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USE OF ANTI-APICAL DOMINANCE TO ENHANCE LATERAL BRANCHING AND FRUIT SET IN OLIVE TREES BY SAFE TREATMENTS

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ABSTRACT

Olives is one of the Mediterranean's oldest and most significant crops. There has been an expansion of olive culture in Egypt especially in the newly cultivated investigated area under a condition. There is a great need to enhance the formation of lateral branches increase fruiting of olive areas under desert agriculture. A field experiment was conducted during the two consecutive seasons 2020 and 2021 using "Manzanillo" olive trees. Where the fruiting area is mainly concentrated, especially the outer circumference of the olive trees (about 50-70 cm), foliar sprays of anti-apical dominance compounds namely phenthalamic acid, cis-cinnamic acid, or triiodobenzoic acid (TIBA) treatments were applied twice at the stage of bud swelling (in first week of March) and one week later at a concentration of 25 ppm, or 50 ppm, for each to study the effect of these compounds on enhancing the number of lateral branches in "Manzanillo" olives. These compounds were classified as (non-auxin compounds).

The obtained results showed that a foliar application of all the anti-apical dominance examined resulted in a considerable increase in the number of branches as compared to the control. The highest values new shoots, fruit yield per tree, the number of fruits per mature branches and the percentage of pollen viability recorded with cis-cinnamic acid at 50 ppm. That caused the greatest increase in initiation of vegetative and floral buds. Tree yield responded better to all of the anti-apical dominance applications. No significant variations in fruit attribute indicators between treatments and the control. According to the findings of this study, it appears that a foliar spray of

anti-apical dominance compounds for boosting the number of lateral branches in "Manzanillo" olive trees can be applied on a field scale.

KEYWORDS: Olive**,** Manzanillo, chlorophyll content, anti-apical dominance**,** triiodobenzoic acid, TIBA**,** Phthalamic acid**,** cis-cinnamic acid, foliar sprays

INTRODUCTION

Olive (*Olea europaea* L.) is one of the most important fruit trees grown in an arid region and the Mediterranean basin countries. The tree tolerance to many environmental tolerances to many abiotic stresses especially water and salt stresses attracted many growers and producers to adopt the activation of olive crop and oil picking and became part of the tradition of people in these countries. The world olive production was approximately 20,344,343 tons produced 10,242,194 hectares **(FAO, 2020)**.

In Egypt, the total average planted with olive reached 247, 742 acres with a total yield of 882,092 tons **(FAO, 2020)**. The major olive producing districts in Egypt are Fayoum, Ismailia, Matrouh, and South Sinai – Noubaria in addition to the newly reclaimed areas. The cultivation of “Manzanillo” is the widest spread fable olive cultivar in the world. This cultivar is highly fruitful particularly under intensive cultivation and produce uniform – medium fruit size that makes it most attractive to growers and the processing industry **(Fabbri and Benelli, 2000)**. However, one of major drawbacks is the high harvest cost due to the cost of manual labor. “Manzanillo” fruits have a delicate skin which tends to bruise easily and develop a severe and rapid oxidative browning. Another major problem that affects the yield of “Manzanillo” olive tree is the limited canopy size, the density and limited lateral branching **(Lavee *et al*., 2012)**. The trees of Manzanillo cultivar are medium usually grown as an open vase on a low trunk **(Lavee, 2006)**. Meanwhile, pruning could have the potential to change the shape and size along with intensive irrigation program.

The other major production problem is the natural fruit bearing area of olive fruits that form a shell like shape around the canopy or the tree periphery. There need to produce more new branches in this periphery to increase the potential for more fruiting in the next season since the bearing habit of olive fruits is on the wood produced in the previous season.

