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STUDIES ON THE ROOTING AND SUBSEQUENT GROWTH OF BOUGAINVILLEA

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ABSTRACT

Two season trials were carried out to study the effect of five concentrations of Indole -3- butyric acid (IBA, with purity 98 %), talc powder and three different levels of potassium nitrate (KNO_3) solution and their combinations on rooting of *Bougainvillea glabra* cv. "Golden Glow". Hard–wood cuttings were taken in February of 2001 and 2002 and dipped in KNO_3 solution at 0,1000, 2000 ppm for 24 hr, then the stem basal ends of the cuttings were dipped in IBA talc powder for 5 seconds at 0, 2000, 4000,6000 or 8000 ppm. The results showed that cuttings pretreated with IBA separately or in combinations with KNO_3 had significant effects on rooting percentage, number of roots, cutting, root length, fresh and dry weight of roots /cutting, survival percentage, shoot number and length/cutting and leaf dry weight when compared with the untreated cuttings. The highest values of rooting and growth parameters were obtained by 4000 or 6000 ppm IBA combined with 2000 ppm KNO_3.

The chemical analysis indicated that the total chlorophyll contents (a + b), were markedly increased as IBA concentration increased up to 6000 ppm with KNO_3 at a higher level (2000 ppm).

***Key words**: auxins, bougainvilleas, growth regulators, , post propagation , Potassium nitrate, rooting.*

1. INTRODUCTION

Bougainvilleas are tropical and sub - tropical woody vines of the Four – o'clock family (Nyctaginaceae) native to South America. The genus Bougainvillea contains several species, only three (*B. spectabilis, B. glabra and B. peruviana)* are important horticulturally as landscape plants for the home and park gardens, because of their adaptability to various soil types in Egypt, their variability in the color – range of bracts, leaf shapes and color and their low maintenance requirements. *Bougainvillea species*, vary in the capacity to initiate adventitious roots. Hess (1962) reported that easily rooted plants contain essential rooting co- factors that are present in reduced quantities or lacking in difficult–to–root cultivars. Endogenus indole acetic acid level declines during the asexual propagation of stem cuttings from easy–to–root *Hibiscus* cultivars, while no measurable auxin was found initially or throughout propagation in stem cutting bases of different – to – root cultivars. Also, the interrelationship of auxin balance and/or nutrient elements on the rooting of cuttings need to be tested. The stimulation of adventitious roots by using auxins was reported for a number of *Bougainvullea spp* by many investigators such as Awad *et al.* (1988), Panwar *et al.* (1994), Chovatia *et al.*(1995), Mahros (2000) and Singh (2001).

The objective of this study was to determine the effect of Indole–3–butyric acid (IBA) and/or potassium nitrate solution (KNO_3) on the rooting of *Bougainvillea glabra* cv. "Golden Glow" cuttings under prevalent conditions in Alexandria region.

2. MATERIALS AND METHODS

2.1. Cutting pre-treatment

This study was carried out at the Floriculture and Ornamental Plants Research Gardens of Alexandria University in 2001 and 2002 seasons.

Hardwood cuttings of *Bougainvullea glabra* cv. "Golden Glow" plants were taken in February 15^{th} and 17^{th} for the seasons of 2001 and 2002, respectively. The cuttings were chosen from 2 – year old plants (Panwar *et al.* 1999). Uniformal stem hard cuttings were taken with a diameter (1.5 cm) and a length (15cm). The stem basal emds

were dipped in Indole - 3 – butyric acid in talc powder at concentrations of 0, 2000,4000,6000 and 8000 ppm, after soaking the cuttings in potassium nitrate (KNO_3) solution at 0, 1000 and 2000 ppm for 24 hours. Cuttings dipped in distilled water acted as control. After auxin treatments with or without nutrient element (KNO_3), the cuttings were inserted in plastic pots (10 cm diameter), containing a mixture of sandy soil and peatmoss (3:1, v/v)and placed under the greenhouse conditions to maintain high relative humidity (90 ± 5% RH) of the air surrounding the cuttings at 23 ± 2 °C.

