Response of Olive Trees (*Olea europaea* L.) cv. Zaity to Bio health and Foliar Spray of Tecamin max and Boron

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Abstract

During the growing season of 2022, the experiment was conducted in one of the private orchards located in Hassan ava village, Zakho district, Dohuk governorate, Kurdistan region, Iraq, to study the response of olive tree (*Olea europaea* L.) cv. Zaity to biofertilizer (bio health) and foliar spray of the amino acid (tecamin max) and Boron. Olive trees were planted 6 x 6 m apart on clay sandy loam soil and fed with well water using a drip irrigation system. Olive trees were treated with three levels of biofertilizer (bio health) at (0, 1,0 and 15 $g.L^{-1}$), added to the soil, and three levels of the foliar spray with amino acid (tecamin max) at (0, 10, 15 $ml.L^{-1}$), and three levels (0, 200 and 300 mg. L^{-1}) of boron foliar spray. A factorial experiment with three replications was carried out in a randomized complete block design (RCBD), using one tree for each experimental unit. The study reached the following results: application of biofertilizer (bio health) in the soil, especially at 15 $g.L^{-1}$, and foliar spraying of the amino acid (tecamin max) at 15 $ml.L^{-1}$ led to a significant increase in all studied characters (leaves mineral content N, P, K, and B%) and physical characters of fruit (fruit weight, fruit length, fruit width and total yield per tree) except pulp: stone ratio, while the control treatment gave the lowest average for the aforementioned traits. Foliar spray of boron especially the level of 300 mg. L^{-1}, led to a significant increase in all the studied characteristics (leaves mineral content N, K, and B%) and physical characters of fruit (fruit weight, fruit length, fruit width, and total yield per tree) except pulp: stone ratio and phosphorus content in leaves, while the comparison treatment gave the lowest average for the aforementioned traits. There was also a significant increase in the binary and triple interactions of the study treatments on all the studied traits, especially the high levels of the study factors (15 $g.L^{-1}$ bio-health, 15 $ml.L^{-1}$ tecamin max, and 300 mg. L^{-1} boron).

Keywords: Biofertilizer, Amino acid, Boron, Olive tree cv. Zaity

Introduction

The olive tree (*Olea europaea* L.), family Oleaceae, is an evergreen tree and one of the oldest fruit trees believed to be indigenous to the entire Mediterranean basin. Its cultivation was considerably developed in Syria and Palestine and spread to the island of Crete towards Egypt (13). Olive is widely cultivated all over Kurdistan region, especially in the mountainous regions, occasionally in the steppes and foothill region, frequently in FNI, Bashiqa and Bahzani. The plant is also found most probably growing wild in MAM: Dihey village, about 65 km North Duhok, altitude 985m; Bekhair mountain, West Duhok altitude about 130m, North West facing, near Syria frontier (31). In 2020, estimated number of olive fruitful trees growing in Iraq, including nearly 1329191 tree produces up to 33912 tons, and average production per tree 25.51 kg (8). While acreage of olive in the world reached about 10578246 hectares, with production of 19464495 tons (5). Main producing countries are Spain the Italy, Morocco, Turkey and Greece (5). Biofertilizer is defined as a product which contains living microorganisms that, when applied to soil of surfaces of plants colonize the rhizosphere or the plant internal tissues and induce plant growth. Biofertilizers are typically bacteria or fungi capable of nitrogen fixation, phosphate solubilization, sulfur oxidization, plant hormone production, or decomposition of organic compounds (37). Bio-fertilizer acts as a soil conditioner adding organic matter to the soil which helps to bind the soil particles together preventing soil eructing, desertification, and erosion while increasing the water retention capacity of the soil (35). Due to their low-cost, environmental friendliness, and beneficial effects on plant growth, bio-fertilizers are increasingly being used, according to recent studies. The production of bio-fertilizers increased widely, including the bio health product, which contains *Trichoderma harzianum* and *Bacillus sublutus*. *Trichoderma* is belonged to Deuteromycota fungi. It is located in the rhizosphere and contributes significantly to plant growth through its secretion of many organic and biochemical compounds that enter into plant metabolism and contribute to the regulation and increase of plant growth (12). It also effects the formation of a dense root system, thus increasing the surface area for absorption of water and nutrients (10), as well as reducing the absorption of heavy elements and salty by the roots, dismantling organic compounds in the soil and gaining the plant high resistance against pathogens and increasing the readiness of nutrients (22). Many researchers have indicated that *Trichoderma* fungus secretes a number of enzymes that degrade plant residues in the soil, the most important of which is cellulose enzyme. It also secretes the enzymes chitenas and B-103-Glucalas, which contribute to the elimination of pathogenic fungi pythium, as well as the ability of the fungus to secret substances similar to auxin and gibberellin and its ability to increase the availability of iron and also works on dissolving phosphorous and increasing its readiness (3). The researchers showed that bacillus bacteria have a high ability to dissolve phosphorus because they secrete organic acids that cause the pH of the soil to be lowered, increasing the availability of

