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Effect of Mineral and Bio-NPK Soil application on Vegetative Growth, Flowering, Fruiting and Leaf Chemical Composition of Young Olive Trees.

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Abstract: The present study was carried out on one year -old trees of two olive cultivars, Coronaki as oil cultivar and Manzanillo olive as double purpose cv. (table and oil) in a private farm located at Western desert along Cairo, Alexandria Road (50 km from Cairo), Egypt and planted at 5 x 6 meter apart in sandy soil and irrigated with drip irrigation system, similar in growth vigour and received the common horticultural practices. Manzanillo olive trees exhibited significantly the highest values of both fruit set percentage and fruit drop percentage as well as sex expression while the opposite was found with Manzanillo olive trees during the two seasons of study. Concerning the specific effect of bio- NPK fertilizer treatments, obtained results revealed that all five bio- NPK fertilizer treatments significantly increase during the study. Data obtained regarding the interaction effect of (olive cultivar x bio- NPK soil fertilizer treatments) showed that the highest value of number of shoots/branch/meter, number of leaves per shoot, shoot length, shoot diameter, leaf area, leaf fresh and dry weights, number of inflorescence per shoot and number of flowers per inflorescence exhibited statistically the highest values by Coronaki olive trees fertilized with the treatment 6 (kotengin + Biofertilizer + K_2So_4), while the lowest increase was found by Manzanillo olive trees fertilized with the treatment 2 (kotengin + $(NH_4)_2$ so_4 at 150 g/tree + P_2o_5 at 150 g/tree + K_2 So_4 at 150 g/tree) soil applied treatment during the two season of study. Manzanillo leaves were the richest in chlorophyll A&B and the poorest in Carotenoids, while the reverse was true in Coronaki leaves during the two seasons of study. On the other side, Coronaki cultivar had the richest leaves and exceeded statistically the Manzanillo olive cultivar regarding leaf, N; P; K; Ca, Mg; Fe; Mn and Zn contents from one hand, but the poorest leaves of Cu content from the other hand. All measurements in vegetative growth, flowering and some fruiting properties, were significantly increased with all different bio-NPK fertilizer soil applied treatments during the two seasons, and treatment 6 (kotengin + Biofertilizer + K_2So_4) was the superior in this concern.

Key words: Coronaki olive, Manzanillo olive, fertilized, Biofertilizer, kotengin.

INTRODUCTION

Olive (*Olea europaea* L.) is one of the oldest cultivated tree crops in the history of the world about 8000 years age. It was originated in the ancient times in the eastern side of the Mediterranean Sea. Olive has speared to all the countries around the Mediterranean basin, which is still the major region of olive production until today.

Although olive trees can survive and grow under low soil fertility and water availability conditions, many research studies have been indicating that improving soil fertility and satisfying water requirement are essential factors to obtain a high production. However, increasing olive tree productivity under desert conditions must be based on appropriate technical and economic management to the natural resources scarcity. Biofertilization are biological preparations containing primarily patent strains of micro- organisms in sufficient numbers. These micro- organisms have definite beneficial roles in the fertility of soil rhizosphere and the growth of seedlings. The multi-strain biofertilizers might contain different starins of symbiotic associative diazatrophes, phosphate-solubilizing micro- organisms, silicate dissolving micro-organisms, blue green algae and VAM, Saber,[1]. Biofertilizers proved to eliminate the use of pesticides sometimes, and rebalance the ratio between plant nutrients in soils. They are easy and safe to handle with field applications improved their efficiency in increasing crop yields and decreasing the costs of some agricultural practices. It is worthy to state that biofertilizers do not replace mineral fertilizers, but significantly reduce their rate of application, Saber,[2]. A variety of biofertilizers are now available commercially. Specific strains are used as biological fertilizers, for nitrogen, phosphorus and silicate dissolving such as N-fixing bacteria and yeasts. The

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use of these matierals encourages yield and keeps the environment clean.

The present study aimed to throw some light on the beneficial effect of soil application with N, P & K as well as to some biofertilizers namely, phosphorene, Rizobacterin, and Kotengin on growth and nutritional status of olive juvenile phase grown in sandy soil. The direct effect of some biological treatments on olive seedlings was reported by Brooks,[3]; Khamis *et al.* [4,5]; Sharaf *et al.*[6]; Kilany and Kilany[7]; Ahmed[8]; Haggag and Azzazy[9]; Akl *et al.,*[10]; Fernandez *et al.*[11]; Ahmed *et al.,*[12]; Emtithal *et al.,*[13]; Abd El-Aziz[14]; El-Kholy[15] and Hasan[16].

MATERIALS AND METHODS

This study was conducted during two successive seasons, 2003 and 2004 in a private farm located at Western desert along Cairo Alexandria road, 50 km from Cairo, Egypt.

On two olive cultivars, Coronaki as oil cultivar and Manzanillo cv., as a double purpose (table and oil). Juvenile young trees (one year old) of the two olive cultivars grown on their own roots; planted at 5 x 6 meter apart in a sandy soil, in a private orchard under drip irrigation system using underground water resource pumped from a depth of 70 m were carefully selected for being uniform in their growth vigour and devoted as plant materials in this regard. The biofertilizer (BF) which used in this study were produced by soil microbiology unit, desert research center, it was applied with a concentration of 1 × 108 CFm, a multi strains of Azotobacter Chroococcum ASW 35, Azotobacter Chroococcum ED 21, Azospirillum Brasilense ASW 14, Azospirillum Brasilense Rs 17 and Bacillus Megatherium LCS. 38. Rizobacterin application as an additional N biofertilization, while phosphorene additional P-Biofertilization additional micro and macro elements biofertilization to the trees.

Before experiments had been conducted in the 1st season, mechanical and chemical analysis of orchard soil from the successive depth of two profiles: (0: 30 cm), (30 – 60 cm) and irrigation water were analyzed according to methods described by Piper,[17] and Jackson[18] as shown in Table (1 & 2).

