J. Agric. Sci. Mansoura Univ., 29(2): 775 - 785, 2004

PHYSIOLOGICAL STUDIES ON *Ficus benjamina* PLANTS 1:EFFECT OF CUTTING COLLECTION, IBA AND NOFATREIN ON CHEMICAL COMPOSITION, ROOTABILITY OF CUTTINGS AND TRANSPLANTS GROWTH

Abdou, M. A.; M. A. Mohamed and F. A. Attia
Department of Horticulture, Faculty of Agriculture, Minia University, Egypt

ABSTRACT

Ficus benjamina L. plant represents an important component of the foliage interior landscape. This study was carried out during 2001/2002 and 2002/2003 to investigate the effect of date of cutting and cutting dipping for 10 min. in, 3 g/L of Nofatrein (a foliar fertilizer) and/or 3000 ppm IBA or a mixture of both on rooting and growth of *F. benjamina* cuttings. Terminal cuttings were collected and planted on first day of each month along the year.

Cutting date significantly affected total carbohydrates, soluble sugars, free indoles and total phenol contents. Rootability was paralleled with cutting content of total carbohydrates, soluble sugars and free indoles. Rootability had an adverse relationship with total phenol concentration. None of cuttings planted in Jan., Nov. or Dec. developed roots. Both dates of cutting and cutting treatments significantly affected rootability and transplants growth. Nofatrein and/or IBA significantly improved rootability as well as the growth of developed transplants over the other untreated cuttings. Rootability was gradually increased from 34 for February planted cuttings to 87% for June planted cuttings thereafter rootability decreased to 27 % for cuttings collected in October. Hundred percentages of cuttings collected on June and treated with Nofatrein + IBA developed transplants. The tallest transplants with the highest leaf number and heaviest leaves and root dry weights were obtained when cuttings were collected in June and treated with both IBA and Nofatrein.

Correlation coefficient values exhibited significant positive correlation between rootability % and each of total carbohydrates and total free indoles, while rootability % was negatively correlated with total free phenols in both seasons.

INTRODUCTION

Ficus benjamina L. plant (weeping fig) is a tree species, belongs to Moraceae family, it is native to tropical Southeast Asia. Since it has been adapted to indoor conditions, it represents an important component of the foliage interior landscape (Florida Nurserymen and Growers Association, 1997 and Veneklass *et al.,* 2002).

Changes in different environmental conditions during the year round such as temperature, day length, light intensity, humidity etc. causes an alteration in the level of mother plant stored of carbohydrates, proteins and growth regulators within their tissue.

A significant correlation between sucrose concentration, which changes during the year, of chrysanthemum cuttings and its root number has been found by Druege *et al.,* (2000). Klein *et al.* (2000) who noted that the rooting percentage of myrtle cutting increased from 20 of cuttings taken during December-February to 70% for those taken during May-August. El-

Gendy *et al.*, (1995) found that rooting and growth of developing transplants of *Sanchezia cophyila, Pittisporum tobira and Polyscias guiloylei* were significantly affected by date of cutting. Blazich (1988) declared that adventitious roots formation of cutting was affected by the total carbohydrates content as well as its metabolism. Moreover, carbohydrates alter C:N ratio which is an important factor for adventitious roots formation.

Auxins are involved in different physiological responses, which influence different phenomena of plant growth and differentiation including root initiation and elongation. Auxins have been widely used to enhance root formation in cuttings (Loach, 1988). Among different auxins, IBA, is more stable and insensitive to auxin degrading enzyme. Therefore, it is the most common used auxin for adventitious root formation. Both of percentage of rooted cuttings, counts and length of developing roots of eastern red cedar were affected with 5000 ppm IBA as well as the interaction between IBA and cutting time (Henry *et al.*, 1992).

Softwood cuttings of *Chamaelaucium-uncinatum schauer* showed some rootability whereas hardwood cuttings did not root as they contained a higher concentration of phenol compounds (Curir *et al.*, 1993). Plants accumulate a wide variety of phenolic compounds, which comprise a large group of endogenous growth inhibitors. Phenolic compounds affect plant growth directly by their involvement in plant metabolism, function and development such as hormone involved in physiology of root initiations (Kozlowski and Pallardy, 1997). Kaur *et al.* (2002) found that total phenol declined and adventitious root formation was increased when grapevine cuttings were treated with IAA.

