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A Combination of Wounding, IBA and NAA Resulted in Better Rooting and Shoot Sprouting in White Adriatic Fig (*Ficus Carica* L.) Stem Cuttings

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Research Article

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Abstract

This research aimed to study effects of wounding, IBA, NAA and their combinations on rooting ability and shoot sprouting in White Adriatic fig cuttings. Cuttings were collected and treated with (in ppm w/w): 0, wounding, 2000 IBA, 4000 IBA, 500 NAA, 1000 NAA, wounding+2000 IBA, wounding+4000 IBA , wounding+ 500 NAA, wounding+ 1000 NAA, 2000 IBA+500 NAA, 4000 IBA+1000 NAA, wounding+2000 IBA+500 NAA, wounding+4000 IBA+1000 NAA. To record the timing and percentage of rooting, cuttings were treated with wounding, (in ppm w/w) IBA and NAA or without wounding and auxin as control. Total carbohydrates, total and reducing sugar, total indols, total free amino acids, total and conjugated phenols, N, P, K in leaves were determined. The results revealed that, treating cuttings with IBA /or NAA raised the rooting percentages. In addition data mentioned that wounding treatment and quick dipping of cuttings in IBA and NAA gave the highest percentages of rooting and consequently the high survival percentages in comparison to other treatments. Results also showed that the growth parameters of stem, roots and other chemical constituents took the same trend as affected by the previously treatment. The best treatment for rooting and shoot sprouting were (in ppm) wounding plus the highest rate of growth regulators (4000ppm indole butyric acid and 1000ppm of naphthalene acetic acid, either alone or together) 4000 IBA+1000 NAA, since it produced higher root length, better root morphology and higher shoot sprouting.

Keywords: Fig; Wounding; IBA; NAA; Rooting Ability

Abbreviations: IBA: Indole Butyric Acid; NAA: Naphthalene Acetic Acid.

Introduction

Fig (*Ficus carica L.)* is one of the most important deciduous fruit trees grown in Egypt. It is believed to be indigenous to the Mediterranean where dryer warm temperature climates are dominant. It has been cultivated for thousands of years and mentioned in the holly Muslim book (Quran) and other religion books [1].

It is well known that fig trees are almost propagated by cuttings. However, some of fig varieties are considered semi and hard-to-root such as Conadria, White Adriatic, Kadota and Roxo de Valinhos [2]. Tekintas and Seferoglu [3] reported that the rooting performance ratios of hardwood cuttings of Bursa Siyahi cultivar of figs planted in sand and soil production parcels and perlite and peat filled holes were 71%, 24%, 31% and 21% respectively. Average number of roots (42.75%) and root length (29.25 cm) of Bursa Siyahi cutting were obtained in sandy media.

Different wounding methods were conducted for increasing root production in several plant species. In some plant species, root production on stem cuttings may be

promoted by wounding the base of cuttings. A vertical cut with the tip of a sharp knife down each side of the cutting for one inch or two, penetrating through the bark and into the wood may be enough [4].