some micronutrients and phosphorous (32). Porras *et al*., (22) reported that inoculating olive trees with biofertilizer (mycorrhizal fungi) increased plant growth and their ability to uptake nitrogen, phosphorus and potassium. Ameen and Al-Hamdani, (4) discovered that applying biofertilizers to olive trees of the cultivar Sorani of *Olea europaea* L. significantly increased the studied properties at a rate of 40 gm L^{-1} (yield rate per tree, fruit weight, fruit volume, pulp thickness). Also, Reyes-Díaz *et al*., (26) reached a significant increase in all characteristics of fruit yield of olive trees cultivar Manzanillo after treating them with biofertilizer at a level of (15g/tree). Amino acid are organic compounds that contain amine (-NH2) and carboxyl (-COOH) functional groups, along with a side chain (R group) specific to each amino acid (20). Amino acids are organic precursor and constituents of the protein (24), which are important for stimulation of cell growth. They include both acid and basin groups and work as a buffer, which aid to maintain favorable or indirectly influence the physiological activities in plant growth and development such as exogenous application of amino acids have been reported to modulate the growth (33). Tecamin max is a free amino acid compound from a plant source, activating the biological processes of construction and metabolism within the plant, thus increasing most of the growth traits (34). However, effects of foliar application of amino acid on the growth, functionally, are involved in the enzymes reliable for the structural photosynthesis process. Also have chelating effect on micronutrients when applied together making absorption and transportation of micronutrients easier inside the plant (1). Also, amino acid is a well-known bio-stimulant which has positive effects on plant growth and yield (17). Al-Isaw and Al-Janabi, (2) showed a significant effect in most of the studied growth characteristics of olive trees cv. K18 especially with foliar spaying of amino acids at a concentration of (1.5 ml. L^{-1}) which were achieved a significant superiority in the leaves content of nitrogen. Boron is considered as the major element for the plant nutrient and growth. Boron is used with calcium in cell wall synthesis and is essential for cell division. Boron requirements are much higher for reproductive growth so it helps with pollination, seed development and fruit, other function include translocation of sugars and carbohydrate, nitrogen metabolism, formation of certain protein, regulation of hormone levels and transportation of potassium to stomata (which help regulate internal water balance) (40). Hegazi *et al*., (11) investigated the effect of foliar spray boron at (0, 100, 200, 300, 400, 500 mg. L^{-1}) on olive trees. The obtained results indicated that boron application significantly improved fruit yield and fruit quality compared with the control. The highest increment of all mentioned traits was achieved at concentration of 200 mg. L^{-1} boron. Gul *et al*., (6) study the effect of different boron concentrations (0, 200, 400 and 600ppm) was applied as foliar sprays to olive tree cv. Manzanillo. Maximum fruit size, fruit flesh and minimum stone were recorded at 600 ppm foliar spray of boron. The aim of this study is to improve vegetative growth nutritional status and

yield characteristics of olive (*Olea europaea* L.) cv Zaity, preserving the soil and environment from pollution by using environmentally friendly fertilizer like (Biofertilizer and Amino acid) and also to determine the optimum concentration of boron foliar application that could lead to an increase in yield and fruit characters of olive trees.

Material and Methods

The current study was carried out at a private orchard in Hassan ava village, Zakho district, Duhok governorate, Kurdistan region, Iraq, during the growing season (2022). This region is 582 meters above sea level and located (37º 06' N, 42º 39' E) to evaluate the reaction of the olive tree (*Olea europaea* L.) cv. Zaity to biofertilizer (bio health), amino acid (tecamin max), and boron foliar spray. This study used 15-year-old healthy and nearly uniform olive trees (*Olea europaea* L.) cv. Zaity planted 6 × 6 m apart on clay sandy loam soil with drip watering. The experiment includes three factors, the first factor involved three levels of bio-fertilizer (Bio Health): [bio health (*Trichoderma* strains and *bacillus subtilis*, humic acids and seaweed extract)], as soil application at conc. (0, 10 and 15 $g.L^{-1}$). The decided concentration was dissolved in a liter of water, then the solution was added to soil around the tree, second factor include three levels of amino acids (Tecamin Max) [tecamin max (contains 20 essential amino acid, isoleucine, phenylalanine, methionine, leucine, valine, tyrosine, tryptophan, arginine, proline, glycine, cysteine, glutamic, ac, histidine, aspartic, asparagine, glutamine, serine, threonine, alanine and lysine)], as foliar application at conc. (0, 10 and 15 $ml.L^{-1}$). The third factor include three levels of Boric acid H_3BO_3 (B approx. 17.48%) as foliar application at conc. (0, 200 and 300 mg. L^{-1}). All treatments in all factors were applied twice per season: first: prior-flowering. Second: after setting of fruits. The trees were sprayed in the morning till the runoff and the Tween 20 was added at 0.1 ml/L to reduce the surface tension of water molecules while the controls were sprayed only by distilled water with Tween20. Normal cultural practices, such as pruning, suckers removing, cultivation and weed control was performed at constant rate at the required. The experiment was consisting of twenty-seven treatments (3 conc. of biofertilizer (bio-health) x 3 conc. of amino acid (tecamin max) x 3 conc. of boric Acid (H_3BO_3), with three replications for each experiment unit, using factorial experiment by using (RCBD) design. All results are analyzed statistically by using SAS program. The collected data subject to analysis of variance and means separate by Duncan Multiple range test at the level of 5%. The experimental measurements were recorded as following: Leaves mineral content (N, P, K and B %), Fruit weight (g), Fruit length (mm), Fruit width (mm), pulp: stone ratio and total yield per tree (kg. $tree^{-1}$).

