

## EFFECT OF SOME AUXINS ON ROOT ABILITY OF *Ficus benjamina* PLANTS

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### ABSTRACT

The effects of overnight dipping of *Ficus benjamina* L " Starlight " cuttings in IBA, IAA, NAA and their mixtures at 0.0, 25, 50 and 100 ppm on percentage of rooted cuttings, some roots and aerial part parameters, pigment contents as well as soluble and insoluble sugars in the leaves were studied during 1999 and 2000 seasons.

Results showed that using a mixture from IBA, IAA and NAA was very effective in improving rooted cuttings %, number of roots, length of root, plant height, number of shoots, number of leaves, leaf area, fresh and dry weights of roots and shoots as well as leaf total carbohydrates %, leaf N%, C/N ratio, chlorophyll a and b, total chlorophylls, carotenoid content and soluble and insoluble sugars in the leaves compared to using each singly. Increasing auxin concentrations from 25 to 100 ppm caused a gradual promotion on such root and shoot parameters as well as chemical constituents.

In *Ficus benjamina* " Starlight " rooting ability of cuttings was greatly favoured by dipping in a mixture of IBA, IAA and NAA at 50 ppm for overnight.

### INTRODUCTION

In order to insure higher percentage of rooting, application of auxins namely IAA, IBA and NAA has been found to encourage root formation in the ornamental plants propagated by cuttings (Hess, 1962, Singh, 1983 and Hartmann *et al.*, 1990). Both IBA and NAA are more effective than IAA for rooting. Endogenous IAA levels decline sharply during the asexual propagation of stem cuttings for easy to -root of Hibiscus cvs, while no measurable auxin was found initially or throughout propagation in stem cuttings bases of difficult to root cultivars (Bose *et al.*, 1973). Overnight dipping of IAA, IBA and NAA at 25 to 200 ppm or quick dipping at 1000 to 2000 ppm was very effective in rooting of *Hibiscus syriacus* ( Whatley *et al.*, 1966 ), Bougainvillea and Hibiscus (Bose *et al.*, 1973 and Kale and Bhujbal, 1975), sage plants (Kwack and Chang, 1980 and Raviv *et al.*, 1984), *Ficus retusa* (Zayed *et al.*, 1986 and Zeowail *et al.*, 1986, Olives (Ibrahim *et al.*, 1988), *Ficus nitida* (El-Sayed, 1989), Bougainvillea (Baraskar *et al.*, 1990) and *Nerium oleander* (Patil and Shirol, 1991). Application of IAA, IBA, NAA and their mixtures 1000 to 3000 ppm effectively improved rooted cuttings %, root, length and root number of *Hibiscus* (Carpenter and Cornell, 1992 and Haikal, 1992), *Chionanthus retusus* (Eaken *et al.*, 1993); Golden Japanese plum (Edriss *et al.*, 1993), Iris ( Mazrou and Afify , 1993 ), Bougainvillea (Panwar *et al.*, 1994) and *Citharexylum quadarengulare* Jacq, *Hibiscus rosasinensis* and *Myrtus communis* (Nofal *et al.*, 1996).

The objective of this research was to determine the effect of IBA, IAA, NAA and their mixtures at 25 , 50 and 100 ppm on the rooting ability and quality of roots and shoots of *Ficus benjamina* " Starlight " plants.

## **MATERIALS AND METHODS**

This study was carried out during the two successive seasons of 1999 and 2000 at King Abdulaziz University Experimental station in Wadi Hada Al-Sham 120 km north-east Jeddah, Saudi Arabia. Middle hardwood cuttings of 20-25 cm long and 1-1.25 cm diameter of *Ficus benjamina* "Starlight" were taken from stock plants on the middle of April in both seasons. Cuttings were dipped overnight in alcoholic solutions of IBA, IAA, NAA, IBA+IAA, IBA+NAA, IAA+NAA and IBA+IAA+NAA (factor A) at 0.0, 25, 50 and 100 ppm (factor B) one double or triple mixtures of auxins were applied in equal percentage (i.e 50% for each in double and 33.3% for each in triple) Untreated cuttings were soaked in distilled water. Cuttings were immediately planted in clay pots of 30 cm diameter, containing rooting medium of 1 sand: 1 clay by weight under the polyethylene house for two months. The rooted cuttings were then transplanted in greenhouse until the end of study (last week of Oct. in both seasons). The experimental layout was split-plot arranged in completely randomized block design. The seven treatments of the three auxins and their mixtures were considered the main plots, meanwhile the four concentrations of auxins were distributed in the sub-plots. Therefore, the experiment included twenty-eight treatments. Each treatment contained five replicates and each replicate had six cuttings per pot. At five months from planting the following parameters were recorded: rooted cuttings, number of roots per cutting, length of root (cm) fresh and dry weights of roots per cutting (g) plant height (cm) number of shoots per cutting, fresh and dry weights of shoots per cutting (g), number of leaves per cutting, leaf area (cm)<sup>2</sup> (according to Jain and Misra 1966), leaf total carbohydrates % (A.O.A.C. 1985), leaf N% (according to Wilde *et al*, 1985), C/N ratio, chlorophyll a and b and carotenoid content in the leaf/(mg/g fresh weight, according to Saric *et al.*, 1976 and Moran, 1982), total chlorophylls, as well as soluble and insoluble sugars % in the leaves (A.O.A.C. 1985).

