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Efficacy of Indole-3-butyric Acid (IBA) on Growth Performance of Terminal Stem Cuttings of Rose-Scented Geranium [*Pelargonium graveolens* (L.) Herit.]

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Abstract: The experiment was conducted to study the effect of different treatments of indole-3-butyric acid (IBA) on the growth performance of terminal stem cuttings of rose-scented geranium [*Pelargonium graveolens* (L.) Herit.] at PAU, Regional Research Station, Gurdaspur (Punjab, India).The basal portion of terminal stem cutting of rose scented geranium were dipped in different treatments of Indole-3-butyric acid (IBA) *viz.* 250,500,750,1000,1250,1500ppm along with control (un-treated) to check the best fit concentration in respect to its growth behaviour after 30 days and 60 days of planting. The terminal stem cuttings of rose-scented geranium treated with IBA 1000ppm significantly reduced the number days to rooting with maximum sprouting percentage, survival percentage, plant height, plant girth, number of leaves, leaf length, leaf breadth, leaf weight, percentage rooting, number of roots, root length, root weight, root girth and number of branches in both 30 and 60 days after planting of cutting.

Keywords: Indole-3-butyric acid (IBA), *Pelargonium graveolens* (L.) Herit, Rose-scented geranium, Rooting, Terminal stem cuttings, Vegetative growth

Rose-scented geranium [*Pelargonium graveolens* (L.) Herit.] is an important high value perennial, aromatic shrub which belongs to the family Geraniaceae (Shawl et al 2006) originated from South Africa and is widely cultivated in Egypt, India, China, and to a lesser extent in Central Africa, Madagascar, Japan, Central America, Belgium, Reunion Islands, Congo and Europe (Shawl et al 2006, Singh et al 2011). There are about 700 different species in the Geraniaceae family (Shawl et al 2006). Out of which rose-scented geranium grows for production of essential oil from its leaves, tender shoots and flowers by using steam or hydro-distillation (Verma et al 2011). The current international demand is more than 600 tons mostly met by countries like China, Morocco, Egypt, Reunion Island and South Africa (Anonymous 1996). Against own requirement of approximately 200 tonnes, India produces less than 20 tonnes of geranium oil annually and meets its requirement by imports (Navale and Mungse 2002). Hence, it is necessary to take up cultivation of this crop on a commercial scale to meet internal demand and make a significant dent in the export trade. Presently two types of geranium called 'Algerian' or 'Tunisian' and 'Bourbon' or 'Re-union' are identified in India. Another cultivar 'Kelkar' has been recently introduced by M/s SH Kelkar and Company Limited-Mumbai, a leading flavour and fragrance company in India (Ram et al 2003). Geranium oil is one of the top 20 essential oils in the world. Mild climate with low humidity is ideal for its growth. The high humidity, heavy rainfall with mist, fog and water logging are detrimental. Quick multiplication of geranium from seeds is difficult. It does not set seeds under Indian conditions and as such vegetative propagation is the only means of perpetuation of this plant. With the recent emphasis on extending geranium cultivation, there has been increased demand for planting material. This warranted an easier and quicker method of propagation. However, no specific information is available in respect to faster multiplication of geranium plants for nursery production. The present investigation was undertaken with the objective to find out the efficacy of indole-3-butyric acid (IBA) on faster rooting/multiplication with improved vegetative growth parameters.

MATERIAL AND METHODS

The present investigation was conducted during the years 2022-23 and 2023-24 at Punjab Agricultural University Regional Research Station, Gurdaspur in sub-mountainous regions of Punjab which is situated between 32°3′ N latitude, 75°22′ E longitude and has an altitude of about 257 m from mean sea level having humid subtropical and dry winter climate. The terminal stem cuttings of rose-scented geranium about 10cm long with 2-4 leaves were taken from matured shoots. The growth substance i.e. indole-3-butyric acid (IBA) at 250,500,750,1000,1250 and 1500 ppm concentrations were prepared in lanolin paste. The basal portions of the prepared geranium terminal stem cuttings were smeared with lanolin having different concentration of IBA. In control, the cuttings were treated with lanolin paste only. The treated stem cuttings were planted during September in poly bags consisting of rooting media and kept in green shade net house. The experiment was laid out in completely randomized block design with three replications. The rooted cuttings (300 cuttings per replication in each treatment) were uprooted carefully without damaging the roots after 30 days and 60 days of planting and washed with water. The data on various growth parameters were recorded both after 30 days and 60 days of planting. Experimental data was statistically analyzed by using SPSS software.

