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Effect of wounding and different concentration of IBA on the rooting and vegetative growth of stem cutting of three olive cultivars

(*Olea europaea* L)

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Abstract:

This study was carried out in greenhouse of the College of Agriculture, University of Duhok during growing season of 2015, to investigate the response of hard wood cuttings of three cultivars of olive (Arbokonia ,Hojblanka and Arbokonia 18) dwarf Spanish origin to wounding (with and without wounding) and IBA treatment at three concentrations (0, 2000 and 4000 $mg.1^{-1}$). The results indicated that wounding significantly increased rooting percentage, root length and leaf area, whereas IBA at both concentrations (2000 and 4000 $mg.1^{-1}$) significantly improved rooting and shoot percentage, root dry weight, root length and number of branches per transplant while untreated cutting had the highest total chlorophyll. The cultivars undertaken in the study differed in their response to the studied factors since the cultivar Hojblanka was more responsible followed by Arbokonia 18. For the interaction among the study factors, the best interaction was among the interaction of wounding + IBA 2000 $mg.1^{-1}$ and IBA 4000 $mg.1^{-1}$ + Arbokonia cultivar.

Keyword: Olive, Wounding, IBA, Cultivar.

Introduction

Olive (*Olea europaea* L.) is now commercially produced in the Mediterranean basin; in addition to some countries such as Australia, Argentina, Chile and South Africa where the climatic conditions are identical (16). Olive has been propagated from large parts (shoots, branches, ovules, suckers) since ancient times (4), olive has been propagated mainly by cutting, Stem cuttings are the important means of vegetative propagation in horticultural industry for mass production within a short time, but great differences in the rooting potential between cultivars or clones within cultivars were shown in olive (2, 5, 12).The biggest problem in vegetative propagation, in some olive cultivars, is the low ability of rooting leading to low percentage of rooting (13).

Wounding the basal of olive cuttings have been accepted as techniques to improve the effect of auxin treatments (4). Early works showed the incision wounding significantly improved the rooting of olive cultivars (1and 4). Cuttings are initially wounded when severed from stock plants. Additional, basal wound is beneficial in rooting of certain woody species, wounding induces cell division and meristematic activity of affected cells (9), and also increases the tissue competence to rooting hormones in cuttings (3).

The external application of Auxin is one of the most important factors to increase the rooting ability of many species (8). Several studies have indicated that Auxin has the greatest effect on the initiation of adventitious roots and the division of root initials. Growth regulators and hormones are usually used for rooting (5) IBA is the most common material which used for increasing the rooting of cutting. This acid has got weak auxin effect and can be gradually destroyed by the enzyme monoamine oxidize (MAO).

Murat and Elmas (11) studied the effects of five different wounding treatments on the rooting of 'Domat' olive leafy semi hardwood cuttings in two consecutively years. The cutting were wounded and treated with (5 $g.l^{-1}$ IBA) after wounding. Shallow incision wounding significantly augmented the rooting of cuttings especially in the second year. The highest rooting percentage and root number were with incisions compared to the unwounded cuttings. Shallow slice wounding gave the longest roots in the same period. The highest number of secondary roots was also obtained with incision wounding in the second year. Despite the highest root fresh and dry weights were obtained with no wounds in the first year, incisions gave the highest figures in the second year.

Maghsudlu *et al.*, (10) Evaluated of the effect of different IBA concentration and different kinds of cutting on rooting of two compatible olive cultivars cuttings. five levels of IBA treatment as a rooting hormones (0, 2500, 3000, 3500 and 4000 ppm) on two olive cultivars (mission and koroneiki), the results indicated that there were a considerable difference between the different levels of IBA, and the treatment of cutting with IBA by 3500 ppm concentration gave the highest effect on the increase in the rooting indexes of the olive cultivars mission and koroneiki. This experiment aimed to increase the rooting ability of stem cutting of three dwarf olive cultivars by using wounding technique and different concentrations of IBA.