All the obtained data were statistically analyzed according to Snedecor and Cochran (1980), using L.S.D. test for comparison between different means.

## **RESULTS AND DISCUSSION**

### **1- Effect of IBA, IAA, NAA and their mixtures on percentage of rooted cuttings.**

Data in Table (1) clearly show that dipping cuttings of *Ficus benjamina* in IBA, IAA and NAA in descending order, proved to be very effective in increasing rooted cuttings%. Combined dipping was preferable in producing the highest percentage of rooted cutting compared with the individual treatment. Dipping cuttings in a mixture containing IBA, IAA and NAA was more favourable than using double or single treatment, in this connection. Out of the studied double applications of auxins, using IBA plus IAA was superior in enhancing percentage of rooted cuttings.

Significant differences in the rooted cuttings% were found between all auxin treatments. These results were true in both seasons.

With regard to the effect of auxin concentrations, results clearly show that dipping the cutting in auxins at 25 to 100 ppm for one day significantly

increased the percentage of rooted cuttings over the control in both seasons. and the effect was a concentration dependent. Significant differences in the percentage of rooted cuttings were observed between all concentrations except that occurred at 50 and 100 ppm.

**Table 1: Effect of single or combined application of IBA, IAA and NAA at various concentrations on percentage of rooted cutting and number of roots/cutting of *Ficus benjamina* " Starlight" plants during 1999 and 2000 seasons.**

Characters Auxins (A)	Percentage of rooted cuttings									
	1999					2000				
	Auxin concentrations (B)									
	0.0	25	50	100	Mean	0.0	25	50	100	Mean
IBA	41.2	53.3	60.0	63.4	54.4	47.3	62.0	67.3	69.0	61.4
IAA	41.3	49.0	56.3	57.0	50.6	48.3	56.3	62.0	62.3	57.2
NAA	42.0	46.3	51.0	51.9	47.8	46.0	51.9	57.3	58.0	53.3
IBA + IAA	41.9	71.2	77.2	78.1	67.1	45.9	80.1	84.3	85.0	73.8
IBA + NAA	41.8	66.3	71.2	71.3	62.6	48.0	75.2	80.0	81.3	71.1
IAA + NAA	42.0	56.9	64.3	65.3	57.8	46.3	69.3	73.8	74.0	65.8
IBA+IAA+ NAA	41.9	78.3	87.3	88.7	74.0	46.7	48.3	93.3	94.0	79.5
Mean (B)	41.7	60.6	66.7	67.9		46.9	68.4	74.0	74.8	
LSD. 5 %	A		B		AB	A		B		AB
	3.3		2.8		7.4	4.0		3.3		8.7
Character	Number of roots/cutting									
IBA	7.3	10.5	11.0	11.2	10.0	8.9	12.9	13.5	13.6	12.2
IAA	7.6	9.9	10.5	10.7	9.6	9.0	11.8	12.5	12.5	11.4
NAA	7.4	8.7	9.8	10.0	8.9	9.2	10.3	10.9	11.0	10.3
IBA + IAA	7.5	14.9	16.8	17.0	14.0	9.3	16.9	17.7	17.9	15.4
IBA + NAA	7.6	13.0	13.8	14.0	12.1	9.5	15.2	15.9	16.2	14.2
IAA + NAA	7.6	11.9	12.9	13.0	11.3	9.6	14.0	14.5	14.7	13.2
IBA+IAA+ NAA	7.6	16.7	19.0	20.3	15.9	9.7	17.8	20.0	20.4	16.9
Mean (B)	7.5	12.2	13.4	13.7		9.3	14.1	15.0	15.1	
LSD. 5 %	A		B		AB	A		B		AB
	0.5		0.3		0.8	0.6		0.4		1.1

The maximum percentage of rooted cuttings was recorded in cuttings immersed overnight in solution containing IBA+IAA+NAA at 50 ppm in both seasons.

These results might be attributed to the important role of auxins in enhancing metabolic activity and mobilization of sugar roots which help in the initiation of root primordia in cuttings. Treating cuttings with auxins is responsible for increasing phenolic compounds that appear to act synergistically with auxins in promoting rooting through their effect on protecting the natural IAA from destruction by IAA oxidase (Hess, 1962). These results are in conformity with those reported by Zayad *et al.*, (1986) and Zeawail *et al.*, (1986) on *Ficus retusa*, Eakes *et al.* (1993) on *Chionanthus retusus* and Nofal *et al.* (1996). on *Citharexylum quadregulare* Jacq, Hibiscus. Rosa sinensis and Myrtus communis.