Auxins such as IAA, IBA & NAA have been traditionally applied to improve rooting of fig stem cuttings. The beneficial effect of IBA & NAA on root ability of fig cuttings was reported by several workers [5-9]. In this connection, Ali [10] studied the effect of IBA or IAA at (2000 and 4000 ppm) or NAA at (500 and 1000ppm) on root ability of stem cuttings of Sultani fig and reported that treating the cutting with 2000 or 4000 IBA and 4000 IAA gave the highest significant number of roots per cutting after 8 months from culturing under field conditions. Moreover, the highest roots length per cutting was obtained when cuttings were treated with 2000ppm IBA, 4000ppm IBA, 4000ppm IAA and 1000ppm NAA. Moreover, Chalfun, et al. [11] using fig cv. Roxo de Valinhos found that, the cuttings obtained from one-year-old branches of adult fig trees every fortnight between April and August and treated with IBA (100 mg/litre) for 24 h. and cultured in mixture of soil and sand at 3:2 ratio (v/v) gave the highest percentage of rooted cuttings in cuttings collected during April and May (92.5% without IBA and 100% with IBA). The highest percentage of cuttings which sprouted and rooted were obtained with cuttings that were collected early. The application of IBA increased the dry matter weight of shoots and roots. However, the increment in shoot and root dry matter contents due to IBA application decreased with the delay in the collection of cuttings. Also, Karadeniz [12] evaluated the rooting performance of 3 local fig cultivars (Siyah, Patlcan and Kabak). Hardwood cuttings 25-30 cm long obtained from one-year-old branch, treated with IBA (1000 or 2000 ppm) and planted in perlite from the end of October to the end of March, that the highest rooting percentage (58%) was obtained with Patlcan cuttings treated with 1000 ppm IBA. Moreover, Singh, et al. [9], working with fig cv. Daulatabad revealed that IBA application at (500, 1000 and 1500 ppm) affected days to first sprouting and number of roots per cutting more than the other traits. Overall results showed that fig can be successfully propagated by cuttings with quick dip treatment of 1500 ppm IBA under mist chamber.

The beneficial effect of IBA, NAA and their combinations on rooting ability and some chemical constituents of several trees were reported by several workers such as Wahab, et al. [13] on gauava, Morsi, et al. [14] on fig, Hussein, et al. [15] on olive, Yusnita, et al. [16] on apple, Ayaz, et al. [17] on olive trees.

Accordingly, the present work was planned to study the effect of wounding and some growth regulators (IBA and NAA) at different concentrations on root production of fig cuttings of White Adriatic classified as hard to root variety.

Materials and Methods

The present study was carried out in the two successive seasons of 2006 and 2007 at the Experimental farm, Faculty of Agriculture, Fayoum Univ. at Demo, Fayoum, Egypt. Stem cuttings of fig (*Ficus carica L.*) cv. "White Adriatic" (14 years old) were used for propagation trials under greenhouse conditions. The stem cuttings of "White Adriatic" fig were prepared from hardwood cuttings (adult), taken from secondary branches on the fig trees grown in the Experimental farm of Faculty of Agriculture, Fayoum Univ. These trees were uniform as possible and received normally agricultural practices. The hardwood cuttings were prepared on February, 20th, 2006 and 2007 from one year old branches. Each treatment contained 30 cuttings in three replicates. The average length of each cutting was about 20 cm.

Wounding was carried out in the basal portions of the cutting as longitudinal cut with sharp knife for about 1.5 inch long directly below a node. These cuttings were sterilized with Rizolex 3gm /L. as fungicide for about 5 minutes and then were left for 30 minutes to dry. The basal portions were dipped in different concentrations of each growth regulators for quick dipping. Ethyl alcohol 50% was used as solvent for IBA and NAA. Cuttings were designed to study the effects of some treatments on root ability of stem cuttings of "White Adriatic" fig. The different treatments are summarized in Table 1.

No.	Treatment
1	Stem cuttings (control)
2	Wounding
3	2000 ppm(IBA)
4	4000 ppm (IBA)
5	500 ppm (NAA)
6	1000 ppm (NAA)
7	Wounding + 2000 ppm (IBA)
8	Wounding + 4000 ppm (IBA)
9	Wounding + 500 ppm (NAA)
10	Wounding + 1000 ppm (NAA)
11	2000 ppm IBA +500ppmNAA
12	4000 ppm IBA +1000ppmNAA
13	Wounding + 2000 IBA + 500 ppm NAA
14	Wounding + 4000 IBA + 1000 ppm NAA

Table 1: The different treatments used.

Cuttings were prepared February on 20th, 2006 and 2007 and were stored in fine sand for a month to increase their root ability, then, they were treated with different treatments and then cultured March on 20th in media composed of peat-

moss and sand (1:1v/v) in plastic boxes under greenhouse conditions. The experimental design used was complete randomized design. Each treatment contained 30 cuttings. The results were recorded after 30, 60 and 90 days from culturing.