Results and Discussion

Leaves nitrogen concentration (%): data reported in table (1) illustrates that soil application of bio health at $15g.L^{-1}$ and foliar spray with tecamin max at $15ml.L^{-1}$ and boron at 200mg. L^{-1} recorded the leaves nitrogen concentration's highest significant

value (2.59, 2.22 and 2.06%) respectively. Regarding the effect of interaction between bio health + tecamin max, bio health + boron and tecamin max + boron, there was a significantly affected on leaves nitrogen concentration, the maximum value (2.90, 2.67 and 2.27%) respectively, was obtained when olive trees were treated with 15g.L^{-1} bio health + 15ml.L^{-1} tecamin max, 15g.L^{-1} bio health + 200mg. L^{-1} boron and 15ml.L^{-1} + 200mg. L^{-1}, whereas the minimum value was occurred at the interaction of control treatment. Results of interaction among bio health, tecamin max and boron, indicated that the interaction among 15g.L^{-1} bio health + 15ml.L^{-1} tecamin max + 200mg. L^{-1} boron produced the highest leaves nitrogen concentration (2.94%), whereas the control treatment produced the lowest.

Table 1. Effect of bio health, tecamin max and boron and their interactions on leaves nitrogen concentration (%) of olive trees cv. Zaity

Bio health (g.L^{-1})	Tecamin max (ml.L^{-1})	Boron (mg. L^{-1}) 0	200	300	Bio health * Tecamin max	Mean effect of Bio health
	0	1.14 m	1.24 lm	1.37 k-m	1.25 h	
0	**10**	1.47 jk	1.55 i-k	1.55 i-k	1.52 g	1.48 c
	15	1.56 i-k	1.74 hi	1.66 h-j	1.65 f	
	0	1.81 gh	1.81 gh	1.89 e-h	1.84 e	
10	**10**	1.88 f-h	2.04 d-g	2.02 d-g	1.98 d	1.98 b
	15	2.13 de	2.13 de	2.08 d-f	2.12 c	
	0	2.20 cd	2.55 b	2.39 bc	2.38 b	
15	**10**	2.48 b	2.52 b	2.47 b	2.49 b	2.59 a
	15	2.83 a	2.94 a	2.91 a	2.90 a	
Bio health * Boron	**0**	1.39 e	1.51 de	1.53 d	**Mean effect of Tecamin max**	
	10	1.94 c	1.99 c	2.00 c		
	15	2.50 b	2.67 a	2.59 ab		
Tecamin max * Boron	**0**	1.72 e	1.87 d	1.88 cd	1.82 c	
	10	1.94 b-d	2.03 b	2.01 bc	2.00 b	
	15	2.18 a	2.27 a	2.22 a	2.22 a	
Mean effect of Boron		1.95 b	2.06 a	2.04 a		

Mean within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 level

Leaves phosphor concentration (%): based on the outcomes from table (2), it was discovered that soil application of bio health at 15 g.L^{-1} resulted in the significant effect in leaves phosphor concentration and exhibited the greatest value (0.570%), in comparison to other treatment. Foliar spray of tecamin max at both levels (10 and 15 ml.L^{-1}) significantly increased leaves phosphor concentration, highest percentage was with high level of tecamin max (15 ml.L^{-1}) which gave (0.487%), whereas there are no significant differences between all treatments of boron spraying. In respect with

the interaction between bio health + tecamin max, bio health + boron and tecamin max + boron indicated that the effect of interaction was a significant effect of leaves phosphor concentration and the highest value (0.627, 0.592 and 0.503%) were obtained from the treatment combination of 15 g.L^{-1} bio health + 15 ml.L^{-1} tecamin max, 15 g.L^{-1} bio health + 300 mg. L^{-1} boron and 15ml.L^{-1} + 200 mg. L^{-1} boron. The control treatment gave the lowest value. Results of bio health, tecamin max and boron interaction indicated that there was a significant effect on leaves phosphor concentration and displayed that the interaction among 15 g.L^{-1} bio health + 15 ml.L^{-1} tecamin max + 300 mg. L^{-1} boron produced the highest leaves phosphor concentration (0.647%) compared to the control treatment's lowest value.

Table 2. Effect of bio health, tecamin max and boron and their interactions on leaves phosphor concentration (%) of olive trees cv. Zaity

Bio health (g.L^{-1})	Tecamin max (ml.L^{-1})	Boron (mg. L^{-1}) 0	200	300	Bio health * Tecamin max	Mean effect of Bio health
0	**0**	0.167 i	0.230 hi	0.283 g-i	0.227 f	0.311 c
	10	0.327 e-i	0.307 f-i	0.360 d-h	0.331 e	
	15	0.363 d-h	0.400 c-h	0.367 d-h	0.377 de	
10	**0**	0.433 b-g	0.440 b-g	0.433 b-g	0.436 cd	0.439 b
	10	0.403 c-g	0.397 c-h	0.470 b-f	0.423 cd	
	15	0.430 b-g	0.467 b-f	0.480 a-f	0.459 cd	
15	**0**	0.487 a-e	0.510 a-d	0.527 a-d	0.508 bc	0.570 a
	10	0.560 a-c	0.560 a-c	0.603 ab	0.574 ab	
	15	0.590 ab	0.643 a	0.647 a	0.627 a	
Bio health * Boron	**0**	0.286 d	0.312 d	0.337 d	**Mean effect of Tecamin max**	
	10	0.422 c	0.434 c	0.461 bc		
	15	0.546 ab	0.571 a	0.592 a		
Tecamin max * Boron	**0**	0.362 c	0.393 bc	0.414 a-c	0.390 b	
	10	0.430 a-c	0.421 a-c	0.478 ab	0.443 a	
	15	0.461 ab	0.503 a	0.498 a	0.487 a	
Mean effect of Boron		0.418 a	0.439 a	0.463 a		

Mean within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 level.

