EFFECT OF INDOLE BUTYRIC ACID AND TYPES OF CUTTINGS ON ROOT INITIATION OF *Ficus hawaii*

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ABSTRACT

The research was conducted on three different types of *Ficus hawaii* cuttings i.e., Softwood, Semi hardwood and Hardwood cuttings that were treated with different concentrations of Indole Butyric Acid (IBA) i.e. 1000, 2000, 3000, 4000, 5000 ppm and 0 ppm (control) at Agriculture Research Institute Tarnab, Peshawar, during the year 2002. The results showed that the treatment of IBA produced significant variation while there was no significant variation among different types of cutting and in the interaction between types of cutting and IBA concentrations in all study parameters. Maximum sprouting (43.7%) leaves per plant (63), plant height (37.46cm), shoots per plant (13), leaf area (19.33 cm^2), shoot thickness (0.57 cm), root length (11.5 cm) and roots per cutting (13) were recorded in cuttings treated with 4000 ppm IBA, as compared to the minimum survival (5%), leaves per plant (7), plant height (5.33 cm), shoots per plant(1.2), leaf area (3.3 cm^2), plant thickness (0.06 cm), root length (0.6 cm), and roots per cuttings (2.1) in control. In interactions, non significant difference was observed for all parameters; however the sprouting was more (48.25%) by treating hard wood cuttings with 4000 ppm IBA compared to 0% success of softwood cuttings in control. Plant height was more (42.81 cm) by treating soft wood cuttings with 4000 ppm IBA as compared to 6.0 cm of semi hard wood cuttings in control. All sprouted plants were survived.

Keywords: *Ficus hawaii* , IBA, Root Initiation

INTRODUCTION

The Genus Ficus has about 800 species of trees, shrubs or vines, commonly called figs, and belongs to the family Moraceae. It is native to the tropical areas of eastern Asia. Many are tall forest trees with great spreading roots, other are planted as ornamentals(Frenssen 1986) .

Moraceae mostly is a family of trees or shrubs, monoecious or dioecious, with milky juice. *Artocarpus altilis (*Breadfruit) and *A. heterophullus (*jackfruit) are important for their edible fruit. The genus Morus also has edible fruit, and the leaves of some species are used for feeding silkworm. The inner bark of *Broussonetia papyrifera* (Paper mulberry) provides fiber that is used in making paper. The latex of *Castilloa elastica* is the source of Panama rubber. Several species of *Ficus* (Fig) bear edible fruit, the most widely grown being *F. carica. R*ubber is obtained from *F. elastica,* which in tropical regions reaches a giant size(Stone *et al.* 1967). *Morus alba* (*white* mulberry) and *M. nigra* are cultivated in large gardens and parks as ornamental trees as well as for their fruit. *Machura pomifera (*Osage Orange) is used as a hedge plant in the United States, but in Britain is grown only for its curious orange-like inedible fruit(Hickey and C.J.King. 1981).

According to (Baily 1963) the important species are *Ficus benjamina, Ficus callosa, Ficus carica, Ficus elastica, Ficus pumila, Ficus religiosa, Ficus altissima, Ficus benghalensis, Ficus globella, Ficus diversifolia and Ficus hawaii.*

Ficus is an important ornamental plant for the nurserymen. It is generally propagated by air layering and tip cuttings. The plants propagated through air layering are small in quantity, need more skill and time. So the easiest and economic method is multiplication through cutting but the problem lies in very low or undesirable percentage of success. Root promoting hormones play important role in the success of rooting of cuttings. Keeping in view the importance of propagation through cuttings, this project was designed to see the effect of various concentration of IBA on soft, semi hard and hard wood cuttings of *Ficus hawaii* on the rooting success and plant height.

MATERIALS AND METHODS

Field experiments were conducted at Agricultural Research Institute Ternab, Peshawar during the year 2002-2003. Different types of cuttings i.e. softwood, semi hardwood and hardwood about 15 cm long were taken and were treated with 0 ppm (control), 1000, 2000, 3000, 4000 and 5000 ppm IBA solution. The cuttings were dipped for five minutes in each concentration, and then were planted in sand + silt + clay (1:1:1) mixture.