**2- Effect of IBA, IAA, NAA and their mixtures on number of roots / cutting, length of root, as well as fresh and dry weights of roots / cutting.**

Data in Tables (1 & 2 & 3) clearly show that single application of IBA, IAA and NAA, in a descending order was very effective in increasing number of roots, length of root as well as fresh and dry weights of roots per cutting. Results further reveal that combined application of these auxins was proved to give the maximum values of root criteria. The applied auxins and their mixtures caused significant differences in such root parameters. These results were true in both seasons.

Dipping cutting of *Ficus benjamina* in solutions containing auxins at 25, 50 and 100 ppm caused significant stimulation effect on the number of roots, root length as well as fresh and dry weights of roots per cutting compared with the untreated one. The promotion on such root criteria was in proportional with increasing concentrations of auxins. A slight increase on such parameters was detected due to raising concentrations from 50 to 100 ppm. Similar results were obtained in both seasons.

**Table 2:. Effect of single or combined application of IBA, IAA and NAA at various concentrations on length and fresh weight of roots of *Ficus benjamina* " Starlight" plants during 1999 and 2000 seasons.**

Characters Auxins (A)	Average length of root (cm)									
	1999					2000				
	Auxin concentrations (B)									
	0.0	25	50	100	Mean	0.0	25	50	100	Mean
IBA	6.0	8.8	9.3	9.3	8.3	5.3	7.5	8.3	8.4	7.3
IAA	6.1	7.5	8.5	8.6	7.7	6.0	7.1	7.8	7.9	7.2
NAA	6.2	6.9	7.8	8.0	7.2	6.0	6.6	7.1	7.1	6.7
IBA + IAA	5.9	11.0	11.6	11.6	10.0	6.2	9.5	10.2	10.3	9.0
IBA + NAA	5.9	10.5	11.1	11.2	9.6	6.1	9.0	9.5	9.6	8.5
IAA + NAA	6.0	10.0	10.5	10.6	9.2	6.0	8.3	9.2	9.3	8.2
IBA+IAA+ NAA	6.0	11.6	12.9	13.0	10.8	6.0	10.1	11.0	11.0	9.5
Mean (B)	6.0	9.5	10.2	10.3		5.9	8.3	9.0	9.1	
LSD. 5 %	A		B		AB	A		B		AB
	0.6		0.4		1.1	0.5		0.3		0.8
Character	Fresh weight of roots /cutting (g)									
IBA	1.03	1.37	1.47	1.48	1.33	1.09	1.33	1.41	1.41	1.31
IAA	1.00	1.31	1.39	1.41	1.27	1.10	1.25	1.33	1.34	1.25
NAA	1.00	1.15	1.21	1.22	1.14	1.10	1.17	1.23	1.24	1.18
IBA + IAA	1.00	1.68	1.75	1.76	1.54	1.10	1.63	1.70	1.71	1.53
IBA + NAA	1.02	1.59	1.66	1.66	1.48	1.11	1.52	1.58	1.60	1.45
IAA + NAA	1.03	1.43	1.52	1.52	1.38	1.12	1.41	1.49	1.50	1.38
IBA+IAA+ NAA	1.03	1.75	1.92	1.93	1.65	1.09	1.73	1.95	1.96	1.68
Mean (B)	1.01	1.47	1.28	1.56		1.10	1.43	1.52	1.53	
LSD. 5 %	A		B		AB	A		B		AB
	0.06		0.05		0.13	0.08		0.05		0.13

Application of a mixture of IBA, IAA and NAA at 50 ppm was very beneficial in producing the maximum stimulation of root system of *Ficus benjamina* in both seasons. This increment may be attributed to the presence of large amounts of soluble sugars and nitrogen substances in the cuttings treated with different auxins which have a beneficial effect on root formation (Hess, 1962 and Hartmann *et al.* 1990).

These results are in harmony with those obtained by Kale and Bhujbal (1975), Baraskar *et al.* (1990) and Banwar *et al.* (1994) on *Bougainvillea*.

**3- Effect of IBA, IAA, NAA and their mixtures on plant height, number of shoots, fresh and dry weight of shoots, number of leaves / cutting and leaf area.**

Data in Tables (3 & 4 & 5 & 6) obviously reveal that the superiority of the three tested auxins on improving plant height, number of shoots, fresh and dry weights of shoots, number of leaves per cutting and leaf area could be arranged as IBA, IAA and NAA, in a descending order. Mixtures of the auxins was more effective in increasing growth parameters than using each alone. The maximum values were detected on cuttings treated with a solution containing IBA, IAA and NAA. These results were true in both seasons.