Thus, it was very important to enhance the formation of more new lateral branches especially at the 50 to 70 cm of the tree periphery. Few fruits are borne inside this shell that is closer to the trunk **(Seifi *et al*., 2008)**. It was reported that for maximum crops, pruning should be designed to promote a continues supply of fruit wood. It is desired to enhance branching without severe cutting out the top to avoid shading since you might eliminate fruiting **(Hartmann *et al*., 1980)**. Thus, it is very crucial to stimulate the formation of the more lateral branch by using safe treatments. Such activation could occur by spraying some anti-apical dominance compounds that inhibit the polar transport of auxins from the terminal buds into the lateral ones. These treatments can liberate the lateral buds from their forced dominance which consequently increases the number of new shoots that have the potential to bear flowers and fruits in the next season. Moreover, it was reported that some anti-apical dominance were able to affect the effective pollination period of the newly formed flowers **(Connor and Fereres, 2005)**, or inhibit the abscission of newly formed fruitlets **(Yuan *et al*., 2002)** or stimulate branching of the fruit trees while increasing the number of lateral branches **(Elfving and Visser, 2005)** that can bear more fruits.

The objectives of this study could be summarized in the following points:

1- To stimulate the formation of new lateral branching by spraying some anti – apical dominance safe compounds.
2- By increasing fruit set of “Manzanillo” olive trees, by enhancing the effective pollination period.
3- By reducing the abscission of newly formed olive fruitlets.
4- By providing a production system that could be adopted by olive producers on a large field scale which enhances the potential to increase olive fruit production even under arid conditions.

MATERIALS AND METHODS

The present study was carried out during the 2020 and 2021 growing seasons to study the effect of foliar spray of non-auxin compounds (Phthalamic acid, cis-cinnamic acid, or Triiodobenzoic acid) on enhancing the number of lateral branches, vegetative growth characteristics (number of buds (closed)/total number of branches, number of vegetative buds, number of floral buds, and number of fruits/branch), and leaf chlorophyll content, as well as yield of fruits, and fruit characteristics (weight, size, stone weight, TSS, acidity, chlorophylls) of "Manzanillo" olive trees.

This study was conducted at Wadi El-Natron, West of Nile Delta (El-Beheira Governorate), Egypt (longitude 30°29'16''N & latitude 29°53'43''E). The experiments were conducted on five years old trees of the Manzanillo cultivar grown in loamy sand soil and irrigated with well water (salinity level about 3500 ppm) and received similar cultural practices adopted in the orchard. The analysis of the experimental soil and irrigation water are shown in Tables 1 and 2. Trees were spaced at 6 × 6 m between trees and rows respectively. These trees received the same horticultural management. Healthy, uniform, and regular-bearing olive trees were used in this study.

The selected trees received the following treatments: Control (sprayed with water only), Phthalamic acid at 25ppm, 50 ppm, Cinnamic acid at 25 ppm, 50 ppm, and Triiodobenzoic acid at 25 ppm and 50 ppm. The foliar spray treatments were applied twice at the stage of bud swelling and at one-week intervals (at the beginning of March). The foliar application was carried out using a pressure tank sprayer of about 20 liters' size to the runoff point. The surfactant Tween 20 was added to all treatments at a concentration of 0.1%. Ten branches around every treated tree were selected and labeled for measuring the following parameters at full bloom (first week of April):Total number of buds (closed), No. of vegetative buds, and No. of floral buds.

According to the report produced by **Shivanna and Rangaswamy (1992)**, 9ml distilled water was added to 50mg 2,3,5-triphenyltetrazolium chloride (TTC). 5 g of sucrose were dissolved in 10 ml distilled water. Then, 1 ml of sucrose solution was added to the TTC solution to produce TTC- sucrose solution. One drop of TTC- the sucrose solution was placed on a counting slide (Hemocytometer) and a small amount of pollen was placed in that drop and covered with a cover slip. The covered counting slide was wrapped with aluminum foil and then incubated in the chamber room at 30 ºC for 60 minutes. After the incubation period, the aluminum foil was removed; the percentage of viable pollen was scored under the light microscope at (10X). For each replicate, three counting areas were taken.

Fruit set on the selected shoots was counted and recorded 15 days after the full bloom date. Yield was collected and weighed (kg) from every treated tree.

At harvest (15 September during the two seasons), 20 fruits / tree were randomly selected to determine the following measurements: Fruit dimensions (length and diameter (cm)), fruit and flesh weight (g), Seed weight (g), flesh/stone ratio, TSS %, total acidity (mg malic acid/100m juice), vitamin C (mg L^- ascorbic/100m juice), chlorophylls a, b (skin) (mg/100ml), and carotene (skin) (mg/100ml).

