16.74	1.52	6.81	14.46	24.22	47.84	0.52	0.32	0.84
M_3	16.23	1.95	6.39	16.50	28.51	52.40	0.45	0.31	0.76
S. Em. ±	0.24	0.033	0.13	0.28	0.45	0.39	0.008	0.004	0.010
CD at 5%	0.70	0.097	0.37	0.82	1.31	1.14	0.023	0.013	0.029

Note: PH: Plant height, NLP: Number of leaves per plant, NLR: Number of leaflets per rachis, TNLP: Total number of leaflets per plant, WR: weight of rhizome, DR: Diameter of rhizome, Chl-a: Chlorophyll-a, Chl-b: Chlorophyll-b, TC: Total chlorophyll

Table 5: Effect of different IBA concentration on roots and callus parameter of cutting in *Zamioculcas zamiifolia* L.

	Number of roots per cutting	Longest root length (cm)	Diameter of longest root (mm)	Rooting (%)	Fresh weight of roots (g)	Dry weight of roots (g)	Diameter of callus (mm)	Fresh weight of Callus (g)	Dry weight of Callus (g)	Number of sprouts on callus	Survival (%)
I_1M_1	18.47	15.60	1.53	75.00	0.81	0.1066	13.17	2.29	0.330	2.39	74.17
I_1M_2	11.87	11.07	1.56	65.83	0.53	0.067	16.36	3.32	0.481	2.33	63.33
I_1M_3	10.87	11.81	1.41	66.67	0.66	0.084	18.27	5.16	0.743	2.24	64.17
I_2M_1	19.47	18.67	1.92	84.17	1.21	0.154	14.80	2.52	0.362	4.60	83.33
I_2M_2	13.60	12.80	1.83	70.83	0.73	0.092	18.28	3.85	0.554	2.60	68.33
I_2M_3	12.67	12.67	1.61	66.67	0.87	0.109	19.02	5.50	0.793	2.40	64.14
I_3M_1	26.07	24.20	2.36	91.67	1.57	0.188	17.68	2.75	0.402	7.07	90.83
I_3M_2	14.67	13.93	1.79	76.67	0.88	0.108	19.25	4.22	0.613	3.87	74.17
I_3M_3	13.87	13.93	1.77	73.33	0.95	0.116	20.29	6.29	0.916	4.67	70.83
I_4M_1	27.20	24.53	2.46	93.33	1.60	0.269	17.44	2.83	0.413	7.20	93.33
I_4M_2	15.20	14.20	1.91	80.83	0.92	0.121	19.55	4.52	0.659	4.07	78.33
I_4M_3	14.53	15.01	1.89	74.17	0.99	0.128	22.02	6.58	0.960	5.07	71.67
S. Em. ±	0.50	0.37	0.05	1.48	0.03	0.004	0.41	0.14	0.021	0.16	1.61
CD at 5%	1.45	1.07	0.15	4.33	007	0.012	1.19	0.40	0.061	0.46	4.71

Table 6: Effect of different IBA concentration on vegetative parameter of cutting in *Zamioculcas zamiifolia* L.

	Number of leaves per plant	Number of leaflets per rachis
I_1M_1	1.20	15.00
I_1M_2	1.00	13.11
I_1M_3	1.07	16.00
I_2M_1	1.60	15.78
I_2M_2	1.07	14.78
I_2M_3	1.27	16.00
I_3M_1	3.53	17.96
I_3M_2	1.93	14.93
I_3M_3	2.73	16.74
I_4M_1	3.67	19.56
I_4M_2	2.07	15.04
I_4M_3	2.73	17.26
S. Em. ±	0.067	0.56
CD at 5%	0.195	1.63

Conclusion

On the basis of results obtained from the present investigation, it can be concluded that propagation of *Zamioculcas zamiifolia* through one pair of leaflets cutting along with rachis (5.00 cm length with near around 1.00 cm diameter at basal end) dipped in IBA @ 500 ppm for 30 minutes and placed in water media produced better callus, roots and biomass for getting higher survival and establishment.

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Conflict of interest

The authors declare that they have no conflict of interest.

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