The enhancing effect of different nutrition elements on rootability of different types of cuttings has been investigated (Josten and Kutschera, 1999) on sunflower, (Zhao *et al.*, 1991) on cucumber and (Thangavel and Subburam 1998) on *Portulaca oleracea*.

Therefore, seasonal variation considers a critical factor affecting the adventitious roots formation of cuttings especially in woody species. However, Howard (1996) stated that the adequate time for cuttings is varying among different species and should be individually established. So far, the objective of this part of study was to investigate the effect of season (time of cutting) and cutting treatments with Nofatrein, a foliar fertilizer which contains some nutrition elements and/or IBA; on adventitious roots formation and growth of terminal cuttings of *Ficus benjamina.*

MATERIALS AND METHODS

Four-years-old *Ficus benjamina* trees grown at Minia University nursery, El-Minia, Egypt, were used as a source of cuttings for this investigation during 2001/2002 and 2002/2003. Terminal cuttings (8-10 cm in length with 5-6 leaves) were collected at the first day of each month starting from January till December. Foliage was stripped from the basal 3 cm, then cuttings were divided into four replicates. Before planting the cuttings, one cm from the base of four cuttings of each replicate was excised, crushed and extracted with 80% methyl alcohol (Daniel and George, 1972) to determine total carbohydrates and soluble sugars as described by Smith *et al.*, (1956).

P-dimethylamino benzaldehyd was used to measure the concentration of total free indoles (Larshen *et al.*, 1962). Whereas, total free phenols were determined using Folin and Denis colorimetric method (Association of Official Agricultural Chemists, 1970).

A factorial experiment in a randomized complete block design with 4 replicates was used in each season. Cuttings base were dipped for 10 min in distilled water (control),, 3000 ppm indole buteric acid (IBA) and/or 3 g/L; Nofatrein or both IBA + Nofatren. The composition of Nofatrein (a foliar fertilizer) is 5% N, 5% P, 5% K, 0.15 % EDTA-Fe, 0.1% EDTA-Mn, 0.15% EDTA-Zn, 0.05 % EDTA-B and 0.02 % EDTA-Mo. So, date of collecting cuttings represented factor A and dipping treatments represented factor B. Fourty cuttings of each treatment for each month were placed in four replicates, each replicate contained 10 clay pots (one cutting per 15 cm pot). Pots were filled with peat moss and sand 1:1 v/v. All pots were watered as needed and misted twice a day.

After 4 months from planting percentage of rooted cuttings, transplants height, number of leaves /cutting and leaves and roots dry weight/cutting were recorded. Cuttings were considered rooted when they had produced at least three main roots 2 cm each. Roots and leaves of individual plants were dried at 70°C to measure dry weight. Different chemical composition determinations of collected cuttings during the 12 months were statistically analyzed using F test. While other vegetative data were subjected to an analysis of variance (ANOVA) and the means were compared using LSD test at 5% level. Correlation coefficient (r) was estimated between rooting percentage and each of total carbohydrates, total free indoles and total free phenols in the two seasons (Gomez and Gomez, 1984). All January, November and December harvested cuttings failed to develop roots, so they were excluded from the statistical analysis.

RESULTS AND DISCUSSTION

Effect of cutting date on chemical composition of the cuttings:

Table (1) shows clearly that the highest total carbohydrates (142-145mg/100 g), soluble sugars (30 and 31 mg/1000 g) and free indoles (57-59 Mg/1000 g) were obtained from cuttings taken in June and July in the first season. In the second season the highest values were slightly shifted as they were recorded in May and June cuttings for total carbohydrates and soluble sugars, and in July and Aug. cuttings for total free indoles. Such high values for the three chemical components, in both seasons, were significantly higher than those recorded in cuttings taken during Jan., Feb., March, Oct., Nov. and Dec. Meanwhile, the lowest values, for the three chemical components in the two seasons, were obtained from Jan. and Dec. cuttings as indicated in Table (1). Similar results indicating the effect of reserved carbohydrates in cutting rootability were found in chrysanthemum (Druege et al., 2000). Also, Kozlowski and Pallardy (1997) recorded the correlation between reserved carbohydrates of cutting and rooting. They stated that accumulation of carbohydrates during the growth season of evergreen trees plays an important role in early-season growth, transplants survival and rooting.