The olive orchard was fertilized with 15m^3 cattle manure per feddan, 2.5 Kg. of superphosphate and 1.75 Kg. of potassium sulphate per tree as soil application at the 1st week of December. Nitrogen fertilizer was added to the recommended rate (5 Kg. of ammonium sulphate per tree) divided to three doses at January, June and August. Thus, the field experiment was conducted as follows:

1- Control (*)
2- Soil application of kotengin + (NH4)2 SO_4 at 150 g/tree + P_2O_5 at 150 g/tree + K_2 SO_4 at 150 g/tree.
3- Soil application of kotengin + (NH4)2 SO_4 at 150 g/tree + phosphorene + K_2 SO_4.
4- Soil application of kotengin + phosphorene + Rhizobacterin + K_2 SO_4.
5- Soil application of kotengin + Super Phosphate+Rhizobacterin + K_2 SO_4.
6- Soil application of kotengin + Biofertilizer + K_2 SO_4.

Talking into consideration that ammonium sulphate, superphosphate and potassium sulphate as N; P and K fertilizers each at 150 g/ tree was fractionated to be soil added at March, May and July for the corresponding treatment. However, Kotengin at 80 g/tree phosphorene and Rhizobacterin at 400 g/tree, Biofertilizer at 1 L/24 liters water were added to wetted soil, applied once a year in 1st two seasons at February for each treated plant.

The complete randomized block design with three replications was used for arranging the differential investigated treatments (combinations between 2 olive cvs. and different mineral / bio- fertilizers) included in each of the aforesaid experiment. Every replicate was represented by two trees. The response of two olive cultivars to the differential treatments of the aforesaid experiment was investigated through determining the following measurements.

A. Vegetative Growth Measurements:

1. Shoot and Leaves Growth (Number and Weight): For each experimental tree, four similarly branches well distributed around the tree canopy were labeled in each season. Fifteen shoots on each branch were selected and tagged. Average number of shoots / per one meter of every main branch and number of leaves / shoot were calculated on both late April and November 1st while leaf fresh and dry weights (g) was recorded when experiments were terminated in November.

2. Leaf Area: Twenty mature leaves from the middle of every new spring growth shoot were taken in mid October (after 7 months) from inner and outer portions of the tree, Leaf area was measured (cm^2) by leaf area meter Model Ci 203 apparatus (USA mode).

B. Flowering Behavior and Some Fruiting Measurements: Twenty shoots of one – year old were chosen at random and labeled for every tree at the second week of March, the following parameters were estimated:

1. Number of Inflorescences per Shoot and Number of Flowers per Inflorescence: were determined at full bloom in the second week of April.

Table 1: Chemical Analysis of orchard Soil from the successive depth of two profiles: (0:30 cm) and (30–60 cm).

Depth (cm)	Ec mmhos / cm	PH	O.C. %	O.M. %	Total N ppm	C/N Ratio	Cations mg/ L				Anions mg/ L			
							Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}	Cl-	SO_4^{--}
0-30	3.6	7.95	0.098	0.169	126	7.78	56.5	64.3	233	1.1	-	32.5	226.5	95.9
30-60	2.23	7.93	0.12	0.206	189	6.35	31	29.6	158.9	0.8	-	24.2	146	50.1

Table 2: Physical Analysis of orchard Soil from the successive depth of two profiles: (0:30cm) and (30–60 cm).

Depth (cm)	$CaCO_3$ %	Gravel %	Coasre sand %	Fine sand %	Total sand %	Silt %	Clay %	Soil texture
0-30	3.2	31.9	23.2	44.4	67.6	0.5	-	Gravel sand
30-60	3.3	32	24.4	39.7	64.1	3.6	0.3	Gravel sand

2. Sex Ration (%): Twenty flowering shoots (5 shoots from each direction) were chosen per tree in early April till the end of early May. The number of total flowers and perfect flowers per inflorescence were counted.

Sex ratio was calculated as a percentage of perfect to total flowers according to the following equation used by Fouad *et at.,*[19].

$$\text{Sex ratio (\%)} = \frac{\text{No. of perfect flowers}}{\text{Total No. of flowers}} \times 100$$

3. Fruit Set Percentage: Twenty inflorescences were chosen per tree for counting the initial number of flowers at full bloom. Fruit set was recorded after 75% of petal fall. Data were tabulated as fruit set percentage of perfect flower according to the following equation used by Fouad *et at.,*[19].

$$\text{Fruit set (\%)} = \frac{\text{Number of set fruitlets}}{\text{Number of perfect flowers}} \times 100$$

C. Fruit Physical Characteristics.

1. Fruit Dimensions: Length and width of individual 20 fruits were measured using the Varner caliper and the average was recorded in centimeters. The fruit shape indexes (L/W) was recorded.

2. Fruit Weight: It was determined by weighing the fruits samples and average fruit weight were recorded in grams.

3. Flesh Weight: The average weight of the flesh and fruit were determined for all fruit samples and recorded as grams.

D. Chemical Analysis:

1- Photosynthetic Pigments (Chlorophyll A, B and Carotene): Chlorophylls a, b and carotene contents in mature leaves in response to different treatments in both seasons were determined, where leaf samples (20 mature fresh leaves from spring cycle) were selected from the middle of each new shoots and taken at the 1st week of October according to Saric *et al.,*[19]. Fresh samples (0.5 gm) from each replicate were homogenized with acetone (88% V: V) in the presence of little amount of $Na_2 CO_3$ and silica quartz, and then filtered through central glass funnel G4. The residue was washed several times with acetone until the filtrate became colorless. The combined extract was completed to a known volume for the calorimetric determination at wave length of 662, 644 and 440.5nm to determine chlorophyll a, b, and carotenoids, respectively, then concentrations of each component was calculated as follows:

Chlorophyll "a" = (9.784 ´ E662) – (0.99 ´ E644) = mg/L.

Chlorophyll "b" = 21.426 ´ E644) – (4.65 ´ E662) = mg/L.

Carotene= (4.695 ´ E440.5) – 0.268 (Chl. "a" + Chl. "b") = mg/l.

E = optical density at a given wave length.