For the preparation of different concentrations of IBA, first a stock solution of 6000 ppm was prepared by dissolving 3 g of IBA in 100 ml of ethanol and then distil water was added to make a solution of 500 ml. The cuttings were planted in polyethylene tubes. The experiment was laid out as Randomized Complete Block Design (RCBD) with two factors. There were thirty cuttings per treatment and the experiment was replicated four times.

RESULTS AND DISCUSSIONS

The result on Sprouting, survival, Plant height, number of branches, number of leaves, stem thickness, number of roots, root length and leaf area are presented in Tables 1-8. Various concentrations of IBA produced significant

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variation while there was no significant variation among different types of cutting and in the interaction between types of cutting and IBA concentrations in all study parameters

Sprouting percentage

The data pertaining to sprouting percentage are presented in Table 1, while the analysis of Variance is given in ANOVA Table. Highly significant differences among various concentrations of IBA were observed for sprouting (Table 1). Different concentrations of IBA have significant effect on sprouting of cuttings while there was no significant variation among different types of cutting and in the interaction between types of cutting and IBA concentrations. It is revealed from results that maximum sprouting percentage (43.67) was observed by treating cuttings with 4000 ppm of IBA solution and minimum sprouting (5.0 %) was recorded in control.

All types of cuttings treated with 4000 ppm IBA gave more sprouting. Since IBA is root promoting hormone which helped in root induction and increased sprouting. (Souidan *et al.* 1995), (Hore and S.K.Sen. 1992) also got more sprouting success of cuttings by treating with IBA

Number of leaves per plant

The data pertaining to number of leaves are presented in Table-2, while the analysis of variance is given in ANOVA Table. Number of leaves per plant was significantly affected by various concentrations of Indole Butyric Acid, while types of cuttings and their interaction had non significant effect.

It is evident from the results that maximum number of leaves per plant (63.0) was observed on cuttings which were treated with 4000 ppm IBA solution, and minimum number of leaves per plant (7.0) was recorded in control. The increase in number of leaves in 4000 ppm IBA concentration may be due to more number of roots, plant height and branches per plant.

Plant height

The data pertaining to plant height are presented in Table-III while the analysis of Variance is given in ANOVA Table. Different concentrations of IBA have significant effect on plant height.

The plant height by treating cutting with various concentration of IBA solution showed non significant difference, however more plant height of 37.46 cm was recorded by treating cuttings with 4000 ppm IBA and minimum plant height (5.33 cm) in control.

In interaction, the difference in plant height is statistically non significant, however more plant height (42.81 cm) was recorded by treating soft wood cuttings with 4000 ppm IBA solution and minimum plant height of 6.0 cm in semi hard wood cuttings without any treatment. The increase in plant height is related with rooting. Cuttings treated with IBA gave more rooting which helped in more nutrient uptake and ultimately increased the plant height.

Shoots per cuttings

The data pertaining to number of shoots per cutting are presented in Table-4 while the analysis of variance is given in ANOVA Table. Different concentrations of IBA have significant effect on number of shoots while there was no significant variation among different types of cutting and in the interaction between types of cutting and IBA concentrations.

The mean Table indicates that maximum number of shoots per plant (13.2) was observed on plants, cuttings of which were treated with 4000 ppm IBA, followed by 9.0 and 5.7 in 3000 and 1000 ppm IBA. The minimum shoot per plant (1.2) was recorded in control.

In interaction, the difference in number of shoots per cutting is not significant, however more shoots per cuttings (16.8) were produced by treating soft wood cuttings with 4000 ppm IBA and less shoots per cuttings (1.5) in Semi hard wood cuttings in control. The increase in number of shoots per plant by 4000 ppm IBA concentration may be due to more number of roots, and more growth of the plant.

Leaf area

The data pertaining to leaf area per cutting are presented in Table-5 while the analysis of Variance is given in ANOVA Table. Different concentrations of IBA have significant effect on leaf area while there was no significant variation among different types of cutting and in the interaction between types of cutting and IBA concentrations.

The results of this study showed that maximum leaf area (19.33cm^2) was observed on plants, cuttings of which were treated with 4000 ppm IBA followed by 14.88 cm^2 in 3000 ppm of IBA concentration. The minimum leaf area (3.3 cm^2) was recorded in control.

