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# Effect of IBA (Indole-3-butyric acid) and 1-Naphthalene acetic acid (NAA) on rooting in stem cuttings of golden pothos (*Epipremnum aureum* Lindl.)

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ABSTRACT

The present investigation was carried out at the OHLU (Ornamental Horticulture and Landscaping Unit), ICAR-IARI, New Delhi during 2019-2020. The experiment was set up as Completely Randomised Design (CRD) including 10 (ten) treatments combinations, replicated thrice with five cuttings per replication. Three-node stem cuttings of golden pothos (10-12cm) were planted in plug trays consisting of three soilless media *viz.*, peat: perlite: vermiculite (1:1:1) and recommended cultural practices were followed using cuttings of uniform length and thickness. Stem cuttings were prepared in morning hours and dipped in the rooting hormone solutions for 10 seconds and immediately planted in the plug trays under shade net conditions. Treatment consisted of $T_1$- control (without hormone treatment), $T_2$ - IBA@ 300ppm, $T_3$ - IBA@ 500ppm, $T_4$ - IBA@ 1000ppm, $T_5$ - NAA@ 300ppm, $T_6$ - NAA@ 500ppm, $T_7$ - NAA@ 1000ppm, $T_8$- IBA + NAA ( 150 ppm + 150 ppm), $T_9$ - IBA + NAA ( 250 ppm + 250 ppm) and $T_{10}$-IBA + NAA ( 500 ppm + 500 ppm). At 30DAP and 60 DAP, different root growth attributes were determined on stem cuttings. From the analysis of variance, the effects of different levels of growth hormones on rooting attributes of golden pothos was found to be statistically significant against control treatment . High hormone concentration caused marked increased in percent rooting, root numbers/cutting, root length, rooting zone and fresh root biomass. Among the treatments, $T_4$ - IBA @1000 ppm was found best for root production and overall root growth of golden pothos.

## 1. Introduction

Ornamental house plants bring aesthetic feelings to our surroundings and they play important role in global horticultural trade (Memon *et al.,* 2013). They possess pivotal importance in human life because of their beauty, beliefs, culture and environmental benefits. They can be grown in garden beds or as window plants in pots, according to their variety and provide the best visual effect in any garden or space where they are placed. Golden Pothos (*Epipremnum aureum* Lindl.) belonging to Araceae family, is a naturally variegated foliage ornamental plant and a tree-climbing vine native to the Solomon Islands. Its cultivars are amongst the most widely used tropical ornamental hanging basket crops in the interior landscape. Its decorative marbled leaves and easy maintenance make it very popular amongst indoor-plants. Juvenile leaves heart-shaped and sometimes are variegated, with yellow, white or silver green streaks depending on the cultivar. The plant is an excellent air purifier (Yang and Liu 2011) and it possesses antibacterial, anti-termite and antioxidant properties (Anju and Nidhi 2015). Cuttings is the most popular and quickest method of propagation and growth regulators can improve the rooting ability of these difficult to root cuttings. The application method, time of application, concentration of PGRs, plant species and also the environmental conditions largely effect the efficacy of PGRS (Wroblewska and Dębicz, 2013). Dipping the cuttings before planting and substrate drenching at planting time enhanced the growth and chemical use efficiency and in most cases, multiple applications gave better results over single application (Ranwala *et al.*, 2005). Hence, the present investigation was carried out to study the effect of IBA

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(Indole-3-butyric acid) and 1-Naphthalene acetic acid (NAA) on rooting in stem cuttings of golden pothos.

