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Effect of Cutting Type and Humic Acid on Growth and Root Traits of Fig (*Ficus carica* L.) Wazeri cv. Saplings

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Abstract: Greenhouse trial was carried out at University of Anbar, Iraq, during the growing season of 2018 to study the effect of the cutting type (terminal, middle and basal) and the application of humic acid 0, 2 and 4 ml/litter on some traits of vegetative and root growth of fig. The humic acid was added to the cultural media in three stations. The different types of cutting showed a significant effect on all vegetative and root growth traits (except the dry weight of the vegetative system). Basal cuttings resulted in maximum s saplings height (49.86 cm), branches per sapling (7.69), stem diameter(12.82 mm), sapling leaves area (180.5 cm) and root length (41.61 cm), respectively. The addition of 4 ml/ litter concentration gave the maximum saplings height, number of branches, -1stem diameter, sapling leaves area, dry weight of vegetative system, roots length and dry weight of the root system (53.42 cm, 7.58 branch sapling, 13.00 mm, 176.2 cm, 21.30 g, 42.14 cm and 8.43 g, respectively). The basal cuttings resulted in positive effect on vegetative and root traits as compared to the middle and terminal cuttings.

***Keywords*:** Figs, Cutting type, Humic acid, Vegetative growth, Root growth

Fig (*Ficus carica L.*) belongs to the Moraceae family which includes more than 800 species (Harrison 2005). The origin of fig is West Asia, and its cultivation spread in the Mediterranean region (Herre et al 2008). Recently, fig cultivation has spread in different parts of the world such as Turkey, Egypt, Spain, Greece, America, Italy, Brazil (Mars et al 2008). In Iraq, the climate is suitable for figs culturing, but cultivation is not at the commercial level. The figs productivity is estimated as 3104 tonnes in 2018 with decrease of 7.32% from last year production (CSSIT 20١8). Fig is propagated by many methods such as the propagation by stem cutting taken from branches of one to many years during the bud dormancy period which is the most common vegetative propagation method (Hartmann et al 2002). There are many factors affecting the propagation by stem cuttings, the important one of these factors is the time of taking and planting of the cutting. Furthermore, choosing the type of cutting is the other most important factor, which is affecting the rooting ability of the cuttings relied on their physiological and anatomical status. Hamooh (2004) and Reddy et al (2008) observed that the hardwood fig cuttings were significantly superior in all root traits compared with semi hardwood cuttings. Khapare et al (2012) showed that hardwood fig cuttings were superior in rooting percentage and all the other studied traits.

MATERIAL AND METHODS

Greenhouse experiment was conducted at College of Agriculture/Anbar University/Iraq, during the growing season of 2018. Cuttings have been taken on January 20th, 2018 from eight years-old fig. Factorial experiment with two factors (cuttings type and humic acid concentrations) was done in Completely Randomized Block Design (RCBD) with three replicates and 15 cuttings for each experimental unit. Three types of cutting (terminal, middle and basal) were used in this study. These cutting with 15–20 cm lengths were collected from one-year-old branches. The cuttings were treated with the fungicide Benomyl 4 g l^{-1} for 30 minimums, and then they were fully dried, and then bases dipped for 5 s in 2000 mg l^{-1} of the auxin IBA. Cuttings were then planted in polyethylene bags of 5 kg capacity that contain soil mixture (3 river sand: 1 peatmoss) (Table 1). This culture medium had been sterilized in 4% formaldehyde on 1st of April. The rooted saplings were translocated to the lath house to avoid damages by high temperature in the greenhouse. Humic acid was added to the bags in three concentrations viz. 0, 2 and 4 ml l^{-1} on 20th of April, 20th of July and 20th of October. Shoot and root traits were recorded at the end of the experiment on 20th of November, which included, saplings height (cm), number of branches (branch saplings^{-1}), stem diameter (mm), sapling leaves area (cm^2), dry weight of vegetative system (g), root length (cm) and dry weight of the root system (g).