**Table 3: Effect of single or combined application of IBA, IAA and NAA at various concentrations on dry weight of roots and plant height of *Ficus benjamina* " Starlight" plants during 1999 and 2000 seasons.**

Characters Auxins (A)	Dry weight of roots /cutting (g)											
	1999					2000						
	Auxin concentrations (B)											
	0.0	25	50	100	Mean	0.0	25	50	100	Mean		
IBA	0.41	0.55	0.59	0.60	0.53	0.44	0.60	0.66	0.66	0.59		
IAA	0.40	0.50	0.54	0.55	0.49	0.41	0.55	0.60	0.60	0.54		
NAA	0.39	0.47	0.50	0.50	0.46	0.41	0.50	0.55	0.56	0.50		
IBA + IAA	0.40	0.70	0.70	0.71	0.62	0.42	0.71	0.75	0.75	0.65		
IBA + NAA	0.41	0.64	0.66	0.67	0.59	0.42	0.68	0.72	0.72	0.63		
IAA + NAA	0.40	0.60	0.63	0.64	0.56	0.41	0.64	0.67	0.68	0.60		
IBA+IAA+ NAA	0.41	0.75	0.81	0.81	0.69	0.43	0.76	0.85	0.86	0.72		
Mean (B)	0.40	0.60	0.63	0.64		0.42	0.63	0.68	0.69			
LSD. 5 %	A		B		AB		A		B		AB	
	0.03		0.02		0.05		0.04		0.03		0.08	
Character	Plant height (cm)											
IBA	22.0	27.3	28.9	29.0	26.8	19.3	25.9	27.5	17.5	25.0		
IAA	22.0	25.2	26.7	27.0	25.2	19.5	23.8	25.3	25.4	23.5		
NAA	21.3	23.3	25.0	25.5	23.7	19.6	21.7	33.3	33.5	27.0		
IBA + IAA	23.0	34.0	35.5	35.6	32.0	19.7	32.0	33.6	33.7	29.7		
IBA + NAA	22.1	31.9	33.6	33.7	30.3	20.0	29.9	31.5	31.6	28.2		
IAA + NAA	22.2	29.5	31.0	31.0	28.4	20.0	27.7	29.3	29.9	26.7		
IBA+IAA+ NAA	22.8	34.9	37.9	38.0	33.4	20.0	34.0	34.8	34.9	30.9		
Mean (B)	22.2	29.4	31.2	31.4		19.7	27.8	30.7	30.9			
LSD. 5 %	A		B		AB		A		B		AB	
	1.8		1.5		4.0		1.6		1.4		3.7	

Application of the three auxins at 25, 50 and 100 ppm significantly improved all growth parameters compared with the nutreated cuttings. The promotion was associated with increasing concentrations of auxins. A slight and insignificant stimulation on such growth criteria was observed due to raising auxin concentrations from 50 to 100 ppm. Similar results were obtained in both seasons. The maximum values were detected on cuttings treated with IBA, IAA and NAA at 50 ppm in both seasons.

**Table 4: Effect of single or combined application of IBA, IAA and NAA at various concentrations on number and fresh weight of shoots of *Ficus benjamina* "Starlight" plants during 1999 and 2000 seasons.**

Characters Auxins (A)	Number of shoots/ cutting									
	1999					2000				
	Auxin concentrations (B)									
	0.0	25	50	100	Mean	0.0	25	50	100	Mean
IBA	6.0	7.3	7.9	8.0	7.3	7.0	8.6	9.1	9.1	8.4
IAA	6.0	6.9	7.3	7.4	6.9	6.9	8.1	8.6	8.7	8.0
NAA	6.0	6.5	6.8	6.9	6.5	7.0	7.6	8.0	8.1	7.6
IBA + IAA	5.9	8.5	9.1	9.2	8.1	7.0	10.2	10.6	10.6	6.9
IBA + NAA	6.0	8.1	8.7	8.8	7.9	7.2	9.5	9.9	10.0	9.1
IAA + NAA	6.1	7.6	8.3	8.4	7.6	7.1	9.1	9.5	9.5	8.8
IBA+IAA+ NAA	6.2	9.0	9.6	9.7	8.6	7.3	10.7	12.2	12.3	10.6
Mean (B)	6.0	7.7	6.8	8.3		7.0	9.1	9.7	9.7	
LSD. 5 %	A		B		AB	A		B		AB
	0.3		0.7		0.5	0.4		0.3		0.8
Character	Fresh weight of shoots / cutting (g)									
IBA	8.1	10.3	10.9	11.0	10.0	9.2	11.0	11.6	11.6	10.8
IAA	8.2	9.6	10.2	10.3	9.5	8.9	10.2	11.0	11.0	10.2
NAA	8.4	9.0	9.5	9.6	9.1	8.5	9.3	10.4	10.5	9.6
IBA + IAA	8.2	12.2	12.9	13.1	11.6	8.6	13.1	14.3	14.4	12.6
IBA + NAA	8.1	11.6	12.3	12.4	11.1	8.7	12.9	13.9	14.0	12.3
IAA + NAA	8.1	11.0	11.5	11.5	10.5	8.9	11.8	12.2	12.2	11.2
IBA+IAA+ NAA	8.0	13.5	15.3	15.4	13.0	9.0	15.9	17.5	17.6	15.6
Mean (B)	8.1	11.0	11.8	11.9		8.8	12.0	12.9	13.0	
LSD. 5 %	A		B		AB	A		B		AB
	0.5		0.4		1.1	0.6		0.5		1.3

The promotion on growth of aerial parts by using such auxins could be attributed to the effect of auxins in increasing and stimulation of root parameters which help in increasing the roots.

These results are in the same line with those obtained by El-Sayed (1989) on *Ficus nitida*, Baraskar et al. (1990) on *Bougainvillea*, Patil and Shirol (1991) on *Bougainvillea*.