Leaves potassium concentration (%)**:** table (3) clearly shows that there was a significant difference in leaves potassium concentration among the three treatments, Bio health at 15 g. L^{-1}, tecamin max at 15 ml. L^{-1} gave the highest significant value (0.846 and 0.808%) respectively, when compared to the control treatment, foliar applications of boron at 200 mg. L^{-1} and 300 mg. L^{-1} showed a significant benefit, and the maximum value was obtained from 300 mg. L^{-1} which gave (0.781%). The interaction between bio health + tecamin max, bio health + boron and tecamin max + boron showed that there

was a significant influence on leaves potassium concentration. Moreover, the highest value (0.918, 0.858 and 0.831%) was obtained at 15 g.L^{-1} bio health + 15 ml.l^{-1} tecamin max, 15 g.L^{-1} bio health + 200 mg. L^{-1} boron and 15 ml.L^{-1} tecamin max + 300 mg. L^{-1} boron respectively. Regarding the interaction's impact on bio health, tecamin max and boron, the maximum leaves potassium concentration (0.953%) was acquired when olive trees treated with maximum value of each treatment; it was significantly higher compared to most of other interactions. Furthermore, the lowest value was obtained at the control treatment.

Table 3. Effect of bio health, tecamin max and boron and their interactions on leaves potassium concentration (%) of olive trees cv. Zaity

Bio health (g.L^{-1})	Tecamin max (ml.L^{-1})	Boron (mg. L^{-1}) 0	200	300	Bio health * Tecamin max	Mean effect of Bio health
	0	0.553 l	0.583 l	0.667 jk	0.601 f	
0	**10**	0.647 k	0.697 ij	0.723 hi	0.689 e	0.677 c
	15	0.693 ij	0.770 e-g	0.763 f-h	0.742 d	
	0	0.760 f-h	0.770 e-g	0.787 d-f	0.772 c	
10	**10**	0.770 e-g	0.787 d-f	0.760 f-h	0.772 c	0.769 b
	15	0.743 gh	0.770 e-g	0.777 d-g	0.763 c	
	0	0.807 c-e	0.807 c-e	0.787 d-f	0.800 b	
15	**10**	0.817 cd	0.830 bc	0.813 cd	0.820 b	0.846 a
	15	0.863 b	0.937 a	0.953 a	0.918 a	
Bio health * Boron	**0**	0.631 f	0.683 e	0.718 d	**Mean effect of Tecamin max**	
	10	0.758 c	0.776 c	0.774 c		
	15	0.829 b	0.858 a	0.851 a		
Tecamin max * Boron	**0**	0.707 d	0.720 d	0.747 c	0.724 c	
	10	0.744 c	0.771 b	0.766 bc	0.760 b	
	15	0.767 bc	0.826 a	0.831 a	0.808 a	
Mean effect of Boron		0.739 b	0.772 a	0.781 a		

Mean within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 level

Leaves boron concentration (%): table (4) indicate that increasing levels of bio health, tecamin max and boron significantly increased leaves boron concentration, the maximum value (25.54, 20.62 and 20.49 %) were obtained from soli application of 15 g. L^{-1} bio health, spraying tecamin max at 15 ml.L^{-1} and boron at 300 mg. L^{-1}. Concerning the interaction of bio health + tecamin max, bio health + boron and tecamin max + boron, table (4) clearly shows that the highest leaves boron concentration (26.47, 22.49 and 27.11%) resulted from the interaction of 15 g. L^{-1} bio health + 15 ml. L^{-1} tecamin max, 15 g. L^{-1} bio health + 300 mg. L^{-1} boron and 15 ml.L^{-1} tecamin max + 300 mg. L^{-1} boron respectively, there were significant as compared to other interactions.

Regarding how the three factors under study interacted with one another (bio health, tecamin max and boron), the highest value of leaves boron concentration (28.15%) was obtained from the treatment combination of 15 g. L^{-1} bio health + 15 ml. L^{-1} tecamin max + 300 mg. L^{-1} boron.