Table (1): Effect of date of cuttings on total carbohydrates, total soluble sugars, total free indoles and total free phenols content of *Ficus benjamina* cuttings in the two seasons

Month	First season				Second season			
	TC[1] mg/g	TSS[2] mg/g	TFI[3] mg/g	TFF[4] mg/g	TC[1] mg/g	TSS[2] mg/g	TFI[3] mg/g	TFF[4] mg/g
January	68	14	14	134	65	14	14	140
February	86	18	16	130	93	21	16	137
March	101	21	19	127	112	24	19	125
April	113	24	27	122	125	28	21	122
May	131	28	40	117	165	36	30	116
June	142	30	57	114	167	37	56	11
July	145	31	59	111	143	32	63	115
August	132	28	45	117	128	28	60	120
September	129	26	37	118	105	23	42	136
October	95	20	17	128	115	24	24	136
November	77	16	15	131	79	17	16	137
December	69	15	15	132	66	15	15	139
LSD 0.05	10	7	3	14	10	5	6	13

[1] total carbohydrates, [2] total soluble sugars, [3] total free indoles and [4] total free phenols

Concerning total free phenols, a reverse trend was obtained where the lowest values were recorded in June and July cuttings in the two seasons (111-114 and 110-115 mg/1000 g in the first and second season respectively, which differed significantly than the total free phenols of Jan., Feb., Nov. and Dec. cuttings (130-134 mg/1000 g in the first season and 137-140 mg/1000 g in the second one).

The inhibitory effect of phenol level on rootability has been observed on mung bean by Nag *et al*., (2001). Kozlowski and Pallardy (1997), who referred that the inhibitory effect of total free phenols on root initiations could be due to its interaction with plant hormone rather than its direct effect on rootability. Berthon et al., (1993) noted that phenol is involved in different steps of adventitious root formation. Phenols cause modification of IAA-ox activities, and formations of covalently linked auxinphenolic conjugates and appear to be involved in rooting (Hassig 1974).

Effect of cutting date and Nofatrein and/or IBA on rooting percentage:-

Rooting percentage of Ficus benjamina cuttings in the first season was gradually increased parallel to the date of cuttings from Feb. (34%) and up to June (87%), then gradually decreased up to Oct. (27%). While, the cuttings taken in Nov., Dec. and Jan. were not able to produce any roots. The highest rooting percentages were recorded for June and July treatments were significantly higher than all other cutting dates, (Table 2). Almost similar trend of rooting percentage was obtained in the second season with the highest percent of rooting being obtained from cuttings taken in June (94%) which was significantly higher than all other cutting dates as shown in Table (2). Bollmark et al., (1999) found a relationship between season, and re-sprouting of *Salix viminalis* due to the effect of season variation on soluble carbohydrate contents. Similar results regarding the effect of date of cutting on rooting of *Sanchezia cophyila*, *Pittosporum tobira* and *Polyscias guiloylei* was observed by El-Gendy *et al.*, (1995). This variation in rootability of *F. benjamina* as cause of date of cuttings collection was similar to results found in *Chamaelaucium unicnatum* (Curir *et al.*, 1993).

In regard to the effect of the other factors, Nofatrein and/or IBA treatments recorded, significantly, higher rooting percentage than the untreated control treatment in the two seasons. Moreover, Nofatrein/IBA treatment (79 and 79% in both seasons) surpassed, significantly, Nofatrein/or IBA alone. Also, IBA treatment gave significantly higher rooting % (71 and 73%) than that of Nofatrein (49 and 50%) in both seasons, as clearly indicated in Table (2). Zeawail, (1995) found that IBA at 4 gl^{-1} significantly improved rooting of *Bougainviellea glabra* and *Hibiscus rosa-sinensis*. Whereas 2 gl^{-1} was the best treatment for *Acalypha macrophylla* cuttings. Davies (1995) stated that auxin is an important plant growth regulator in root initiation and rooting of stem cutting was one of the first uses of auxins.