In the fruit juice, the percentage of TSS was measured using a hand refractometer, and acidity as malic acid was determined by titration with 0.1 NaOH according to **AOAC (1970)**. Chlorophylls a, b and Beta-Carotene pigment in the peel of olives were determined as follows: a half gram of fresh peel was extracted by about 15 ml of 85% acetone and 0.5 g calcium carbonate, then the mixture was filtered through a glass funnel and the residue was washed with a small volume of acetone and completed to 25 ml. The optical density of a constant volume of the filtrate was measured at a wavelength of 662 nm, for chlorophyll A, 645 nm, for chlorophyll B and 470 nm, for carotene using a spectrophotometer **(Lichtenthaler and Wellburn, 1983)**.

The experiments were laid out in a completely randomized design. Four replications were used in each treatment with one plant per replicate. The data was analyzed using CoStat Version (6.400) CoHort Software **(CoStat 2005)**. The mean of all treatments was compared by the least significant.

RESULTS AND DISCUSSION

The influence of various filed applications of anti-apical dominance on the total number of buds per branch and their type was reported in Table 1. The data indicated that the greatest number of buds was obtained with the application of cis-cinnamic acid in both seasons whether at 25 ppm or 50 ppm as compared with the control or with other treatments. Meanwhile, the total number of buds per branch did not significantly vary between the use of cis-cinnamic acid at 25 or 50 ppm. Furthermore, there was another increase in the total number of buds caused by TIBA relative to the control in both seasons. However, the difference between the two seasons when TIBA was applied at 25 ppm, the number of total buds in the second season was higher than that obtained in the first season. In addition, Phthalamic acid treatment resulted in a significant increase in total buds/branch except with Phthalamic acid at 50 ppm in the first season. Concerning the number of initiated vegetative buds, with the control and the treatment, the data revealed that cis-cinnamic acid resulted in the greatest number in a consistent in bath season as compared with the control or other treatments. Furthermore, TIBA treatment was able to increase the number of initiated vegetative buds relative to the control. Thus, the two concentrations of TIBA were equally effective in their influence on the number of initiated vegetative buds relative to the control.

However, the difference between the two concentrations of Phthalamic acid on their influence on the number of initiated vegetative buds were not significant and the only obtained difference was found between Phthalamic acid at 50 ppm and the control in the second season.

The data also showed the influence of various used treatments on the number of initiated floral buds (Table 1). It was evident from the obtained results that cis-cinnamic acid had the superior effect on increasing the number of initiated floral buds as compared with the control or with other the two treatments in a significant manner in the two seasons. In addition, the two applied concentrations of TIBA resulted in a significant increase in such number especially in the first season. Moreover, application of TIBA was also effective on inducing more initiated floral buds than that obtained with the control on the contrary, the application of Phthalamic acid at 50 ppm resulted in lower number of initiated floral buds than that found with Phthalamic acid at 25 ppm. Thus, the relay truly high concentration of Phthalamic acid (50 ppm) could have an adverse influence the number of initiated floral buds which directs us to emphasize the importance of selecting the convenient concentration of the compound Phthalamic acid.

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Table 1: Effect of various applications under field conditions of anti-apical dominance compounds on the total number of buds, number of vegetative buds, and number of floral buds in "Manzanillo" olive trees during the two seasons 2020 and 2021

Treatments		Total buds/branch*		Initial growth of Vegetative buds/branch **		Initial growth of Floral buds/branch **	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control		9.92 d***	11.15 e	5.30 d	6.47 e	9.20 d	8.77 e
Phthalamic acid (NPA)	25 ppm	11.93 bc	12.58 d	5.92 bc	6.90 de	10.15 bc	9.47 de
	50 ppm	10.85 cd	13.25 d	5.57 cd	7.20 cd	9.67 d	9.87 d
Cis-cinnamic acid	25 ppm	15.43 a	15.98 ab	7.20 a	8.05 a	12.00 a	11.28 ab
	50 ppm	16.38 a	16.95 a	7.47 a	8.32 a	12.38 a	11.65 a
Triiodobenzoic acid (TIBA)	25 ppm	12.7 b	13.98 cd	6.17 b	7.32 cd	10.58 b	10.20 cd
	50 ppm	12.88 b	15.05 bc	6.30 b	7.70 bc	10.65 b	10.75 bc

* Assessed in Feb. in both seasons.
** Initial growth of vegetative buds was assessed in March while initial growth of floral buds was on April in both seasons.
*** Data within each column with similar letters were not significantly different based on the use of least-significant difference (LSD) 0.05 level.