2- Total Free Amino Acids as mg/100g F. wt: Total free amino acids were determined according to the photometric Ninhydrin method of Moore and Stein,[20]. The blue colour produced by Ninhydrine reaction at 100°C was determined in colorimeter at 570 mm as alanine was used for calculation of total amino acids content.

3- Leaf Mineral Determination: Representative samples of fourth and fifth leaves from the base of spring shoots were collected from each replicate in October during both seasons. The samples were thoroughly washed with tap water, rinsed twice with distilled water and oven dried at 70°C till a constant weight and finally ground for determination of:

3-1 Total nitrogen by the semi – micro – kjeldahl method as out lined by Pregl,[21].

3-2 Phosphorus estimated according to the method described by Murphy and Riely,[22] using speklo spectrophomoter at 88.2 Uv.

3-3 Potassium was estimated by the flame spectrophotometer methods recommended by Brown and Lilleland[23].

3-4 Calcium, Magnesium, iron, Manganese, Zinc and copper were determined using the Atomic absorption spectrophotometer "Perkin Elmer -3300" after Chapman and Pratt,[24].

All data of the present investigation were subjected to analysis of variance and significant differences among means were determined according to Snedecor and Cochran,[25]. In addition; significant differences among means were distinguished according to the Duncan's , multiple test range, Duncan,[26], where capital and small letters were used for differentiating the values of specific and interaction effects of the investigated factors, respectively.

RESULTS AND DISCUTION

A. Vegetative Growth Measurements:

1- Number of Shoots/branch/meter: Table (3) showed the specific effect of each factor was directly reflected on their combinations during both seasons of study, since, Coronaki trees received both the T3 (Kotengin + Phosphorene + (NH_4) 2 SO_4 + K_2SO_4) and the T6 (kotengin + Boifertilizer + K_2SO_4) exhibited the greatest number of shoots/branch/meter during the two seasons of study.

In addition; "Manzanillo" olive trees received the T1 ordinary NPK program (control) treatment was statistically the inferior as exhibited the lowest value of number of shoots/branch/meter in both seasons of study. Meanwhile; other combinations were in between. In this concern, Abdel Hameed,[27] mentioned that the interaction between 100% N and BF + BS gave the highest significant number of shoots / twigs.

2- Number of Leaves per Shoot: In addition Table (3) shown a considerable and statistical effect in both seasons of study, where the highest number of leaves / shoots was shown with " Coronaki " olive trees received the T6 (kotengin + Biofertilizer + K_2SO_4). On the other hand, the reverse was true with combination between "Manzanillo" olive plants received the ordinary NPK fertilizer (control) treatment; whereas, the results significantly in the least number of leaves per shoot during the first and second season. In addition other combination was in between. The same results are in line with the findings of Ahmed *et al.,*[12] who found that, applying phosphorene improved growth of Shemlali olive seedlings in comparison to the phosphate fertilizer alone.

3- Leaf Fresh and Dry Weights (gm): As for the interaction effect between olive cultivar and different Bio-NPK mineral fertilizer treatments on fresh and dry weight of leaf, it is quite clear that the most increase in leaf fresh and dry weights were exhibited by combination between Coronaki cultivar T6 (Kotengin + Biofertilizer + K_2SO_4). Where, the least increase of leaf fresh and dry weights were detected by Manzanillo trees received the T2 (NPK) treatments as compared to other treatments during the two seasons of study. On the Other hand, the reverse was true with combination between Manzanillo olive trees received the ordinary program (control) treatment; whereas, the results significantly in the least weight of leaf fresh and dry weights during the 1st and 2nd seasons. In addition, other combinations were in between the two aforesaid discussed combinations. The observations are in accordance with those obtained by Haggag and Azzazy[9] who demonstrated that, the use of multi – strain biofertilizer "Microbein" has a significant positive effect on the vegetative growth patterns of mango seedlings, the use of this biofertilizer increased significantly the dry weight of roots, similar observations was obtained by sorghum with *A-brasilense* increased total plant dry weight, shoot / root ratio and green leaf area, Table (3).

4- Average Leaf Area (Cm^2): Table (3) showed that the most increase in leaf area was coupled with combination represented when Coronaki trees received the T6 (kotengin + Biofertilizer + k_2SO_4) whereas the highest increase of average leaf area were resulted. On the other hand, the lowest increase in average leaf area were detected by Manzanillo trees received T2(NPK) as compared to other treatments under study during 2003 and 2004 seasons, Moreover, other combinations were in between. The observations are in accordance with those obtained by Haggag,[28] where, increasing nitrogen fertilization resulted an increase in leaf area.

B. Flowering Behavior and Some Fruiting Measurements:

1- Number of Inflorescences per Shoot: Table (4) showed clearly that the specific effect of each investigated factor was reflected on its various combinations.

Herein, the greatest number of inflorescences/shoot were significantly in closed relationship with Coronaki olive trees received both the T6 (Kotengin + Biofertilizer + K_2 SO_4) and the T5 (Kotengin + superphosphate + Rhizobacterin + K_2 SO_4).

On the other hand, T2 (NPK) had the least increase in number of inflorescence/shoot in both seasons of study. On the contrary, both Manzanillo and Coronaki olive trees received the ordinary program (control) treatment, exhibited the other way around.

These results are agree with Emtithal *et al.,*[13] that, increasing N and K fertization rate significantly increased number of inflorescences per meter of Manzanillo olive trees.

Table 3: Specific and Interaction effect of olive cultivars, some bio- mineral NPK fertilizers soil applied and their combinations on some vegetative parameters during both 2003 and 2004 eseperimental seasons.