2.2. Experimental layout

The experiment was designed as Randomized Complete Block Design (RCBD) containing 15 treatments (5 IBA × 3 KNO_3) with three replications (Snedecor and Cochran,1981).

2.3. Data recorded

Rooting response was evaluated after 60 days from planting date by determining (I) rooting percentage (II) number or roots/ cutting, (III) root length (cm) and (IV) fresh and dry weight/rooted cutting. Twenty rooted cuttings of each treatment were weighed after rinsing the roots then left to dry and reweighed. The remaining rooted cuttings were transplanted in clay pots (20cm in diameter) containing the pervious rooting media and placed under full sun for another 60 days. The following data were recorded (I) survival percentage, (II) number of shoots /cutting, (III) shoot length (cm), (IV) leaf dry weight (g), (V) total chlorophyll (A+ B) content (Greig *et al.* 1968), (VI) nitrogen and potassium content of leaves, (*i.e.*). Nitrogen was determined in leaves by using micro-kjeldahl technique, while potassium was determined by using a flame spectrometer (Chapman and Pratt, 1961).

3. RESULTS AND DISCUSSION

3.1. Rooting percentage

Data presented in Table (1) show that all the concentrations of IBA separately or in combination with KNO_3 at any level (1000 and 2000 ppm) significantly increased the rooting percentage as compared with the control. A maximum increase was obtained at 6000 ppm IBA

in combination with 2000 ppm of KNO_3 in both seasons (2001 and 2002). These results may be attributed to the effect of auxins at a specific concentration alone or with minerals on promoting the differentiation of root primordia (Carpenter and Cornell, 1992). More -over, auxin may influence the induction of meristematic activity in the root (Scott, 1972). Subsequently, the total percentage of rooted cuttings was increased. Similar results were reported by Panwar *et al.*, (1999) Hosni *et al.*, (2000) and Mahros (2000) on Bougainvillea.

Table (1) : Effect of IBA and KNO_3 concentrations on rooting percentage and number of roots/cutting of *Bougainvillea glabra* cv. "Golden Glow" during the two seasnos (2001 and 2002).

IBA ppm	KNO_3 (ppm)							
	0.0	1000	2000	Mean	0.0	1000	2000	Mean
	Rooting percentage							
	1st season (2001)				2nd season (2002)			
0.0	47.02	56.72	59.82	54.52	48.85	56.79	58.87	54.84
2000	86.72	90.85	93.00	91.19	88.01	90.21	93.02	90.41
4000	89.36	94.05	96.79	93.40	90.51	95.02	96.30	93.94
6000	92.56	97.30	98.36	96.07	92.46	96.86	98.51	95.94
8000	92.02	95.50	95.50	94.45	91.93	94.27	96.02	94.07
Mean	81.54	86.95	88.69		82.35	86.63	88.54	
	Number of roots/cutting							
0.0	6.18	6.22	7.02	6.47	6.07	6.18	7.00	6.42
2000	13.83	14.30	16.02	14.72	13.90	14.14	16.30	14.75
4000	14.69	15.81	17.32	15.94	14.98	15.97	17.85	16.27
6000	15.51	16.78	17.92	16.74	15.49	16.71	17.80	16.66
8000	14.69	15.31	15.20	15.16	14.87	15.26	15.30	15.14
Mean	13.03	13.68	14.70		12.97	13.65	14.85	

$LSD_{0.05}$ for:	Rooting percentage		Number of roots/cutting	
	1st	2nd	1st	2nd
IBA	1.22	1.70	0.14	0.13
KNO_3	1.89	1.96	NS	NS
Inter.	2.03	2.06	0.062	0.71

NS = not significant

3.2. Number of roots /cutting

The number of roots/cutting was generally higher in IBA treated

cuttings with or without KNO_3 solution than those of the control (Table 1). The highest number of roots/cutting was obtained from the combination of IBA at 6000 ppm (First season) and 4000 ppm (second season) with KNO_3 at the highest level (2000 ppm). However, there were no significant differences between the levels of KNO_3 in both seasons.

