World Journal of Agricultural Sciences 3 (2): 210-217, 2007
ISSN 1817-3047

Effect of Organic and Bio-Fertilization on Vegetative Growth and Flowering of Picual Olive Trees

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Abstract: This experiment was carried out in a private orchard at Egypt-Alex. Desert Road during the two successive seasons 2005 and 2006 to study the most efficient nitrogen fertilization source from organic fertilization alone or in combination with bio and chemical fertilizers to supply olive trees with the requirements of nitrogen and its influences on vegetative growth and flowering. The obtained results showed that, the highest values of the studied growth characters were obtained with 100% organic fertilization (poultry manure). N and K contents in leaf increased significantly with applying 100% organic fertilization (poultry manure), but no significantly difference was observed on leaf content of P in both seasons. Plants applied with 100% organic fertilization (poultry manure) gave the highest Fe contents in leaf in both seasons and Mn in the second season, while leaf Zn content increased in the second season with using 100% mineral fertilization. No significantly difference was observed between treatments on leaf chlorophyll A content, however leaf chlorophyll B content was enhanced in the second season than in the first one. Olive trees amended with 100% organic fertilization (poultry manure) and 75% organic fertilization (poultry manure)+biofertilization were the most effective on flowering characteristics, except the inflorescence length in the second season which improved by 100% mineral fertilization. Therefore, it could be recommended to use poultry manure with rate 100% or 75%+biofertilization to fertilize the olive trees planted under the same condition.

Key words: Olive · organic fertilization · biofertilization · vegetative growth · leaf chemical content · flowering

INTRODUCTION

Olive cultivation has an important role in agricultural production. Since it increases the land value especially in unsuitable soil for other fruit crops due to its capability to grow under several conditions [1]. Most of new reclaimed areas in Egypt are planted with fruit trees and the majority of these areas are sandy soil. Olive is one of fruit crops that can grow in such soil due to its capability to tolerate drought and stress. The production of olive in these areas is generally low due to the poor soil fertility and low water holding capacity. Accordingly, it seems that trees are not only in need to mineral nutrition but also organic fertilization [2].

Organic matter is not necessary for plant nutrition as slow release fertilizer but also essential for efficient plant production system [3]. In sandy soil, organic fertilization improves soil condition besides an important source of macro and micro nutrition. Several studies had shown that addition of manure not only increased organic matter content in the soil but also the available P and exchangeable K, Ca and Mg content [4].

The beneficial effect of the use of organic waste materials as N source is considered as the best management for N fertilization practice [5].

Biofertelizers are biological preparations containing primarily potent strains of microorganisms in sufficient number. These microorganisms have definite beneficial role in the fertility of soil rhizosphere. The biofertilizers might contain different strains of a symbiotic associative diazotrophes, phosphate solubilizing microorganisms, silicate dissolving microorganisms [6]. In addition to, biofertilizers contained bacteria led to increase in plant dry weight, leaf chlorophyll and net assimilation rate [7].

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Also, inoculation with biofertilizers helps in availability of minerals and their forms in the composted material and increases levels of extractable N, P, K, Fe, Zn and Mn [8]. Moreover, *Azotobacter* species produced adequate amount of IAA and cytokinin, which increases the surface area per unit root length and were responsible for root hair branching [9].

The target of this study is to investigate the effect of organic manure as compost or poultry with or without nitrogen fixing bacteria namely Biogein as biofertilizer on vegetative growth and flowering characters of Picual olive trees.

MATERIALS AND METHODS

This study was carried out during two successive seasons, (2005 and 2006) on "off " ten years old of Picual olive trees in an private farm located at Cairo-Alexandria, desert road (about 90 Km from Cairo). The trees were planted at 5×8 m apart, in sandy soil under drip irrigation system. The physical and chemical properties of the experimental soil are shown in Table 1 according to Wild *et al.* [10].

The experiment was set in a Completely Randomized Block Design with eight treatments each content three replicates and the replicate represented by two trees. The normal agriculture practices that used in the farm were applied to all Picual olive trees except those dealing with nitrogen fertilization. According to the recommendation of Ministry of Agriculture, Egypt, the olive trees required actual nitrogen yearly (1000 g tree^{-1} year^{-1}) equal 60 kg of compost and 50 kg of poultry manure, the chemical composition of the tested organic fertilizers are shown in Table 2.

