RESEARCH ARTICLE

The Effect of Wounding, Indole Butyric Acid Levels, and Cutting Date on Rooting Ability of *Ficus benghalensis*

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ABSTRACT

The experiment was conducted in the plastic house of the Department of Horticulture and Gardening Engineering at College of Agriculture, Anbar University during the period from March to September 2019 to study the effect of wounding, levels of indole butyric acid, and date of cutting on the rotting ability of ficus. The experiment was carried out using complete randomized design (CRD) with a factorial experiment consisting of three factors; the first factor involved applying two levels of wounding (without wounding, two wounds at the base of the cutting); the second factor included the treatment of the cutting base with four levels of indole butyric acid (0, 1,500, 2,000, and 3,000 mg-liter^{-1}), while the third factor was the date of cuttings (March and April). The results showed superiority of cutting during March on the percentage of rooting (99%), the number of days required for rooting (22 days), number of roots (89 per plant), a diameter of the roots (0.75 mm), and length of the roots (17.33 cm).

Keywords: Ficus, Date of cutting, IBA, Wounding.

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INTRODUCTION

Ficus benghalens belongs to the Moraceae family; the plants are evergreen and fast-growing. The leaves have an oval shape with light green color; the branches give air roots that dangle to reach the ground and are rooted in it. The ficus plants are used for shading at big streets. Ficus is considered as a difficult rooting plant and needs a long time to reach the emergence stage of transverse roots and the production of seedlings with a faster time.[1]

Treating cuttings with auxins helps to form transverse roots and speeds up their formation. Auxins are used for propagating of woody, semi-woody, and fleshy cuttings. Indole acetic acid (IAA), indole butyric acid (IBA), and naphthalene acetic acid (NAA) are the most widely used because they help in stimulating the emergence of roots in the cuttings of many kinds of plants. IBA is the most widely used because it is not affected by auxins destroying enzymes and because of its slow transition rate and its effectiveness.[2]

Previous studies have shown that wounding of cuttings facilitates the emergence of transverse roots via breaking of the sclerenchyme tissues between the bark and the cortex.[3] Several studies have proven the importance of stem cuttings date on the extent of failure or success of rooting and in the characteristics of the root and vegetative parts. Each plant species is characterized by the presence of a specific time period, in which, the plant tissue is active in the flow of plant sap, and thus, the cutting can give more rooting.[4,5] Indicated that the best percentage of rooting could be obtained in ficus plant when the stem cuttings are taken in February and March due to the formation of sugars and phenols in the mother plant that changed seasonally according to growth cycles.

MATERIALS AND METHODS

The experiment was carried out in the green-house of the Department of Horticulture and Gardening Engineering in the College of Agriculture, Anbar University during the period from 01/03/2019 to 29/12/2019. The rooted cuttings were taken off after two months of planting the ficus plants for each appointment in the breeding ponds and raising them in the greenhouse for six months in plastic bags. The concrete pond with dimensions of 90 × 360 × 80 cm (width, height, length) was prepared, as shown in Figure 1, and fixed with a plastic cover. The basin was filled with red sand that was washed several times to ensure the washing of suspended

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salts, sterilized with a 0.5 mL solution for one minute. The drip irrigation method was used in the propagation ponds by providing it with three lines, in which, the distributors were distributed interchangeably and at distances of 15 cm between one dotted one and another, and the interchange between the lines. The basin was irrigated several times to make sure that the water reached each planting line.

A terminal cutting of 4 to 5 mm in diameter and 10 cm in length containing 4 to 5 nodes were used; two leaves were kept on each cutting. The base of each cutting was submerged in a 0.5 mL^{-1} liter of pentanol solution for one minute, then treating with different concentrations (0, 1,500, 2,000, and 3,000 mg/kg) of cerradix commercial powder produced by Vilmorin company. Each ten cuttings was weighted to keep it as uniform as possible.

The experiment was carried out as a factorial experiment using a CRD. The number of experimental units was 16, containing ten cuttings per treatment. The results were analyzed using analysis of variance (ANOVA) in the SAS statistical version (2000). The means were tested using LSD at a probability level 0.05, according to Al-Rawi (2000).