The slight differences in the number of roots per cutting in the two seasons are probably due to the different levels of endogenous auxins in the two seasons which were responsible for stimulating the root formation (Hartmann and Kester, 1983). These results are in agreement with those reported by Davies ,(1984) on *Ficus pumila*, El-torky *et al.* ,(1993) on *Ficus benjamina* and *Ficus microcarpa* and Chovatia, *et al.*, (1995) on Bougainvillea.

3.3. Root length

The data in Table (2) show the effect of IBA treatments and KNO_3 levels and their interaction on root length of *Bougainvillea glabra* cv. "Golden Glow" cutting.,It revealed that root length was significantly increased over the control in both seasons due to the application of IBA either alone or combined with potassium nitrate (KNO_3) solution. Whereas, this parameter was not significantly affected when the cuttings were treated with KNO_3 separately in the second season (2002). IBA at concentrations of 6000 ppm plus. 2000 ppm KNO_3 gave the maximum increase in root length for all treated cuttings in both seasons. This treatment led to an increase in root length by 167.32% and 164.35 % as the average of relative increase, in the first and second seasons, respectively. This increase may be due to the mode of action of IBA, which increases the cambial activity, root intial formation, differentiation and elongation (Scott, 1972).

These results agree with the findings of Carpenter and Cornell (1992) and Davies *et al.* (1982) on *Hibiscus* and *Ficus*, respectively, and Gupta and Kher (1991) and Chovatia *et al.* (1995) on Bougainvillea. Using IBA and/or KNO_3 in combination has an enhancing effect on the synthesis and activity of RNA and various enzyme proteins in root cells. Consequently cell division and elongation could be increased as stated by Scott (1972).

3.4. Root fresh weight (FW) and dry weight (DW) per rooted cutting

In general all concentrations of IBA alone or in combination with KNO_3 significantly increased the fresh and dry weight of roots for treated cuttings. (Tables 2 and 3). IBA at 6000 ppm in combination with KNO_3 at 1000 or 2000 ppm proved to be more effective during both seasons. Also, increasing the concentration of IBA more than 6000 ppm caused a reduction in FW and DW which was still better than the control. High level of auxins have been reported to inhibit the development of root primordia (Carpenter and Cornell, 1992). The differences between the treatments namely 6000 ppm IBA plus 1000 or 2000 ppm KNO_3 were not significant.

Table (2): Effect of IBA and KNO_3 concentrations on root length (cm) and fresh weight (g) of *Bougainvillea glabra* cv. "Golden Glow" during the two seasnos (2001 and 2002).

IBA ppm	KNO_3 (ppm)							
	0.0	1000	2000	Mean	0.0	1000	2000	Mean
	1st season (2001)				2nd season (2002)			
	Root length (cm)							
0.0	6.12	6.72	6.98	6.61	6.20	6.81	6.95	6.65
2000	9.41	10.15	11.26	10.27	9.40	10.14	11.27	10.27
4000	13.02	15.12	15.89	14.68	13.10	15.13	15.91	14.71
6000	15.00	15.98	16.36	15.78	15.02	15.96	16.39	15.79
8000	14.86	15.50	16.12	15.49	14.91	15.49	16.15	15.52 •
Mean	11.86	12.69	13.22		11.73	12.71	13.33	
	Root fresh weight (g)							
0.0	2.29	2.59	2.94	2.61	2.30	2.50	2.96	2.62
2000	3.50	3.83	2.94	3.78	3.46	3.83	3.99	3.76
4000	4.30	4.86	4.83	4.77	4.25	4.89	5.13	4.77
6000	5.36	5.72	4.86	5.66	5.40	5.73	5.76	5.36
8000	5.19	5.30	5.72	5.41	5.17	5.32	5.73	5.41
Mean	4.13	4.46	5.12		4.12	4.47	4.71	

$LSD_{0.05}$ for:-	Root length (cm)		Root fresh weight (g)	
	1st	2nd	1st	2nd
IBA	0.24	0.19	0.22	0.19
KNO_3	0.31	0.29	NS	NS
Inter.	0.50	0.41	0.36	0.28

NS = not significant

The increase in both FW and DW of root /cutting was due to

IBA treatment in promoting the growth or the number of root primordia at specific concentrations. Similar results were obtained by Haikal (1992) on *Ficus retusa*. Furthermore, the combination between KNO_3 and IBA was probably important to supply the formed roots with feeding to induce the grouth, leading to better fresh and dry weight of roots. Similar trends were recorded by Beland *et al.* (1983) on poinsettias.