Treatments	Number of shoots / branch/ m			Number of leaves/ shoot			Leaf fresh weight (g)			Leaf dry weight (g)			Leaf area (cm^2)		
	M	C	Mean**	M	C	Mean**	M	C	Mean**	M	C	Mean**	M	C	Mean**
						2003 season									
(T1) Control	12.3 g	16.13 f	14.22 D	11.13 i	16.73 f	13.93 E	2.44 i	3.37 e	2.90 D	0.86 l	1.17 f	1.02 E	2.87 I	4.63 f	3.76 E
(T2) NPK	15.4 f	20.2 c	17.80 C	13.03 h	21.43 d	17.23 D	2.61 h	3.61 d	3.11 C	0.97 k	1.31 e	1.42 D	2.93 k	4.73 e	3.83 D
(T3) Kotengin+ Phosphorene + $(NH_4)_2$ SO_4+K_2SO_4	17.6 de	23.1 a	20.4 AB	18.20 e	28.87 b	23.53 B	2.66 gh	3.61 d	3.13 C	1.01 j	1.37 d	1.19 C	3.10 h	5.00 b	4.05 B
(T4) Kotengin+ Phosphorene + Rhizo- bacterin +K_2SO_4	16.63 ef	21.83 b	19.2 AC	14.78 g	23.73 c	19.26 C	2.66 gh	3.67 c	3.16 BC	1.05 i	1.43 c	1.24 B	3.02 j	4.87 d	3.95 C
(T5) Kotengin+ P+ Rhizo-bacterin +K_2SO_4	16.23 f	21.27bc	18.8 BC	19.17 e	28.93 b	24.05 B	2.71 g	3.74 b	3.22 B	1.08 h	1.47 b	1.27 B	3.08 i	4.96 c	4.02 B
(T6) Kotengin+ Biofertilizer+ K_2SO_4	18.1 d	23.73 a	20.92 A	20.47 d	33.63 a	27.05 A	2.81 f	3.88 a	3.34 A	1.12 g	1.51 a	1.31 A	3.14 g	5.05 a	4.10 A
Mean*	16.04 B	21.04 A		16.13 B	25.56 A		2.65 B	3.64 A		1.01 B	1.37 A		3.02 B	4.87 A	
						2004 season									
(T1) Control	13.6 g	17.9 f	15.75 D	11.83 l	17.83 i	14.83 F	2.51 l	3.60 f	3.06 D	0.92 l	1.24 f	1.08 E	2.91 I	4.69 f	3.80 E
(T2) NPK	17.03 f	22.37 c	19.70 C	13.93 k	22.87 e	18.40 E	2.69 k	3.85 e	3.27 C	1.03 k	1.39 e	1.21 D	3.00 k	4.79 e	3.89 D
(T3) Kotengin+ Phosphorene + (NH4)2 SO4+K_2SO_4	19.47de	25.63 a	22.6 AB	19.03 h	31.57 c	25.30 C	2.74 j	3.92 d	3.33 BC	1.08 j	1.46 d	1.27 C	3.14 h	5.07 b	4.11 AB
(T4) Kotengin+ Phosphorene + Rhizo- bacterin +K_2SO_4	18.37 ef	24.2 b	21.3 AC	15.57 j	25.93 d	20.75 D	2.80 i	4.00 c	3.40 B	1.12 i	1.52 c	1.32 B	3.06 j	4.93 d	3.99 C
(T5) Kotengin+ P+ Rhizo-bacterin +K_2SO_4	17.9 f	23.57 bc	20.7 BC	20.47 g	32.63 b	26.55 B	2.85 h	4.14 b	3.50 B	1.15 h	1.56 b	1.35 B	3.12 i	5.03 c	4.07 B
(T6) Kotengin+ Biofertilizer+ K_2SO_4	20.0 d	26.33 a	23.2 A	21.40 f	35.83 a	28.62 A	3.05 g	4.21 a	3.63 A	1.19 g	1.61 a	1.40 A	3.18 g	5.11 a	4.14 A
Mean	17.73 B	23.33 A		14.07 B	27.78 A		2.77 B	3.95 A		1.08 B	1.46 A		3.07 B	4.94 A	

*M = Manzanillo cv.. C. = Coronaki cv.
* and ** refer to specific effect of olive cultivars and soil NPK mineral respectively. Means fallowed by the same letter/s in each column didn't significantly differ at 5% level.

2- Number of Flowers/inflorescence: Table (4) showed obviously the combinatuion between Coronaki trees received the T6 (Kotengin + biofertilizer + K_2 SO_4) exhibited the greatest number of flowers/inflorescence. On the other hand, the least increase in number of flowers/inflorescence was detected by Manzanillo cv fertilized with the T2 (NPK) during the two seasons of study. Conversely, ordinary program (control) treatment exhibited the opposite trend during 2003 and 2004 seasons. In addition, other combinations were in between. The present results are in agreement with those obtained by Abdel – Hameed,[27] who found that nitrogen fertilizer significantly increased number of flowers/inflorescence and the number of inflorescences / shoot.

3- Sex Expression Percentage of Perfect Flowers: Table (4) showed obviously that the Manzanillo olive cv. received theT4 (kotengin + phosphoren + Rhizobacterin + K_2 SO_4) and the T6 (Kotengin + biofertilization + K_2 SO_4) exhibited the highest values of sex expression % during 1st and 2nd seasons, respectively. Moreover, Coronaki olive plants received the T2 (NPK) had the least increase of sex expression % during the two seasons of study. In addition, the least value was statistically coupled with both Manzanillo and Coronaki olive trees fertilized with ordinary program (control). Other combinations were in between.

These results agreed with Emtithal *et al*.,[13] who reported that adding potassium to soil, significantly enhanced the sex pression %, also, the same trend was found by Aly,[29] who found that adding N, P, K, Mg, NF and EM each at two levels to the soil significantly enhanced the sex expression % of "Aggizi shami", "Manzanillo" and "Kalamata olive" trees as compared to control trees.

4- Fruit Set Percentage: Results reported in Table (4) indicated a significant interaction between bio-NPK mineral soil fertilizer treatments and olive cultivar, where, Manzanillo olive trees received the T6 (Kotengin + biofertilizer + K_2 SO_4) had the greatest value of increase in fruit set %, while the T2 (NPK) treatment showed the lowest increase during the study. Conversly, both Manzanillo and Coronaki trees received ordinary program (control) treatment took the other way arround in fruit set % during 1st and 2nd season of study. In addition, other combinations were in between. In this respect, Abdel – Hameed,[27] mentioned that the interaction between 100% N and BF gave the highest significant fruit set%. Moreover, the highest significant fruit set % was observed with BF.