RESULTS AND DISCUSSION

Sprouting and survival percentage: The significantly maximum sprouting and survival were observed in stem cutting treated with IBA 1000ppm as compared to rest of the treatments. The minimum survival and sprouting of stem cuttings were observed in control after 30 and 60days of planting of cutting. This result coincides with the findings of Ali (2018) in guava, Padekar et al (2018) in *Momordica dioica* Roxb, Venugopal et al (2018) in rosemary, Maninderdeep and Singh (2022) in grapes and Ali et al (2022) in dragon fruit. Number of sprouts increases due to better utilization of stored carbohydrates, nitrogen and other factors with the aid of growth regulators (Chandramouli 2001).

Number of days taken for rooting: Stem cutting of geranium treated with IBA 1000ppm took significantly minimum number of days to rooting after 30 days of planting, but control treatment took maximum number of days to rooting (Table 1). Similarly, minimum duration was observed for root initiation with the application of IBA @2000 ppm in stem cuttings of the 'Scented geranium' (*Pelargonium graveolens* L), while the longest duration to rooting was noticed in control (Kumar et al 2023). Similar results were reported in grape (*Vitis vinifera* L.) cuttings treated with IBA @ 3000 ppm (Maninderdeep and Singh 2022).

Growth parameters: The plant height, plant girth, number of leaves, leaf length, leaf breadth, leaf weight and number of branches were significantly higher in the stem cutting treated with IBA 1000ppm after 30 and 60 days of planting. With increased concentration beyond 1000ppm, the growth of plant physiological parameters was decreased. This may due to the inhibitory or phytotoxic effect of IBA at higher concentration (Jamal 2016). Similarly, Rani et al (2018) reported that IBA 3000 ppm treatment on the terminal cuttings of Guava *cv.* 'Taiwan Pink' resulted in highest number of leaves and leaf area of the cuttings. In study, IBA 1000 ppm could be attributed to the rapid hydrolysis of polysaccharides stored in the cuttings into physiologically active sugars by activation of hydrolytic enzymes. These sugars provide energy for the meristematic tissue through respiratory activity leads to early formation of shoots. Ali et al (2022) reported that in dragon fruit cuttings, IBA 7000ppm showed good results with maximum shoot growth, individual shoot length and number of new shoots per cutting.Plant height, number of leaves and collar diameter were also significantly higher in IBA treated patchouli (*Pogostemon cablin* Benth.) cuttings as reported by Kumar et al (2014). The IBA treatment may be complement by activating hydrolyzing enzymes at rooting site which catalyse the starch degradation and thereby enable availability of sugars for rapidly multiplying cells at the site of root initiation (Venugopal et al 2008). The higher number of leaves was due to growth regulators in the soil which increased the activity of lateral meristem and uptake of more nitrogen by plants which were required to intensify vegetative growth (Jadhav et al 2003). Mani et al (2022) also reported that the maximum number of leaves and average leaf area were recorded in cuttings of firethorn shrub treated with 6000 ppm of IBA, while the minimum number of leaves per cutting and average leaf area were observed in control. This may be due to the fact that IBA produced healthier lengthy roots and hence absorbed more nutrients and water contents which has resulted in higher number of leaves produced by the cutting. The increase in number of leaves per cutting might be due to the reason that the plant might diverted maximum assimilate quantities to the leaf buds, since the leaves are one of the production sites of natural auxins in them besides being very important for vital processes like photosynthesis and respiration (Wahab et al 2001). Similarly, Hossain and Gony (2020) reported that the maximum number of leaves per plant, leaf area, leaf length and leaf weight was obtained from IBA treatments to strawberry plants as compared to control. Among all IBA concentrations in bougainvillea cutting, the highest stems number per cutting and longest shoot length were noted under 3000 mg L^{-1} IBA concentration (Sadeeq 2024). Among various concentrations of IBA 7000 ppm to dragon fruit stem cuttings showed better results in terms of maximum shoot growth, individual shoot length and number of new shoots per cutting (Ali et al 2022).