## 2. Materials and Methods

The present investigation was carried out at the OHLU (Ornamental Horticulture and Landscaping Unit), ICAR-IARI, New Delhi during 2019-2020. The experiment was set up as Completely Randomised Design including 10 (ten) treatments combinations, replicated thrice with five cuttings per replication. Three-node cuttings of Golden Pothos (10-12cm) were planted in plug trays consisting of three soilless media *viz.*, peat: perlite: vermiculite (1:1:1) and recommended cultural practices were followed using cuttings of uniform length and thickness. Treatment consisted of $T_1$-control (without hormone treatment), IBA (Indole-3-butyric acid) and 1-Naphthalene acetic acid (NAA) which were applied in single dose and in varrying combinations $T_2$ - IBA@ 300ppm, $T_3$ - IBA@ 500ppm, $T_4$ - IBA@ 1000ppm, $T_5$ - NAA@ 300ppm, $T_6$ - NAA@ 500ppm, $T_7$ - NAA@ 1000ppm, $T_8$- IBA + NAA ( 150 ppm + 150 ppm), $T_9$ - IBA + NAA ( 250 ppm + 250 ppm) and $T_{10}$-IBA + NAA ( 500 ppm + 500 ppm). Cuttings were prepared in morning hours and dipped in the rooting hormone solutions for 10 seconds and immediately planted in the plug trays. Observations were recorded at 30 and 60 DAP (days after planting) for important root growth attributes *viz.*, rooting percentage (%), number of primary roots/ cutting, primary root length (cm), rooting zone (cm) and fresh root biomass (g). Treatment means were compared by Duncan's Multiple Range Test (DMRT) at 0.05 probability level. All statistical analysis was done By SAS version 9.2 (SAS Institute, 2010).

## 3. Results and Discussion

*Rooting percentage* (%)

The ANOVA table showed that levels of IBA and NAA in single and combined application exerted a significant effect on root growth and development attributes, *viz.* rooting percentage, number of primary roots, longest primary root length, rooting zone and fresh root biomass compared to control. At 30 DAP, rooting percentage varies from 27.50% to 56.00% for all the treatments (Table 1) (Fig 1). Significantly higher percentage of rooting was observed under the treatment $T_4$ - IBA 1000 ppm (56.00%) followed by $T_5$-NAA 300 ppm (45.65%) and $T_3$-IBA 500 ppm (39.80%) whereas lowest rooting was recorded under the control $T_1$-(27.75%) followed by $T_9$ -IBA+NAA 500 ppm (29.35%). At 60 DAP, rooting percentage varies from 45.50% to 82.47 % for all the treatments. Maximum rooting percentage was recorded under the treatment $T_4$-IBA 1000 ppm (82.47%) followed by $T_7$-NAA 1000 ppm (80.03%) and $T_{10}$-IBA 500ppm+NAA 500 ppm (62.87%) whereas lowest rooting percentage was recorded under the $T_1$-control (45.50%) followed by $T_8$-IBA 150ppm+NAA 150 ppm (47.05%). These findings corroborate the findings of Aminah *et al.* (2006), who found that hormone treatment expedited rooting and resulted in stronger root system. Sharma *et al.* (2002) experimented on the effect of IBA and NAA on *Gardenia lucida* cuttings and observed that at higher concentration of IBA (2000 ppm), rooting percentage, number of roots per cutting, root length and weight per cutting were all maximum. Higher concentration of IBA might have triggered callus production on stem for initiation of roots besides enhancing the probing of the hormone action on tissues. Maximum rooting percentage with high concentration of IBA has also been reported by Hedge (1988) in *Lantana camara* L., Singh (1977) in softwood cuttings of *Ixora banduca* and *Allamanda cathartica*. Mesen et al. (1997) reported barely 10% rooting on *Cordia alliodora* cuttings without plant growth substances.

*Number of primary roots/cutting*

The present investigations revealed a significant influence of IBA and NAA on primary roots/cutting of golden pothos compared to control (Table 1). Perusal of the data revealed that at 30 DAP, number of primary roots/cutting varies from 1.13 to 4.38 for all the treatments. Maximum number of primary roots/cutting was recorded under treatment $T_4$-IBA 1000 ppm (4.38 ) followed by $T_3$-IBA 500 ppm (4.00) and $T_2$- IBA 300 ppm (3.26) whereas lowest number of primary roots/cutting was recorded under $T_1$-control (1.13) followed by $T_9$ – IBA 250ppm+NAA 250 ppm (1.75 ). At 60 DAP, number of primary roots/cutting varies from 2.07 to 6.56 for all the treatments (Table 1). Maximum number of primary roots/cutting was recorded under treatment $T_4$- IBA 1000 ppm (6.56 ) followed by $T_3$-IBA 500 ppm (6.05) and $T_{10}$- IBA 500ppm+NAA 500 ppm (3.70) whereas lowest number of primary roots/cutting was recorded under $T_1$- control (2.07) followed by $T_9$- IBA 250ppm+NAA 250 ppm (2.30). High IBA concentration induced faster cell division and cell elongation with enhanced root productions. This is in concordance with the findings of Bhattacharjee and Balakrishna (1990) who reported that dipping the stem cuttings of *Clerodendrum splendens* in IBA solutions (1000-6000ppm) improved the number of roots while studying the rooting behaviour of woody ornamental climbers, and Sharma (2002) who reported on the positive effect of IBA on number of roots/cuttings. Combination of IBA and NAA might have an inhibitory effect on mean length of primary roots due to its toxicity effect at high concentration.