Table 4: Specific and Interaction effect of olive cultivars, some bio- mineral NPK fertilizers soil applied and their combinations on flowering behavior measurements during both 2003 and 2004 eseperimental seasons.

Treatments	No. of inflorescences / shoot			No. of flowers/ inflorescence			Sex expression %			Fruit set%		
	Mean**	C	M	Mean**	C	M	Mean**	C	M	Mean**	C	M
						2003 season						
(T1) Control	0.00 h	0.00 h	0.00 D	0.00 i	0.00 i	0.00 E	0.00 k	0.00 k	0.00 F	0.00 k	0.00 k	0.00 F
(T2) NPK	3.84 g	4.30 de	4.07 C	13.60 h	15.05 f	14.31 D	19.63 i	16.22 j	17.92 E	13.18 i	11.21 j	12.19 E
(T3) Kotengin+ Phosphorene + $(NH_4)_2$ SO_4+K_2SO_4	4.03 fg	4.65 c	4.34 BC	15.69 e	17.46 b	16.56 B	27.29 c	22.48 g	24.87 C	17.21 e	14.29 h	15.75 D
(T4) Kotengin+ Phosphorene + Rhizo- bacterin +K_2SO_4	4.15 ef	4.77 bc	4.46 AB	14.55 g	16.12 d	15.33 C	28.92 a	23.10 e	26.11 A	18.40 c	15.68 g	17.04 C
(T5) Kotengin+ P+ Rhizo- bacterin +K_2SO_4	4.30 de	4.90 ab	4.60 AB	15.23 f	16.86 c	16.04 B	26.80 d	21.42 h	24.10 D	19.25 b	16.51 f	17.88 B
(T6) Kotengin+ Biofertilizer+ K_2SO_4	4.42 d	5.08 a	4.75 A	16.45 d	18.32 a	17.38 A	28.36 b	22.89 f	25.61 B	20.32 a	18.01 d	19.17 A
Mean*	3.46 B	3.95 A		12.59 B	13.97 A		21.83 A	17.72 B		14.73 A	12.62 B	
						2004 season						
(T1) Control	0.00 g	0.00 g	0.00 D	0.00 j	0.00 j	0.000 F	0.00 k	0.00 k	0.00 E	0.00 k	0.00 k	0.00 F
(T2) NPK	4.03 f	4.51 cd	4.07 C	17.93 i	19.84 g	18.88 E	20.35 i	16.79 j	18.56 D	13.74 i	11.47 j	12.61 E
(T3) Kotengin+ Phosphorene + $(NH_4)_2$ SO_4+K_2SO_4	4.23 ef	4.70 c	4.34 BC	20.74 f	23.01 b	21.87 B	28.40 c	23.23 g	25.81 B	17.80 e	14.84 h	16.32 D
(T4) Kotengin+ Phosphorene + Rhizo- bacterin +K_2SO_4	4.35 de	5.00 b	4.46 AB	19.18 h	21.25 e	20.21 D	29.34 b	27.19 e	26.76 A	18.82 c	15.99 g	17.41 C
(T5) Kotengin+ P+ Rhizo- bacterin +K_2SO_4	4.51 cd	5.14 ab	4.60 AB	20.09 g	22.24 c	21.15 C	27.75 d	22.19 h	24.96 C	20.03 b	17.17 f	18.59 B
(T6) Kotengin+ Biofertilizer+ K_2SO_4	4.63 c	5.32 a	4.75 A	21.70 d	23.58 a	22.63 A	29.77 a	23.74 f	26.74 A	20.63 a	18.17 d	19.40 A
Mean	3.62 B	4.11 A		16.60 B	18.32 A		22.59 A	18.35 B		15.17 A	12.94 B	

*M = Manzanillo cv.. C. = Coronaki cv.
* and ** refer to specific effect of olive cultivars and soil NPK mineral respectively. Means fallowed by the same letter/s in each column didn't significantly differ at 5% level.

C. Fruit Physical Characteristics:

1- Fruit Height and Fruit Diameter (cm): It could be obviously noticed from Table (5) that the specific effect of each investigated factor was directly reflected on their combinations, whereas, as a Manzanillo olive trees received the T6 (Kotengin + biofertilzer + K_2 SO_4) exhibited statistically the greatest value on fruit height. On the other hand, the lowest value of both fruit height and diameter was detected by Coronaki olive trees received T2 (NPK) soil treatment during the two seasons of study. In addition, both Manzanillo and Coronaki olive trees received the ordinary program (control) took the other way around. Other combinations were in between.

The present's results are in an agreement with those found by Fouad *et al.,*[19] and Aly,[29] who noticed that both fruit length and diameter differed according to cultivar. Also, the same trend was reported by Girgis,[30] who mentioned that Aggizi cv. exhibited the highest values of both fruit diameter ones in reverse to Coronaki olive cultivar, meantime Picual and Manzanillo were in between.

2- Fruit Weight: Table (5) showed that the most increase was coupled with combination represented fertilized Manzanillo olive trees with the T6 (Kotengin+ Biofertilization + K_2 SO_4), whereas, the highest average increase of both fruit weight and size were resulted. On the other hand, the lowest increase in both average fruit weight was detected by Coronaki olive trees fertilized with the T2 (NPK) during the 1st and 2nd seasons. In addition; both Manzanillo and Coronaki olive trees received the ordinary program (control) took the other way around. Moreover other combinations were in between. In this concern; Abdel-Hameed,[27] reported that the interaction between 100% N and BF + BS significantly increased fruit weight and volume of Manzanillo olive trees.

3- Flesh Weight: Table (5) clear that the specific effect of each investigated factor was reflected on its various combinations. Herein, the heaviest flesh weight were significantly in closed relationship with Manzanillo olive trees soil fertilized with the T6 (Kotengin + Biofertilizer + K_2 SO_4), whereas, Coronaki olive trees received the T2 (NPK) exhibited the lowest value of flesh weight. Such trend was true during both seasons of study. In addition, both Manzanillo and Coronaki olive trees received the ordinary program (control) took the opposite trend. Moreover, other combinations were in between. In this concern, Girgis,[30] found that Aggizi cv. exhibited the highest value in flesh weight, in reverse to Coronaki cv., meantime; Picual and Manzanillo olive trees were in between.