Data Recorded

Growth Characters: Total number of successful cutting after one month, two month and three month (survival %) were recorded. At the end of the experiment, (September 16th), samples of each treatment (10 cuttings) were taken and average of the following characters were recorded: stem fresh weight; stem length; stem diameter; stem dry weight; leaves fresh weight/ cutting; leaves dry weight/cutting; number of leaves /cutting; root length / cutting; roots fresh weight/cutting and roots dry weight/cutting.

Chemical Constituents: After four months old fresh and dried leaves were used for determination of the following constituents: total carbohydrates as g/100g dry weight was extracted by sulphuric acid (0.1 N) then determined calorimetrically by using phenol-sulphuric cid reagent according to the method described by Michel KA, et al. [18], total and reducing sugars as mg/g dry weight were determined in ethanolic extract using phosphomolybdic acid reagent as described by AOAC [19], total indols as mg/g dry weight were determined in ethanolic extract using 4-dimethyl–amino-benzaldehyde reagent as described by Larson, et al. [20], total free amino acids as mg/g dry weight were determined colorimetrically in ethanolic extract using ninhydrin reagent according to the method described by Jayarman J [21], total, free and congujated phenols as mg/g dry weight were determined in ethanolic extract using Folin-Denis reagent as described by AOAC [19], nitrogen and phosphorus % were determined according to AOAC [19] and potassium % were determined using Flame Photometer, Parkin–Elmer model 52 with acetylene burner according to Page AI, et al. [22]. All data were statistically analyzed according to Steel and Torrie [23] using L.S.D. test. The values presented in the results obtained in this investigation the means of the two seasons under study.

Results

Percentage of Rooted Cuttings (Survival %)

Results in Table 2 show that rooting percentage of fig cuttings as affected by wounding and/or two growth regulators (indole butyric acid and naphthalene acetic acid) at different rates resulted in a high increase in rooting percentage in fig cuttings. The beneficial effects of the used treatments were more pronounced with the highest rate of the two growth regulators, (4000ppm IBA or 1000ppm NAA) either alone or in combination with wounding. At these treatments survival % after one, two and three months were significantly increased. The highest percentages of rooted cuttings recorded 53.30, 48.40 and 55.20 % after one month, 68.30, 66.60 and 69.50% after two months and 88.80, 83.30 and 89.30 % after three months for treatments No. 8, 10 and 14, respectively.

No.	Treatment	Survival %		
		One month	Two months	Three months
1	Stem cuttings (control)	5.5	22.2	62.2
2	Wounding	22.2	33.3	77.7
3	2000 ppm(IBA)	23.3	50	65.1
4	4000 ppm (IBA)	27.7	61.1	66.2
5	500 ppm (NAA)	22.2	33.3	66.6
6	1000 ppm (NAA)	23.3	38.8	71.7
7	Wounding + 2000 ppm (IBA)	46.1	65.2	80.1
8	Wounding + 4000 ppm (IBA)	53.3	68.3	88.8
9	Wounding + 500 ppm (NAA)	46.6	65.3	80.9
10	Wounding + 1000 ppm (NAA)	48.4	66.6	83.3
11	2000 ppm IBA +500ppmNAA	42.1	59.9	75.4
12	4000 ppm IBA +1000ppmNAA	43.3	61.5	78.7
13	Wounding + 2000 IBA + 500 ppm NAA	48.3	66.4	83.1
14	Wounding + 4000 IBA + 1000 ppm NAA	55.2	69.5	89.3
	L.S.D. 0.05	2.82	2.48	2.81

Table 2: Effect of wounding treatments either alone or combined with IBA or NAA on survival % after one, two and three months of fig cuttings.