Material and methods:

This study was carried out in greenhouse of the College of Agriculture, University of Duhok during 2015. Hard wood cuttings of three dwarf Spanish cultivars of olive (Arbokonia ,Hojblanka and Arbokonia 18) were taken in 25/2/2015 from mother plants (5- 6 years old) with a length of 15-20 cm containing 5-6 buds, with

remaining only 2 leaves on each cutting. The cuttings were divided into two groups. The bases of first group cuttings wounded longitudinally with the length of 1 cm; two opposite wounds for each cutting and the second group left without wounding. The bases of cuttings were treated with three concentrations of IBA (0, 2000 and 4000 $mg1^{-1}$) for 10 s. The cuttings were sterilized by Benomyl fungicide ($2gl^{-1}$) before soaking with IBA and then planted in pots filled with sterilized sand. A randomized complete block design with three factors was followed in the experiment. Every treatment consisted of 5 cutting per replicate with three replications. Spraying system was used for the irrigation cutting. The cuttings were removed after nine months of planting and the experimental measurements were recorded as following: shoot percentage (%), root percentage (%), shoot dry weight per transplant (g), root dry weight per transplant (g), root length (cm), number of branches, leaf area (cm^2) and total chlorophyll (%). All data were analyzed statistically by using SAS programs (14).

Results and Discussion:

Rooting percentage (%):

Table (1) shows that wounding olive cutting significantly increased rooting percentage and gave the highest value (60.93%). Rooting percentage increased significantly by increasing the concentration of IBA, the higher root percentage was (70.56%) when olive cutting treated with 4000 $mg.1^{-1}$IBA. Hojblanka cultivar significantly superior root percentage than other cultivars and gave the maximum value (64.72%). The data of interaction between wounding and IBA concentrations indicated that wounding cutting treated with 4000 $mg.1^{-1}$ IBA gave the highest significant value of rooting which was (87.78%). The interaction between wounding cutting and hojblanka cultivar was the most

significant effective treatment which gave the maximum root

Table (1) Effect of wounding and Auxin treatment on rooting percentage of three cultivars of olive (*Olea europaea* L).

Wounding	IBA	Varieties			Wounding × IBA	Wounding
		Arbokonia 18	Hojblanka	Arbokonia		
Wounding	0	20.00 h	50.00 d-g	20.00 h	30.00 c	60.93 a
	2000	66.67 b-e	91.67ab	36.67 f-h	65.00 b	
	4000	83.33 a-c	86.67ab	93.33 a	87.78 a	
non wounding	0	46.67 e-g	33.33gh	40.00 f-h	40.00 c	52.59 b
	2000	60.00 c-f	73.33 a-d	60.00 c-f	64.44 b	
	4000	46.67 e-g	53.33 d-g	60.00 c-f	53.33 b	
Varieties		53.89 b	64.72 a	51.67 b	IBA	
wounding ×	wounding	56.67 b	76.11 a	50.00 b		
	Non	51.11 b	53.33 b	53.33 b		

cv.	wounding				
IBA × cv.	0	33.33 de	41.67 de	30.00 e	35.00 b
	2000	63.33bc	82.50 a	48.33 cd	64.72 a
	4000	65.00bc	70.00ab	76.67ab	70.56 a

Means within a column, row and their interactions followed with the same letters are not significantly different from each others according to Duncan multiple ranges test at 5% level**.**

percentage (76.11%). The highest root percentage (82.50%) was obtained from the interaction between 2000 $mg.1^{-1}$ IBA and hojblanka cultivar. On the other hand, the interaction among wounding, 4000 $mg.1^{-1}$ IBA and arbokonia cultivar gave the highest value which was (93.33 %).

Shoot percentage (%):

It can be seen from table (2) that wounding the olive cutting significantly increased the shoot percentage and gave the highest value (54.81%), IBA treatments also had significant effect on shoot percentage and gave the highest value (60%). The same table shows that there was no significant

difference in shoot percentage in different cultivars. As for the interaction between wounding and IBA concentrations, the results showed that wounded cuttings treated with IBA at 2000 $mg.l^{-1}$ gave higher shoot percentage (60%). The interaction between wounding olive cutting and cultivars effect significantly on shoot percentage and the highest value (60%) was recorded as a result of the interaction between wound olive cutting and Arbogonia cultivar, whereas the interaction between 2000 $mg.1^{-1}$ IBA and

Hojblanka cultivar was the most influential interaction treatment which gave the maximum value (63.33%). In respect with interaction of the three studied factors, the interaction treatment of wound cutting, 2000 mg.1^{-1} IBA and Hojblanka cultivar gave the highest shoot percentage which was (73.33).