3.5. Survival percentage

Data in Table (3) show the survival percentage of rooted cuttings after 60 days from transplanting. IBA at all concentrations (2000, 4000 and 6000 ppm) and/or KNO_3 levels resulted in high survival percentages of rooted cutting. The treatment with IBA at 6000 ppm combined with the high level of KNO_3 (2000 ppm) was significantly higher than using 2000, 4000 and 8000 ppm; survival percentages

Table (3) : Effect of IBA and KNO_3 concentrations on root dry weight (g) and survival percentage of cuttings of *Bougainvillea glabra* cv. "Golden Glow" during the two seasons (2001 and 2002).

IBA ppm	KNO_3 (ppm)							
	0.0	1000	2000	Mean	0.0	1000	2000	Mean
	Root dry weight (g)							
	1st season (2001)				2nd season (2002)			
0.0	0.21	0.24	0.26	0.24	0.22	0.24	0.25	0.24
2000	0.29	0.31	0.38	0.33	0.03	0.33	0.38	0.37
4000	0.44	0.50	0.59	0.51	0.58	0.52	0.57	0.52
6000	0.58	0.62	0.63	0.61	0.63	0.63	0.64	0.62
8000	0.51	0.54	0.60	0.55	0.50	0.52	0.60	0.54
Mean	0.41	0.44	0.49		0.41	0.45	0.49	
	Survival percentage							
0.0	54.00	57.68	59.89	57.28	54.67	57.96	60.21	57.61
2000	81.36	84.89	88.00	84.57	83.41	86.51	89.84	86.59
4000	87.81	91.09	92.56	90.49	88.63	91.91	93.96	91.50
6000	93.87	96.27	98.41	96.18	93.02	97.31	98.50	96.28
8000	92.81	94.50	94.03	93.78	91.83	93.65	94.01	93.16
Mean	82.02	84.89	86.58		82.31	85.47	87.30	

$LSD_{0.05}$ for:-	Root length (cm)		Survival percentage (sp)	
	1st	2nd	1st	2nd
IBA	0.03	0.02	1.21	1.26
KNO_3	0.03	0.03	1.64	1.47
Inter.	0.04	0.04	2.31	2.50

were 98.41% and 98.50% for the first and second seasons, respectively. The increases in survival percentage were 81.36% and 80.17% over the control. This might be due to the higher rooting percentage, which would be the result of earlier roots in IBA treated cutting. Besides the role played by (KNO_3) in the synthesis of protein and carbohydrates as reported by Mostafa (1996), this leads to a higher survival percentage. These results agree with earlier work of Bhattacharjee and Balakrishna (1993) on Bougainvilleas and Haikal (1992) on *Ficus retusa*.

3.6. Shoot number and length per cutting

Data in Table (4) show that, IBA concentrations with KNO_3 levels gave significant increase in both the number and length of

Table(4): Effect of IBA and KNO_3 concentrations on shoot number and length per cutting of *Bougainvillea glabra* cv. "Golden Glow" during the two seasons (2001 and 2002).