The geranium cuttings treated with IBA 1000ppm recorded significantly highest rooting, number of roots, root length, root weight and root girth as compared to other treatments both in 30 and 60 days after planting (Table 1 and 2). Similarly, the maximum rooting percentage, number of roots , root length and root diameter were obtained in IBA treated cuttings of *Acacia catechu* Willd. & *Toona ciliata* M. Roem (Thakur et al 2018), grapes (Maninderdeep and Singh

2022), dahlia (Singh et al 2023) and bougainvillea (Sadeeq 2024). Increased root length was may be due to increased plant height, number of green leaves which may help in production of photosynthates and further supply to the roots in patchouli (*Pogostemon cablin* Benth.) (Venugopal et al 2008). The effects of auxins are significant on rooting as they facilitate the synthesis of ribonucleic acid and also induce ethylene production which is necessary for cell division and root initiation and hence, more number of roots recorded with auxin treated cuttings. It might be due to the fact that stimulation of cell wall plasticity which accelerates cell division, cambial and metabolic activity and leads to callus development and involved in root initiation by growth regulators as observed in many species (Ullah et al 2005). Auxins promote adventitious root formation by their ability to promote the initiation of lateral roots and also enhanced the transport of carbohydrates to basal portion of the cuttings. This effect may be due to rapid translocation property or fast destruction by auxin, increasing the enzymatic activity resulted in increased root length with IBA treatments of cuttings. But at higher dose of IBA i.e. beyond IBA 1000ppm, performance of all vegetative growth parameters were significantly lower. Similar trend of higher dose beyond IBA 500 ppm treated cuttings of Patchauli (*Pogostemon Cablin* (Blanco) Benth.) was observed *w.r.t* plant height, number of leaves, collar diameter, root length and number of roots (Kumar et al 2014). Similarly, Tien et al (2020) reported that treatments with higher doses of the IBA, remarkable inhibition effects on root number, root length and root weight were obtained among the stem cuttings of *Solanum procumbens*. Meanwhile number of roots at decrease concentration of IBA is attributed to more root length per cuttings and vegetative growth of per cuttings by utilizing applied IBA at concentration in Patchouli. Similarly, IBA treated stem cuttings showed better results in terms of average number of roots per cuttings, individual root length, fresh weight of roots, dry weight of roots and survival percentage of rooted cuttings in dragon fruit (Ali et al 2022),

Table 1. Effect of different treatments of Indole-3-butyric acid (IBA) on the vegetative growth of geranium (*Pelargonium graveolens* (L.) Herit) stem cutting after 30 days of planting

Treatment (ppm)	Survival (%)	Sprouting (%)	Number of days taken for rooting	Plant height (cm)	Plant girth (cm)	Number of leaves	Leaf length (cm)	Leaf breadth (cm)	Leaf weight (gm)	Rooting (%)	Number of roots	Root length (cm)	Root weight (gm)	Root girth (cm)
250	40.18	48.16	24.52	5.56	0.75	6.0	4.25	3.76	0.50	50.0	100.15	8.17	0.50	0.15
500	50.54	55.63	22.25	7.83	0.80	7.55	4.52	4.05	0.70	60.50	145.53	10.25	0.65	0.20
750	65.0	68.10	19.32	9.85	0.95	9.20	4.85	4.31	0.98	68.50	165.5	11.50	0.70	0.25
1000	95.85	92.72	10.0	15.50	2.0	13.0	6.12	5.51	2.06	85.0	250.64	14.55	0.95	0.45
1250	75.50	78.05	15.50	12.45	1.30	11.0	5.56	5.0	1.51	75.20	195.55	13.0	0.80	0.34
1500	70.24	73.35	17.25	11.50	1.0	10.45	5.15	4.65	1.25	72.45	180.77	12.50	0.75	0.28
Control	28.0	40.55	30.0	2.50	0.50	4.0	3.70	3.20	0.30	35.0	40.26	6.0	0.25	0.11
CD (p=0.05)	4.90	5.33	3.10	2.60	0.41	2.25	0.75	0.90	0.25	4.34	8.53	1.84	0.17	0.10

Table 2. Effect of different treatments of IBA on the vegetative growth of geranium (*Pelargonium graveolens* (L.) Herit) stem cutting after 60 days of planting.