Table (2) Effect of wounding and Auxin treatment on shoot percentage of three cultivars of olive (*Olea europaea* L).

wounding	IBA	Varieties			Wounding × IBA	wounding
		Arbokoni a 18	Hojblanka	Arbokoni a		
wounding	0	53.33 a-d	33.33 c-e	60.00 a-c	48.89ab	54.81 a
	2000	46.67 a-e	73.33 a	60.00 a-c	60.00 a	
	4000	60.00 a-c	46.67 a-e	60.00 a-c	55.56 a	
non wounding	0	20.00 e	26.67 de	20.00 e	22.22 c	39.48 b
	2000	66.67ab	53.33 a-d	60.00 a-c	60.00 a	
	4000	28.67 de	40.00 b-e	40.00 b-e	36.22bc	

Varieties		45.89 a	45.56 a	50.00 a	IBA
wounding × cv.	wounding	53.33ab	51.11ab	60.00 a	
	Non wounding	38.44 b	40.00 b	40.00 b	
IBA × cv.	0	36.67ed	30.00 e	40.00 c-e	35.56 c
	2000	56.67 a-c	63.33 a	60.00ab	60.00 a
	4000	44.33 a-e	43.33 b-e	50.00 a-d	45.89 b

Means within a column, row and their interactions followed with the same letters are not significantly different from each other's according to Duncan multiple ranges test at 5% level**.**

Shoot dry weight per transplant (g):

From data in table (3) it is observed that shoot dry weight was not affected by wounding, IBA treatments of different cultivars and the interaction between wounding and cultivars. On the other hand, non-wounded cuttings treated with 4000 $mg.1^{-1}$IBA gave the maximum value which was (2.38)g. The highest shoot dry weight (2.80)g was obtained when arbokonia olive cutting treated with 4000 $mg.1^{-1}$ IBA, whereas the interaction treatment of wounding, 4000 mg/l IBA and arbokonia cultivar gave the highest shoot dry weight (3.27)g .

Table (3) Effect of wounding and Auxin treatment on shoot dry weight of three cultivars of olive (*Olea europaea* L).

wounding	IBA	Varieties			Wounding × IBA	Wounding
		Arbokonia 18	Hojblanka	Arbokonia		
wounding	0	2.10 b-d	2.62 a-c	2.06 b-d	2.26ab	2.06 a
	2000	1.76 cd	1.74 cd	1.51 cd	1.67 b	
	4000	2.07 b-d	1.38 d	3.27 a	2.24ab	
non wounding	0	1.45 d	1.69 cd	2.00 b-d	1.72 b	2.09 a
	2000	2.02 b-d	2.12 b-d	2.34 a-d	2.16ab	
	4000	1.89 b-d	2.93ab	2.33 a-d	2.38 a	
Varieties		1.88 a	2.08 a	2.25 a	IBA	
wounding ×	wounding	1.98 a	1.92 a	2.28 a		
	Non	1.79 a	2.25 a	2.23 a		

cv.	wounding				
IBA × cv.	0	1.78 b	2.16ab	2.03 b	1.99 a
	2000	1.89 b	1.93 b	1.93 b	1.92 a
	4000	1.98 b	2.16ab	2.80 a	2.31 a

Means within a column, row and their interactions followed with the same letters are not significantly different from each other's according to Duncan multiple ranges test at 5% level**.**

Root dry weight per transplant (g):

Results in table (4) showed that there was no significant difference in root dry weight in both wounding and non-wounding olive cutting. While root dry weight increased significantly by increasing the concentration of

IBA, the higher root dry weight was (2.80)g when cutting treated with 4000 $mg.l^{-1}$ IBA. Arbokonia cultivar exhibited maximum root dry weight (2.54)g. The combination between non-wounded cutting and 4000 $mg.1^{-1}$ IBA appeared to be the most effective treatment as it gave the highest root dry weight (2.91)g. as for the interaction between non-wounded olive cutting and hojblanka cultivar appeared to be the most potent interaction treatment which gave the highest root dry weight (2.65)g. While the interaction between 4000 $mg.1^{-1}$ IBA and arbokonia cultivar appeared to be the most operative treatment as it gave the highest value (3.26)g. Significantly, the maximum value of this parameter was obtained from the interaction of wounding, 4000 $mg.l^{-1}$ IBA and arbokonia cultivar.

Table (4) Effect of wounding and Auxin treatment on root dry weight (g) of three cultivars of olive (*Olea europaea* L).