D. Chemical Analysis:

1- Leaf Chlorophyll (A) Content: Table (6) showed obviously a variable response during the two seasons. Results indicated that; Manzanillo olive trees received the T6 (Kotengin + Biofertilizer + K_2 SO_4), had statistically the highest value of leaf chlorophyll (A) content. Coronaki olive trees fertilized with the ordinary program (control) showed a relative lower

Table 5: Specific and Interaction effect of olive cultivars, some bio- mineral NPK fertilizers soil applied and their combinations on some fruiting measurements during both 2003 and 2004 eseperimental seasons.

Treatments	Fruit length (cm)			Fruit diameter (cm)			Fruit weight (g)			Flesh weight (g)		
	M	C	Mean**	M	C	Mean**	M	C	Mean**	M	C	Mean**
						2003 season						
(T1) Control	0.00 k	0.00 k	0.00 F	0.00 j	0.00 j	0.00 E	0.00 j	0.00 j	0.00 F	0.00 j	0.00 j	0.00 F
(T2) NPK	2.76 e	2.39 j	2.58 E	1.98 e	1.29 i	1.64 D	5.11 e	1.76 i	3.43 E	4.34 e	1.34 i	2.84 E
(T3) Kotengin+ Phosphorene + $(NH_4)_2$ SO_4+K_2SO_4	2.88 d	2.51 i	2.70 D	2.05 d	1.33 h	1.69 C	5.40 d	1.85 h	3.62 D	4.59 d	1.41 h	3.00 D
(T4) Kotengin+ Phosphorene + Rhizo- bacterin +K_2SO_4	2.98 c	2.53 h	2.76 C	2.13 c	1.36 g	1.74 B	5.49 c	1.87 h	3.68 C	4.68 c	1.43 h	3.05 C
(T5) Kotengin+ P+ Rhizo- bacterin +K_2SO_4	3.03 b	2.58 g	2.80 B	2.16 b	1.38 g	1.77B	5.59 b	1.90 g	3.75 B	4.76 b	1.46 g	3.11 B
(T6) Kotengin+ Biofertilizer+ K_2SO_4	3.18 a	2.70 f	2.94 A	2.25 a	1.45 f	1.85 A	5.73 a	1.96 f	3.85 A	4.87 a	1.51 f	1.19 A
Mean*	2.47 A	2.12 B		1.76 A	1.14 B		4.55 A	1.56 B		3.87 A	1.19 B	
						2004 season						
(T1) Control	0.00 k	0.00 k	0.00 F	0.00 j	0.00 j	0.00 E	0.00 k	0.00 k	0.00 F	0.00 k	0.00 k	0.00 F
(T2) NPK	2.87 e	2.49 j	2.68 E	2.10 e	1.34 i	1.72 D	5.20 e	1.76 j	3.48 E	4.40 e	1.32 j	12.86E
(T3) Kotengin+ Phosphorene + $(NH_4)_2$ SO_4+K_2SO_4	3.00 d	2.57 i	2.79 D	2.17 d	1.39 h	1.78 C	5.48 d	1.85 i	3.67 D	4.64 d	1.39 i	3.02 D
(T4) Kotengin+ Phosphorene + Rhizo- bacterin +K_2SO_4	3.09 c	2.64 h	2.86 C	2.25 c	1.42 g	1.84 B	5.58 c	1.88 h	3.73 C	4.73 c	1.42 h	3.08 C
(T5) Kotengin+ P+ Rhizo- bacterin +K_2SO_4	3.15 b	2.68 g	2.91 B	2.28 b	1.45 g	1.87B	5.67 b	1.91 g	3.79 B	4.81 b	1.45 g	3.13 B
(T6) Kotengin+ Biofertilizer+ K_2SO_4	3.30 a	2.81 f	3.06 A	2.38 a	1.52 f	1.95 A	5.81 a	1.97 f	3.89 A	4.92 a	1.49 f	3.21 A
Mean	2.57 A	2.20 B		1.86 A	1.19 B		4.62 A	1.56 B		3.92 A	1.18 B	

*M = Manzanillo cv.. C. = Coronaki cv.
* and ** refer to specific effect of olive cultivars and soil NPK mineral respectively. Means fallowed by the same letter/s in each column didn't significantly differ at 5% level.

Table 6: Specific and Interaction effect of olive cultivars, some bio- mineral NPK fertilizers soil applied and their combinations on leaf Chlorophyll (A) and (B) contents, Carotene content (mg/100 gm. F.W) and Total free amino acid (mg/ 100 d.w) during both 2003 and 2004 experimental seasons.