Olives physical characteristics

The response of "Manzanillo" olive fruit to the applications of the anti-apical dominance compound on some physical characteristics at harvest during the two season 2020 and 2021 was reported in Table 2. The data indicated that fruit length was similar with significant differences between the control and all the concentrations of the used anti-apical dominance compounds in both seasons except with Phthalamic acid treatment at 50 ppm in the second season which resulted in a greater fruit length than that of the control.

Moreover, fruit diameter changes of "Manzanillo" olives revealed that all treatments and the control had similar fruit diameters in both seasons with any significant difference among all used concentrations. Furthermore, fruit size at harvest showed slight changes from reported physical characteristics since in the first season, all the treatments had similar fruit size to each other's but they all was able to increase fruit size more than the control in a significant manner. However, in the second season, cis-cinnamic acid at 25 ppm resulted in greater fruit size than that of the control, Meanwhile, all treatments in all used concentrations did not vary in their fruit size in the second season.

The effect of various field applications of the anti-apical dominance compound on fruit weight at harvest of "Manzanillo" olive indicated that all treatments at all used concentrations had similar fruits weight that was significantly higher than that obtained by the control, invariably in the two seasons. A typical trend of the result was also obtained by using treatments on flesh weight since they were equally effective but had greater influence on flesh weight that was significantly greater than that flesh weight of the control (Table 3).

The data in Table 3 showed the influence of various used treatments and their concentrations on stone weight. It was evident that all treatments regardless the concentrations had similar fresh weight to that found in the control fruits in both seasons that trend was repeated when flesh/stone ratios were compound, as the least significant difference between all treatments and the control had equal ratios.

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Table 2: Effect of various applications under field conditions of anti-apical dominance compounds on fruit length, fruit diameter, and fruit size in "Manzanillo" olive trees during the two seasons of 2020 and 2021

Treatments		Fruit length (cm)		Fruit diameter (cm)		Fruit size (cm^3)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control		1.96 a*	2.03 b	1.27 a	1.19 a	3.28 b	4.13 b
Phthalamic acid (NPA)	25 ppm	2.39 a	2.26 ab	1.60 a	1.35 a	4.60 a	4.86 ab
	50 ppm	2.33 a	2.66 a	1.31 a	1.49 a	4.83 a	4.95 ab
Cis-cinnamic acid	25 ppm	2.38 a	2.33 ab	1.40 a	1.41 a	4.80 a	5.18 a
	50 ppm	2.57 a	2.46 ab	1.54 a	1.55 a	4.58 a	4.99 ab
Triiodobenzoic acid (TIBA)	25 ppm	2.18 a	2.28 ab	1.57 a	1.43 a	4.68 a	4.93 ab
	50 ppm	2.49 a	2.51 ab	1.48 a	1.31 a	4.58 a	4.83 ab

*Data within each column with similar letters were not significantly different based on the use of least-significant difference (LSD) 0.05 level.

Olives chemical characteristics

- **Skin chlorophylls A and B**

Changes in chlorophylls a, and b contents of "Manzanillo" olives in response to various applied treatments (Table 4) indicated that skin chlorophyll a did not vary among all treatments and concentrations in both seasons. That was the case with chlorophyll b in the olive fruit (Table 4) since all values had similar LSD values and did not vary from that obtained for the control in the two seasons.

- **Total soluble solids percentage (TSS %)**

The response of TSS in "Manzanillo" dives to various applied treatments at harvest indicated that (Table 5) there were significant increases in TSS by all used treatments and concentrations as compared with the control in both seasons. Moreover, there was no significant difference in the TSS values between the low and high concentrations of each treatment. Thus, all concentrations at 25 ppm or 50 ppm were similar in their influence on the obtained TSS at harvest.