Table 4. Effect of bio health, tecamin max and boron and their interactions on leaves boron concentration (%) of olive trees cv. Zaity

Bio health ($g.L^{-1}$)	Tecamin max ($ml.L^{-1}$)	Boron (mg. L^{-1})			Bio health * Tecamin max	Mean effect of Bio health
		0	200	300		
0	0	11.57 n	13.18 l-n	13.35 l-n	12.70 g	13.97 c
	10	12.63 mn	16.02 i-k	14.25 k-m	14.30 f	
	15	13.43 l-n	14.65 j-m	16.62 ij	14.90 ef	
10	0	14.48 k-m	17.20 hi	15.08 j-l	15.59 e	17.98 b
	10	15.83 i-k	16.67 ij	21.10 ef	17.87 d	
	15	18.90 gh	19.83 fg	22.70 de	20.48 c	
15	0	22.35 de	24.08 cd	25.77 bc	24.07 b	25.54 a
	10	24.15 cd	26.65 ab	27.42 ab	26.07 a	
	15	23.32 d	27.94 a	28.15 a	26.47 a	
Bio health * Boron	0	12.54 g	14.62 f	14.74 f	**Mean effect of Tecamin max**	
	10	16.41 e	17.90 d	19.63 c		
	15	23.27 b	26.22 a	27.11 a		
Tecamin max * Boron	0	16.13 e	18.16 d	18.07 d	17.45 c	
	10	17.54 d	19.78 c	20.92 b	19.41 b	
	15	18.55 d	20.81 bc	22.49 a	20.62 a	
Mean effect of Boron		17.41 c	19.58 b	20.49 a		

Mean within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 level

Fruit weight (g): table (5) indicates that increasing levels of the soil application of bio health and foliar sprayed with tecamin max and boron to the olive trees significantly increased fruit weight, the highest value (4.19, 3.55 and 3.37g) resulted from 15 g. L^{-1} bio health, 15 ml. L^{-1} tecamin max and 300 mg. L^{-1} boron respectively. The same table also shows that the bilateral interactions significantly increased fruit weight which recorded the highest value of fruit weight (4.47, 4.30 and 3.67g) from the interaction between 15 g. L^{-1} bio health + 15 $ml.L^{-1}$ tecamin max, 15 $g.L^{-1}$ bio health + 300 mg. L^{-1} boron and 15 ml. L^{-1} tecamin max + 300 mg. L^{-1} respectively, compared to the lowest value obtained from untreated trees (control). Data in the same table clearly demonstrates that the three factors (bio health, tecamin max, and boron) when combined effect on fruit weight significantly, maximum value of each treatments recorded maximum value (4.57g)

and untreated tree gave the lowest value (1.67g).

Table 5. Effect of bio health, tecamin max and boron and their interactions on fruit weight (g) of olive trees cv. Zaity

Bio health ($g.L^{-1}$)	Tecamin max ($ml.L^{-1}$)	Boron ($mg.\ L^{-1}$) 0	200	300	Bio health * Tecamin max	Mean effect of Bio health
	0	1.67 n	1.93 mn	2.20 lm	1.93 h	
0	**10**	2.30 kl	2.30 kl	2.57 jk	2.39 g	2.36 c
	15	2.60 jk	2.83 ij	2.87 h-j	2.77 f	
	0	2.90 g-j	2.73 ij	3.00 g-i	2.88 ef	
10	**10**	2.70 ij	3.27 fg	3.23 f-h	3.07 e	3.12 b
	15	3.43 ef	3.23 f-h	3.57 d-f	3.41 d	
	0	3.70 de	3.83 cd	4.10 bc	3.88 c	
15	**10**	4.20 ab	4.27 ab	4.23 ab	4.23 b	4.19 a
	15	4.37 ab	4.47 ab	4.57 a	4.47 a	
Bio health * Boron	**0**	2.19 f	2.36 ef	2.54 e	**Mean effect of Tecamin max**	
	10	3.01 d	3.08 cd	3.27 c		
	15	4.09 b	4.19 ab	4.30 a		
Tecamin max * Boron	**0**	2.76 f	2.83 f	3.10 de	2.90 c	
	10	3.07 e	3.28 cd	3.34 bc	3.23 b	
	15	3.47 a-c	3.51 ab	3.67 a	3.55 a	
Mean effect of Boron		3.10 b	3.21 b	3.37 a		

Mean within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 level.

Fruit length (mm): table (6) explained that the soil application of bio health at 15 g. L^{-1} and foliar spray of tecamin max at 15 $ml.L^{-1}$ and boron at 300 mg. L^{-1} significantly increased fruit length which registered (23.45, 22.67 and 21.96 mm) respectively in comparison with lowest value. The interactions of bio health + tecamin max, bio health + boron and tecamin max + boron have a significant effect on fruit length. The highest value (24.27, 23.73 and 23.04 mm) was obtained from the interaction of 15 g. L^{-1} bio health + 15 ml. L^{-1} tecamin max, 15 g. L^{-1} bio health + 300 mg. L^{-1} boron and 15 ml. L^{-1} tecamin max + 300 mg. L^{-1} boron respectively. There were significant differences among the mean of fruit length as a result of interaction among bio health, tecamin max and boron. The maximum fruit length (24.80mm) was obtained at the interaction of 15 g. L^{-1} bio health + 15 ml. L^{-1} tecamin max + 300 mg. L^{-1} boron. While the minimum value of fruit length was obtained from the control treatment.