Treatments	Chlorophyll (A) content (mg/100 gm. F.W)			Chlorophyll (B) content (mg/100 gm. F.W)			Carotene content (mg/100 gm. F.W).			Total free amino acid (100 g. D.W.)		
	M	C	Mean**	M	C	Mean**	M	C	Mean**	M	C	Mean**
						2003 season						
(T1) Control	1.04 g	0.83 j	0.93 F	0.45 gh	0.36 j	0.41 D	0.33 h	0.41 ef	0.37 D	1.19 i	1.10 j	1.15 F
(T2) NPK	1.24 d	1.00 h	1.12 D	0.55 c	0.43 hi	0.49 BC	0.40 f	0.50 b	0.45 B	1.37 f	1.27 h	1.32 E
(T3) Kotengin+ Phosphorene + $(NH_4)_2$ SO_4+K_2SO_4	1.38 b	1.10 f	1.24 B	0.61 ab	0.48 ef	0.55 A	0.43 ce	0.55 g	0.49 AB	1.44 d	1.33 g	1.39 D
(T4) Kotengin+ Phosphorene + Rhizo- bacterin +K_2SO_4	1.16 e	0.93 i	1.05 E	0.52 d	0.41 i	0.46 C	0.37 g	0.46 c	0.41 C	1.58 b	1.47 d	1.53 B
(T5) Kotengin+ P+ Rhizo- bacterin +K_2SO_4	1.33 c	1.06 g	1.20 C	0.58 b	0.46 fg	0.52 AB	0.42 df	0.53 a	0.48 AB	1.51 c	1.40 e	1.46 C
(T6) Kotengin+ Biofertilizer+ K_2SO_4	1.43 a	1.15 e	1.29 A	0.62 a	0.50 de	0.56 A	0.44 cd	0.56 a	0.50 A	1.64 a	1.52 c	1.58 A
Mean*	1.26 A	1.01 B		0.56 A	0.44 B		0.40 B	0.50 A		1.46 A	1.35 B	
						2004 season						
(T1) Control	1.33 h	1.06 k	1.93 E	0.61 f	0.49 i	0.55 E	0.37 i	0.46 fg	0.42 D	1.22 i	1.13 j	1.17 F
(T2) NPK	1.59 d	1.27 i	1.43 D	0.73 c	0.58 g	0.66 C	0.45 f	0.57 c	0.51 B	1.40 f	1.30 h	1.35 E
(T3) Kotengin+ Phosphorene + $(NH_4)_2$ SO_4+K_2SO_4	1.76 b	1.41 ef	1.59 B	0.81 a	0.65 e	0.73 AB	0.50 de	0.62 ab	0.56 A	1.47 d	1.36 g	1.42 D
(T4) Kotengin+ Phosphorene + Rhizo- bacterin +K_2SO_4	1.49 e	1.19 j	1.34 E	0.69 d	0.55 h	0.62 D	0.42 h	0.52 d	0.47 C	1.62 b	1.50 d	1.56 B
(T5) Kotengin+ P+ Rhizo- bacterin +K_2SO_4	1.70 c	1.36 g	1.53 C	0.79 b	0.62 f	0.70 AB	0.48 ef	0.60 b	0.54 AB	1.55 c	1.43 e	1.49 C
(T6) Kotengin+ Biofertilizer+ K_2SO_4	1.83 a	1.46 e	1.65 A	0.84 a	0.67 de	0.75 A	0.50 de	0.63 a	0.57 A	1.68 a	1.55 c	1.62 A
Mean	1.62 A	1.29 B		0.74 A	0.59 B		0.45 B	0.57 A		1.49 A	1.38 B	

*M = Manzanillo cv.. C. = Coronaki cv.
* and ** refer to specific effect of olive cultivars and soil NPK mineral respectively. Means fallowed by the same letter/s in each column didn't significantly differ at 5% level.

value of chlorophyll (A) content during the two seasons of study. In addition, other combinations were in between the above mentioned two extents. The previous results are agree with the early findings of Jackson and Volk[31] that potassium is required for development of chlorophyll "A" and activated enzyme reactions involved in chlorophyll "A" synthesis Weaver,[32]. The increase in chlorophyll "B" may be due to the increase in chlorophyll "A" because chlorophyll "A" is a precursor for the synthesis of chlorophyll "B" Smith and French,[33] and Castelfranco and Beale,[34]. Moreover, Aly[29] found that all treatments of soil nutrients (N, P, K, Mg and EM) increased the leaf chlorophyll "A" and magnesium gave the highest values concerning to chlorophyll "B" content there were no significant differences among treatments.

Table 7: Specific and Interaction effect of olive cultivars, some bio- mineral NPK fertilizers soil applied and their combinations on leaf N, P, K and Ca content (%), during both 2003 and 2004 experimental seasons.

Treatments	Leaf N%			Leaf P%			Leaf K%			Leaf Ca%		
	M	C	Mean**	M	C	Mean**	M	C	Mean**	M	C	Mean**
						2003 season						
(T1) Control	0.45 k	0.51 j	0.48 F	0.10 c	0.12 be	0.11 B	0.67 g	0.86 c	0.77 C	1.25 g	1.53 c	1.39 C
(T2) NPK	0.72 i	0.82 h	0.77 E	0.12 bc	0.17 a	0.14 AB	0.80 f	1.04 b	0.92 B	1.34 d	1.61 ab	1.48 A
(T3) Kotengin+ Phosphorene + $(NH_4)_2$ SO_4+K_2SO_4	1.13 g	1.28 f	1.21 D	0.13 b	0.18 a	0.16 A	0.81 ef	1.05 b	0.93 B	1.31 e	1.59 ab	1.45 AB
(T4) Kotengin+ Phosphorene + Rhizo- bacterin +K_2SO_4	1.35 e	1.53 d	1.44 C	0.14 b	0.19 a	0.16 A	0.83 de	1.06 b	0.94 B	1.30 ef	1.58 b	1.44 AB
(T5) Kotengin+ P+ Rhizo- bacterin +K_2SO_4	1.58 c	1.79 b	1.69 B	0.13 bc	0.17 a	0.15 AB	0.85 cd	1.07 b	0.96 B	1.33 de	1.61 a	1.47 A
(T6) Kotengin+ Biofertilizer+ K_2SO_4	1.75 b	1.99 a	1.87 A	0.14 b	0.19 a	0.17 A	0.86 c	1.18 aa	1.02 A	1.28 f	1.55 c	1.42 BC
Mean*	1.16 B	1.32 A		0.13 B	0.17 A		0.80 B	1.05 A		1.30 B	1.58 A	
						2004 season						
(T1) Control	0.48 k	0.54 j	0.51 F	0.13 e	0.18 c	0.16 B	0.70 f	0.91 c	0.81 C	1.31 g	1.59 c	1.45 C
(T2) NPK	0.77 i	0.86 h	0.82 E	0.15 de	0.21 b	0.18 AB	0.84 e	1.10 b	0.97 B	1.39 e	1.69 a	1.54 AB
(T3) Kotengin+ Phosphorene + $(NH_4)_2$ SO_4+K_2SO_4	1.20 g	1.35 f	1.28 D	0.17 cd	0.24 ab	0.20 A	0.84 e	1.10 b	0.97 B	1.47 d	1.66 ab	1.57 A
(T4) Kotengin+ Phosphorene + Rhizo- bacterin +K_2SO_4	1.44 e	1.62 d	1.53 C	0.17 cd	0.23 ab	0.20 A	0.84 e	1.10 b	0.97 B	1.36 ef	1.64 ab	1.50 AC
(T5) Kotengin+ P+ Rhizo- bacterin +K_2SO_4	1.68 c	1.89 b	1.79 B	0.16 ce	0.21 b	0.18 AB	0.88 d	1.11 b	1.00 B	1.39 e	1.67 a	1.53 AB
(T6) Kotengin+ Biofertilizer+ K_2SO_4	1.87 b	2.12 a	2.00 A	0.17 cd	0.25 a	0.21 A	0.91 c	1.19 a	1.05 A	1.34 fg	1.61 bc	1.48 BC
Mean	1.24 B	1.40 A		0.16 B	0.22 A		0.83 B	1.09 A		1.38 B	1.64 A	