**Table 5: Effect of single or combined application of IBA, IAA and NAA at various concentrations on dry weight of shoots and number of leaves/cutting of *Ficus benjamina* "Starlight" plants during 1999 and 2000 seasons.**

Characters Auxins (A)	Dry weight of shoots (g)										
	1999					2000					
	Auxin concentrations (B)										
	0.0	25	50	100	Mean	0.0	25	50	100	Mean	
IBA	2.81	3.51	3.92	3.93	3.54	2.11	3.01	3.22	3.22	2.89	
IAA	2.81	3.41	3.72	3.73	3.41	2.22	2.70	2.99	3.00	2.72	
NAA	2.80	3.00	3.35	3.36	3.12	2.20	2.41	2.69	2.70	2.50	
IBA + IAA	2.71	4.80	5.20	5.21	4.48	2.21	4.0	4.23	4.24	3.67	
IBA + NAA	2.78	4.36	4.70	4.71	4.13	2.11	3.66	4.00	4.00	3.44	
IAA + NAA	2.79	3.99	4.36	4.37	3.87	2.11	3.32	3.66	3.67	3.19	
IBA+IAA+ NAA	2.80	5.11	5.50	5.50	4.72	2.22	4.31	4.50	4.51	3.88	
Mean (B)	2.78	4.08	4.39	4.40		2.16	3.34	3.61	3.62		
LSD. 5 %	A 0.41		B 0.30		AB 0.80	A 0.31		B 0.21		AB 0.56	
Character	Number of leaves/cutting										
	0.0	25	50	100	Mean	0.0	25	50	100	Mean	
	IBA	46.0	60.0	64.0	66.0	59.0	47.0	59.0	66.0	66.0	59.5
	IAA	47.0	55.2	58.9	61.3	55.6	48.0	55.0	61.0	61.3	56.3
NAA	46.3	50.0	53.0	55.5	51.2	47.0	51.0	55.9	56.0	52.4	
IBA + IAA	47.0	73.0	77.0	81.0	69.5	47.0	75.0	79.0	80.0	70.2	
IBA + NAA	47.0	70.0	72.0	75.0	66.0	48.0	69.3	74.0	74.0	66.3	
IAA + NAA	48.0	66.0	68.0	71.3	63.3	48.0	64.0	70.0	71.0	63.2	
IBA+IAA+ NAA	49.0	76.0	81.0	83.0	72.2	49.1	79.0	84.0	84.3	74.1	
Mean (B)	47.1	64.3	67.7	70.4		47.7	64.6	69.9	70.3		
LSD. 5 %	A 3.0		B 2.9		AB 7.7	A 3.3		B 2.7		AB 7.2	

**Table 6: Effect of single or combined application of IBA, IAA and NAA at various concentrations on leaf area and leaf total carbohydrates % of *Ficus benjamina* "Starlight" plants during 1999 and 2000 seasons.**

Characters Auxins (A)	Leaf area (cm) <sup>2</sup>										
	1999					2000					
	Auxin concentrations (B)										
	0.0	25	50	100	Mean	0.0	25	50	100	Mean	
IBA	15.0	17.4	17.91	18.2	17.1	16.2	18.0	19.2	19.3	18.1	
IAA	14.9	16.5	6.916	17.1	16.3	15.8	17.1	17.9	18.0	17.2	
NAA	14.8	15.8	320.5	16.3	15.8	15.7	16.3	16.9	17.0	16.4	
IBA + IAA	15.0	19.9	191.1	20.5	18.9	16.0	20.7	21.9	29.0	20.1	
IBA + NAA	15.0	18.7	8.521	19.2	18.0	16.2	19.9	20.8	20.8	16.4	
IAA + NAA	14.8	18.0	5	18.2	17.4	16.1	18.8	19.9	20.6	18.7	
IBA+IAA+ NAA	15.2	20.3		21.6	19.6	16.3	21.9	23.2	23.6	21.3	
Mean (B)	14.9	18.0	18.6	18.7		16.0	18.9	20.0	20.1		
LSD. 5 %	A 0.6		B 0.4		AB 1.1	A 0.7		B 0.5		AB 1.3	
Character	Total carbohydrates (mg/g dry weight)										
	0.0	25	50	100	Mean	0.0	25	50	100	Mean	
	IBA	28.0	35.0	35.1	35.2	33.3	27.3	33.9	34.0	34.0	32.3
	IAA	28.2	33.7	33.8	34.0	32.4	28.0	31.9	32.0	32.0	30.9
NAA	29.0	31.3	31.9	32.0	31.0	28.0	29.9	30.0	30.3	29.5	
IBA + IAA	29.0	39.5	40.0	40.0	37.1	27.0	40.0	40.3	40.5	36.9	
IBA + NAA	27.9	38.0	38.0	38.3	35.5	28.0	38.0	38.0	38.3	35.5	
IAA + NAA	28.1	36.5	37.0	37.0	34.6	27.0	35.6	36.0	36.2	33.7	
IBA+IAA+ NAA	28.9	40.0	40.0	40.0	37.2	27.9	40.3	40.3	40.5	37.2	
Mean (B)	28.4	36.2	36.5	36.6		27.6	35.6	35.8	35.9		
LSD. 5 %	A 1.5		B 1.2		AB 3.2	A 2.0		B 1.7		AB 4.5	

**4- Effect of IBA, IAA, NAA and their mixtures on percentages of total carbohydrates and nitrogen and C/N Ratio**

Data in Tables (7&8) revealed that using a mixture of IBA, IAA and NAA was remarkably very effective in enhancing the percentages of total carbohydrates and nitrogen as well as C/N compared with each auxin alone. The maximum values were recorded on cuttings treated with the auxins together in both seasons.