Wounding	IBA	Varieties			wounding × IBA	wounding
		Arbokoni a 18	Hojblank a	Arbokonia		
Wounding	0	2.11 c-f	2.28 c-e	1.30fg	1.90 b	2.23 a
	2000	2.11 c-f	1.77ef	2.47 c-e	2.11 b	
	4000	1.61 e-g	2.43 c-e	4.01 a	2.68 a	
non wounding	0	0.83 g	2.34 c-e	1.94 d-f	1.70 b	2.45 a
	2000	3.03bc	2.15 c-f	3.04bc	2.74 a	
	4000	2.77 b-d	3.46ab	2.51 c-e	2.91 a	
Varieties		2.07 b	2.41ab	2.54 a	IBA	
wounding ×	Wounding	1.94 b	2.16ab	2.59 a		
	Non	2.21ab	2.65 a	2.50 a		

Cv	wounding				
IBA × cv.	0	1.47 f	2.31 b-d	1.62ef	1.80 c
	2000	2.57 b-d	1.96 d-f	2.76 a-c	2.43 b
	4000	2.19 c-e	2.95ab	3.26 a	2.80 a

Root length (cm):

It's obvious from table (5) that wounding technique had a significant effect on root length which gave the highest value (19.48cm). IBA at concentration of 2000 $mg.1^{-1}$ gave the highest value of root length (20.67 cm). Arbokonia 18 cultivar significantly surpass in root length and gave the maximum value (24.89). The highest value (21.22cm) was obtained from the interaction

between wounding and IBA at a concentration of 2000$mg.l^{-1}$.

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Also the maximum significant value (31.33cm) was obtained from the interaction between wounded olive cutting and arbokonia 18 cultivars and the value (31.50cm) was significantly obtained from the interaction between the concentration of 2000 $mg.1^{-1}$ IBA and arbokonia 18 cultivars. The combination among wounding, IBA at concentrate 4000 $mg.1^{-1}$ and arbokonia 18 cultivar was resulted the highest value (31.68cm).

Table (5) Effect of wounding and Auxin treatment on root length (cm) of three cultivars of olive (*Olea europaea* L).

Wounding	IBA	Varieties			wounding × IBA	Wounding
		Arbokonia 18	Hojblanka	Arbokonia		
Wounding	0	31.00 a	9.33 f-h	8.33 f-h	16.22 b	19.48 a
	2000	31.33 a	15.00 c-f	17.33 b-e	21.22 a	
	4000	31.67 a	18.67 b-d	12.67 d-g	21.00 a	
non wounding	0	11.00 e-g	8.93 f-h	3.33 h	7.76 c	14.66 b
	2000	31.67 a	20.67bc	8.00gh	20.11 a	
	4000	12.67 d-g	21.67 b	14.00 d-g	16.11 b	
Varieties		24.89 a	15.71 b	10.61 c	IBA	
wounding × C.V	wounding	31.33 a	14.33 cd	12.78 d		
	Non	18.44 b	17.09bc	8.44 e		

	wounding				
IBA × cv.	0	21.00 b	9.13 cd	5.83 d	11.99 b
	2000	31.50 a	17.83 b	12.67 c	20.67 a
	4000	22.17 b	20.17 b	13.33 c	18.56 a

Number of branches*:*

Results in table (6) showed that there was no significant difference in number of branches in wounding effect. IBA at concentrate 2000 $mg.l^{-1}$ significantly surpass in

number of branches and gave the highest value (5.89). The maximum significant value of number of branches was obtained from hojblanka cultivar which was (6.11). the highest number of branches (5.89) was obtained as a result of the interaction between wounding effect and 2000 $mg.l^{-1}$ IBA, and also the maximum number of branches (6.44) as a result of the combination between non-wounding and hogeblanga cultivar. While the interaction between 2000 $mg.l^{-1}$ IBA and hojblanka cultivar was (10.67). in respect with the interaction among the three studied factors, the interaction treatment of non-wounding , IBA at concentrate 2000 $mg.l^{-1}$ and hojblanka cultivar gave the highest number of branches (11).