Table 6. Effect of bio health, tecamin max and boron and their interactions on fruit length (mm) of olive tree cv. Zaity

Bio health ($g.L^{-1}$)	Tecamin max ($ml.L^{-1}$)	Boron (mg. L^{-1}) 0	200	300	Bio health * Tecamin max	Mean effect of Bio health
	0	17.30 m	18.27 l	19.10 kl	18.22 f	
0	**10**	19.27 k	19.17 kl	20.97 j	19.80 e	19.94 c
	15	21.67 g-j	22.53 d-g	21.23 ij	21.81 cd	
	0	21.00 j	21.37 h-j	21.47 h-j	21.28 d	
10	**10**	22.23 e-i	21.30 h-j	21.57 g-j	21.70 cd	21.64 b
	15	21.43 h-j	22.30 e-h	22.10 f-i	21.94 c	
	0	22.70 c-f	22.57 d-g	23.17 c-e	22.81 b	
15	**10**	23.47 b-d	23.13 c-e	23.23 c-e	23.28 b	23.45 a
	15	23.70 bc	24.30 ab	24.80 a	24.27 a	
Bio health * Boron	**0**	19.41 d	19.99 c	20.43 c	**Mean effect of Tecamin max**	
	10	21.56 b	21.66 b	21.71 b		
	15	23.29 a	23.33 a	23.73 a		
Tecamin max * Boron	**0**	20.33 g	20.73 fg	21.24 ef	20.77 c	
	10	21.66 de	21.20 ef	21.92 cd	21.59 b	
	15	22.27 bc	23.04 a	22.71 ab	22.67 a	
Mean effect of Boron		21.42 b	21.66 ab	21.96 a		

Mean within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 level

Fruit width (mm): table (7) pointed out that there was significant difference between the treatments. Increasing the levels of bio health, tecamin max and boron significantly increased fruit width, the highest value of fruit width is registered in the olive trees fertilized with 15 g. L^{-1} bio health, 15 ml. L^{-1} tecamin max and 300 mg. L^{-1} boron, which are (16.75, 16.03 and 15.55mm) respectively. As for the interactions, data in table (7) indicates that the interaction of bio health + tecamin max, bio health + boron and tecamin max + boron were significantly differed, the maximum value of fruit width (17.96, 17.22 and 16.28mm) were obtained by the interaction of 15 g. L^{-1} bio health + 15 ml. L^{-1} tecamin max, 15 g. L^{-1} bio health + 300 mg. L^{-1} boron and 15 ml.L^{-1} + 200 mg. L^{-1} compared with the lowest value from the control. The same table made it abundantly clear that the three factors studied had a positive impact on fruit width with regard to their interaction, the maximum value (18.67mm) was resulted from the interaction of 15 g. L^{-1} bio health + 15 ml. L^{-1} tecamin max + 300 mg. L^{-1} boron in comparison with untreated trees which gave the lowest value of fruit width.

Table 7. Effect of bio health, tecamin max and boron and their interactions on fruit width (mm) of olive trees cv. Zaity

Bio health ($g.L^{-1}$)	Tecamin max ($ml.L^{-1}$)	Boron ($mg.\ L^{-1}$)			Bio health * Tecamin max	Mean effect of Bio health
		0	200	300		
0	0	11.73 m	12.53 lm	13.47 j-l	12.58 f	13.67 c
	10	13.53 j-l	13.33 kl	14.20 i-k	13.69 e	
	15	14.47 h-j	15.27 e-i	14.53 g-j	14.76 d	
10	0	15.10 f-i	15.33 e-i	15.43 e-h	15.29 cd	15.32 b
	10	15.30 e-i	15.33 e-i	15.27 e-i	15.30 cd	
	15	15.07 f-i	15.70 d-g	15.37 e-i	15.38 cd	
15	0	15.37 e-i	15.93 d-f	16.27 c-f	15.86 c	16.75 a
	10	16.33 c-e	16.27 c-f	16.73 cd	16.44 b	
	15	17.33 bc	17.87 ab	18.67 a	17.96 a	
Bio health* Boron	0	13.24 e	13.71 de	14.07 d	**Mean effect of Tecamin max**	
	10	15.16 c	15.46 c	15.36 c		
	15	16.34 b	16.69 ab	17.22 a		
Tecamin max * Boron	0	14.07 e	14.60 de	15.06 cd	14.57 c	
	10	15.06 cd	14.98 cd	15.40 c	15.14 b	
	15	15.62 bc	16.28 a	16.19 ab	16.03 a	
Mean effect of Boron		14.91 b	15.29 a	15.55 a		

Mean within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 level.

Pulp: stone ratio**:** As can be seen from table (8), there was no discernible impact of pulp: stone ratio when bio health was applied to the soil and tecamin max and boron were sprayed onto the leaves. The interaction between bio health + tecamin max and bio health + boron displayed that there was no significant effect of pulp: stone ratio, while the interaction between tecamin max + boron, the highest value (3.08) was obtained at 0 ml. L^{-1} tecamin max with 300 mg. L^{-1} boron. In respect with the interaction among bio health + tecamin max + boron, the highest value of pulp: stone ratio (3.35) was obtained from the treatment combination of 0g. L^{-1} bio health + 0 ml. L^{-1} tecamin max + 300 mg. L^{-1} boron.