The interaction between date of cutting collection and Nofatrein-IBA treatments was significant in the two seasons. The maximum rooting % (100%) was recorded on cuttings taken in June and received both Nofatrein and IBA as shown in Table (2).

Table (2): Effect of Nofatrein and IBA on percentage of rooting of *Ficus benjamina* cuttings in two seasons.

Date (A)	First Season					Second season				
	Treatment (B)					Treatment (B)				
	Cont.	Nof. (3 g/l)	IBA (3000 ppm)	3 g/l Nof. + 3000 ppm IBA	Mean A	Cont.	Nof. (3 g/l)	IBA (3000 ppm)	3 g/l Nof. + 3000 ppm IBA	Mean A
February	3	9	58	64	34	4	11	55	62	33
March	5	15	60	66	37	8	22	60	60	38
April	20	40	84	91	59	25	51	85	90	63
May	40	70	92	99	75	63	75	90	95	81
June	70	84	95	100	87	84	93	100	100	94
July	75	83	85	93	84	70	83	84	93	83
August	50	75	65	71	65	41	61	67	75	61
Septem.	35	58	60	65	55	5	59	61	67	38
October	3	8	36	62	27	10	30	58	66	41
Mean B	33	49	71	79		34	50	73	79	
LSD 5%	A: 4	B: 2		AB: 6		A: 4	B: 2	AB: 6		

Vegetative growth of the transplants:

Obtained data in Tables (3 and 4) indicated the existance of significant differences among different dates of taken cuttings, in the two seasons, for the four studied vegetative characters of *Ficus benjamina* transplants. The tallest transplants ranged from 20.8-21.7 cm and 22.5-23.2 cm) respectively and the heaviest roots dry weights ranged from 1.48-1.58 g and 1.57-1.67) in the two seasons, respectively were recorded, planted on cuttings taken in May, June and July. Whereas, the shortest transplants (14.9 and 14.7 cm) and the least roots dry weight (0.98 and 0.92 g) were obtained on cuttings taken in Feb. of both seasons. Almost a similar trend was obtained for leaves number and leaves dry weight/plant where June and July cuttings produced, significantly in both seasons, the highest values for both traits (16.7 and 16.2 leaves in the first season and 16.1 and 16.2 leaves in the second one, as well as, 2.81 and 2.82 g in the first season, and 2.97 and 2.93 g in the second one as leaves dry weight). On the other hand, the least number of leaves (9.8 and 9.4 for the two seasons) and the highest leaves dry weight (1.86 and 1.79 for the two seasons) were obtained on cuttings taken in Feb. as clearly illustrated in Tables (3 and 4).

Table (3): Effect of cutting date and Nofatrein and IBA on transplants growth [height (cm) and leaf number/plant] of *Ficus benjamina* cuttings in two the seasons