- **Fruit total acidity percentage**

The effect of pre-harvest treatments on the acidity of "Manzanillo" olives at harvest was shown in Table 5. The data indicated that there was a general trend of acidity reduction by all used treatments and their concentrations in both seasons relative to the control. This trend was consistent thus, the higher concentration of each treatment had a similar influence on fruit acidity to that found with the lower concentration (Table 5).

The data in Table 3 showed the influence of various used treatments and their concentrations on stone weight. It was evident that all treatments regardless the concentrations had similar fresh weight to that found in the control fruits in both seasons that trend was repeated again when flesh/stone ratios were compound, as the least significant difference between all treatments and the control had equal ratios.

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Table 3: Effect of various applications under field conditions of anti-apical dominance compounds on fruit weight, flesh weight,stone weight, and flesh/stone ratio in "Manzanillo" olive trees during the two seasons 2020 and 2021

Treatments		Fruit weight (g)		Flesh weight (g)		Stone weight (g)		Flesh/Stone Ratio	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control		4.09 b*	4.83 b	3.35 b	3.83 b	0.75 a	1.00 a	4.90 a	3.95 a
Phthalamic acid (NPA)	25 ppm	5.23 a	6.43 a	4.33 a	5.45 a	0.90 a	0.98 a	4.99 a	6.18 a
	50 ppm	5.58 a	6.00 a	4.75 a	5.10 a	0.83 a	0.90 a	6.01 a	5.88 a
Cis-cinnamic acid	25 ppm	6.38 a	6.15 a	5.40 a	5.08 a	0.98 a	1.08 a	5.88 a	4.75 a
	50 ppm	5.88 a	6.20 a	5.00 a	5.28 a	0.88 a	0.93 a	5.96 a	6.27 a
Triiodobenzoic acid (TIBA)	25 ppm	5.98 a	6.40 a	4.93 a	5.38 a	1.05 a	1.03 a	4.90 a	5.46 a
	50 ppm	6.20 a	5.58 a	5.28 a	4.75 a	0.93 a	0.83 a	5.80 a	6.16 a

*Data within each column with similar letters were not significantly different based on the use of least-significant difference (LSD) 0.05 level.

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Table 4: Effect of various applications under field conditions of anti-apical dominance compounds on skin chlorophyll (a), skin chlorophyll (b), and skin total chlorophyll in "Manzanillo" olive trees during the two seasons of 2020 and 2021

Treatments		Chlorophyll (a) (mg/100ml)		Chlorophyll (b)(mg/100ml)		Total chlorophyll (mg/100ml)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control		2.78 a*	3.09 a	1.41 a	1.37 a	4.19 b	4.46 a
Phthalamic acid (NPA)	25 ppm	3.21 a	3.35 a	1.67 a	1.62 a	4.87 ab	4.97 a
	50 ppm	3.16 a	3.44 a	1.61 a	1.65 a	4.77 ab	5.09 a
Cis-cinnamic acid	25 ppm	3.34 a	3.37 a	1.53 a	1.65 a	4.87 ab	5.02 a
	50 ppm	3.40 a	3.19 a	1.65 a	1.68 a	5.05 a	4.86 a
Triiodobenzoic acid (TIBA)	25 ppm	3.42 a	3.35 a	1.52 a	1.62 a	4.94 ab	4.96 a
	50 ppm	3.18 a	3.39 a	1.78 a	1.53 a	4.96 ab	4.92 a

*Data within each column with similar letters were not significantly different based on the use of least-significant difference (LSD) 0.05 level.