*Primary root length (cm)*

The data pertaining to longest primary root length is presented in Table 1. Significant differences were observed for primary root length of golden pothos subjected to IBA and NAA compared to control. At 30 DAP, primary root length varies from 11.40 cm to 22.85 cm. Maximum

value for longest primary root length was recorded in $T_4$- IBA 1000 ppm (22.85 cm) followed by $T_2$- IBA 300 ppm (18.60cm) and $T_7$- NAA 1000 ppm (18.00 cm) whereas the root length was lowest in $T_1$- control (11.40cm) followed by T3- IBA 500ppm (14.03 cm). At 60 DAP, primary root length varies from 17.50 to 27.55. Maximum value for primary root length was recorded in $T_4$ - IBA 1000 ppm (27.55 cm) followed by $T_7$- NAA 1000 ppm (26.50 cm) and $T_3$- IBA 500 ppm (25.68 cm) whereas the root length was lowest in $T_1$- control (17.50cm) followed by $T_8$ – IBA 150ppm + NAA 150ppm (21.30 cm). Plant growth hormone concentrations were directly correlated with their efficacy. The comparative effectiveness of IBA might be due to its low auxin activity and its slow degradation by auxin destroying enzyme. Higher concentration of IBA might also induce faster cell division and cell elongation and the respective root elongation. In Rosa species, IBA produced considerably longer roots than control (Hussain A and Khan MA, 2004). Ayanoglu (2002) and Paul and John (1991) both showed increased rooting length in medicinal plant Spiraea prunifoli cuttings with high NAA concentrations.

*Rooting zone (cm)*

Data in Table 1 showed significant increment on rooting zone with the application of IBA and NAA in golden pothos compared to control (Table 2). Perusal of the data revealed that at 30 DAP, rooting zone of golden pothos varies from 2.20 cm to 5.21 cm for all the treatments (Table 2). Maximum rooting zone was recorded under treatment $T_4$- IBA 1000 ppm (5.21 cm) followed by $T_3$ - IBA 500 ppm (4.45cm) and $T_{10}$- IBA + NAA 1000 ppm (3.20 cm) whereas lowest rooting zone was recorded under $T_1$-control (2.20 cm) followed by $T_9$- IBA+NAA 500 ppm (2.28 cm). At 60 DAP, rooting zone of golden pothos ranges from 4.88 cm to 9.71 cm for all the treatments (Table 2). Maximum value for rooting zone was recorded under treatment $T_4$- IBA 1000 ppm (9.71 cm) followed by $T_7$ - NAA 1000 ppm (8.80 cm) and $T_3$- IBA 500 ppm (8.60 cm) whereas lowest rooting zone was recorded under $T_1$-control (4.88 cm) followed by $T_{10}$- IBA+NAA 1000 ppm (5.6 cm). The efficiency of the growth regulator to act on the stem tissues is higher with increment in hormone concentration. The current findings are consistent with those of (Singh and Singh, 2000), who reported that IBA treatment increased the root diameter of Clerodendrum thomsoniae cuttings. Toxicity caused by the combined effects of IBA and NAA may have resulted in a reduced rooting zone in golden pothos in our study.