The experiment included a study of three factors; the first factor included the date of planting the cuttings (March and May), and the symbols for them were D1 and D2. The second factor included wounding of the cuttings that injured at two levels (zero and two); the symbols for them were W0 and W1. The third factor included treating the rules the cuttings with four concentrations of indole butyric acid (0.0, 1,500, 2,000, and 3,000 $mg^{-1}kg$), and the symbols for them were B0, B1, B2, and B3.

The following characters were studied:

- *Rooting percentage:* The rooted cuttings were calculated for each experimental unit according to the following equation:

The percentage of rooting = (number of rooted cuttings / total cuttings number) × 100%

A number of days from implantation of the cuttings until the formation of transverse roots; days were calculated in the various treatments from planting to the appearance of roots.

- *Number of roots average:* Calculating the number of major roots originating from the selected cuttings in each experimental unit and also calculates the average number of roots of each cutting.

The diameter of the main roots (mm) average: the diameter average of the roots of plants from each experimental unit was calculated using micro-fernacles; the average was recorded in millimeters.

The length of roots (cm) average was measured by calculating the length of the main roots formed in the selected cutting from the experimental unit and estimated in centimeters.

RESULTS AND DISCUSSION

Percentage of Rooting: Table 1 showed that the treatment of the wounding of rooting was statistically significant comparing to non-wounded one, and the percentage were 51.43 and 37.91%, respectively. With respect to IBA, the concentrations (1500 mg per liter -1) was significantly superior to in the percentage of rooting and reached 52.67%, while the percentage of rooting

Table 1: Effect of wounding, indole butric acid and date of cuttings in the percentage of rooting (%) of plant *Ficus benghalensis*

5% R.L.S.D			*Date of take cutting D*		*IBA B*	*Level wounding*
		IBA X wounding	*April*	*March*		
3.75	Wounding ×	40.24	56.66	65.00	0	
		60.62	60.63	99.00	1,500	W0
8.38	Date take cutting	46.81	47.50	58.33	2,000	
		44.99	37.50	50	3,000	
8.38	IBA	28.24	10.83	16.66	0	
		47.91	45.83	56.00	1,500	W1
14.2	wounding × IBA	35.44	33.33	51.16	2,000	
		39.58	33.33	50.33	3,000	
16.00	Date take cutting wounding X	51.43	49.99	69.99		Wounding
17.76	Date of take cutting × IBA	37.91	30.83	48.95		Woundingless
		42	40.41	59.47		
20.02	Triinteraction	42.51	38.74	45.91	0	Interaction of date IBA X
		52.76	52.08	55	1,500	
		41.14	35.41	60	2,000	
		42.28	35.41	44.99	3,000	

of the cuttings was 35.41%, when treating the concentration decreased 3,000 mg l^{-1}. The date of taking the cuttings increased significantly and the percentage of rooting for D1 reached 59.47%, while the percentage of rooting decreased for D2 and reached 40.41%.

It was evident from Table 1 that the interaction between wounding treatment and the treatment of IBA acid with a concentration of 1500 mg-liter^{-1} reached 60.62%, whereas the interaction between non-wounding and without IBA reached 28.24%. The interaction between wounding and dates of taking the cuttings increased significantly with March and reached 69.99%, while the percentage of rooting decreased during the date of May and reached 30.83%. The interaction between the dates of taking the cuttings and IBA concentration showed significant differences in March and May with a concentration of 1,500 and 2,000 mg liters^{-1}; the percentage of rooting reached 60.00, 52.08, and 56.24%. The interaction between the study factors represented as wounding, and the concentration of IBA (1,500 mg^{-1} liter) in March recorded 99.00%, while the control treatment decreased to 10.83%.

The number of days of culturing cuttings until the formation of transverse roots: Table 2 showed that the treatment of wounding was significant in the early stage, with the emergence of transverse roots recorded 32.50 days, while the unwounded treatment was delayed for the emergence of the first transverse root and recorded 47 days. Regarding the effect of IBA, it denounced the treatment of 1,500 mg^{-1} liter in the emergence of transverse roots that reached 30 days compared to the control treatment which reached 45.37 days, while for cuttings taking dates, transverse roots appeared early in March recording 42.57 days, while the emergence of transverse roots at a later date reached 52.50 days.