Table 8. Effect of bio health, tecamin max and boron and their interactions on pulp: stone ratio of olive trees cv. Zaity

Bio health ($g.L^{-1}$)	Tecamin max ($ml.L^{-1}$)	Boron ($mg.\ L^{-1}$)			Bio health * Tecamin max	Mean effect of Bio health
		0	200	300		
0	0	2.24 d	2.97 a-d	3.35 a	2.85 a	2.92 a
	10	2.72 a-d	3.13 a-c	3.13 a-c	2.99 a	
	15	3.06 a-d	3.25 a-c	2.47 b-d	2.93 a	
10	0	2.75 a-d	2.77 a-d	3.11 a-c	2.88 a	2.74 a
	10	2.81 a-d	3.11 a-c	2.51 a-d	2.81 a	
	15	2.49 a-d	2.72 a-d	2.43 cd	2.55 a	
15	0	2.39 cd	3.11 a-c	2.79 a-d	2.76 a	2.81 a
	10	3.32 ab	2.43 cd	3.22 a-c	2.99 a	
	15	2.73 a-d	2.45 b-d	2.90 a-d	2.69 a	
Bio health * Boron	0	2.67 a	3.12 a	2.98 a	**Mean effect of Tecamin max**	
	10	2.68 a	2.87 a	2.68 a		
	15	2.81 a	2.66 a	2.97 a		
Tecamin max * Boron	0	2.46 c	2.95 ab	3.08 a	2.83 a	
	10	2.95 ab	2.89 a-c	2.95 ab	2.93 a	
	15	2.76 a-c	2.81 a-c	2.60 bc	2.72 a	
Mean effect of Boron		2.72 a	2.88 a	2.88 a		

Mean within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 level.

Total yield (kg. $tree^{-1}$)**:** table (9) illustrates that increasing levels of bio health, tecamin max and boron significantly increased total yield (kg. $tree^{-1}$). The highest value (29.96, 29.54 and 29.07 kg. $tree^{-1}$) were obtained in the tree receiving 15 $g.L^{-1}$ bio health, 15 $ml.L^{-1}$ tecamin max and 300 mg. L^{-1} boron respectively, as compared to the control treatment. Concerning the interaction of bio health + tecamin max, bio health + boron and tecamin max + boron, data in table (9) shows that the interaction of 15 g. L^{-1} bio health + 15 ml. L^{-1} tecamin max, 15 g. L^{-1} bio health + 300 mg. L^{-1} boron and 15 ml. L^{-1} tecamin max + 300 mg. L^{-1} boron give the maximum value of total yield. $tree^{-1}$ (31.22, 30.47 and 30.05kg. $tree^{-1}$) respectively, compared to the minimum value from control. For the interaction among three studied factors (bio health, tecamin max and boron), The same table shows that the interaction of 15 g. L^{-1} bio health + 15 ml. L^{-1} tecamin max + 300 mg. L^{-1} boron give the highest value (32.57kg. $tree^{-1}$) which differed significantly from other treatment, the lowest value was recorded with control treatment.

Table 9. Effect of bio health, tecamin max and boron and their interactions on total yield (kg. tree^{-1}) of olive trees cv. Zaity

Bio health (g.L^{-1})	Tecamin max (ml.L^{-1})	Boron (mg. L^{-1}) 0	200	300	Bio health* Tecamin max	Mean effect of Bio health
0	0	26.43 h	28.12 e-g	27.78 g	27.44 d	27.93 c
	10	27.77 g	28.37 d-g	28.42 c-g	28.18 cd	
	15	28.45 c-g	27.96 g	28.06 fg	28.15 cd	
10	0	28.19 d-g	28.67 c-g	27.89 g	28.25 c	28.72 b
	10	28.69 c-g	28.74 c-g	28.58 c-g	28.67 bc	
	15	29.30 c-g	28.91 c-g	29.54 c-f	29.25 b	
15	0	29.62 c-e	28.89 c-g	29.20 c-g	29.24 b	29.96 a
	10	29.14 c-g	29.52 c-f	29.64 cd	29.43 b	
	15	29.91 c	31.17 b	32.57 a	31.22 a	
Bio health* Boron	0	27.55 d	28.15 cd	28.08 cd	**Mean effect of Tecamin max**	
	10	28.73 c	28.77 c	28.67 c		
	15	29.56 b	29.86 ab	30.47 a		
Tecamin max* Boron	0	28.08 c	28.56 bc	28.29 c	28.31 c	
	10	28.53 bc	28.88 bc	28.88 bc	28.76 b	
	15	29.22 b	29.34 ab	30.05 a	29.54 a	
Mean effect of Boron		28.61 b	28.93 ab	29.07 a		

Mean within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 level.

The present study was investigating the effect of soil application of biofertilizer (bio-health) on leaves mineral content, yield and physical characters of the olive fruits cv. Zaity. It is clear that all studied parameters (leaves mineral content N, P, K and B) from tables (1-4), fruit quantitative and yields characteristics from table (5-9) were significantly affected by biofertilizer (bio health). The effect of bio health on leaf mineral content (N, P, K and B), which may be due to its containing *Trichoderma harzinum*, *Bacillus subtilis* and humic acid where *Trichoderma* fungi colonize the root zone and secrete many organic acids that contributes to lowering soil PH, which increases the availability and absorption of nutrients, especially iron, zinc and manganese (12), as well as its positive effect on the formation of a dense root hair density, which increases the surface area for absorption of water and nutrients (9) and this is reflected in the plant's content of nutrients N, P and K, and these results agree with (28), and the reason for the improvement leaf mineral content (N, P, K and B) may be due to the high ability of Bacillus bacteria to dissolve phosphorous through its secretion of many of organic acids as well as an increase in the availability of some nutrients, especially the macro elements (32), and thus this effect was reflected on the increase in the root