*M = Manzanillo cv.. C. = Coronaki cv.
* and ** refer to specific effect of olive cultivars and soil NPK mineral respectively. Means fallowed by the same letter/s in each column didn't significantly differ at 5% level.

2- Leaf Chlorophyll (B) Content: From Table (6) one can detect a significant interaction between olive cultivars and different Bio-NPK mineral fertilized treatments in both seasons, where Manzanillo trees received both the T6 (Kotengin + Biofertilizer + K_2 SO_4) and T3 (Kotengin + phosphorene + (NH4)2 So4+ K_2 SO_4) showed the highest value of leaf chlorophyll (B) content during the two seasons of study. Conversly, Coronaki olive trees received the ordinary program (control) exhibited the lowest value of leaf chlorophyll (B) content in both seasons. In addition, other combinations were in between.

3- Leaf Carotenes Content: Table (6) showed obviously significant response during both seasons of study. However, Coronaki olive trees received both the T6 (Kotengin + Biofertilizer + K_2 SO_4) in both seasons and the T3 (Kotengin + phosphorene + $(NH_4)_2$ So_4+ K_2 SO_4) in the 2nd season showed the highest value of leaf carotene content. On the contrary, Manzanillo trees fertilized with the ordinary program (control) exhibited statistically the lowest value during the two seasons of study. In addition, other combinations are in between.

4- Leaf Total Free Amino Acids Contents: Table (6) showed obviously the response of olive trees to the different combinations used during the two seasons. The highest value of total free amino acids content were detected by that combination between Manzanillo olive trees received the T6 (Kotengin + Biofertilizer + K_2 SO_4). However, the lowest value of total free amino acids content were detected by Coronaki trees fertilized with ordinary program (control) during both 2003 and 2004 seasons. Moreover, other combinations were in between. This result are in agreement with the findings of Hasan,[16] who found that leaves of Aghizi transplants were the richest in leaf amino acids content followed by Manzanillo, while Coronaki had the poorest leaves. Differences were significant of a given cultivar was compared to the analogous ones of the two other cultivars.

5- Leaf Mineral Contents:

5-1- Leaf Nitrogen Content: Table (7) showed obviously that the most increase effect was observed with the combination between Coronaki olive trees received the T6 (Kotengin + Biofertilizer + K_2 SO_4) during two seasons of study. Moreover, the least increase in leaf-N content was detected by Manzanillo trees fertilized with T2 (NPK) during 2003 and 2004 seasons. On the other hand, other combinations were in between. Abdel-Hameed,[27] found that the interaction between 100% N and BF+ BS recorded the highest significant leaf content of N.

5-2- Leaf Phosphorus Content: Results in Table (7) showed the effect of the interaction between olive cultivars and different Bio-NPK mineral soil treatments on leaf phosphorus content. The result revealed that leaf-P content exhibited significantly the highest level by the combination between Coronaki olive trees fertilized with any of the five soil treatments, while Manzanillo olive trees showed plants with the lowest value of leaf-P% content in both seasons. In this concern, Abdel-Hameed,[27] found that the interaction between 100% and BF+ BS gave the highest leaf P content.

5-3- Leaf Potassium Content: Table (7) showed obviously the significant variances in this concern, during 2003 and 2004 experimental season. The most increase in leaf-k content was detected by the combination between Coronaki cvs fertilized with the T6 (Kotengin + Biofertilizer + K_2 SO_4). Whereas, the lowest increase in leaf-k content was detected by Manzanillo trees received the (T2, T3 and T4) during the two seasons of study. On the contrary, Manzanillo trees received the ordinary program (control) exhibited the lowest value of leaf-k % content during 1st and 2nd seasons. Moreover, other combinations were in between. In this respect, Abdel-Hameed,[27] found that the interaction between 100% N and BF+ BS gave the highest significant leaf content of K.

4- Leaf Calcium Content: Table (7) showed obviously the variable response of olive trees to the different combinations used during the two seasons of study, The higher leaf-Ca % was detected by the combination between Coronaki olive trees received the T2 (NPK), the T3 (Kotengin + Phosphorene + (NH4)2 So4+ K_2 SO_4), the T4 (Kotengin + phosphorene + Rhizobacterin + K_2 SO_4) and the T5 (Kotengin + Superphosphate + Rhizobacterin + K_2 SO_4) while, the lowest leaf-Ca content was detected by Manzanillo olive trees received the ordinary program (control) during both 1st and 2nd seasons. Other combinations were in between.

In this concern Girigs,[30] found that Coronaki olive cv. has the highest value of leaf- Ca content during the growing seasons. Reversely, Manzanillo has the least significant aloes in both seasons. In addition, Hasan,[16] showed that Aghizi olive leaves had statistically the highest value of leaf- Ca content, while the reverse was true with Coronaki transplants during both seasons.

In this respect, Aly,[29] found that adding phosphorous, nitrogen and magnesium resulted in significant increase in the leaves calcium content as compared with control trees but K application has high or no effect.

However, it could be generally concluded that, using T6 (Kotengin + Biofertilizer + K_2 SO_4) soil applied solely to young olive trees especially Coronaki is a recommended treatment for improving vegetative growth and encouraging flowering and fruiting as well as hastening fruit quality.

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