RESULTS AND DISCUSSION

Sapling height (cm): The different cutting types significantly

affected in sapling height, basal and middle cuttings (C_2 and C_3) significantly superior with the terminal ones with mean of 49.86 and 49.04 cm). The increase in rooting supporting materials such as auxins and other rooting factors in the basal cuttings could be a reason to be led this result (Owais 2010, Rana and Sood 2012), where the auxin function providing saccharides in lateral root sites due to the increased starch motion by the increased vitality of carbohydrate metabolic enzymes to free energy to form enzymes and enhance cell dividing and disclosing enzymes (Bhattacharya and Nanda 1978). All of what mentioned above have their own participation on the enhancement of transplants shoot and roots growth. Also budding in woody cuttings has gained more maturity and germination and growth ready physiological status. The addition of humic acid @ 4 ml l^{-1} h gave the highest mean (53.42 cm) compared with the interaction between the two factors showed significant differences (application of 4 ml l^{-1} humic acid to the middle cuttings (C_2H_4) gave the maximum height (56.44 cm) (Table 2). The positive effect of humic acid addition in enhancement of vegetative and root traits of the saplings, may be because of its role for improving soil chemical, physical and biological properties (Schnitzer and Khan 1971). Furthermore, it contains many plants essential nutrients. On other hands, Atee and Al-Sahae (2007) referred that the humic acid has a role in increasing the cation exchange capacity, reducing soil pH and make macro and micro nutrients more available, as well as building a highly efficient root system to absorb nutrients, which positively reflected on plant growth (Eissa et al 2007).

Branches number (branches sapling^{-1}): Basal cutting (C_3) gave the highest number of branches per sapling 7.69 branch sapling^{-1}, but not significantly different from the treatment C_2 but was significantly better than with the terminal cuttings (C_1). The increase in rooting supporting materials such as auxins and other rooting factors in the basal cuttings could be a reason to be led this result (Owais 2010).The addition of humic acid resulted in significant differences between the treatments in the number of branches. The humic acid @ 4 ml l^{-1} (H_3) gave the maximum branches (7.58) compared with control. The interaction between both factors significantly affected on branches number produced per sapling. The C_3H_3 gave the highest average branch sapling^{-1} (9.58) compared with (C_1H_1).

Stem diameter (mm): There were significant differences in the stem diameter average recorded in the different types of the cuttings. The highest diameter was shown in the basal cuttings (C_3) which was (12.82 mm), and significantly different from the other cuttings types, while the terminal cuttings (C_1) gave the lowest diameter (10.76 mm) (Table 2). The effect of humic acid was clear when added, so the treatment (H3) gave the highest average (13.00 mm) which significantly differed with the non addition treatment (H_1) which recoded the lowest average (9.88 mm). Furthermore, the interaction between both studied factors, showed the significant effect, especially for the treatment (C_3H_2) which

Table 1. Some chemical and physical properties of media soil

Mg mmol L^{-1}	Ca mmol L^{-1}	K Av. g kg^{-1}	P Av. g kg^{-1}	N Av. g kg^{-1}	O.M g kg^{-1}	EC ds m^{-1}	pH
37	43	21.7	17.4	2.56	2.3	1.8	7.8
Texture	Sand g kg^{-1}	Silt g kg^{-1}	Clay g kg^{-1}	HCO_3 mmol L^{-1}	SO_4 mmol L^{-1}	CO_3 mmol L^{-1}	Na mmol L^{-1}
Clay loam	422.4	210	367.6	4	9.6	Nil	13.1

Table 2. Effect of cutting type and humic acid on vegetative growth traits of fig Waziri cv. saplings

Cutting type	Humic (ml l^{-1})	Saplings height (cm)	Number of branches (branches sapling^{-1})	Stem diameter (mm)	Sapling leaves area (cm^2 sapling)	Dry weight of vegetative system (g)
Terminal cuttings	0	35.79	5.63	9.41	145.5	15.18
	2	46.31	7.51	9.87	148.8	17.44
	4	50.53	6.00	13.00	179.7	21.52
Middle cuttings	0	46.94	6.97	10.09	158.2	16.93
	2	43.75	6.30	11.48	180.8	18.15
	4	56.44	7.16	12.65	175.1	21.62
Basal cuttings	0	41.87	6.14	10.16	183.3	16.70
	2	54.42	7.34	14.94	184.4	20.91
	4	53.30	9.58	13.35	173.9	20.77
LSD (0.05)		7.55	1.74	2.30	17.69	N.S

gave the highest average (14.94 mm) compared with non-humic addition treatment for terminal cuttings (C_1H_1) in which the stem diameter reached the lowest average 9.41 mm (Table 2).

Sapling leaves area (cm^2): The leaf area had significantly differed among the various stem cuttings. The basal cuttings (C_3) gave the highest average (180.5 cm^2) which is not significantly different from the middle cuttings (C_2) but differed from the terminal cuttings (C_1) which registered the lowest leaves area (158.0 cm^2). Additionally, the addition of humic acid resulted in significant differences in this trait, and the treatment (H_3) gave the highest leaves area (176.2 cm^2) which is significantly differed from the non-application treatment (H_1) which recorded the lowest average (162.3 cm^2). The interaction between the two factors showed significant differences among the treatments (Table 2). The treatment (C_3H_2) gave the highest leaves area (184.4 cm^2), while the non-addition of humic acid to the terminal cuttings (C_1H_1) gave the lowest average (145.5 cm^2). The humic acid participates supporting nutritional minerals for chlorophyll biosynthesis and improving roots ability to absorb that minerals (Arancon et al 2006), especially nitrogen, phosphorus and potassium which nave important role in chlorophyll synthesis by participating in the composition of proteins and amino-acids and activating enzymes that functionally building them. It's clear that the basal cuttings and humic acid application have a positive role in leaves area increase for saplings.