Date (A)	First Season					Second season				
	Treatment (B)					Treatment (B)				
	Cont.	Nof. (3 g/l)	IBA (3000 ppm)	3 g/l Nof. + 3000 ppm IBA	Mean A	Cont.	Nof. (3 g/l)	IBA (3000 ppm)	3 g/l Nof. + 3000 ppm IBA	Mean A
Transplants height (cm)										
February	12.1	16.6	15.0	16.0	14.9	8.1	18.0	16.0	16.7	14.7
March	16.5	17.0	19.1	21.2	18.5	16.9	18.8	20.3	22.0	19.5
April	16.9	18.3	20.3	22.4	19.5	18.0	20.3	22.9	25.0	21.6
May	17.5	19.0	22.9	23.7	20.8	19.1	21.5	23.7	25.9	22.6
June	18.0	19.4	23.7	24.8	21.5	19.5	22.7	24.5	25.9	23.2
July	19.2	20.1	22.8	24.5	21.7	20.3	22.8	21.2	25.8	22.5
August	18.0	19.1	19.1	21.1	19.3	19.0	21.5	21.2	22.3	21.0
Septem.	16.0	18.0	18.0	19.0	17.8	17.0	19.0	20.7	21.5	19.6
October	15.0	16.0	17.0	18.0	16.5	16.0	17.8	18.5	19.1	17.9
Mean B	16.6	18.2	19.8	21.2		17.1	20.3	21.0	22.7	
LSD 5%	A:1.0	B:0.7		AB:0.8		A:1.2		B:0.8	AB:2.4	
Leaf number/plant										
February	7.1	10.2	10.3	11.4	9.8	5.1	10.4	10.8	11.1	9.4
March	10.9	11.5	11.7	12.1	11.6	10.7	11.3	11.4	12.0	11.4
April	12.1	13.3	15.0	15.3	13.9	12.1	13.3	14.4	14.8	13.7
May	14.4	15.2	15.4	16.3	15.3	12.1	14.9	15.5	15.8	14.6
June	16.3	16.9	16.8	18.8	16.7	15.0	15.9	16.5	17.1	16.1
July	15.1	15.8	16.6	17.1	16.2	15.0	16.0	16.6	17.2	16.2
August	12.7	14.0	16.0	16.9	15.4	15.1	15.2	15.6	16.0	15.5
Septem.	10.2	11.4	14.5	15.0	12.8	12.7	14.1	14.8	15.2	14.2
October	10.6	11.9	12.4	12.7	11.9	10.2	10.6	12.0	12.8	11.4
Mean B	12.2	13.4	14.3	15.1		12.0	13.5	14.2	14.7	
LSD 5%	A:0.6	B:0.4		AB:1.2		A:0.7		B:0.5	AB:1.4	

Table (4): Effect of cutting date and Nofatrein and IBA on transplants growth [leaves dry weight g/plant and roots dry weight (g)] of *Ficus benjamina* cuttings in two the seasons

Date (A)	First Season					Second season				
	Treatment (B)					Treatment (B)				
	Cont.	Nof. (3 g/l)	IBA (3000 ppm)	3 g/l Nof. + 3000 ppm IBA	Mean A	Cont.	Nof. (3 g/l)	IBA (3000 ppm)	3 g/l Nof. + 3000 ppm IBA	Mean A
Leaves dry weight g/plant										
February	1.47	2.02	1.93	2.11	1.86	0.96	2.11	1.96	2.11	1.79
March	2.04	2.08	2.23	2.57	2.20	2.08	2.25	2.39	2.57	2.32
April	2.16	2.36	2.86	3.01	2.54	2.28	2.50	2.82	3.01	2.65
May	2.28	2.53	2.86	3.11	2.65	2.49	2.71	2.91	3.11	2.81
June	2.51	2.63	3.00	3.19	2.81	2.67	2.95	3.08	3.19	2.97
July	2.56	2.68	2.94	3.20	2.82	2.64	2.88	3.00	3.20	2.93
August	2.43	2.56	2.59	2.91	2.59	2.61	2.65	2.78	2.91	2.74
Septem.	2.19	2.40	2.45	2.70	2.40	2.06	2.25	2.64	2.70	2.41
October	1.88	1.99	2.16	2.37	2.08	1.98	2.23	2.30	2.37	2.22
Mean B	2.17	2.36	2.56	2.80		2.20	2.50	2.65	2.80	
LSD 5%	A:0.12	B:0.08		AB:2.4		A:0.15		B:0.03	AB:0.09	
Root dry weight (g)										
February	0.72	1.02	1.08	1.10	0.98	0.45	1.02	1.07	1.13	0.92
March	0.99	1.08	1.37	1.45	1.22	1.03	1.15	1.39	1.47	1.26
April	1.13	1.28	1.55	1.65	1.40	1.14	1.32	1.60	1.66	1.43
May	1.22	1.43	1.55	1.71	1.48	1.36	1.52	1.69	1.71	1.57
June	1.41	1.55	1.65	1.72	1.58	1.53	1.68	1.72	1.75	1.67
July	1.42	1.53	1.50	1.70	1.54	1.42	1.57	1.60	1.70	1.57
August	1.31	1.47	1.43	1.47	1.42	1.20	1.40	1.46	1.54	1.40
Septem.	1.19	1.45	1.40	1.42	1.37	1.00	1.12	1.42	1.46	1.25
October	0.96	1.10	1.20	1.39	1.14	1.09	1.21	1.37	1.45	1.28
Mean B	1.15	1.31	1.41	1.51		1.14	1.33	1.48	1.54	
LSD 5%	A:0.06	B:0.04		AB:0.16		A:0.07		B:0.05	AB:0.13	

Improving the growth parameters of transplants developed from summer-collecting cuttings may be due to their higher content of carbohydrates, soluble sugars and total free indoles with a low concentration of total free phenols. These results were similar to those observed by Mesen et al., 2001) who found that, the initial perseverance of carbohydrates of *Albizzia guachapele*, had a significant effect on transplants growth.