Using concentrations of auxins ranged from 25 to 100 ppm was accompanied with maximal percentages of total carbohydrates and nitrogen as well as C/N ratio compared with non-application treatment. In most cases, the promotion was a concentration dependent. Increasing concentrations of auxins from 50 to 100 ppm failed to show significant increase on such chemical constituents in both seasons.

The maximum values were recorded in cuttings immersed in a solution containing IBA, IAA and NAA at 50 ppm in both seasons. The increase in the absorption of N via roots and the stimulation on both chlorophyll a and b in response to application of IBA, IAA and NAA could explain the present results.

**Table 7: Effect of single or combined application of IBA, IAA and NAA at various concentrations on percentage of N and C/N in the leaf of *Ficus benjamina* " Starlight" plants during 1999 and 2000 seasons.**

Characters Auxins (A)	Percentage of N in the leaf									
	1999					2000				
	Auxin concentrations (B)									
	0.0	25	50	100	Mean	0.0	25	50	100	Mean
IBA	1.15	1.36	1.40	1.40	1.32	1.11	1.23	1.30	1.31	1.23
IAA	1.18	1.33	1.36	1.37	1.31	1.09	1.20	1.25	1.25	1.19
NAA	1.22	1.28	1.31	1.31	1.28	1.09	1.15	1.19	1.20	1.15
IBA + IAA	1.23	1.47	1.50	1.51	1.42	1.10	1.33	1.49	1.50	1.35
IBA + NAA	1.25	1.44	1.47	1.48	1.41	1.10	1.30	1.41	1.41	1.30
IAA + NAA	1.20	1.40	1.43	1.44	1.36	1.11	1.27	1.37	1.38	1.28
IBA+IAA+ NAA	1.22	1.50	1.60	1.60	1.48	1.12	1.37	1.46	1.46	1.35
Mean (B)	1.20	1.39	1.43	1.44		1.10	1.26	1.35	1.35	
LSD. 5 %	A		B		AB	A		B		AB
	0.03		0.02		0.05	0.04		0.03		0.08
Character	C / N									
IBA	24.34	25.73	25.07	25.14	25.07	24.59	27.56	26.15	25.95	26.06
IAA	23.72	25.33	24.85	24.81	24.67	25.68	26.59	25.60	25.60	25.86
NAA	23.77	24.45	24.35	24.42	24.24	25.68	26.00	25.21	25.25	25.53
IBA + IAA	23.77	26.87	26.67	26.49	25.95	24.54	30.07	27.04	27.00	27.16
IBA + NAA	22.32	26.39	25.85	25.87	25.10	25.45	29.23	26.95	27.16	27.19
IAA + NAA	23.42	26.07	25.87	25.69	25.26	24.32	28.03	26.27	26.23	26.21
IBA+IAA+ NAA	23.68	26.67	25.00	25.00	25.08	24.91	29.41	27.61	27.73	27.41
Mean (B)	23.57	25.93	25.38	25.34		25.02	28.12	26.40	26.41	
LSD. 5 %	A		B		AB	A		B		AB
	0.33		0.31		0.82	0.41		0.39		1.03



**Table 8: Effect of single or combined application of IBA, IAA and NAA at various concentrations on total chlorophylls a and b of *Ficus benjamina* " Starlight" plants during 1999 and 2000 seasons.**