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Table 5: Effect of various applications under field conditions of anti-apical dominance compounds on TSS %, total acidity %, vitamin C content, and carotene in "Manzanillo" olive trees during the two seasons 2020 and 2021

Treatments		TSS (%)		Total acidity (mg/100ml)		Vitamin C (mgl- ascorbic/100 ml juice)		Skin carotene (mg/100ml)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control		11.15 b	10.93 b	0.25 b	0.30 c	3.93 a	3.99 b	4.57 a	4.39 a
Phthalamic acid (NPA)	25 ppm	12.35 a	12.06 a	0.42 a	0.50 a	4.98 a	4.53 ab	4.90 a	4.80 a
	50 ppm	12.48 a	12.16 a	0.43 a	0.40 ab	4.83 a	4.88 a	4.75 a	4.86 a
Cis-cinnamic acid	25 ppm	12.14 a	11.78 a	0.46 a	0.46 ab	5.00 a	4.00 b	4.60 a	4.82 a
	50 ppm	12.15 a	12.62 a	0.46 a	0.38 bc	4.27 a	4.97 a	4.70 a	4.79 a
Triiodobenzoic acid (TIBA)	25 ppm	12.39 a	12.63 a	0.36 a	0.49 a	4.80 a	4.56 ab	4.66 a	4.72 a
	50 ppm	12.23 a	11.73 a	0.43 a	0.51 a	5.08 a	4.83 a	4.73 a	4.50 a

***Data within each column with similar letters were not significantly different based on the use of least-significant difference (LSD) 0.05 level.**

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Table 6: Effect of various applications under field conditions of anti-apical dominance compounds on No. of fruits/branch, yield of fruits , pollen viability percentage, and No. of new shoots in "Manzanillo" olive trees during the two seasons of 2020 and 2021

Treatments		No. of fruits/branch		Yield of fruits (kg/tree)		Pollen viability (%)		No. of new shoots	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control		67.5 c*	73.75 e	19.38 c	19.63 c	62.50 c	60.77 c	21.75 c	20.75 e
Phthalamic acid (NPA)	25 ppm	106.0 ab	120.30 bc	25.38 b	30.38 b	74.00 b	77.23 b	34.75 b	36.50 d
	50 ppm	82.0bc	92.00 de	28.25 ab	28.00 b	76.62 b	78.11 b	40.75 ab	44.50 bc
Cis-cinnamic acid	25 ppm	123.3 a	136.50 b	28.00 ab	28.75 b	78.30 b	79.87 b	43.00 ab	47.25 b
	50 ppm	126.0 a	165.00 a	31.38 a	35.50 a	87.92 a	96.50 a	50.25 a	58.75 a
Triiodobenzoic acid (TIBA)	25 ppm	105.3 ab	106.30 cd	28.13 ab	27.38 b	76.26 b	78.07 b	37.00 b	40.75 c
	50 ppm	110.5 ab	115.80 bc	28.88 ab	28.38 b	77.42 b	78.05 b	41.75 ab	44.75 bc

***Data within each column with similar letters were not significantly different based on the use of least-significant difference (LSD) 0.05 level.**

- **Vitamin C content**

Changes in vitamin C in response to pre-harvest treatments of "Manzanillo" olives were reported in Table 5. The data revealed that there was no significant difference between the control and all applied treatments in the first season. Meanwhile in the second season, the treated olives with each of the anti-auxin compounds at the low concentration resulted in similar vitamin C to that obtained in the control fruits while at 50 ppm for each treatment they were equally effective and resulted in greater vitamin C content than that of the control.

- **Skin carotene content**

The effect of the applications of various anti-auxin treatments on carotene content in "Manzanillo" olive fruit skin was shown in Table 5. The data indicated that all treatments at harvest had similar carotene content in both seasons and they did not vary in their carotene from that found in the control.

- **Number of fruits / branches**

The influence of various applied treatments on the number of fruits per branch of "Manzanillo" olive at harvest time was shown in Table 6. The data of the first season indicated that cis-cinnamic acid treatment at 25 ppm or 50 ppm resulted in the greatest number of fruits/branch and both concentrations were equally effective in that regard. Moreover, both used concentrations of TIBA had similar number of fruits/branch to that obtained with the cis-cinnamic acid treatment. On the other hand, Phthalamic acid was also capable of increasing the number of fruits per branch at each used concentration when compared with the control.