Concerning the effect of Nofatrein and/or IBA, such three treatments produced, significantly in both seasons, higher values for each of transplants height, number of leaves and dry weight of leaves and roots, in comparison with those of untreated cuttings as clearly indicated in Table (3 and 4). Among these three treatments, the use of both Nofatrein + IBA together gave, significantly in the two seasons, better results for the four studied vegetative growth traits than those of either Nofatrein or IBA when used alone. However, IBA treatment ranked second, while Nofatrein ranked third in this concern. Numerically, the increase in transplant height, leaves number, leaves and roots dry weights due to Nofatrein/IBA treatment reached 27.7, 23.8, 22.6 and 31.3%, respectively, in the first season over those of untreated cuttings. The corresponding values in the second season recorded 32.7, 22.5, 27.3 and 35.1%, respectively.

The interactions between date of cuttings and Nofatrein/IBA treatments were significant in the two seasons for the four studied vegetative growth characters with the best results being obtained from cuttings taken in June and July and treated with both Nofatrein + IBA as clearly shown in Tables (3 and 4).

Transplants height and leaves and root dry weights of developing transplants of *F. benjamina* were significantly improved due to IBA treatment. Similar results were obtained in different ornamental plants. Zeawail, (1995) found that developing transplants of *Bougainviellea glabra*, Hibiscus rosa-sinensis and *Acalypha macrophylla* were significantly improved when cuttings treated with IBA. Also, Nofal et al. (1996) treated cuttings of *Hibiscus rosa-sinensis* and *Myrtus communis* with different auxins which not only significantly improved rootability of the cuttings by IBA but also significantly enhanced transplants height, the number of roots, root length and leaf number. Similar results about the effect of date on growth of developing transplants, with correlation between nutrient content and carbohydrates of the cutting, were found in *Albizzia guachapele* (Mesen *et al.*, 2001).

So, it might be concluded that apical cuttings of *F. benjamina* could be used for propagation without chemical treatments during May-August. However, if cuttings have to be cultured during Feb.-March, September or October, it is recommended to be treated with 3 g/l Nofatrein + 3 gl^{-1} IBA to improve percentage of rooting as well as improving transplants growth.

Correlation coefficient (r) between rooting percentage and chemical composition of the cuttings:-

The relationship between rooting percentage and each of total carbohydrates, total indoles and total free phenols throughout 9 months starting February to October was studied via correlation coefficients as shown in Table (5).

Table (5): Correlation coefficients between rooting percentage and each of total carbohydrates, total free indoles and total free phenoles in the two seasons.

Chemical composition	Rooting percentage	
	1st season	2nd season
Total carbohydrate	0.889**	0.953**
Total free indoles	0.948**	0.632*
Total free phenoles	-0.949**	-0.932**

*** & ** Significant and highly significant at 5 and 1% levels of probability, respectively.**

The results of correlation coefficient (r) indicated that rooting percentage was significantly and positively correlated with both total carbohydrates and total free indoles in both seasons. In contrast, highly significant negative correlation was observed between rooting percentage and total free phenoles during both seasons. These results confirmed the trend obtained from treatment means as mentioned previously.

REFERENCES

Association of Official Agricultural Chemists (1970). Official Method of Analysis. The A.O.A.C. Washington DC. USA. pp. 832.

Berthon, J.Y.; M.J. Battraw; T. Gaspar and N. Boyer (1993). Early test using phenolic compounds and peroxidase activity to improve *in vitro* rooting of *Sequoiadendron giganteum* Lindl. Buchholz. Saussurea 27: 7-10.