Dry weight of vegetative system (g): The using of different types of cuttings didn't affect significantly in the dry weight of the vegetative system. While, the humic acid addition significantly affected in this trait, and the treatment (H_3) gave the highest dry weight (21.30 g) compared with the lowest value (16.26 g) recorded at the non-addition treatment (H_1). On the other hand, the interaction between the two studied factors significantly affected this trait (Table 2). the highest mean (21.62 g) recorded by the treatment (C_2H_3) treatment compared with the lowest dry weight of the vegetative system (15.18 g) shown in the treatment (C_1H_1).

Roots length (cm): Root length has significantly differed among cutting types used in the experiment, where the basal and middle cuttings (C_2 and C_3) gave the highest average (41.61 and 40.73cm) with an increase percentage of (17.94 and 15.45%) respectively, from the longest roots in the terminal cuttings (C_1) which recorded the lowest average (35.28 cm). The superiority of basal cuttings on terminal ones in root growth traits could be attributed to be contained more quantity stored nutrients such as carbohydrate, which play the important role in rooting process, especially at the early stages of root formation in the cuttings (Karakurt et al 2009). Palanisamy and Kumar (1997) also obtained that there's a positive relationship between taken cuttings' diameter and number and length of roots formed, which could be explained for the thicker cuttings have more quantity of carbohydrate that is necessary to form roots (Hartmann et al 2002).The addition of humic acid to saplings also caused significant differences in their root length. The treatment (H_3) gave the highest average (42.14 cm) with an increase percentage of 18.14% compared on the non-humic acid addition (H1) which gave the lowest average (35.67cm). Furthermore, the both studied factors interaction significantly affected in this trait (Table 3). The treatment (C_2H_3) treatment gave the highest average (45.41 cm), while the non-addition of humic acid treatment to the terminal cuttings (C1H1) recorded the lowest average (31.54 cm).

Dry weight of the root system (g): Dry weight of the root system has been significantly affected by the cuttings type used in this experiment, where the middle cuttings (C_2) gave the highest average (8.35 g) compared with the basal and terminal cuttings (C_1 and C_3) which gave the averages (7.88 and 7.61g), respectively. The superiority of basal cuttings on the dry weight of root growth could be attributed to be contained more quantity stored nutrients such as carbohydrate, which play an important role in rooting process, especially at the early stages of root formation in the cuttings (Karakurt et al 2009). The increase in rooting supporting materials such as auxins and other rooting factors in the basal cuttings could be a reason to be led this result (Owais 2010, Rana and Sood 2012). Additionally, the humic acid addition significantly affected the same trait, where the treatment (H_3) gave the highest dry weight of the root system (8.43 g), followed by (H2), which gave 8.07 g, while the lowest value (7.33 g) recorded in the non-humic acid addition treatment (H_0). The interaction between both studied factors

Table 3. Effect of cutting type and humic acid interaction on root growth traits of figs saplings cv. Waziri

Cutting type	Humic (ml L^{-1})	Roots length (cm)	Dry weight of root system (g)
Terminal cuttings	0	31.54	6.86
	2	35.76	7.01
	4	38.53	8.94
Middle cuttings	0	33.18	7.73
	2	43.58	9.11
	4	45.41	8.22
Basal cuttings	0	42.30	7.40
	2	40.06	8.10
	4	42.47	8.13
LSD (0.05)		5.08	0.98

significantly affected this trait, especially, the treatment (C_2H_2), which gave the highest average (9.11 g). Whereas, the lowest dry weight of the root system appeared in the non-humic with addition for terminal cuttings (C_1H_1), which gave 6.86 g (Table 3). The humic acid has a role in increasing the cation exchange capacity, reducing soil pH and make macro and micro nutrients more available, as well as building a highly efficient root system to absorb nutrients, which positively reflected on plant growth (Eissa et al 2007). Also humic acid participates supporting nutritional minerals for chlorophyll biosynthesis and improving roots ability to absorb those minerals (Arancon et al 2006).

CONCLUSION

Accordingly, the results obtained from this study, it's possible to conclude that the basal cuttings resulted, a positive effect on the studied vegetative and root traits compared on the middle and terminal cuttings. Furthermore, the application of humic acid at (4 ml l^{-1}) concentration improved vegetative and root growth of fig saplings under this study. So, we recommend using basal cutting in fig propagation, as well as, adding humic acid to improve vegetative and root growth traits of fig saplings.

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