Growth Characters: Data presented in Tables 3-5 indicate that, growth parameters of fig stem cuttings represented as stem fresh weight; stem dry weight; stem length; stem diameter; leaves fresh weight/ cutting; leaves dry weight/ cutting; number of leaves/cutting; root length/cutting; roots fresh weight/cutting and roots dry weight/cutting were greatly improved by wounding or by using the two growth regulators treatments (indole butyric acid and naphthalene acetic acid) at different rates. The best result regarding the growth parameters was observed when fig cuttings were treated with wounding plus the highest rate of growth regulators (4000ppm indole butyric acid and 1000ppm of naphthalene acetic acid, either alone or together), (treats No. 8, 10 and 14) which gave 9.60, 9.20 and 10.30 g. for stem fresh weight; 2.65, 2.50 and 3.13 g. for stem dry weight; 30.00, 29.50 and 32.60 cm. for stem length; 0.83, 0.80 and 0.93 cm. for stem diameter; 16.36,15.80 and 21.32 g. for leaves fresh weight/ cutting; 4.20, 4.05 and 5.50 g. for leaves dry weight/cutting; 5.50, 5.40 and 5.80 for number of leaves /cutting; 23.03, 21.50 and 27.50 cm. for root length /cutting; 4.76, 4.35 and 5.53 g; 14.60, 12.40 and 17.60 for roots fresh weight/ cutting; 4.76, 4.35 and 5.53g for roots dry weight, respectively.

No.	Treatment	Stem fresh weight(g)	Stem dry weight(g)	Stem length (cm.)	Stem diameter (cm.)
1	Stem cuttings (control)	3.1	0.76	14	0.46
2	Wounding	4.75	0.89	19	0.5
3	2000 ppm(IBA)	3.7	0.81	17	0.5
4	4000 ppm (IBA)	4.1	0.85	21	0.5
5	500 ppm (NAA)	4.3	0.83	21	0.6
6	1000 ppm (NAA)	4.4	1.02	25.6	0.66
7	Wounding + 2000 ppm (IBA)	8.9	2.31	26.35	0.7
8	Wounding + 4000 ppm (IBA)	9.6	2.65	30	0.83
9	Wounding + 500 ppm (NAA)	8.9	2.31	28.15	0.7
10	Wounding + 1000 ppm (NAA)	9.2	2.5	29.5	0.8
11	2000 ppm IBA +500ppmNAA	7.44	1.73	25.92	0.65
12	4000 ppm IBA +1000ppmNAA	7.6	2	26.3	0.7
13	Wounding + 2000 IBA + 500 ppm NAA	9.15	2.46	29.15	0.73
14	Wounding + 4000 IBA + 1000 ppm NAA	10.3	3.13	32.6	0.93
	LSD 0.05	1.29	0.09	2.02	0.09

Table 3: Effect of wounding, IBA and NAA treatments either alone or in combination with each other on stem fresh weight, stem dry weight, stem length and stem diameter of fig cuttings after 180 days from planting.

No	Treatment	Number of leaves/cutting	Leaves fresh weight(g)	Leaves dry weight(g)
1	Stem cuttings (control)	4	9.6	2.2
2	Wounding	4.5	9.85	2.3
3	2000 ppm(IBA)	4	9.7	2.2
4	4000 ppm (IBA)	4.5	10.5	2.4
5	500 ppm (NAA)	4.6	10.13	2.96
6	1000 ppm (NAA)	4.5	11.8	3.1
7	Wounding + 2000 ppm (IBA)	5.3	15.71	3.98
8	Wounding + 4000 ppm (IBA)	5.5	16.36	4.2

9	Wounding + 500 ppm (NAA)	5.3	15.75	3.91
10	Wounding + 1000 ppm (NAA)	5.4	15.8	4.05
11	2000 ppm IBA +500ppmNAA	4.9	14.7	3.84
12	4000 ppm IBA +1000ppmNAA	5	14.8	3.9
13	Wounding + 2000 IBA + 500 ppm NAA	5.3	15.7	4.03
14	Wounding + 4000 IBA + 1000 ppm NAA	5.8	21.32	5.5
	LSD 0.05	0.23	0.66	0.12

Table 4: Effect of wounding, IBA and NAA treatments either alone or in combination with each other on number of leaves/ cutting, leaves fresh and dry weight/cutting of fig cuttings.