Table 2 Shows the effect of interaction treatment between the wounding and the treatment of IBA in early rooting. The treatment of the wounding was significantly superior with the concentration of 1,500 mg^{-1} liter and reached 25 days, while the emergence of transverse roots at the untreated treatment and the control concentration gave 50 days. For the interaction between wounding and the cutting-taking dates, the treatment of March interfering with the wounding showed early emergence of transverse roots. It was recorded 35 days, while treatment of May with unwounded treatment was delayed in the emergence of transverse roots to 50 days.

The interaction between the dates and IBA concentration has a clear effect on the emergence of transverse roots, as it was early in the treatment of March with the concentration of IBA 1,500 mg^{-1} and reached 35 days compared to the May treatment with a concentration of IBA 3,000 mg^{-1} that reached 60 days. The three-way interaction between the study factors, increased significantly for the treatment of wounds with IBA 1,500 mg^{-1} liter at March in early rooting, which amounted to 22 days, while unwounded treatment with a concentration of IBA 3,000 mg liter^{-1} was delayed in the appearance of transverse roots and reached 66 days.

An average number of roots (plant root -1): The treatment of wounding achieved a significant increase in the average number of roots recorded 51.43 plant root -1 (Table 3), while the average number of roots decreased to 37.91 plant root^{-1}. The IBA treatments showed significant differences; the concentration of 1500 mg-liter^{-1} produced 52.43 roots of the plant -1 compared to the concentration of 3000 mg liter^{-1} that reached 42.28 mg liter^{-1}. For the dates of taking the cuttings, the treatment of March achieved a significant increase in the number of the roots that reached 59.47 root-plant-1.

Table 2: Effect of wounding, indole butric acid, and date of cuttings in the number of days needed for rooting of plant *Ficus benghalensis*

5% RLSD			*Date of take cutting D*		*IBA B*	*Level wounding*
		IBA X wounding	*April*	*March*		
1.55	wounding ×	30.00	50	40	0	
		25.00	40	22	1,500	W0
20.20	Date take cutting	40.00	40	50	2,000	
		35.00	55	60	3,000	
2.20	IBA	35.00	66	60	0	
		35.00	50	40	1,500	W1
3.11	Wounding × IBA	42.00	55	60	2,000	
		50.00	66	45	3,000	
3.11	Date take cutting X wounding	32.50	45	35		W1
		47.00	50	47.50		
4.40	Date of take cutting × IBA	Range IBA	52.50	42.57		W0
		45.37	55	50	0	
6.23	Triinteraction	30.00	47	35	1,500	Interaction of date IBA X
		39.00	55	45	2,000	
		44.75	60	45	3,000	

Table 3: Effect of wounding, indole butric acid, and date of cuttings in the number of root of plant *Ficus benghalensis*

5% RLSD			*Date of take cutting D*		*IBA B*	*Level wounding*
		IBA X wounding	*April*	*March*		
3.75	wounding ×	56.24	63.33	73.00	0	
		82.62	73.11	89.00	1,500	W1
8.38	Date take cutting	46.81	51.66	58.33	2,000	
		44.99	60.83	61.66	3,000	
8.38	IBA	28.24	27.50	47.66	0	
		47.91	49.16	66.66	1,500	W0
10.51	wounding × IBA	55.44	54.16	54.16	2,000	
		39.58	50.66	58.33	3,000	
11.02	Date take cutting X wounding	51.43	55.73	69.99		W1
11.66	Date of take cutting × IBA	37.91	41.87	48.95		W0
		Range IBA	47.85	59.47		Date of take cuttings
16.02	Tri interaction	–	35.41	45.91	0	Interaction of date IBA X
		–	70.00	88.38	1,500	
		43.14	50.91	56.24	2,000	
		42.28	60.72	68.99	3,000	

The interaction treatment between the wounding and IBA was significant at the concentration of 1,500 mg^{-1} and recorded 82.62 plant roots -1 while the unwounded treatment decreased with 3,000-mg, and the average number of roots reached 39.58 roots per plant. The interaction between the wounding and the dates increased significantly; the wounded treatment in March increased to 69.99 root of a plant -1 compared to the unwounded that taken in May, which reached 41.87 plant $root^{-1}$.