In interaction, between type of cuttings and IBA concentration the difference in leaf area is statistically non significant, however more leaf area (25.43 cm^2) was recorded by treating soft wood cuttings with 4000 ppm IBA as compared to the 3.1 cm^2 in semi hard wood cuttings without any

treatment. The increase in leaf area is related with growth. Plants with vigorous growth gave more leaf area and vice versa. Cuttings treated with 4000 ppm IBA produced more roots which increased nutrient uptake and increased growth of the plants and leaf area.

Shoot Thickness

The data pertaining to shoot thickness per cutting are presented in Table-6 while the analysis of Variance is given in ANOVA Table. Different concentrations of IBA have significant effect on shoot thickness while there was no significant difference among different types of cutting and in the interaction. The maximum shoot thickness (0.57cm) was observed in those cuttings, which were treated with 4000 ppm IBA followed by 0.4 cm in 3000 ppm IBA. The minimum shoot thickness (0.06 cm) was recorded in control.

In interaction, the difference in shoot thickness is non significant, however more shoot thickness (0.38 and 0.55 cm) was observed by treating soft wood and semi hard wood cuttings with 4000 ppm IBA solution and less shoot thickness (0.05 cm) by treating semi hard wood cuttings with 0 ppm solution of IBA.

Root length

The data pertaining to root length per cutting are presented in Table-VII while the analysis of Variance is given in ANOVA Table. Different concentrations of IBA have significant effect on root length while there was no significant variation among different types of cutting and in the interaction between types of cutting and IBA concentrations.

In various IBA treatments, the maximum root length (11.5cm) was observed on plants cuttings of which were treated with 4000 ppm IBA, however the difference in root length among all IBA concentration was non significant. The minimum root length of 0.6 cm was recorded in control.

In interaction, the difference in root length was statistically non significant, however more root length (12.cm) was recorded by treating semi hard wood and hard wood cuttings with 4000 ppm IBA solution and minimum root length of 0.6 cm in semi hard wood cuttings with out any treatment. This increase in root length may be due to the effect of growth regulators IBA on the metabolites translocation and carbohydrates metabolism which may be involved in the role of hormones on root length

Number of roots per cutting

The data pertaining to number of roots per cutting are presented in Table-8 while the analysis of Variance is given in ANOVA Table. Different concentrations of IBA have significant effect on number of roots per plant while there was no significant variation among different types of cutting and in the interaction between types of cutting and IBA concentrations.

The significantly maximum number of roots per plant (13.9) was recorded in those cuttings treated with 4000 ppm of IBA concentration, however the difference in number of roots per cuttings was statistically non significant among various IBA concentrations and minimum number of roots (2.1) was recorded in control.

In interaction, the number of roots was not significantly affected by various concentrations of IBA and types of cuttings; however more roots (15.0) were produced by planting of hardwood cuttings treated with 4000 ppm IBA as compared to 2-8 roots per plant by planting hard wood cuttings without any IBA treatment. IBA is a root promoting hormone which helped in root induction. The increase in trend in number of roots with increase in IBA concentration up to 4000 ppm showed positive but beyond this level root numbers per cuttings was decreased. Similar results were also reported by (Hore and S.K.Sen. 1992)and (Souidan *et al.* 1995).

Survival percentage

No significant differences among various concentrations of IBA and types of cutting were observed for survival. 100% survival was observed for all cuttings sprouted in various treatments.

CONCLUSION

i. Cuttings treated with 4000 ppm IBA induced maximum sprouting and plant growth.
ii. Types of cuttings and interaction of IBA and types of cuttings have no effect on any parameter

RECOMMENDATIONS

The following recommendations are made from the findings of the study for further exploring the subject and future studies.

i. Indole Butyric Acid (IBA) at 4000 ppm was found the best for rooting of the Ficus Hawaii cuttings.
ii. While reviewing the literature and looking into the findings of the study, certain other factors may also be responsible for root promotion in Ficus Hawaii. For this purpose the possibilities of other compounds and natural products should be explored.

iii. Research work on planting of cuttings in various times should be done.

Table –I: ***Sprouting percentage as affected by different concentrations of IBA and types of cutting of Ficus hawaii***

IBA concentration (PPM)	Types of cutting			Means
	Soft wood	Semi-hard wood	Hard wood	
1000	12.50	15.00	19.00	15.50b
2000	10.00	15.00	10.00	11.67b
3000	17.50	37.50	30.00	28.33ab
4000	36.75	46.00	48.25	43.67a
5000	15.75	5.00	13.75	11.50b
Control	0.00	5.00	10.00	5.00b
Means	15.42	20.58	21.83	

LSD at 5% for concentrations = 27.54

Means of each category followed by a common letter are not significantly different at 0.05 level of significance.