Treatment (ppm)	Survival (%)	Plant height (cm)	Plant girth (cm)	Number of leaves	Leaf length (cm)	Leaf breadth (cm)	Leaf weight (gm)	Rooting (%)	Number of roots	Root length (cm)	Root weight (gm)	Root girth (cm)	Number of branches
250	35.30	11.0	1.50	12.50	5.55	4.60	1.45	62.48	145.80	12.45	0.75	0.35	3.12
500	42.40	13.25	2.0	15.0	6.0	4.96	1.70	70.25	180.25	14.15	0.95	0.42	3.52
750	55.0	15.50	2.55	18.55	6.35	5.30	2.16	76.32	215.70	15.55	1.43	0.56	4.0
1000	85.30	26.40	4.92	26.50	9.06	7.85	4.01	95.45	390.25	19.13	3.15	1.13	6.14
1250	70.25	18.0	3.51	22.25	7.65	6.46	3.05	80.42	255.65	17.50	2.10	0.72	5.10
1500	62.23	16.45	2.98	20.0	6.80	5.72	2.53	78.0	236.75	16.75	1.75	0.65	4.52
Control	24.50	5.50	1.12	8.50	5.05	4.0	1.10	42.55	85.60	10.0	0.40	0.20	2.0
CD (p=0.05)	4.61	3.80	0.29	3.19	0.84	0.82	0.34	3.65	7.90	2.15	0.17	0.12	1.62

firethorn (Mani et al 2022) and strawberry(Hossain and Gony 2020) as compared to control. Indole-3-butyric acid initiates the formation of maximum root length, could be due to the hydrolysis of polysaccharides stored in the cuttings into physiologically active sugars, which provides energy through respiratory activity to the root primordia and helps in rapid elongation of meristematic cells and initiate to obtain maximum root length (Singh et al 2014).

CONCLUSION

The terminal stem cuttings of rose-scented geranium [*Pelargonium graveolens* (L.) Herit.] treated with 1000ppm IBA (jndole-3-butyric acid) during September proved to be more effective in terms of various root and physiological growth parameters with minimum days taken for the root initiation, sprouting and maximum survival percentage.

REFERENCES

Ali Y 2018. Rooting and survival percentage in Guava (*Psidium guajava* L.) cuttings and its response to different IBA concentrations. *International Journal of Advanced Research and Review* **3**(1): 55-58.

Ali SI, Kumar TS, Kumar AK, Joshi V and Kumar BN 2022. Studies on effect of different concentrations of IBA and length of cuttings on rooting and shoot growth performance in dragon fruit Hylocereus spp.-red flesh with pink skin under Telangana conditions. *The Pharma Innovation Journal* **11**(3): 738-743.

Ali U, Ali M, Nazim M, Sadiq Q, Iqbal M and Naz T 2018. The effect of different concentrations of IBA on rooting of avocado (*Persea americana* M.) cuttings. *Abasyn Journal of Life Science* **1**(2): 82-86.

Anonymous1996. Impact of chemicals and allied products. *Chemical Weekly* **11:** 237-280.

Bhattacharjee SK and Thimmappa DK 1991. Studies on the growth hormone, length of cuttings and number of leaves on root formation of *Pogostemon patchouli* Benth. *Indian Perfumer* **35**(2): 71-76.

Boukhris M, Bouaziz M, Feki J, Feki A and Sayadi S 2012. Hypoglycemic and antioxidant effects of leaf essential oil of *Pelargonium graveolens* L. Hert. In alloxan induced diabetic rats. *Lipids in Health Dis*ease **11**(1): 81.

Chandramouli H 2001. *Influence of growth regulators on the rooting of different types of cuttings in Bursera penicilliatai (DC) Engl.* M.Sc. Thesis, University *of Agricultural Sci*ences, Bangalore.

Gomes PB, Mata VG and Rodrigues AE 2007. Production of rose geranium oil using supercritical fluid extaction . *Journal* of *Supercritical Fluids* **41**(1): 50-60.

Greenman FL, Fromw BM, Engles TM and Mclellan A 2003. Temporary relief of post-herpetic neuralgia pain with tropical geranium oil. *AME Medical Journal* **115**(7): 586-587.

Guenther E 1950. The essential oils: History and origin in plants production analysis. *Krieger Publishing, New York* 235-240.