With regard to the interaction between dates and concentrations of IBA, the treatment of the interaction between March and the concentration 1,500 mg L^{-1} significantly increased and recorded 88.38 plant root -1, while the average number of roots decreased for the interaction between May treatment and IBA concentration 3000 mg L^{-1} that reached 42.28 plant root -1. The triple interaction treatment between the wounding and at the concentration 1500 mg^{-1} of IBA that was taken in March significantly outperformed and reached 89.00 root-1, while unwounded decreased compared with control taken in May and reached 27.50 root-1.

- *Root diameter ratio (mm):* The wounding led to increase all root growth characteristics, including the increase in root diameter. The wounded treatment exceeded the average root diameter and reached 0.45 mm, while the root diameter of unwounded decreased to 0.25 mm. The diameter of the root when treating with IBA 1500 mg^{-1} liter recorded 0.66 mm, while it decreased at a concentration of 3,000 mg^{-1} liter and reached 0.20 mm. For the date's treatments, the average diameter of the roots increased in March and recorded 0.41 mm, while the average diameter of the roots for May was 0.24 mm.

Table (4) showed an increase in the root diameter for interaction between the wounded treatment that treated with IBA at a concentration of 1,500 mg^{-1} and recorded 0.66 mm compared to the interaction of non-injured cuttings with the concentration of IBA at a concentration of 3000 mg $liter^{-1}$ which amounted to 0.20 mm. Table (4) showed an increase in the average diameter of the root in the treatment of the interaction between the wounding and March, which amounted to 0.41 mm, while the interaction with the date of May amounted to 0.26 mm. The interaction between the dates and IBA concentration of 1,500 mg^{-1} liter reached 0.57 mm compared to the treatment of interaction between May and IBA concentration of 3000 mg^{-1} liter, in which the diameter decreased to 0.23 mm.

Table 4 showed a significant increase in the average diameter of the roots for the triple between the treatment of wounding and the IBA concentration of 1,500 mg l^{-1} and at the time of March and amounted to 0.75 mm while the average diameter of the roots at untreated treatments with a concentration of 3,000 mg l^{-1} taken in May amounted to 0.18 mm.

Root length average (cm): From Table 5, the injured cuttings showed increase in the average length of the roots to 6.22 cm, while the average length of the roots for the control was 4.71 cm. The IBA treatments had a clear effect, the IBA at a concentration of 1,500 mg/$liter^{-1}$ reached 11.33 cm, while the average length of roots at IBA concentration of 3,000 mg l^{-1} recorded 5.35 cm. For the dates of taking the cuttings, the treatment of March reached 10.33 cm compared to May treatment, which amounted to 7.81 cm.

The same table showed an increase in the average root length for interaction between wounding and the treatment of IBA with a concentration of 1,500 mg^{-1}, reaching 14.33 cm, while the average length of roots in the treatment of interaction

Table 4: Effect of wounding, indole butric acid, and date of cuttings in the diameter of root of plant *Ficus benghalensis*

5% RLSD			*Date of take cutting D*		*IBA B*	*Level wounding*
		IBA X wounding	*April*	*March*		
0.20	Wounding ×	0.26	0.16	0.22	0	
		0.66	0.31	0.75	1,500	W1
0.037	Date take cutting	0.50	0.21	0.39	2,000	
		0.22	0.21	0.39	3,000	
0.037	IBA	0.28	0.33	0.35	0	
		0.27	0.38	0.40	1,500	W0
0.041	Wounding × IBA	0.26	0.23	0.34	2,000	
		0.20	0.18	0.31	3,000	
0.041	Wounding X Date take cutting	0.45	0.28	0.41		W1
0.09	Date of take cutting × IBA	0.25	0.26	0.27		W0
		Range IBA	0.24	0.41		Date of take cuttings
0.13	Tri interaction	0.21	0.24	0.31	0	Interaction of date IBA X
		0.66	0.27	0.57	1,500	
		0.50	0.22	0.36	2,000	
		0.20	0.23	0.30	3,000	

between unwounded treatment with IBA concentration of 3,000 mg^{-1} and reached 4.64 cm. In the interaction between the wounding and the dates, the treatment of March was significantly superior to the treatment of wounding and reached 9.60 cm, while the average length of the roots in the interaction between the unwounded with May date reached 5.83 cm.