*Fresh root biomass (g).*

The present investigations revealed a significant influence of IBA and NAA on fresh root biomass of golden pothos compared to control (Table 2) (Fig 2). Analysis of the data revealed that at 30 DAP, root biomass varies from 6.35 g to 16.26 g for all the treatments. Significantly maximum root biomass was recorded under treatment $T_7$ - NAA 1000 ppm (16.26 g) followed by $T_4$ - IBA 1000 ppm (16.00 g) and $T_5$- NAA 300 ppm (14.75 g) whereas minimum biomass weight was recorded under $T_1$-control (6.35 g) followed by $T_2$- IBA 300 ppm (9.12 g). At 60 DAP, root biomass varies from 14.40 g to 35.80 g for all the treatments (Table 2). Significantly maximum fresh root biomass was recorded under treatment $T_7$ - NAA 1000 ppm (35.80 g) followed by $T_4$ - IBA 1000 ppm (28.20 g) and $T_3$- IBA 500 ppm (25.63 g) whereas minimum root biomass was recorded under $T_1$- control (14.40 g) followed by $T_8$- IBA150ppm+ NAA 150 ppm (16.89 g). In golden pothos, higher root production and root growth at high IBA concentrations may result in higher root fresh biomass. Paul and John (1991) also recorded maximum root growth attributes at high concentration of NAA (1500 ppm) in soft wood cuttings of *Spiraea prunifolia.*

## 4. Summary

From the analysis of variance, the effects of different levels of growth promoting substances (IBA and NAA) on rooting attributes of golden pothos was found to be statistically significant. High hormone concentration caused marked increased in percent rooting, root number, root length, rooting zone and fresh root biomass. Among the treatments, $T_4$ - IBA 1000 ppm was found best for root production and overall root growth of golden pothos followed by $T_7$-NAA 1000ppm. T7-NAA@1000ppm yielded the highest fresh root biomass.


## 5. Acknowledgements

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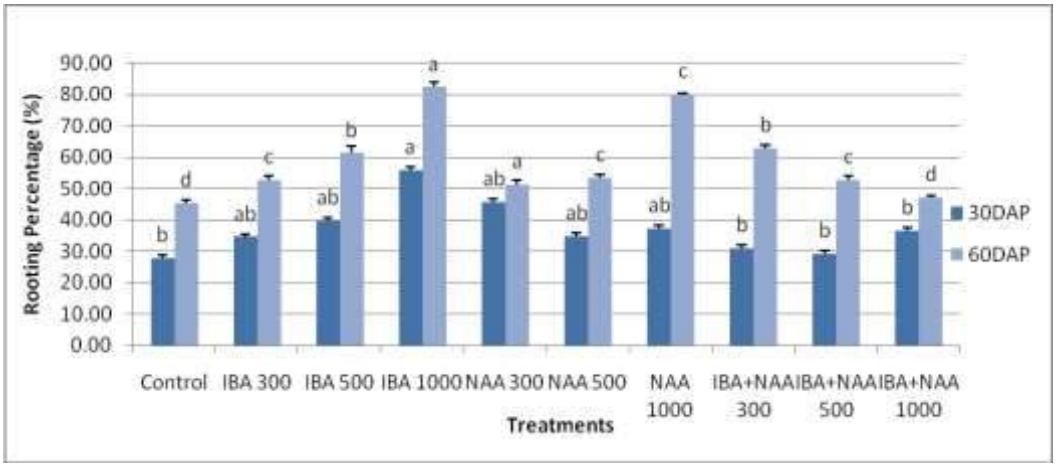


**Fig 1.** Effect of IBA and NAA on rooting percentage (%) of golden pothos. Bar represents the mean of three replicates ± SE (m); treatments were significant at P ≤ 0.01.