Guenther E 1965. The essential oils of plant family Geraneaceae. In: The essential Oils. *Van Nostrand Reinhold Company,New York* **4** : 671-724.

Hossain MM and Gony O 2020. Influence of indole butyric acid on root induction in daughter plants of strawberry. *Journal of Applied Horticulture* **22**(3): 209-214.

Jadhav SG, Jadhav BB and Apte UB 2003. Influence of growth regulators on growth and oil content of patchouli (*Pogostemon cablin* Benth.). *Indian Perfumer* **47**(3) : 287-289.

Jamal A, Ayub G, Rahman A, Rashid A, Ali J and Shahab M 2016. Effect of IBA (Indole Butyric Acid) levels on the growth and rooting of different cutting types of *Clerodendrum splendens*. *Pure and Applied Biology* **5**(1): 64-71.

Juliani HR, Koroch A and Simon JE 2006. Quality of geranium oils (*Pelargonium* species): Case studies in southern and eastern Africa. *Journal of Essential Oil Research* **18**(1): 116-121.

Kumar KA, Sreenivas M, Cheena J, Vidya G and Kumar SP 2023 . Effect of different concentrations of auxin hormone (IBA) upon promoting root development of stem cuttings in the 'Scented Geranium', *Pelargonium graveolens* L. *International Journal of Environment and Climate Change* **13**(11): 2863-2869.

Kumar D, Mehera B, Kalra A, Bijalwan A and Tripathi MK 2014. Effect of growth regulators on vegetative propagation and growth of patchouli (*Pogostemon cablin* (Blanco) Benth.) cuttings. *Asian Journal of Science and Technology* **5**(6): 335-339.

Lawrence BM 1984. Progress in essentials oils. *Perfume Flavour* **9**: 49-60.

Mani G, Pant R, Negi M and Dimri DC 2022 . Effect of different levels of Indole-3- Butyric Acid (IBA) and Naphthalene Acetic Acid (NAA) on rooting of stem cuttings of Firethorn (*Pyracanth crenulata* M. Roem.). *Progressive Horticulture* **54**(2): 161-166.

Maninderdeep and Singh G 2022. Study of IBA containing rooting powder on root induction behaviour of hardwood cuttings of Grape (*Vitis vinifera* L.). *Indian Journal of Agricultural Research* **56**(4): 389-395.

Motsa NM 2006. *Essential oil yield and composition of rose-scented geranium (Pelargonium sp.) as influenced by harvesting frequency and plant shoot age.* MSc. Thesis, University of Pretoria, Gauteng, South Africa.

Nanda KK 1975. Physiology of adventitious root formation. *Indian Journal of Plant Physiology* **18**(1): 18-90.

Navale PA and Mungse HB 2002. Geranium cultivation under Pune condition. *Fragrances & Flavours Association of India Journal* **2**: 41-43.

Padekar VJ, Garande VK, Dodake SS, Sawant SV, Shinde US, Sonawane PN, Pawar RD and Dhuma. SS 2018. Effect of IBA, types of cutting and rooting media on sprouting, survival percentage and growth of cuttings of Kartoli (*Momordica dioica* Roxb.). *International journal of Current Microbiology and Applied Sciences* **7**(10): 1246-1260.

Peterson A, Machmuah SB, Roy BC, Goto M, Sasaki M and Hirose T 2005. Extraction of essential oil from geranium (*Pelargonium graveolens*) with supercritical carbon dioxide. *Journal of Chemical Technology and Biotechnol*ogy **81**(2): 167-172.

Rajeshwara-Rao BR 2002. Biomass yield, essential oil yield and essential oil composition of rose-scented geranium (*Pelargonium* species) as influenced by row spacing and intercropping with Corn mint (*Mentha arvensis*). *Industrial Crops and Products* **16**: 133-144.

Ram M and Kumar S 1996. A method for the production of planting material of geranium (*Pelargonium graveolens*) in the North Indian plains. *Journal of Medicinal and Aromatic Plant Studies* **18**: 297-299.

Ram M, Ram D and Roy SK 2003. Influence of an organic mulching on fertilizer nitrogen use efficiency and herb and essential oil yields in geranium (*Pelargonium graevolens*). *Bioresource Technology* **87**(3): 273-278.