No	Treatment	Root length(cm)	Root fresh weight(g)	Root dry weight(g)
1	Stem cuttings (control)	13	4.2	1.1
2	Wounding	19	4.65	1.15
3	2000 ppm(IBA)	14	4.3	1.12
4	4000 ppm (IBA)	14.5	4.6	1.35
5	500 ppm (NAA)	15	4.9	1.76
6	1000 ppm (NAA)	16.6	4.95	1.83
7	Wounding + 2000 ppm (IBA)	21.4	12.35	4.32
8	Wounding + 4000 ppm (IBA)	23.03	14.6	4.76
9	Wounding + 500 ppm (NAA)	21.05	12.11	4.09
10	Wounding + 1000 ppm (NAA)	21.5	12.4	4.35
11	2000 ppm IBA +500ppmNAA	17.31	7.53	3.05
12	4000 ppm IBA +1000ppmNAA	17.5	7.6	3.36
13	Wounding + 2000 IBA + 500 ppm NAA	21.43	12.36	4.31
14	Wounding + 4000 IBA + 1000 ppm NAA	27.5	17.6	5.53
	LSD 0.05	1.33	0.18	0.12

Table 5: Effect of wounding, IBA and NAA treatments either alone or in combination with each other on root length/cutting , root fresh and dry weight/cutting of fig cuttings.

Chemical Constituents

A. Carbohydrates and Sugars: Data recorded in Tables 6 clearly show that wounding or/and using any of the two growth regulators (indole butyric acid and naphthalene acetic acid) at different concentrations had positive effect on the chemical constituents of the produced fig leaves. It is clear that, carbohydrates represented as total carbohydrates, total sugars and reducing sugars increased with increasing the rate of all growth regulators used. The best results were obtained with wounding plus the highest rate (4000ppm) of indole butyric acid or (1000ppm) of naphthalene acetic acid each alone or together which reached 16.46, 16.21 and 17.00 % for total carbohydrates; 69.18, 67.35 and 75.04 mg/g dry weight for total sugars; 49.60, 47.94 and 51.43 mg/g dry weight for reducing sugars in leaves. The obtained results in this study showed clearly that chemical constituents of fig leaves were greatly improved by wounding the cuttings and growth regulators application especially at high rates.

No.	Treatment	Total carbohydrates% (D.W basis)	Total sugars (mg/g D.W)	Reducing sugars (mg/g D.W)
1	Stem cuttings (control)	12	55.1	40.6
2	Wounding	14.85	63.27	45.24
3	2000 ppm(IBA)	12.5	56.06	42.68
4	4000 ppm (IBA)	14.58	56.87	44.94
5	500 ppm (NAA)	12.92	61.22	43.44
6	1000 ppm (NAA)	16.2	61.43	45.84
7	Wounding + 2000 ppm (IBA)	16.1	66.87	47.88
8	Wounding + 4000 ppm (IBA)	16.46	69.18	49.6
9	Wounding + 500 ppm (NAA)	16.19	67.22	47.45
10	Wounding + 1000 ppm (NAA)	16.21	67.35	47.94
11	2000 ppm IBA +500ppmNAA	15.6	62.1	46.03
12	4000 ppm IBA +1000ppmNAA	15.75	62.27	46.15
13	Wounding + 2000 IBA + 500 ppm NAA	16.2	67.24	46.23
14	Wounding + 4000 IBA + 1000 ppm NAA	17	75.04	51.43
	LSD 0.05	0.86	0.77	0.77

Table 6: Effect of wounding, IBA and NAA treatments either alone or in combination with each other on total carbohydrates, total sugars and reducing sugars in leaves of fig cuttings.