ANOVA Table for Sprouting Percentage

S.V	D.F	S.S	M.S	F value	Prob
Replication	3	1152.111	384.037	1.6726	0.1845
Types of cutting (T)	2	555.444	277.722	1.2096	0.3067
Concentration (C)	5	12160.444	2432.089	10.5925	0.0000
T X C	10	1172.556	117.256	0.5107	
Error	51	11709.889	229.606		
Total	71	26750.444			

Table-II: ***Number of leaves per cutting as affected by different concentrations of IBA and types of cutting of Ficus hawaii***

IBA concentration (ppm)	Types of cutting			Means
	Soft wood	Semi-hard wood	Hard wood	
1000	12.25	13.88	26.00	17.38b
2000	28.13	14.33	14.50	18.99b
3000	34.50	47.13	43.25	41.63ab
4000	81.25	53.17	54.63	63.01a
5000	40.00	13.00	30.00	27.67ab
Control	0.00	6.75	15.50	7.42b
Means	32.69	24.71	30.65	

LSD value at 5 % for concentrations = 41.40

Means of each category followed by a common letter are not significantly different at 0.05 level of significance.

ANOVA TABLE FOR NUMBER OF LEAVES PER PLANT

S.V	D.F	S.S	M.S	F value	Prob
Replication	3	3947.422	1315.807	2.5363	0.0670
Types of cutting (T)	2	824.715	412.358	0.7948	
Concentration (C)	5	24224.076	4844.815	9.3385	0.0000
T X C	10	4436.093	443.609	0.8551	
Error	51	26458.749	518.799		
Total	71	59891.055			

Table-III: ***Plant height (cm) as affected by different concentrations of IBA and types of cutting of Ficus hawaii***

IBA concentration (ppm)	Types of cutting			Means
	Soft wood	Semi-hard wood	Hard wood	
1000	14.69	6.04	15.00	11.91ab
2000	20.00	9.38	10.94	13.44ab
3000	21.25	31.15	29.00	27.13ab
4000	42.81	38.65	30.93	37.46a
5000	23.25	9.38	14.00	15.54ab
Control	0.00	6.00	10.00	5.33b
Means	20.33	16.76	18.31	

LSD value at 5 % for concentrations = 25.91

ANOVA TABLE FOR PLANT HEIGHT (cm)

S.V	D.F	S.S	M.S	F value	Prob
Replication	3	563.941	187.980	0.9251	
Types of cutting (T)	2	153.807	76.904	0.3784	
Concentration (C)	5	8222.576	1644.515	8.0927	0.0000
T X C	10	1425.867	142.587	0.7017	
Error	51	10363.689	203.210		
Total	71	20729.880			

Table –IV: ***Number of shoots per cuttings as affected by different concentration of IBA and types of cuttings of Ficus Hawaii***

IBA concentration (ppm)	Types of cutting			Means
	Soft wood	Semi-hard wood	Hard wood	
1000	7.3	2.8	7.0	5.7ab
2000	7.5	2.3	3.0	4.3ab
3000	5.3	11.0	10.8	9.0ab
4000	16.8	11.4	11.5	13.2a
5000	8.5	2.6	5.2	5.4ab
Control	0.0	1.5	2.0	1.2b
Means	7.5	5.3	6.6	

LSD value at 5% for concentrations = 9.6

ANOVA TABLE FOR NUMBER OF SHOOTS

S.V	D.F	S.S	M.S	F value	Prob	
Replication	3	81.540	27.180	0.9876		N.S
Types of cutting (T)	2	62.506	31.253	1.1356	0.3292	N.S
Concentration (C)	5	1036.446	207.289	7.5323	0.0000	***
T X C	10	287.679	28.768	1.0453	0.4206	N.S
Error	51	1403.523	27.520			
Total	71	2871.694				

Table-V: ***Leaf Area (cm^2) as affected by different concentrations of IBA and types of cutting of Ficus hawaii***

IBA concentration (ppm)	Types of cutting			Means
	Soft wood	Semi-hard wood	Hard wood	
1000	8.15	3.30	10.65	7.37ab
2000	8.65	3.48	3.65	5.26b
3000	15.10	13.65	15.88	14.88ab
4000	25.43	14.90	17.65	19.33a
5000	12.78	3.38	7.28	7.81b
Control	0.00	3.10	7.05	3.38b
Means	11.68	6.97	10.36	

LSD value at 5% for concentrations = 12.48

Means of each category followed by a common letter are not significantly different at 0.05 level of significance.