Characters Auxins (A)	Chlorophyll a (mg / g leaf fresh weight )									
	1999					2000				
	Auxin concentrations (B)									
	0.0	25	50	100	Mean	0.0	25	50	100	Mean
IBA	2.10	3.11	3.10	3.11	2.85	1.71	2.90	3.01	3.11	2.68
IAA	1.90	2.81	2.90	3.01	2.65	1.91	2.60	2.61	2.71	2.45
NAA	2.20	2.50	2.50	2.51	2.42	2.01	2.30	2.31	2.41	2.25
IBA + IAA	2.10	4.11	4.11	4.11	3.60	2.00	3.90	4.01	4.11	3.50
IBA + NAA	2.00	3.90	4.02	4.03	3.48	1.90	3.60	3.62	3.71	3.20
IAA + NAA	1.91	3.50	3.51	3.51	3.10	1.90	3.20	3.31	3.30	2.92
IBA+IAA+ NAA	2.20	4.40	4.41	4.41	3.85	2.00	4.01	4.01	4.01	3.50
Mean (B)	2.05	3.47	3.50	3.52		1.91	3.21	3.26	3.33	
LSD. 5 %	A		B		AB	A		B		AB
	0.30		0.20		0.50	0.40		0.30		0.80
Character	Chlorophyll b (mg / g leaf fresh weight )									
	0.0	25	50	100	Mean	0.0	25	50	100	Mean
IBA	0.85	1.09	1.10	1.11	1.03	0.71	1.16	1.16	1.16	1.04
IAA	0.81	0.99	1.00	1.01	0.95	0.74	1.04	1.06	1.06	0.97
NAA	0.82	0.91	0.93	0.93	0.89	0.80	0.92	0.93	0.93	0.89
IBA + IAA	0.81	1.28	1.29	1.30	1.17	0.79	1.59	1.57	1.58	1.37
IBA + NAA	0.81	1.21	1.21	1.21	1.11	0.80	1.44	0.45	1.45	1.28
IAA + NAA	0.79	1.10	1.10	1.11	1.02	0.80	1.28	1.29	1.30	1.16
IBA+IAA+ NAA	0.83	1.39	1.40	1.41	1.25	0.81	1.62	1.63	1.64	1.42
Mean (B)	0.81	1.13	1.14	1.15		0.77	1.28	1.29	1.30	
LSD. 5 %	A		B		AB	A		B		AB
	0.08		0.07		0.18	0.10		0.08		0.21

Similar results were recorded by Bose *et al.* (1973) on *Bougainvillea* and *Hibiscus*, Zayed *et al.*, (1986) and Zeawail *et al.*, (1986) on *Ficus retusa*.

#### 5- Effect of IBA, IAA and NAA on pigments and sugars in the leaves.

Data in Tables (8 & 9 &10) clearly show that using a mixture containing IBA, IAA and NAA significantly was responsible for enhancing chlorophyll a and b, total chlorophylls, carotenoid content as well as soluble and insoluble sugars compared to each singly or in double application during the two successive seasons.

Dipping cuttings in solutions of auxins at concentrations ranged from 25, to 100 ppm significantly was accompanied by improving the pigment and sugar contents in the leaves and there was a slight and insignificant increase in such chemical constituents with increasing auxin concentrations from 25 to 100 ppm.

Treating cuttings with IBA, IAA and NAA at 25 ppm was enough for maximizing chlorophyll a and b and carotenoids as well as soluble and insoluble sugars in both seasons.

The previous positive action of auxins on parameters of roots and aerial parts as well as total carbohydrates could explain the present results.

These results are in harmony with those obtained by Raviv *et al.* (1984) on sage plants, Ibrahim *et al.*, (1988) on Olives, El-Sayed (1989) on *Ficus nitida* and Carpenter and Cornell (1992) on *Hibiscus*.

Generally, it could be concluded that dipping *Ficus benjamina* stem cuttings in a solution comprised from IBA, IAA and NAA at 50 ppm as slowly dip was preferable for inducing maximum percentages of survival and rooting ability.

**Table 9: Effect of single or combined application of IBA, IAA and NAA at various concentrations on total chlorophyll and carotenoid content of *Ficus benjamina* "Starlight" plants during 1999 and 2000 seasons.**

Characters Auxins (A)	Total chlorophylls (mg / 1 g fresh weight)										
	1999					2000					
	Auxin concentrations (B)										
	0.0	25	50	100	Mean	0.0	25	50	100	Mean	
IBA	2.95	4.20	4.20	4.22	3.89	2.42	4.06	4.17	4.27	3.73	
IAA	2.71	3.80	3.90	4.02	3.60	2.65	3.64	3.67	3.77	3.43	
NAA	3.02	3.41	3.43	3.44	3.32	2.81	3.22	3.24	3.34	3.15	
IBA + IAA	2.91	5.39	5.40	5.41	4.77	2.79	5.46	5.58	5.69	4.88	
IBA + NAA	2.81	5.11	5.23	5.24	4.59	2.70	5.04	5.07	5.16	4.49	
IAA + NAA	2.70	4.60	4.61	4.62	4.13	2.70	4.48	4.60	4.60	4.09	
IBA+IAA+ NAA	3.03	5.79	5.81	5.82	5.11	2.81	5.63	5.64	5.65	4.93	
Mean (B)	2.87	4.61	4.56	4.68		2.69	4.50	4.56	4.64		
LSD. 5 %	A		B		AB	A		B		AB	
	0.10		0.08		0.21	0.11		0.15		0.40	
Character	Carotenoid content (mg / 1 g fresh weight)										
	0.0	25	50	100	Mean	0.0	25	50	100	Mean	
	IBA	0.91	1.00	1.00	1.01	0.98	0.93	1.11	1.11	1.11	1.06
	IAA	0.89	0.97	0.98	0.99	0.95	0.95	1.06	1.07	1.07	1.03
NAA	0.91	0.95	0.96	0.96	0.94	0.96	1.00	1.01	1.01	0.99	
IBA + IAA	0.92	1.10	1.11	1.11	1.03	0.95	1.26	1.26	1.26	1.18	
IBA + NAA	0.93	0.06	1.07	1.07	1.03	0.95	1.20	1.21	1.21	1.14	
IAA + NAA	0.91	1.03	1.04	1.04	1.000	0.96	1.16	1.17	1.17	1.11	
IBA+IAA+ NAA	0.90	1.13	1.13	1.13	1.07	0.97	1.33	1.34	1.35	1.24	
Mean (B)	0.91	1.03	1.04	1.04		0.95	1.16	1.16	1.16		
LSD. 5 %	A		B		AB	A		B		AB	
	0.03		0.02		0.05	0.04		0.03		0.08	