B. Total Free Amino Acids and Total Indoles Concentration: Data presented in Table 7 indicate that, leaves of fig cuttings contained a high concentration of total free amino acids and total indoles under wounding and growth regulator applications comparing to control cuttings. Moreover, the total free amino acids and total indoles were significantly increased with increasing growth regulator rates. The highest rates of the used growth regulators either alone or in combination with each other gave the best results especially with wounding, which recorded 12.69, 12.58 and 12.70 mg/g dry weight for total free amino acids and 3.53, 3.53 and 3.57 mg/g dry weight for total indoles, respectively.

C. Phenols: Data recorded in Table 7 clearly show that total soluble phenols, conjugated phenols and free phenols of fig leaves were greatly affected by the different concentrations of the two used growth regulators application. Moreover, the total soluble phenols and conjugated phenols were significantly increased with increasing growth regulators rates. The maximum values in total phenols concentration reached 10.44, 10.21 and 10.54 mg/g dry weight and the maximum values in conjugated phenols concentration reached 5.55, 4.78 and 5.78 mg/g dry weight for wounding plus IBA, wounding plus NAA and wounding plus IBA and NAA respectively. In contrast, the data also showed that all treatments used decreased free phenols in leaves of fig cuttings.

No.	Treatment	Total indoles (mg/g D.W.)	Total phenols (mg/g D.W.)	Free phenols (mg/g D.W.)	Conjugated phenols (mg/g D.W.)	Amino acids (mg/g D.W.)
1	Stem cuttings (control)	1.77	8.61	6.99	1.62	5.22
2	Wounding	2.12	8.74	6.5	2.24	7.46
3	2000 ppm(IBA)	1.79	9.08	6.5	2.58	9.19
4	4000 ppm (IBA)	2.2	9.46	6.12	3.34	10.56
5	500 ppm (NAA)	2.47	9.79	5.65	4.14	9.48

6	1000 ppm (NAA)	3.03	10.11	5.42	4.69	11.19
7	Wounding + 2000 ppm (IBA)	3.4	10.16	4.93	5.23	12.53
8	Wounding + 4000 ppm (IBA)	3.53	10.44	4.89	5.55	12.69
9	Wounding + 500 ppm (NAA)	3.5	10.19	5.44	4.75	12.56
10	Wounding + 1000 ppm (NAA)	3.53	10.21	5.43	4.78	12.58
11	2000 ppm IBA +500ppmNAA	3.09	9.75	6.34	3.41	11.59
12	4000 ppm IBA +1000ppmNAA	3.12	9.77	6.42	3.35	11.66
13	Wounding + 2000 IBA + 500 ppm NAA	3.57	10.54	4.76	5.78	12.7
14	Wounding + 4000 IBA + 1000 ppm NAA	3.52	10.2	5.45	4.75	12.54
	LSD 0.05	0.22	0.7	0.22	0.14	0.59

Table 7: Effect of wounding, IBA and NAA treatments either alone or in combination with each other on total indoles, total phenols, free phenols, conjugated phenols and total free amino acids in leaves of fig cuttings.

D. Nitrogen, Phosphorus and Potassium Concentrations: Data presented in Table 8 indicate that, leaves of fig cuttings contained a high concentration of nitrogen, phosphorus and potassium under growth regulators application conditions as compared to control plants. Moreover, the concentrations of these elements were significantly increased as the growth regulators rates increased. The maximum values were obtained from wounding plus the highest rate (4000ppm) of indole butyric acid or (1000ppm) of naphthalene acetic acid each alone or together which reached 2.80, 2.76 and 2.82 % for nitrogen concentration; 0.27, 0.27 and 0.28% for phosphorus concentration and 1.64, 1.63 and 1.72% for potassium concentration, respectively.