IBA ppm	KNO_3 (ppm)							
	0.0	1000	2000	Mean	0.0	1000	2000	Mean
	Shoots number/cutting							
	1st season (2001)				2nd season (2002)			
0.0	2.18	2.26	2.56	2.33	2.23	2.29	2.58	2.37
2000	3.10	3.28	3.51	3.30	3.15	3.30	3.61	3.35
4000	3.61	3.85	3.92	3.79	3.64	3.86	3.96	3.82
6000	3.94	4.20	4.79	4.31	3.98	4.21	4.80	4.33
8000	3.96	4.20	4.62	4.24	3.96	4.20	4.76	4.31
Mean	3.35	3.59	3.88		3.39	3.58	3.94	
	Length of shoot/cutting (cm)							
0.0	15.83	16.72	18.96	17.17	16.00	17.02	18.51	17.18
2000	23.51	28.51	30.46	27.46	23.71	29.96	31.81	28.49
4000	31.56	38.19	41.81	37.19	30.91	38.40	41.80	37.04
6000	46.41	52.02	57.92	52.12	46.32	51.96	58.31	52020
8000	47.06	50.12	55.24	50.81	46.71	51.21	55.91	51.28
Mean	32.87	37.11	40.86		32.73	37.71	41.27	

$LSD_{0.05}$ for:-	Shoot number/cutting		Length of shoot/cutting	
	1st	2nd	1st	2nd
IBA	Ns	0.27	0.96	1.06
KNO_3	NS	NS	1.03	1.13
Inter.	0.40	0.47	1.34	2.57

NS = not significant

shoots/cutting of *Bougainvillea glabra* cv. "Golden Glow." as compared with the control in both seasons. Also, the number and length of shoots was correlated positively with increasing IBA concentrations up to 6000 ppm in the first season and 6000 or 8000 ppm in the second season when combined with 2000 ppm KNO_3.

The increase in the number and length of shoots per cutting may be attributed to the effect of using IBA and KNO_3 in the formation of vigorous root systems and efficient absorption of nutrient elements, which enhanced the vegetative growth. These results are in agreement with the findings of Singh (2001), and Kanamadi *et al.* (1997) on Bougainvilleas.

3.7. Leaf dry weight (g)

The dry weight of the produced leaves was significantly increased in the second season when the cuttings were treated with IBA separately or in combination with all KNO_3 levels as compared with the control (Table 5). The highest values of dry matter of leaves (0.8 and 0.82 g) were obtained by using 6000 ppm IBA combined with 2000 ppm KNO_3, in the first and second seasons, respectively, These results may be due to the role of IBA with KNO_3 for improving both the growth rate of roots and leaf production, which led to an increase in the absorption nutrient, photosynthesis efficiency and accumulation of dry matter in the leaves. Similar trend of results was obtained by Wang and Anderson (1989) on *Hibiscus rosa - sinensis*.

3.8.Chemical constituents

3.8.1.Total chlorophyll content

The results in Table (5) indicate that the total chlorophyll content (a + b) as mg per 100 g fresh weight of leaves (FWL) was significantly increased with increasing IBA concentrations separately or combined with KNO_3 application as compared with the untreated cuttings during the two seasons of the experiment. The highest amount of chlorophyll (169.93 and 170.31mg/100g FWL) was produced when the cuttings were treated with IBA at 6000 ppm in presence of 2000 ppm KNO_3 in the first and second season.

These treatments increased total chlorophylls over the control in both seasons, This may be due to the IBA treatment combined with KNO_3, resulting in a better formation vigorous root system, and this

could stimulate the growth as well as pigment biosynthesis in the leaf tissues. These results are in agreement with those obtained by Mostafa (1996) on Hydrangea.

Table (5) : Effect of IBA and KNO_3 concentrations on leaf dry weight (g) and total chlorophyll (a+b) content (mg/100 g leaves fresh weight) of *Bougainvillea glabra* cv. "Golden Glow" during the two seasons (2001 and 2002).