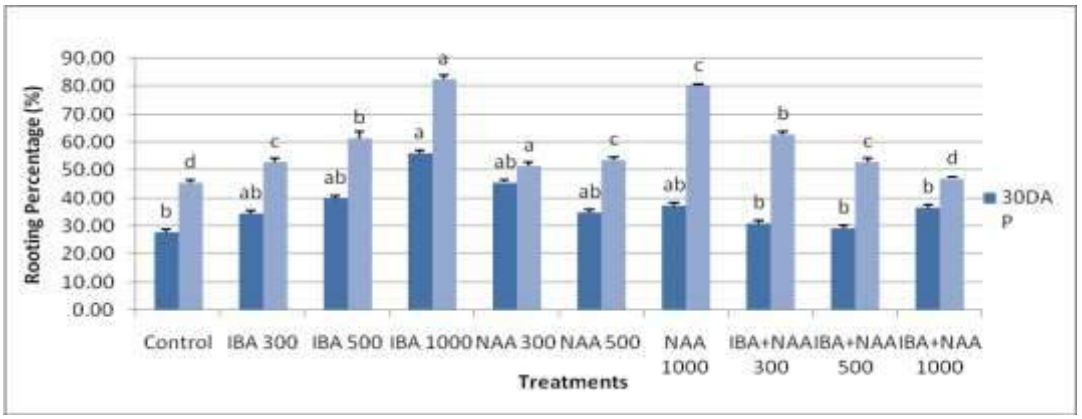


**Fig 2.** Effect of IBA and NAA on fresh root biomass (g) of golden pothos. Bar represents the mean of three replicates ± SE (m); treatments were significant at P ≤ 0.01.

**Table 1.** Rooting percentage (%), number of primary roots/cutting and primary root length (cm) in golden pothos with different doses of IBA and NAA

| S/No. | Treatments | Rooting percentage (%) | | | Number of primary roots/cutting | | | Primary root length (cm) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 30 DAP | 60 DAP | Mean | 30 DAP | 60 DAP | Mean | 30 DAP | 60 DAP | Mean |
| 1 | Control | 27.75 ± 10.25b | 45.50 ± 1.50d | 36.63 | 1.13 ± 1.16$^{cd}$ | 2.07 ± 0.32$^{h}$ | 2.49 | 11.40 ± 1.63$^{f}$ | 17.50 ± 4.37$^{e}$ | 14.45 |
| 2 | IBA 300 | 34.65 ± 10.35ab | 52.87 ±2.20c | 43.76 | 3.26 ± 0.06$^{bc}$ | 5.25 ± 0.17$^{c}$ | 4.26 | 18.60 ± 0.90$^{b}$ | 24.92 ± 0.62$^{abcd}$ | 21.76 |
| 3 | IBA 500 | 39.80 ± 14.70ab | 61.41 ± 4.12b | 50.60 | 4.00 ± 0.10$^{ab}$ | 6.05 ± 0.13$^{b}$ | 5.03 | 14.03 ± 0.53$^{e}$ | 25.68 ± 0.58$^{abcd}$ | 19.85 |
| 4 | IBA 1000 | 56.00 ± 16.00a | 82.47 ± 2.73 a | 69.23 | 4.38 ± 0.18$^{a}$ | 6.56 ± 0.12$^{a}$ | 5.47 | 22.85 ± 0.65$^{a}$ | 27.55 ± 0.55$^{a}$ | 25.20 |
| 5 | NAA 300 | 45.65 ± 12.35ab | 51.38 ± 1.00a | 62.84 | 2.11 ± 0.11$^{e}$ | 4.10 ± 0.10$^{d}$ | 3.11 | 13.25 ± 0.25$^{b}$ | 23.75 ± 0.45$^{bcd}$ | 21.00 |
| 6 | NAA 500 | 34.88 ± 9.12ab | 53.50 ± 1.80c | 44.19 | 3.00 ± 0.06$^{cd}$ | 3.10 ± 0.20$^{f}$ | 3.03 | 13.20 ± 0.60$^{ef}$ | 24.05 ± 1.50$^{abcd}$ | 18.28 |
| 7 | NAA 1000 | 37.25 ± 10.75ab | 80.03 ± 2.26c | 44.32 | 2.34 ± 0.46$^{cde}$ | 3.18 ± 0.14$^{f}$ | 2.72 | 18.00 ± 0.50$^{cd}$ | 26.50 ± 3.00$^{ab}$ | 20.75 |
| 8 | IBA+NAA 300 | 31.00 ± 11.00b | 47.05 ± 1.62b | 46.93 | 1.96 ± 0.67$^{e}$ | 2.55 ± 0.50$^{g}$ | 2.39 | 16.80 ± 0.20$^{bcd}$ | 21.30 ± 1.30$^{d}$ | 19.05 |
| 9 | IBA+NAA 500 | 29.35 ± 3.65b | 52.83 ± 2.56c | 41.09 | 1.75 ± 0.25$^{e}$ | 2.30 ± 0.14$^{gh}$ | 2.03 | 16.95 ± 0.45$^{bc}$ | 24.10 ± 1.60$^{abcd}$ | 20.53 |
| 10 | IBA+NAA 1000 | 37.50 ± 2.50b | 62.87 ± 1.07d | 37.28 | 2.60 ± 0.21$^{e}$ | 3.70 ±0.10$^{e}$ | 2.69 | 15.50 ± 2.35$^{cd}$ | 22.30 ± 1.50$^{cd}$ | 18.90 |
| | LSD (0.05) | 4.630 | 4.261 | | 0.879 | 0.590 | | 1.934 | 3.653 | |