However, the magnitude of that increase was less than that obtained with cis-cinnamic acid. Furthermore, one in the second season cis-cinnamic acid was the most effective treatment especially at 50 ppm on increasing the number of fruits / branches. However, cis-cinnamic acid at 25 ppm resulted in greater number of fruits / branch to the control but with similar efficiency to that obtained by Phthalamic acid (at 25 ppm) and to TIBA at 50 ppm. In general, all treatments were able to enhance the number of fruits per branch in a significant way than that of the control.

- **Yield of fruit / tree (kg/tree)**

The effect of various applied treatments on “Manzanillo” olive yield of fruit per tree was reported in Table 6. The results indicated that the highest yield was found with the application of cis-cinnamic acid at 50 ppm in both seasons. Moreover, the application of cis-cinnamic acid at 25 ppm was also effective in increasing the yield more than the control, in bath seasons but with lower magnitude than cis-cinnamic acid at 50 ppm. Meanwhile, Phthalamic acid with the top used concentrations was able to increase fruit yield per tree but to lesser extent than cis-cinnamic acid. A similar trend of results was obtained with the application of TIBA since its two concentrations were able to cause a significant increase in fruit yield per tree. Thus, it was evident that the applications of anti-auxin were beneficial in increasing the growers return in different magnitudes, but all were efficient on improving the yield of dives significantly in a pattern much higher than the control.

- **Pollen viability percentage**

The effect of various treatments under field conditions on the viability of olive pollen grains of “Manzanillo” pollen grains was reported in Table 6. The data indicated that the use of anti-apical dominance did not cause an adverse influence on pollen viability. Moreover, the highest pollen viability was more than 90% especially with cis-cinnamic acid at 50 ppm.

Moreover, pollen viability of other treatments and concentrations was superior relative to that of the control. Thus, using anti-apical dominance caused a significant increase in pollen viability which was reflected in the number of fruits per branch and the yield of each branch. The pollen viability of phthalamic acid concentration ranged from 74 to 78%, while cis-cinnamic acid ranged between 78 – 96%, and TIBA ranged between 76% to 78%. The pollen viability of the control ranged between 60 to 62%. These ranges were for the average of obtained data range in the two seasons increasing the viability of pollen grains and stigma receptivity was reported by Martin *et al*. (2005)due to the application of some anti-apical dominance.

- **Number of the new shoots**

The response of “Manzanillo” sprayed branches to the applications of various anti-apical dominance in terms of producing more shoots that could pear more fruits in the next season is shown in Table 6. The data revealed one important aspect of this study. It was reported that the application of cinnamic acid at 50 ppm resulted in the greatest number of new shoots as compared with other treatments. Meanwhile, all treated branched with one of the anti-apical dominance compounds were able to induce the formation of the new shoot in a significant way as compared with the control in both seasons. There was a trend of an increased number of new shoots as the concentration of the anti-apical dominance compounds was higher. The difference between the two concentrations of each treatment was not significant as was the case with Phthalamic acid at 25 ppm and 50 ppm in the first season or with cinnamic acid between the two used concentrations in the first season as well. However, TIBA treatments at 25 ppm or 50 ppm resulted in similar magnitudes of increase in both seasons.

The number of new of appeared buds due to the application of anti-apical dominance was almost doubled by many concentrations relative to the control as were the cases with Phthalamic acid at 50 ppm, cinnamic acid at all used concentrations and TIBA at 50 ppm. The formation of new shoots is very important for new seasons flowering and fruit set which would be reflected in raising the yield of "Manzanillo" trees.

Few fruits are borne inside this shell that is closer to the trunk. Pruning was proposed to promote a continuing supply of new fruiting wood and keep this bearing region vigorous and maximize functional leaf area. On a large scale, by growing thousands of olive trees it is difficult to maintain this vigorous region by just pruning. Thus the use of non – auxin antiradical dominance was a relatively new approach to increasing the fruiting wood by enhancing the formation of new shorts in one season, which can carry flowers and fruits in the next season. Furthermore, the application of anti-optical dominance such as TIBA, phthalamic acid and cis – cinnamic acid proved to be effective in stimulating flowering and fruit set of natural wood on the previous season shoots and to enhancing the number of initiated vegetative and floral new growth and even prolonging the effective pollination period as reported on olive tree flowering by the applications of phthalamic acid **(Racskó, 2006)**.