IBA ppm	KNO_3 (ppm)							
	0.0	1000	2000	Mean	0.0	1000	2000	Mean
	Leaf dry weight (g)							
	1st season (2001)				2nd season (2002)			
0.0	0.33	0.40	0.46	0.40	0.31	0.41	0.46	0.40
2000	0.51	0.57	0.62	0.57	0.52	0.59	0.63	0.53
4000	0.59	0.67	0.76	0.67	0.52	0.69	0.77	0.69
6000	0.63	0.71	0.80	0.71	0.65	0.73	0.82	0.73
8000	0.59	0.67	0.77	0.68	0.63	0.69	0.79	0.70
Mean	0.53	0.60	0.68		0.55	0.62	0.70	
	Total Chlorophyll (a+b)							
0.0	48.20	78.56	89.19	71.98	49.20	78.10	89.14	72.15
2000	82.01	112..95	142.36	112.44	83.03	113.02	141.90	112.65
4000	109.15	136.82	156.30	134.09	111.81	138.19	158.61	136.20
6000	130.35	149.15	169.93	149.80	132.09	148.31	170.31	150.24
8000	136.30	161.10	162.90	153.43	138.52	161.90	165.30	155.24
Mean	101.20	37.11	40.86		102.93	127.90	145.05	

$LSD_{0.05}$ for:-	Leaf dry weight		Total Chlorophyll (a+b)	
	1st	2nd	1st	2nd
IBA	NS	0.27	2.46	2.21
KNO_3	NS	NS	NS	3.51
Inter.	0.40	0.47	4.41	4.32

NS = not significant

2.8.2. Nitrogen and Potassium content (%)

Generally, data presented in Table (6) show that all IBA concentrations alone or in combination with KNO_3 levels (1000 or 2000 ppm) significantly increased nitrogen and potassium percentage of the treated cuttings. The nitrogen and potassium percentage in *Bougainvillea glabra* cv. "Golden Glow" leaves was significantly increased by increasing the concentration of IBA plus KNO_3, whereas the highest significant increase in N% or K% was obtained by using 6000 MgL^{-1} IBA combined with the highest level of KNO_3

(2000 ppm) as compared with the control in both seasons. This result may be attributed to the effect of KNO_3 added as a source of N and K on increasing the availability of the absorbed and translocations of N and K in cuttings and hence its accumulation in the leaf tissues especially the specific concentrations of IBA. A similar trend was found by Bertram, (1992) on *Hibiscus rosa –sinensis.*

Table (6) : Effect of IBA and KNO_3 concentrations on nitrogen and potassium content (%) of *Bougainvillea glabra* cv. "Golden Glow" during the two seasons (2001 and 2002).

IBA ppm	KNO_3 (ppm)							
	0.0	1000	2000	Mean	0.0	1000	2000	Mean
	Nitrogen percentage							
	1st season (2001)				2nd season (2002)			
0.0	1.09	1.32	1.56	1.32	1.07	1.34	1.59	1.33
2000	1.30	1.61	1.85	1.59	1.23	1.65	1.86	1.66
4000	1.62	1.98	2.09	1.90	1.64	1.98	2.12	1.91
6000	1.93	2.13	2.37	2.14	1.96	2.16	2.38	2.17
8000	1.86	2.61	2.33	2.10	1.87	2.12	2.35	2.11
Mean	1.56	1.83	2.04		1.56	1.85	2.06	
	Potassium percentage							
0.0	1.23	1.59	1.98	1.60	1.26	1.62	1.96	1.61
2000	1.76	2.14	2.33	2.08	1.78	2.16	2.35	2.10
4000	2.10	2.36	2.46	2031	2.15	2.38	2.47	2.33
6000	2.15	2.70	3.06	2064	2.18	2.70	3.11	2.66
8000	2.15	2.63	2.70	2.64	2.16	2.68	3.16	2.67
Mean	1.88	2.28	2.63		1.91	2.31	2.61	

$LSD_{0.05}$ for:	Nitrogen		Potassium	
	1st	2nd	1st	2nd
IBA	0.10	0.12	0.09	0.11
KNO_3	0.13	0.16	0.11	0.13
Inter.	0.19	0.21	0.20	0.26

Conclusions

From the results of this study it may be indicated that IBA talc powder at 4000 or 6000 ppm followed by KNO_3 at the concentration of 2000 ppm were more effective on parameters of rooting, vegetative growth and chemical constituents of *Bougainvillea glabra* cv. "Golden Glow" plants.

4. REFERENCES

Awad A. E., Dawh A. K. and Attya M. A. (1988). Cuttings thickness and auxin affecting the rooting and consequently the growth and flowering of *Bougainvillea glabra* L. Acta Hort., 226 (II): 445 – 454.