**Table 10: Effect of single or combined application of IBA, IAA and NAA at various concentrations on percentage of soluble and insoluble sugars of *Ficus benjamina* "Starlight" plants during 1999 and 2000 seasons.**

Characters Auxins (A)	Soluble sugars %										
	1999					2000					
	Auxin concentrations (B)										
	0.0	25	50	100	Mean	0.0	25	50	100	Mean	
IBA	8.1	8.7	9.3	9.4	8.8	7.8	8.9	9.5	9.5	8.9	
IAA	8.0	8.5	8.9	9.0	8.6	8.0	8.6	9.0	9.0	8.6	
NAA	8.0	8.2	8.5	8.6	8.3	7.9	8.3	8.6	8.6	8.3	
IBA + IAA	8.1	9.6	10.3	10.3	9.5	8.0	10.3	10.8	10.8	9.8	
IBA + NAA	8.2	9.3	9.9	10.0	9.3	8.1	9.8	10.4	10.4	9.8	
IAA + NAA	8.1	9.0	9.5	9.5	9.0	8.2	9.4	9.9	9.9	9.3	
IBA+IAA+ NAA	8.1	10.0	10.8	10.9	9.9	8.3	10.7	11.5	11.5	10.5	
Mean (B)	8.0	9.0	9.6	9.6		8.0	9.4	9.9	10.0		
LSD. 5 %	A		B		AB	A		B		AB	
	0.3		0.2		0.5	0.3		0.2		0.5	
Character	Insoluble sugars %										
	0.0	25	50	100	Mean	0.0	25	50	100	Mean	
	IBA	4.1	5.1	5.3	5.3	4.9	4.0	4.6	4.9	5.0	4.6
	IAA	4.3	4.8	5.0	5.0	4.7	4.0	4.4	4.7	4.8	4.4
NAA	4.1	4.5	4.7	4.7	4.5	3.9	4.1	4.3	4.4	4.1	
IBA + IAA	4.0	6.1	6.4	6.5	5.7	3.8	5.5	6.0	6.0	5.3	
IBA + NAA	4.0	5.7	6.1	6.1	5.4	3.7	5.2	5.6	5.6	5.0	
IAA + NAA	4.1	5.4	5.7	5.8	5.2	3.9	4.8	5.3	5.3	4.8	
IBA+IAA+ NAA	4.0	6.4	7.0	7.0	6.1	3.9	5.8	6.3	6.4	5.6	
Mean (B)	4.0	5.4	5.7	5.7		3.8	4.9	5.3	5.3		
LSD. 5 %	A		B		AB	A		B		AB	
	0.3		0.2		0.5	0.3		0.2		0.5	

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**تأثير بعض الأوكسينات على القدرة التجذيرية لنباتات الفيكس بنجامينا (ستارليت)**

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تم دراسة تأثير غمس عقل الفيكس بنجامينا " ستارليت " لمدة يوم في إندول حامض البيوتريك ، إندول حامض الخليك ، نفتالين حامض الخليك أو خليط منها بتركيزات متساوية هي صفر ، ٢٥٠ ، ٥٠٠ ، ١٠٠ جزء في المليون على نسبة العقل المجذرة ، وبعض صفات الجذور والنموات الخضريّة ، محتوى الصبغات وكذلك السكريات الذائبة والغير ذائبة في الأوراق وذلك خلال موسمي ١٩٩٩ ، ٢٠٠٠ وأشهرت نتائج الدراسة أن إستخدام مخلوط من إندول حامض البيوتريك ، إندول حامض الخليك ، نفتالين حامض الخليك كان فعالاً جداً في تحسين نسبة العقل المجذرة وعدد الجذور ومساحة الورقة والوزن الطازج والجاف للجذور وعدد الأوراق ونسبة الكربوهيدرات الكلية والنيتروجين في الورقة ونسبة الكربوهيدرات الى النيتروجين وكلوروفيل أ ، ب ومحتوى الكاروتينات وكذلك السكريات الذائبة والغير ذائبة في الأوراق مقارنة باستخدام كل أوكسين بمفرده . بزيادة تركيز الأوكسينات من ٢٥ الى ١٠٠ جزء في المليون يكون هناك زيادة تدريجية في صفات الجذور والنموات وكذلك الصفات الكيميائية . في الفيكس بنجامينا " ستارليت " فإن قدرة التجذير للعقل تكون عالية عند الغمس في مخلوط إندول حامض البيوتريك ، إندول حامض الخليك ، نفتالين حامض الخليك تركيز ٥٠ جزء في المليون لمدة يوم .