For the interaction between the dates and the levels of IBA, the rate increased significantly. The length of the roots at the interaction between March and IBA concentration of 1,500 mg^{-1} liter reached 10.28 cm, while the length of the root decreased with the interaction between May treatment and the concentration of 3,000 mg^{-1} liters, which amounted to 6.83 cm.

The treatment of triple interaction between the wounded cuttings and IBA at a concentration of 1,500 mg^{-1} liter during March, amounted to 17.33 cm compared to the treatment of triple interference between unwounded treatment with a concentration of 3,000 mg^{-1} liter that taken in Mays, which amounted to 4.64 cm.

Studies have proven that wounding has a major role in the early emergence of transverse roots and the ease of their emergence. Its role appeared in the rooting of the cuttings of some plant species such as Rhododendron and Junipers of mature wood. During the induction phase, the IAA-oxidase accumulates.[6] Some compounds move with the auxins, such as, carbohydrates, O-diphenols and other soluble materials, as accumulated uxines at the beginning of cell division lead to the formation of root promordia, and this occurs in the early development phase and in the callus production, which is believed to be the beginning of differentiation into principles of roots mostly along the edge wound.[7]

Wounding may increase the absorption of the prepared auxins to the base of the cutting in order to increase the surface area at the wounding site. Also, the stem tissue in some species contains a scalarnicematic ring consisting of fibrous cells in the cortex outside the region of the emergence of transverse roots in the pericycle and there is evidence to confirm difficulty penetration of new roots of this ring of cells, a simple wound may cut this ring and it may facilitate the external penetration of the roots through it, then through the shell and skin to become visible roots, and this is inferred that cutting causes an increase in the rate of rooting, and this is confirmed by.[8] The effect of the IBA may be attributed to the fact that it helps to stimulate root development in the cutting of many types of plants, as well as, that it is relatively unaffected by the action of IAA phenoxi oxidase enzymes, slow transmission and its rate of effectiveness is important, as well as, it does not result in side damage. The uxine has a role in organizing the formation process of roots by regulating the level of uxine within plant tissues, and the low concentrations of industrial uxine IBA improve the ratios of rooting success and the quality of roots.[9]

The decrease in rooting rates in May could be explained by the rise in temperatures inside the greenhouse, which led to drain the nutritional material stored in the cuttings; also increased the loss of moisture by transpiration and this was reflected on the percentage of rooting, and consequently, the lack of vascular cambium activity.

Therefore, the highest rooting rate in April can be explained because the cuttings were mature, and the plant had completed the growth cycle.

The results can also be explained due to the increase in the weight of the cuttings as a result of its nutritional content, as well as, the timing of taking the stem cuttings from different plant species has a clear impact on the failure or success of

Table 5: Effect of wounding, indole butric acid, and date of cuttings in the length of root of plant *Ficus benghalensis*

5% RLSD			*Date of take cutting D*		*IBA B*	*Level wounding*
		IBA X wounding	*April*	*March*		
1.04	Wounding	7.98	7.42	8.33	0	
		14.33	12.22	17.33	1,500	W1
1.48	Date take cutting	8.42	8.20	9.52	2,000	
		7.11	6.11	5.71	3,000	
1.18	IBA	3.44	3.23	5.66	0	
		5.50	6.66	8.24	1,500	W0
2.09	Wounding × IBA	5.30	8.11	7.92	2,000	
		4.64	5.34	7.0	3,000	
2.09	Wounding X Date take cutting	6.22	7.11	9.60		W1
2.96	Date of take cutting × IBA	4.71	5.83	7.20		W0
		Range IBA	7.81	10.33		Date of take cuttings
4.19	Tri interaction	5.70	7.34	7.66	0	Interaction of date IBA X
		11.33	8.94	10.28	1,500	
		8.22	8.15	8.62	2,000	
		5.36	6.83	7.05	3,000	

rooting the cuttings and on the characteristics of the root, and a vegetative group of that cutting, as each plant type or variety is characterized by the presence of a specific time period in which the cutting capacity of rooting more.[4]

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