Beland W. L., Sanderson K. C. and Williams J. C. (1983). Rooting of poinsettias cuttings treated with various fungicides in IBA talc powder. Hort.Sci. 18: 361 – 362.

Bertram L. (1992). Vegetative propagation of *Hibiscus rosa – sinensis* L. in relatin to nutrients concentration of the propagation medium . Hort . Abst. ,62: 1473.

Bhattacharjee S. K. and Balakrishna M. B. (1993). Propagation of Bougainvillea from stem cuttings. I. Effect of growth regulators, rooting media, leaf number, length and woodiness of cuttings. 12 (1/2): 7- 12.

Carpenter W. J. and Cornell J. A. (1992). Auxin application duration and concentration govern rooting of *Hibiscus* stem cuttings. J. Amer. Hort. Sci., 117 (1): 68 – 74.

Chapman H. D. and Pratt P. F. (1961). Methods of analysis of soils, plants and water. Div. Of Agric. Sci., Priced. Pub., 4034. Univ. Cal. U.S. A.

Chovatia V. P., Poshiya V. K. and Shukl P. T. (1995). Roots initiation studies in bougainvillea (*Bougainvillea pervuiana* L. var. Mary palmar).Gujarat Agric.Univ. Red. Jour., 20 (2):167–169.

Davies F. T. (1984). Shoot RNA, cambial activity and indolebutyric acid affectivity in seasonal rooting of juvenile and mature *Ficus pumila* cuttings. Plant Physiol. 62: 571 – 575

Davies F. T. , Lazarte J. E. and Joiner J.N. (1982). Initiation and development of roots in juvenile and mature leaf – bud cuttings of *Ficus pumila.* Amer. J. Bot. 69: 804-811.

El-torky M. G. Yacout M.A. and El-Shemmawy O. A. (1993). Effect of indole butyric acid on root formation in stem cuttings of *Ficus benjamina* and *Ficus microcarpa.* Alex. J. Afric. Res. 38 (2): 301 – 314.

Greig J., Motes J. and Tikiriti A. (1968). Effect of nitrogen levels and micronutrients on yield of chlorophyil and mineral contents of spinach. Proc. Amer. Soc. Hort. Sci., 92: 508 – 515.

Gupta V. N. and Kher M. A. (1991). A note on the influence of auxin in regeneration of roots in tip cuttings of *Bougainvillea* spp. Var. Garnet Glory under intermittent mist, Haryana J. Hort. Sci. 20 (12): 85 – 87.

Haikal M. S. (1992). Effect of some growth regulators on root formation in terminal stem cuttings of *Ficus retusa*. Alex. J. Agric. Res. 37: 301 – 316.

Hartmann H. and Kester D. (1983). Plant Propagation. Principles Practices, Englwoodcliffs. N. J. Prenticenall Inc. U.S.A.

Hess C.E. (1962). A physiological analysis of root initiation in easy and Difficult to root cuttings. Proceed. 16th Intl. Hort. Congr. 375 – 381.

Hosni A. M., EL-Gendy S. A., Shedeed M.R. and Ebrahim A. K. (2000). Improvement of rooting in Bougainvillea × buttiana " Mrs Butt" by wounding and/or IBA application (s) to cutting basal – ends. Annals Agric. Sci. 45 (2): 659 – 78.

Kanamadi V. C., Patil S., Ryag Y. H., Shiral R. M. and Vijayakunar D.R.(1997). Effect of growth regulators on the rooting of cuttings in Bougainvillea variety Magara Advances in Agric.Res. India (7): 43 – 45.

Mahros O. M. (2000). Rootability and growth of some types of bougainvilleas cutting under IBA stimulation. Assiut jour. Agric. Sci, 31 (1) : 19 – 37.

Mostafa M.M. (1996). Effect of indol – 3 – butyric acid and some nutrient elements on rooting of *hydrangea* cuttings. Alex. J. Agric. Res., 41 (2): 237 – 246.