Blazich, F.A. (1988) Mineral nutrition and adventitious rooting. In: Davis T.D., Haissing B.E. (Eds) Biology of Adventitious Root Formation. Plenum Press, New York 143-154.

Bollmark, L.; L. Sennerby-Forsse and T. Ericsson (1999) Seasonal dynamics and effects of nitrogen supply rate on nitrogen and carbohydrate reserves in cutting-derived *Salix viminalis* plants. *Canadian J. of Forest Res.-revue*, 29: 85-94.

Curir, P.; S. Sulis; F. Mariani; C.F. Vansurnere and A. Marchesini (1993) Influence of endogenous phenols on rootability of *Chamaelaucium-uncinatum schauer* stem cuttings. *J. Horti. Sci.,* 55: 303-314.

Daniel E. and `George C.M. (1972). Peach seed dormancy in relation to endogenous inhibitors and applied growth substances. *J. Amer. Soc.* Hort. *Sci.*, 97: 651-654.

Davies, P.J. (1995). Plant Hormones, Physiological, Biochemistry and Molecular Biology. 2nd Edition. Kluwer Academic Publishers.

Druege, U.; S. Zerche; R. Kadner and M. Ernst (2000). Relation between nitrogen status, carbohydrate distribution and subsequent rooting of chrysanthemum cuttings as affected by pre-harvest nitrogen supply and cold-storage. Annals of Botany, 85: 687-701.

El-Gendy, W.A.; S.M. Saleh and M.M. Ekram (1995). Effect of planting dates and rooting cuttings of *Sanchezia cophyila* var. *variegata* Len., *Pittosporum tobira* Ait, and *Polyscias guiloylei* Bailey. J. Agric Sci. Mansoura Univ., 20: 1773-1781.

Florida Nurserymen and Growers Association (1997) Plant Sources. p 104-106.

Gomez, K.A. and Gomez (1984). Statistical Procedures of Agric. Res. John Wiley and Sons. New York, USA.

Haissig, B.E. (1974) Influence of auxin and auxin synergists on adventitious root primordium initiation and development. Nz. J. Sci., 4: 299-310.

Henry, P.H.; F.A. Blazich and L.E. Hinsley (1992). Vegetative propagation of eastern red cedar by stem cuttings. Hort.Science, 27: 1272-1274.

Howard, B.H. (1996). Relationships between shoot growth and rooting of cuttings in three contrasting species of ornamental shrubs. J. Horti. Sci., 71: 591-605.

Josten, P. and U. Kutschera (1999). The micronutrient boron causes the development of adventitious roots in sunflower cuttings. *Annals of Botany,* 84: 337-342.

Kaur, S.; S.S. Cheema and B.R. Chhabra (2002). Chemical induction of physiological changes during adventitious root formation and bud break in grapevine cuttings. Plant Growth Regulators, 37: 63-68.

Klein, J.D.; S. Cohen and Y.Hebbe (2000). Seasonal variation in rooting ability of myrtle (*Myrtus communis* L.) cuttings. Scientia Hort., 83: 71-76.

Kozlowski, T.T. and S.G. Pallardy (1997). Physiology of Woody Plants 2nd ed. Academic Press.

Larshen P.; A. Herbo; S. Klungsour and T. Asheim (1962). The biogenesis of some indole compounds in *Acetobacter xylinum.* Physiol. Plant., 15: 552-562.

Loach, K. (1988) Hormone application and adventitious root formation in cuttings- a critical review. Acta Hort., 227: 126-133.

Mesén, F.; R. Leakey and Newton (2001) The influence of stockplant environment on morphology, physiology and rooting of leafy stem and cuttings of *Albizzia guachapele.* New Forests, 22: 213-227

Nag S.; K. Saha and M.A. Choudhuri (2001). Role of auxin and polyamines in adventitious root formation in relation to changes in compounds involved in rooting. Journal of Plant Growth Regulation, 20: 182-194.

Nofal, E.M.; M.M. Khalafalla; F.A. Menesy and Y.M. Kandeel (1996). Effect of some auxins on rooting of stem cuttings of *Citharexylum quadarengulare* Jacq, *Hibiscus rosa-sinensis* L. and *Myrtus communis* L. Proc. of 4th Arabic Conf. for Horticultural Crops, El-Minia, 25-28 March, 1996. pp 1445-1450.