Means within a column, row and their interactions followed with the same letters are not significantly different from each others according to Duncan multiple ranges test at 5% level**.**

Leaf area (cm^2):

Table (6) Effect of wounding and Auxin treatment on branches number of three cultivars of olive (*Olea europaea* L).

wounding	IBA	Varieties			wounding × IBA	wounding
		Arbokonia 18	Hojblanka	Arbokonia		
wounding	0	3.33 c-e	2.67 de	2.00ef	2.67 d	4.22 a
	2000	3.33 c-e	10.33 a	4.00 b-d	5.89 a	
	4000	3.67 cd	4.33bc	4.33bc	4.11 b	
non wounding	0	3.33 c-e	3.00 c-e	2.00ef	2.78 cd	4.04 a
	2000	3.00 c-e	11.00 a	3.67 cd	5.89 a	
	4000	1.00 f	5.33 b	4.00 b-d	3.44bc	
Varieties		2.94 b	6.11 a	3.33 b	IBA	
Wounding × cvs.	Wounding	3.44 b	5.78 a	3.44 b		
	non wounding	2.44 c	6.44 a	3.22 b		

IBA × cvs.	0	3.33 c-e	2.83 e-g	2.00 g	2.72 c
	2000	3.17 d-f	10.67 a	3.83 cd	5.89 a
	4000	2.33fg	4.83 b	4.17bc	3.78 b

data in table (7) reported that wounding technique had a significant effect on leaf area and gave the maximum value (106.61 cm^2), the same table showed that there was no significant difference in leaf area when treated with different concentrate of IBA hormone. The maximum significant value of leaf area was obtained from hojblanka cultivar

which was (104.17 cm^2). on the other hand, the highest leaf area was obtained as a result of the combination between wound cutting and 0 $mg.l^{-1}$ IBA (control treatment) which was (111.02 cm^2), the interaction between wound cutting and arbokonia 18 significantly affected on leaf area and gave the highest value (113.71 cm^2), and the value of leaf area (113.07 cm^2) was significantly obtained from the interaction between 4000 $mg.l^{-1}$ IBA and hojblanka cultivar. The combination among wounding effect, 0 $mg.1^{-1}$ IBA and arbokonia 18 was resulted the highest leaf area which was (131.53 cm^2).

Means within a column, row and their interactions followed with the same letters are not significantly different from each other's according to Duncan multiple ranges test at 5% level**.**

Total Chlorophyll (%) measured by SPAD:

Table (8) showed that there was no significant difference in chlorophyll content in wounding effect. Control treatment (0 $mg.l^{-1}$ IBA) gave the maximum value of

Table (7) Effect of wounding and Auxin treatment on leaf area (cm^2) of three cultivars of olive (*Olea europaea* L).

Wounding	IBA	Varieties			Wounding × IBA	Wounding
		Arbokonia 18	Hojblanka	Arbokonia		
Wounding	0	131.53 a	103.80 b-e	97.73 c-e	111.02 a	106.61 a
	2000	111.47bc	100.43 b-e	112.67 a-c	108.19 a	
	4000	98.13 c-e	119.73ab	83.96 e	100.61ab	
non wounding	0	61.23 f	93.13 c-e	86.47ed	80.28 c	89.30 b
	2000	92.97 c-e	101.50 b-e	94.10 c-e	96.19 b	
	4000	65.23 f	106.40 b-d	102.67 b-e	91.43 b	
Varieties		93.43 b	104.17 a	96.27 b	IBA	
wounding ×	wounding	113.71 a	107.99ab	98.12bc		
	Non	73.14 d	100.34bc	94.41 c		

cv.	wounding				
IBA × cv.	0	96.38 b	98.47 b	92.10bc	95.65 a
	2000	102.22ab	100.97ab	103.38ab	102.19 a
	4000	81.68 c	113.07 a	93.31bc	96.02 a

chlorophyll content which was (76.83%). The highest significant value of chlorophyll content was obtained from hojblanka cultivar which was (80.56%). The interaction between wound olive

cutting and 4000 mg.l^{-1} IBA gave the highest value (79.54%). While the combination between wounding effect and hojblanka cultivar gave the maximum value which was (83.09%). In respect with the interaction between 2000 mg.l^{-1} IBA and hojblanka cultivar gave the highest value (82.80%). Among the three studied factors, the interaction of non-wounded cutting, 0 mg.l^{-1} IBA and arbokonia cultivar gave the highest value of chlorophyll content (88.77%).