ANOVA TABLE FOR LEAF AREA

S.V	D.F	S.S	M.S	F value	Prob
Replication	3	23.647	7.882	0.1606	
Types of cutting (T)	2	284.048	142.024	2.8931	0.0645
Concentration (C)	5	2256.806	451.361	9.1945	0.0000
T X C	10	423.664	42.366	0.8630	
Error	51	2503.608	49.090		
Total	71	5491.773			

Table-VI: ***Shoot thickness (cm) as affected by different concentrations of IBA and types of cutting of Ficus hawaii***

IBA concentration (ppm)	**Types of cutting**			**Means**
	Soft wood	**Semi-hard wood**	**Hard wood**	
1000	0.230	0.120	0.275	0.21ab
2000	0.237	0.132	0.150	0.17b
3000	0.362	0.438	0.425	0.41ab
4000	0.638	0.550	0.515	0.57a
5000	0.225	0.125	0.225	0.19ab
Control	0.0	0.050	0.125	0.06b
Means	0.28	0.24	0.29	

LSD value at 5% for concentrations = 0.38

ANOVA TABLE FOR SHOOT THICKNESS

S.V	D.F	S.S	M.S	F value	Prob
Replication	3	0.131	0.044	1.0183	0.3923
Types of cutting (T)	2	0.037	0.019	0.4344	
Concentration (C)	5	2.060	0.412	9.6185	0.0000
T X C	10	0.142	0.014	0.3316	
Error	51	2.185	0.043		
Total	71	4.556			

Table-VII: ***Root length (cm) as affected by different concentrations of IBA and types of cutting of Ficus hawaii***

IBA concentration (ppm)	**Types of cutting**			**Means**
	Soft wood	**Semi-hard wood**	**Hard wood**	
1000	5.3	2.5	5.6	4.5ab
2000	6.3	3.0	3.0	4.1ab
3000	6.9	9.4	9.2	8.5a
4000	10.6	12.0	12.0	11.5a
5000	6.3	2.2	4.0	4.2ab
Control	0.0	0.6	1.3	0.6b
Means	5.9	5.0	5.8	

LSD value at 5% for concentrations = 7.68

Means of each category followed by a common letter are not significantly different at 0.05 level of significance.

ANOVA TABLE FOR ROOT LENGTH

S.V	D.F	S.S	M.S	F value	Prob
Replication	3	35.508	11.836	0.6633	
Types of cutting (T)	2	13.222	6.611	0.3705	
Concentration (C)	5	886.791	177.358	9.9401	0.0000
T X C	10	94.095	9.409	0.5274	
Error	51	909.982	17.843		
Total	71	1939.598			

Table-VIII: ***Number of roots as affected by different concentrations of IBA and types of cutting of Ficus hawaii***

IBA concentration (ppm)	Types of cutting			Means
	Soft wood	Semi-hard wood	Hard wood	
1000	4.0	3.0	6.0	4.3ab
2000	4.3	3.8	4.0	4.0 ab
3000	9.3	12.0	10.8	10.7 ab
4000	12.5	14.3	15.0	13.9a
5000	8.8	3.8	5.8	6.1 ab
Control	0.0	3.5	2.8	2.1 b
Means	6.5	6.7	7.4	

LSD value at 5% for concentrations = 10.19

ANOVA TABLE FOR NUMBER OF ROOTS

S.V	D.F	S.S	M.S	F value	Prob
Replication	3	48.486	16.162	0.5157	
Types of cutting (T)	2	10.778	5.389	0.1720	
Concentration (C)	5	1227.236	245.447	7.8321	0.0000
T X C	10	114.556	11.456	0.3655	
Error	51	1598.264	31.339		
Total	71	2999.319			

ACKNOWLEDGEMENTS

I offer my sincere and cordial thanks to my supervisor, Dr. Syed Asghar Hussein and all other staff at NWFP agricultural University and Tarnab Research station for all their great help and support in organizing the experiment and for their guidance and technical support.

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