The application of anti-apical dominance was also effective in enhancing the number of initiated vegetative or floral buds per recurring branch especially by cis – cinnamic acid at 50 ppm (Table 3) was supported by the findings of other researchers **(Abaza *et al*., 2017)**. However, the fruit's physical characteristics were not affected in general as shown in Tables 4 and 5. The role of the same applied compounds such as cis – cinnamic acid as one of the phenolic compounds that can work as an antioxidant enabled it to maintain the vigor and delay the senescence of olive branches. Cinnamic acid originated from the amino acid tryptophan by the activity of the enzyme phenylalanine ammonia-lyase as a natural compound.

This compound could be very helpful to olive trees grown under arid conditions to increase the olive tree tolerance to many abiotic stresses **(Blanch *et al*., 2018)**. Although the applied anti- apical compounds stimulated the formation of much more lateral branches and new shoots that increase the sink strength and compete with the fruits on biosynthesis carbohydrates formed by mature leaves, however, fruit physical properties of the mature wood belonging to the current season were not adversely affected since the olive characteristics are similar to that obtained with the control such as fruit weight, flesh weight, stone weight and fruit to stone weight. Thus, the use of anti – apical dominance could increase the formation of new lateral shoots this season while keeping adequate vigor for the fruiting of the next season, for further evidence, The TSS percentage of the olive fruits was similar when comparing the control value with those of the treatments.

CONCLUSIONS

According to the findings of this study, it appears that a foliar spray of anti-apical dominance compounds for boosting the number of lateral branches in "Manzanillo" olive trees can be applied on a field scale. The foliar application of the tested compounds, anti-apical dominance, resulted in a considerable increase in the number of branches as compared to the control. The highest values new shoots, fruit yield per tree, the number of fruits per mature branches and the percentage of pollen viability recorded with cis-cinnamic acid at 50 ppm. Tree yield responded better to all treatments of the anti-apical dominance applications.

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الملخص العربي

إستخدام مضادات السيادة القمية لزيادة تكوين الأفرع الجانبية وعقد الثمار فى أشجار الزيتون بمعاملات آمنة

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أجريت هذه الدراسة خلال موسمي نمو 2020 و 2021 على أشجار الزيتون صنف منزانيللو لدراسة تأثير إستخدام مضادات السيادة القمية على زيادة تكوين الأفرع الجانبية وعقد الثمار. ولقد أستخدمت هذه الدراسة ستة معاملات باستخدام مضادات الأوكسينات وهى حمض الفثالميك (NPA) بمعدلات 50 مليجرام/لتر، 25 مليجرام/لتر وحمض السيناميك بمعدل 50 مليجرام/لتر، 25 مليجرام/لتر ومركب التراي أيودوبنزويك أسيد (TIBA) بمعدل 50 مليجرام/ لتر ، 25 مليجرام لتر وبالاضافة الي الكنترول وتم الرش مرتين بين الرشة الأولى والثانية أسبوع وكانت الرشة الأولى بالأسبوع الأول من شهر مارس والثانية بالأسبوع التالى وتم أخذ كلاً من القراءات الخضرية والقياسات الكميائية المقررة بالبحث. ويمكن تلخيص النتائج فيما يلى: أن الرش الورقي بمضادات السيادة القمية قد اظهرت زيادة في عدد الافرع مقارنة بالكنترول. وبالنسبة الي أعلي قيم للافرع الجديدة ، محصول / شجرة ، عدد الثمار / فرع مكتمل النمو ، ونسبة حيوية حبوب اللقاح فقد سجلت في معاملة حامض السينامك بتركيز 50 ملجم/لتر. والتي أدت الي زيادة في تكشف البراعم الزهرية والخضرية. وقد أدت المعاملات بمضادات السيادة القمية الي زيادة محصول الشجرة. ومن النتائج المتحصل عليها يمكن التوصية باستخدام مركب السيناميك بتركيز 50 ملجم/لتر للزيتون صنف منزاينللو لزيادة المحيط الثمرى وعقد الثمار وعدد الأفرع الجانبية تحت ظروف هذه الدراسة.