system and its increase leaf mineral content (N, P, K and B). Humic acid improves the chemical and physical properties of soil as it improves soil aeration and increases its fertility by increasing availability of some elements and increasing the activity of microorganisms the beneficial effect in the rhizosphere of the soil and encouraging its colonization of the root zone (38). The positive superiority in the yield and physical characters of the olive fruits (fruit weight, fruit length, fruit width, pulp: stone ratio and total yield per tree) after adding biofertilizer (bio health) is due to the effect of *Trichoderma harzinum*, *Bacillus subtilis* in providing appropriate conditions for root growth through dismantling soil and improving its physical and chemical properties, in addition to analyzing complex organic compounds into simple ones. Easy to absorb and convert nutrients such as phosphorous and nitrogen from complex form that is difficult to absorb by roots into an easily absorbable form, which leads to an increase and accumulation of minerals in plant tissues, activating the physiological processes of the plant, cell division and increasing its volume, which positively affects the weight and volume of the fruit, it also works to build some vitamins special properties such as vitamin B and other compounds and enzymes that inhibit a number of fungal and bacterial diseases in the soil lead to maintaining the health of the roots from pathogens, which allows the maintenance of plant activity and its vital process, cell division and increase in volume and the formation of phenolic compounds and fatty acids, which are basis in the formation of fruit and improving its quality (7). Or, it may be due to the importance of bio-fertilizers in controlling soil PH and thus controlling the availability of mineral elements and their availability to plants, which improves vegetative growth and increases fruit yield (25). While the moral superiority in the amount of yield shown in (table 9) may be due to the effect of bio-fertilizers (bio-health) in providing mineral elements such as nitrogen, phosphorous and potassium and their accumulation in plant tissue, and these elements are the basis in all vital functions. For plants photosynthesis, and energy production needed for tree growth, fruit formation, yield increase and other physical characters in fruits (27). These results are in line with those a number of researchers on different fruit trees (25 and 27).

Amino acid (Tecmine max) foliar spray affected significantly leaf mineral content and yield parameters. The positive effect of amino acids on nutritional status (N, P, K and B), yield as well as physical characteristics of the olive fruits (fruit weight, fruit length, fruit width, pulp; stone ratio and total yield per tree) in olive tree, might be attributed to the ant oxidative aspects of these amino acids which plays important role in plant defense against oxidative stresses induced by unfavorable conditions. Also, they are responsible for stimulating the biosynthesis of proteins, natural hormones like IAA, ethylene, cytokinin and GA3, DNA, RNA, cell division, organic foods ad plant pigments (21). These beneficial effects surely reflected on producing healthy trees. The present positive effects of amino acids on growth aspects, nutritional status of the olive

trees is in agreement with those obtained by (29). Foliar application of amino acids caused an enhancement in plant growth, fruit yield and its components (30) through enhancing growth nutritional status, yield and fruit quantity in different fruit crops (19). Tecamin max is a free amino acid compound from a plant source, activating the biological processes in the pant and causes to increase the processes of construction and metabolism within the plant, thus increasing most of the growth traits. Physical characteristics of the fruits and yield in olive trees (table 5,6,7,8 and 9) significantly increased by the effect of spraying organic nutrient. Amino acids stimulate cell division, elongation and growth of plant tissue, which are responsible for the activity of the apical meristem thus extending the life of cells, where they have a major impact on the vital functions of food production in (34).

For the influence of foliar spray of boron on the leaf mineral content (N, P, K and B) (tables 1, 2, 3 and 4), yield and fruit quantity (fruit weight, fruit length, fruit width, pulp: stone ratio and total yield per tree) (table 5, 6, 7, 8 and 9). It was noticed from obtained results that increasing boron concentration increased in leaf mineral content, yield and physical characters of olive fruits. Foliar spray of boron effected significantly leaf content of boron and yield parameter and this might be due to its role in cell division and cell elongation. Similar finding has been reported by (14 and 15). The increase in (fruit weight, fruit length, fruit width and pulp: stone ratio) with the foliar spray of boron might be due to the contribution in hormonal metabolism, increase in cell expansion accelerate of cell division and differentiation, cell wall synthesis, lignification and cell wall structural integrity, thereby keep meristematic activity, sugar transport, metabolism of several vital compounds (i. e. carbohydrates, phenol and Indole acetic acid), and respiration, Pincreased in fruit set and the final marketable yield (16; 36 and 39). In addition, boron is considered to be a nutrient that increases the phloem carbohydrate movement, which may increase yield and fruit quality (18).

Conclusion

It can be concluded from this experiment that all studied characters exhibited significant increase by adding bio fertilizer (bio health) to the soil, foliar spray of high level of amino acid (tecamin max) and boron which could be an alternative plant growth substance. This study also revealed that mineral fertilizer like boron could not be excluded from agricultural practices, as the results indicated the significant impact on most studied traits individually or combined. Further studies are required to examine the optimal concentration of bio fertilizer and amino acid and best combination of these growth stimuluses with mineral compound on the different plant.

Conflict of Interest

The authors have no conflict of interest.

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