*Notes : Values within a column followed by different letters indicate significant differences among treatments of different concentrations of IBA and NAA at P≤ 0.01 (Duncan's multiple range test) ; Each value represents the mean of three replicates ± SE (m).*

**Table 2.** Rooting zone (cm) and fresh root biomass (g) in golden pothos with different doses of IBA and NAA

| S/No. | Treatments | Rooting zone (cm) | | | Fresh root biomass (g) | | |
|---|---|---|---|---|---|---|---|
| | | 30 DAP | 60 DAP | Mean | 30 DAP | 60 DAP | Mean |
| 1 | CONTROL | 2.20 ± 0.75$^{b}$ | 4.88 ± 0.50$^{e}$ | 3.54 | 6.35 ± 1.35$^{d}$ | 14.40 ± 1.43$^{d}$ | 10.21 |
| 2 | IBA 300 | 2.45 ± 0.21$^{b}$ | 6.83 ± 0.13$^{c}$ | 4.64 | 9.12 ± 3.12$^{cd}$ | 22.11 ± 3.82$^{c}$ | 15.62 |
| 3 | IBA 500 | 4.45 ± 0.05$^{a}$ | 8.60 ± 0.40$^{b}$ | 6.53 | 10.50 ± 0.20$^{bcd}$ | 25.63 ± 0.48$^{bc}$ | 18.06 |
| 4 | IBA 1000 | 5.21 ± 0.21$^{a}$ | 9.71 ± 0.23$^{a}$ | 7.46 | 16.00 ± 0.10$^{a}$ | 28.20 ± 4.77$^{b}$ | 21.41 |
| 5 | NAA 300 | 2.96 ± 0.90$^{b}$ | 6.30 ± 0.30$^{cd}$ | 4.59 | 14.75 ± 3.70$^{ab}$ | 23.03 ± 0.47$^{bc}$ | 18.89 |
| 6 | NAA 500 | 2.52 ± 0.73$^{b}$ | 5.86 ± 0.68$^{de}$ | 4.38 | 11.75 ± 0.35$^{abc}$ | 21.27 ± 0.07$^{c}$ | 16.51 |
| 7 | NAA 1000 | 3.12 ± 0.79$^{b}$ | 8.80 ± 1.25$^{b}$ | 6.09 | 16.26 ± 5.19$^{a}$ | 35.80 ± 3.22$^{a}$ | 25.75 |
| 8 | IBA+NAA 300 | 2.41 ± 0.67$^{b}$ | 7.01 ± 0.01$^{c}$ | 4.71 | 10.38 ± 2.13$^{bcd}$ | 16.89 ± 0.12$^{d}$ | 13.63 |
| 9 | IBA+NAA 500 | 2.28 ± 0.28$^{b}$ | 6.97 ± 0.09$^{c}$ | 4.63 | 10.19 ± 3.66$^{bcd}$ | 22.55 ± 2.32$^{bc}$ | 16.37 |
| 10 | IBA+NAA 1000 | 3.20 ± 0.10$^{b}$ | 5.16 ± 0.16$^{e}$ | 4.18 | 10.84 ± 2.25$^{bcd}$ | 25.13 ± 0.38$^{bc}$ | 17.98 |
| | LSD (0.05) | 1.057 | 0.964 | | 5.158 | 4.440 | |

*Notes : Values within a column followed by different letters indicate significant differences among treatments of different concentrations of IBA and NAA at P≤ 0.01 (Duncan's multiple range test) ; Each value represents the mean of three replicates ± SE (m).*