Means within a column, row and their interactions followed with the same letters are not significantly different from each others according to Duncan multiple ranges test at 5% level**.**

Discussion

It's clear from tables (1, 2, 5 and 6) that wounding had positive effect on the studied parameters in terms of the rooting and shoots percentage, root length, leaf area, the positive effect of wounding may be due to that wounding induces cell division and meristematic activity of affected cells (10), and also increases the

tissue competence to rooting hormones in cuttings (3).

Table (8) Effect of wounding and Auxin treatment on chlorophyll content of three cultivars of olive (*Olea europaea* L).

wounding	IBA	Varieties			Wounding × IBA	wounding
		Arbokonia 18	Hojblanka	Arbokonia		
wounding	0	87.80ab	78.13bc	66.67ef	77.53ab	74.78 a
	2000	68.13 d-f	88.30 a	45.37 g	67.27 c	
	4000	80.90 a-c	82.83 a-c	74.90 c-e	79.54 a	
non wounding	0	62.60 f	77.00 cd	88.77 a	76.12ab	72.38 a
	2000	61.73 f	77.30 cd	80.30 a-c	73.11 b	
	4000	60.00 f	80.00 a-c	63.73 f	67.91 c	
Varieties		70.19 b	80.59 a	69.96 b	IBA	
wounding	wounding	78.94ab	83.09 a	62.31 c		

× cv.	Non wounding	61.44 c	78.10ab	77.60 b	
IBA × cv.	0	75.20bc	77.57ab	77.72ab	76.83 a
	2000	64.93 de	82.80 a	62.83 e	70.19 b
	4000	70.45 cd	81.42ab	69.32 cd	73.73ab

For the effect of IBA treatment tables (1, 2, 4 and 5) shows that soaking the cutting of olive cultivars with IBA significantly improved root percentage, root dry weight, root length and number of branches per transplant, the reason of this significant effect may be attributed to that the application of IBA leads to stimulating the division of the early cells of rooting beginners and in higher levels because of hormone balance destruction we encounter a drop in the percentage of rooting, wet weight, dry weight and the number of roots, It is agreed according to some surveys, because the application of synthesized Auxin with high level of concentration on cuttings can stop the growth of buds or even shoots and result in wet weight and dry weight decrease in cuttings, Auxin is well known to stimulate root formation of the cuttings (7). Adventitious root initiation in olive cuttings can be stimulated by Auxin, particularly indol-3-butyric acid (IBA) (5).

The differences among the cultivars undertaken in this study (table 1-8) may be attributed to their anatomy have an exclusive potential for rooting and adventitious rooting formation in stem cuttings which is influenced by diverse endogenous factors (6). In addition, equally diverse

exogenous factors can affect rooting parameters.

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تأثير التجريح وتراكيز مختلفة من IBA على التجذير والنمو الخضري للعقل الساقية لثلاث أصناف من الزيتون *Olea europaea* L.

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المستخلص:

اجريت هذه الدراسة داخل البيت الزجاجي التابع لكلية الزراعة جامعة دهوك خلال الموسم الزراعي 2015 لدراسة استجابة العقل الخشبية لثلاثة اصناف من الزيتون (اربيكونيا، هوجي بلانكا، اربيكونيا 18) القزمية الاسبانية الاصل للتجريح (تجريح وبدون تجريح) والمعاملة بثلاث تراكيز مختلفة من IBA (0، 2000، 4000 ملغ.لتر$^{-1}$). بينت النتائج ان التجريح سبب زيادة معنوية في نسبة التجذير و التفريع وطول الجذور والمساحة الورقية في حين الغمس ب IBA بكلا التركيزين (2000، 4000) معنويا حسنت من الصفات المدروسة ومنها نسبة التجذير و التفريع والوزن الجاف للجذور وطول الجذر وعدد الافرع للشتلة الواحدة بينما العقل غير المعاملة اعطت اعلى محتوى للكلوروفيل الكلي. الاصناف المدروسة اختلفت في استجابتها للعوامل المدروسة حيث كان استجابة الصنف هوجى بلانكا للمعاملات المدروسة اكثر من الصنفين الاخرين تلاها صنف اربيكونيا 18. اما بالنسبة للتداخل بين العوامل الثلاثة ، افضل تداخل نتج من التداخل بين التجريح مع (2000، 4000 IBA) وصنف اربيكونيا Arbokonia.

كلمات مفتاحية: زيتون *Olea europaea* L.، تجريح، IBA، أصناف.