Smith, F.; M. A. Giles; J.K. Hamilton and P.A. Godees (1956). Colorimetric method for determination of sugar related substances. Analytical Chemistry, 28: 350.

Thangavel, P.; V. Subburam (1998) Effect of trace metals on the restoration potential of leaves of the medicinal plant, Portulaca oleracea, 61: 313-321.

Veneklass, E.J.; M.P. Santos Silva and F. Den Ouden (2002). Determination of growth rate in *Ficus benjamina* L. compared to related faster-growing woody and herbaceous species. Scientia Hort.; 93:75-84.

Zhao, Z.R.; Li, G.R. and G.Q. Huang (1991) Promotive effect of potassium on adventitious root-formation in some plants. Plant Science, 79 (1): 47-50.

Zeawail, M. (1995) Effect of IBA on rooting of cuttings of some ornamental shrubs. *J. Agric. Sci.* Mansoura Univ., 20: 897-902.

J. Agric. Sci. Mansoura Univ., 29(2), February, 2004

دراسات فسيولوجية على نباتات الفيكس بنجامينا ١: تـــأثير ميعـــاد أخـــذ العقـــل والمعاملة باندول حمض البيوترك والنوفاترين على التركيب الكيماوى و التجذيـــر للعقل ونمو البادرات

محمود عبد الهادى حسن عبده- محمود عبد الحكيم محمد- فتحى عبد اللطيف عطيه
قسم البساتين – كليه الزراعة – جامعة المنيا

أجريت هذه الدراسة خلال عامين متتالين ٢٠٠١/٢٠٠٢ و ٢٠٠٢/٢٠٠٣ لدراسة أثـــر ميعاد أخذ العقل الطرفية والغمس لمده ١٠ دقائق فى محلول ٣جم/لتر من السماد الورقى نوفاترين و IBA أو مخلوط من كليهما معا على تجذير و نمو بادرات نباتات الفيكس بنجامينا التـــى تمثـــل عنصرا هاما فى التنسيق الداخلى، وقد تم جمع العقل الطرفيه وزراعتها فى بداية كل شهر بـــدءا من يناير حتى ديسمبر.

أوضحت الدراسة أن هناك اختلافا معنويا فى محتوى العقله من الكربوهيدرات – السكريات الذائبة –الاندولات والفينولات الكليه، وكانت هناك علاقة طرديه موجبة بين النســـبة المئويـــة للتجذيـــر ومحتوى العقله من الكربوهيدرات – السكريات الكليه و الاندولات الحرة لكن كانت هناك علاقـــة عكسية بين محتوى العقل من الفينولات الكليه والنسبة المئويه للتجذير.

وأظهرت النتائج ان كلا من ميعاد أخذ العقله ومعامله العقله له تأثير معنوى على النســـبة المئويه للتجذير ونمو البادرات. لم يحدث تجذير لأي من العقل التى أخذت فى يناير و نوفمـــبر و ديسمبر باى المعاملات. المعاملة بالنوفاترين او IBA أو كلاهما معا أدت الى تحسين معنوى فى التجذير ونمو البادرات.

و قد زادت نسبة التجذير من ٣٤% فى فبراير إلى أعلى قيمه (٨٧%) فى يونيـــو ثـــم انخفضت تدريجيا حتى وصلت الى ٢٧% فى اكتوبر. اما العقل التى جمعت فى يونيو وعوملـــت ب نوفاترين + IBA فقد كان معدل تجذيرها ١٠٠% وكانت البادرات الناتجة منها أطول البادرات. وأوراقها اكثر عددا وأعطت اكبر وزن جاف للأوراق والجذور الناتجة بالمقارنة بالنباتات غـــير معامله.

وقد أظهرت قيم معامل الارتباط وجود ارتباط معنوى موجب بين نسبة التجذير وكل من الكربوهيدرات الكلية والاندولات الحرة الكلية بينما ارتبطت نسبة التجذير سالبا مع الاندولات الحرة الكلية فى العقل فى كلا الموسمين.