No.	Treatment	Nitrogen %	Phosphorus %	Potassium %
1	Stem cuttings (control)	1.76	0.23	1.32
2	Wounding	2.48	0.23	1.42
3	2000 ppm(IBA)	2.24	0.23	1.46
4	4000 ppm (IBA)	2.4	0.23	1.56
5	500 ppm (NAA)	2.52	0.24	1.32
6	1000 ppm (NAA)	2.54	0.25	1.42
7	Wounding + 2000 ppm (IBA)	2.75	0.26	1.6
8	Wounding + 4000 ppm (IBA)	2.8	0.27	1.64
9	Wounding + 500 ppm (NAA)	2.7	0.27	1.6
10	Wounding + 1000 ppm (NAA)	2.76	0.27	1.63
11	2000 ppm IBA +500ppmNAA	2.5	0.25	1.5
12	4000 ppm IBA +1000ppmNAA	2.52	0.25	1.52
13	Wounding + 2000 IBA + 500 ppm NAA	2.75	0.26	1.62
14	Wounding + 4000 IBA + 1000 ppm NAA	2.82	0.28	1.72
	LSD 0.05	0.16	0.03	0.13

Table 8: Effect of wounding, IBA and NAA treatments either alone or in combination with each other on nitrogen %, phosphorus % and potassium % in leaves of fig cuttings (dry weight basis).

Discussion

It is clear from the results of the present study that, rooting of fig Varity "White Adriatic" stem cuttings may be promoted by wounding the base of the cutting. Moreover, dipping bases the cuttings in different concentrations of any of growth regulators (indole butyric acid or naphthalene acetic acid) at different rates had a positive effect on rooting percentage of these cuttings. The beneficial effect of wounding and growth regulators on rooting percentage and growth characters (stem fresh weight; stem dry weight; stem length; stem diameter; leaves fresh weight/cutting; leaves dry weight/cutting; number of leaves /cutting; root length/cutting; roots fresh weight/cutting) and roots dry weight/cutting as well as chemical constituents of leaves (total carbohydrates, total sugars, reducing sugars, total free amino acids, total indoles, total soluble phenols, conjugated phenols, free phenols, nitrogen, phosphorus and potassium) may be attributed to that wounding plant cells near the base of the cutting stimulates plant cell division and the production of root primordia. This is due to a natural accumulation of hormones and carbohydrates in the wounded cells and to an increase in respiration rate [24]. In addition, the reduction in free phenols contrasted with the increase in total indoles, i.e. endogenous promoters increased and consequently endogenous inhibitors decreased in the leaves leading to an increase in cutting growth parameters such as stem length and leaves number/cutting as shown in Table 3. In this respect, Tognoni, et al. [25]. Moreover, Fadl MS [26] confirmed this idea and reported that easy-to-root cuttings produce one or more materials, depending upon their degree of physiological activity, which move to basal part of cutting and stimulate meristematic activity in this region causing root formation. The increase in stimulate meristematic activity in this region causing root formation. The increase in percentage of rooted cuttings may be due to the role of auxins in the cell division and initiation of root primodia. In this respect, Robbins, et al. [27] added that the presence of auxins, activates the cell division, directly by initiation of root primodia or indirectly by their involvement in overall metabolism. Also, Erikson and Mohamed [28] reported that, IBA increased rooting in treated cuttings by stimulating invitation of cambial activity, root vitals and root primordial. On the others hand, Issel and Chalmers, [29] showed that lower auxin concentration treatments (2500 ppm) can be more effective in adventitious root formation than higher concentrations (5000 ppm). The increase in rooting percentage leaves fresh and dry weight/cutting and root fresh and dry weight/cutting may be due to the increase in carbohydrates, auxins and total amino acids in leaves and stem. In this respect, Reuveni and Ravin [30] reported that, rooting of cuttings was associated with such factors, as carbohydrates, auxins, vitamins and nitrogen compounds. The energy for such activity was derived from carbohydrates, and the oxogenous supply of auxins caused the mobilization of carbohydrates and accumulated near the base of cuttings where certain cells become meristemstic and initiate the roots [31].

Finally, from the present results, it could be concluded that the application of wounding as well as indole butyric acid (IBA) and naphthalene acetic acid (NAA) at different rates had a positive effect on rooting percentage of fig stem cuttings and consequently produced better growth seedlings. In this concern, it could be recommended to use wounding plus IBA at 4000 ppm or NAA at 1000 ppm alone or in combination to obtain best results.

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