Panwar R. D., Gupta A. K., Sharma J. R. and Ratesh L. (1994). Effect of growth regulators on rooting in bougainvillea var. Alok. Inter. J. Trop. Agric., 12 (3/4) : 255 – 261.

Panwar R. D., Gupta A. K., Yamdagni R. and Saini R. S. (1999). Effect of growth regulators on rooting of cuttings of bougainvillea cv. Thimma. Haryana Agric. Univ. J. Res. 29 (1/2): 11 – 17.

Scott T. (1972). Auxins and Roots. Ann. Rev. Plant Physiol. 23: 238 – 258.

Singh A. K. (2001). Effect of wood type and root promoting chemicals on rooting of cuttings in *Bougainvillea peruviana* L. Advances Hort. of Forest., (8): 179 – 184.

Snedecor G. W and Cochran W. G. (1981). Statistical Methods. 7th Edition, Iowa State Univ. press, Ames Iowa, U.S.A.

Wang Q and Anderson A. (1989). Propagation of *Hibiscus rosa - sinensis:* Relation between stock plant cultivar, age, environment and growth regulators treatments. Acta Hort., 251 : 289 – 299.

دراسات على التجذيروالنمو اللاحق للجهنمية

على حســـن النجار

قسم الزهور ونباتات الزينة وتنسيق الحدائق
كلية الزراعة ــ جامعة الإسكندرية ــ الشاطبى ــ مصر

ملخـــــــــــص

أجرى هذا البحث لموسمين متتالين (٢٠٠١ ، ٢٠٠٢) بهدف دراسة تأثير خمســة تركيزات من مسحوق اندول حمض البيوتريك المضاف إليه بودرة التلك وهــى صــفر ، ٢٠٠٠ ، ٤٠٠٠ ، ٦٠٠٠ ، ٨٠٠٠ جــزء في المليون وثلاث مستويات من محلول نترات البوتاسيوم (KNO_3) وهى صفر ، ١٠٠٠ ، ٢٠٠٠ جــزء في المليون على تكوين الجذور والنمو لعقل نباتات الجهنمية صنف جولدن جلــو (*Bougainvillea glabra* cv. "Golden Glow") . تم أخذ العقل فى شــهر فــبراير مــن كــل عام حيث تم نقعها لمدة ٢٤ ساعة فى محلول نترات البوتاســيوم بالتركــيزات الســابقة ثم عوملت قواعد العقل قبل الزراعة مباشرة بمسحوق إندول حمض البيوتريك بالتركيزات سالفة الذكر لمدة خمس ثوانى .

أجرى عمل جميع التوافيق المحتملة بين كل من مستويات نترات البوتاسيوم وتركيزات إندول حمض البيوتريك للحصول على ١٥ معاملة فى ثلاث مكررات .

اوضحت النتائج المتحصل عليها أن معاملة العقل بإندول حمض البيوتريك بتركيزاته المختلفة بصورة فردية أو متداخلة مع محلول نترات البوتاسيوم أدت إلى زيادة معنويــة فى كل من النسبة المئوية للجذور ، عدد الجذور المتكونة على العقل ، طول الجذور ، الوزن الرطب والجاف للجذور، معدل بقاء العقل، عدد الفروع الناتجة طولها والوزن الجاف للأوراق وذلك مقارنة بالعقل غير المعاملة (الكنترول) وتحققت أفضل النتائج عند معاملة العقل باندول

حمض البيوتريك بتركيز ٤٠٠٠ ، ٦٠٠٠ جزء في المليون مع محلول نترات البوتاسيوم عند تركيز ٢٠٠٠ جزء في المليون. كما أشارت نتائج التحليل الكيماوى إلى زيادة معنوية في محتوى الأوراق من الكلورفيلات الكلية وكذلك محتواها من عناصر النتروجين والبوتاسيوم خاصة عند التركيز ٦٠٠٠ ، ٨٠٠٠ جزء في المليون من إندول حمض البيوتريك مع محلول نترات البوتاسيوم عند التركيز المرتفع (٢٠٠٠جزء في المليون) .

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