Rani TD, Srihari D, Dorajeerao AVD and Subbaramamma P 2018. Effect of rooting media and IBA treatments on shoot production ad survival of terminal cutting in guava (*Psidium guajava* L.) cv. Taiwan Pink. *International Journal of Current Microbiology and Applied Sciences* **7**(11): 231-242.

Sadeeq JA 2024. Effect of different concentrations of Indole Butyric Acid on the rooting of Hard-wood cuttings of four cultivars of Bougainvillea sp. *Kirkuk University Journal for Agricultural Sciences* **15** (1): 1-8.

Shawl AS, Kumar T, Chishti N and Shabir S 2006. Cultivation of rose-scented geranium (*Pelargonium sp.*) as a cash crop in a Kashmir Valley. *Asian Journal of Plant Sci*ences **5**(4): 673-675.

Singh KK, Choudary T and Kumar A 2014. Effect of various concentration of IBA and NAA on the rooting of stem cuttings of Mulbery (*Morus alba* L.) under Mist House condition in Garhwal hill region. *Indian Journal of Hill Farming* **27**(1): 125-131.

Singh S, Singh I, Miller CT, Dhatt KK and Dubey RK 2023. Increasing basal dose of indole-3-butyric acid improve rooting and growth of different cutting types in Dahlia. *Rhizosphere* 27: https://doi.org/10.1016/j.rhisph. 2023.100729.

Singh S, Ram M, Singh K and Verma BS 2011 . Growth and yield of geranium (*Pelargonium graveolens*) and garlic (*Allium sativum*) in intercropping system. *Indian Journal of Agricultural Res*earch **45**(3): 179-187.

Strydem DK and Hartman HT 1960. Effect of indole-3- butyric acid and respiration and nitrogen metabolism in Marianna 2624 plum softwood stem cuttings. *Proceedings of American Society for Horticultural Science* **45**(1-2): 81-82.

Thakur L, Gupta T and Kumar R 2018. Effect of growth regulators on sprouting and rooting behaviour in cuttings of *Acacia catechu* Willd. and *Toona ciliata* M. Roem. *Journal of Pharmacognosy and Phytochemistry* **7**(1): 109-114.

Thimann KV 1969. The auxins. *The Physiology of Plant Growth and Development, New York.*

Tien LH, Chac LD, Oanh LTL, Ly PT, Sau HT, Hung N, Thanh VQ, Doudkin RV and Thinh BB 2020. Effect of auxins (IAA, IBA and NAA) on clonal propagation of *Solanum procumbens* stem cuttings. *Plant Cell Biotechnology and Molecular Biology* **21**(55&56): 113-120.

Ullah T, Wazir FU, Ahmad M, Analoui F, Khan MU and Ahmad MA 2005. Breakthrough in guava (*Psidium guajava* L.) propagation from cuttings. *Asian Journal of Plant Sci*ences **4**(3): 238-243.

Venugopal CK, Mokashi AN and Jholgiker P 2008. Influence of different propagation environment and IBA treatments on rooting efficiency of patchouli (*Pogostemon cablin* Benth.) cuttings. *Journal of Medicinal and Aromatic Plant Sciences* **30**: 146-148.

Venugopal CK, Raviprasad SM, Sharma Y and Kumar YKH (2018). Effect of different concentrations of indole-3- butyric acid (IBA) on rooting of rosemary (*Rosmarinus officinalis*) under mist house environment. *International Journal of Chemical Studies* **6**(3): 1524-1526.

Verma RK, Rahman L, Verma RS, Kalra A and Khanuja SPS 2011. Assessing N-use efficiency, planting time and economics of fertilizer N in rose-scented geranium (*Pelargonium graveolens* L. Herit) in Western Himalayan Region of India. *African Journal of Agricultural Research* **6**(1): 553- 559.

Verma RS, Verma RK, Yadav AK and Chauhan A 2010. Change in essential oil composition of rose-scented geranium (*Pelargonium graveolens* L Herit. ex Ait) due to the date of transplanting under hill conditions of Uttarakhand. *Indian Journal of Natural Products and Resources* **1**(3): 367-370.

Wahab F, Nabi G, Ali N and Shah M 2001. Rooting response of semi hardwood cuttings of guava (*Psidium guajava* L.) to various concentrations of different auxins. *Online Journal of Biological Sciences* **1**(4): 184-188.

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