The olive orchard was fertilized with organic fertilization (compost or poultry manure) superficially and digged in the soil at the second week of December and 1.75 kg of super phosphate (15.5% P_2O_5) per tree were added. In addition, 1.50 kg of potassium sulfate (48% K_2O) per tree was added as a soil application divided to two equal doses, the first rate was added at the second week of December combined with phosphate and organic fertilizers and the second rate was added at the first week of June. Nitrogen fertilizer was added as a percent (100%-75%-50%) of the recommended rate (5 kg of ammonium sulphate (20.6% N) per tree) divided to three equal doses applied at January, June and August by mixing with the soil surface layer (20 cm depth) surrounding the trunk till the external end of canopy shade. The biofertilizer Biogein contain *Azotobacter* and *Azospirillum* bacteria as N fixing bacteria was applied in the second week of February with

Table 1: Some physical and chemical analysis of the orchard soil

Characters	Value
Particle size distribution	
Clay %	5.20
Silt %	2.00
Sand %	92.80
Texture	Sand
EC (mmhos cm^{-1})	1.53
pH	8.65
Organic matter %	0.17
Total carbonate %	4.40
Available macronutrients	
N %	1.74
P %	0.81
K %	1.67
Available micronutrients	
Zn ppm	1.20
Cu ppm	2.30
Fe ppm	1.00

constant rate 100 g tree^{-1} in trenches (30 cm length×20 cm width×10 cm depth). Irrigation was conducted after the addition of fertilizers in both seasons.

The treatments included in such experiment were as follows:

- 1-100% Mineral fertilization
  (1000 g mineral nitrogen tree^{-1}) [5 kg ammonium sulfate]
- 2-75% Mineral fertilization+Biofertilization
  (3.75 kg ammonium sulfate)+(100 g *Azotobacter* and *Azospirillum*)
- 3-50% Mineral fertilization+50% Organic fertilization
  (2.5 kg ammonium sulfate)+(30 and 29.4 kg compost El-Neel in both seasons)
- 4-50% Mineral fertilization+50% Organic fertilization
  (2.5 kg ammonium sulfate)+(25 kg Poultry manure)
- 5-75% Organic fertilization+Biofertilization
  (45 and 44.1 kg Compost El-Neel in both seasons)+(100 g *Azotobacter* and *Azospirillum*)
- 6-100% Organic fertilization
  (60 and 58.8 kg Compost El-Neel in both seasons)
- 7-75% Organic fertilization+Biofertilization
  (37.5 kg Poultry manure)+(100 g *Azotobacter* and *Azospirillum*)
- 8-100% Organic fertilization
  (50 kg Poultry manure)

On early January of each season, twenty healthy one year old shoots representing the previous spring growth, well distributed around periphery of each

Table 2: Physical and chemical analysis of organic manure sources

	El-Neel compost		Poultry manure	
Character	First season	Second season	First season	Second season
Weigh of m^3 (kg)	600.00	600.00	530.00	530.00
Humidity (%)	30.00	30.00	20.00	20.00
pH	9.07	9.00	10.25	8.50
EC (mm cm^{-1})	8.66	6.50	16.15	15.50
Organic matter %	30.70	33.60	28.56	31.30
Organic carbon	31.00	31.00	27.90	27.90
C/N ratio	18.70	18.20	13.95	13.95
Total nitrogen %	1.66	1.70	2.00	2.00
Total phosphorus %	0.30	0.44	1.12	0.95
Total potassium %	1.56	1.00	1.21	1.21
Fe ppm	47.60	50.00	38.50	31.70
Mn ppm	32.20	34.70	32.60	36.40
Cu ppm	3.40	4.00	19.40	17.80
Zn ppm	4.70	4.50	46.20	48.50

tree were randomly selected and labeled (5 shoots toward each direction) for carring out the following measurements.

Vegetative growth: At the end of each growing season during first week of October the following characteristics were measured.

- Number of shoots
- Number of leaves per shoot
- Leaf area (cm^2) according to Ahmed and Morsy [11] using the following equilibration: Leaf area = 0.53 (length×width)+1.66.

Leaf chemical composition: Leaves needed were randomly sampled from the previously labeled shoots per each replicate/tree on September. Whereas, 2-3 leaves from every shoot (4 and 5th leaves) were picked then mixed together as a composite for carrying out the following chemical analysis:

Pigments i.e., chlorophyll a and b as mg g^{-1} were colormetrically determined in fresh leaf samples at wave length of 660 and 640 nm for a and b respectively according to Von Wettestien [12].

Mineral composition: Sample leaves from each tree (replicate) were separately oven dried till constant weight and then grounded for determination the following nutrient elements:

- N-Using the modified micro-kjeldahl method as lined by Pregl [13].
- P-Percentage as dry weight was estimated as described by Chapman and Pratt [14].
- K-Flamephotometerically determined according to Brown and Lilleland [15].
- Fe, Zn and Mn-spectrophotometerically determined using atomic absorption (Model, spectronic 21 D) as described by Jackson [16].

Flowering characteristics: At full bloom stage (first week of April), average length of inflorescence, number of inflorescences per shoot, total number of flower per each and sex ratio estimated as a perfect flower percentage.

Statistical analysis: All obtained data during both 2005 and 2006 experimental seasons were subjected to analysis of variances (ANOVA) according to Snedecor and Cochran [17] using MSTAT program. (LSR) were used to compare between means of treatments according to Duncan [18] at probability of 5%.

RESULTS AND DISCUSSION

Vegetative characteristics

Number of shoots: The results presented in Table 3 indicate that, addition the N requirements in mineral or organic form as poultry manure showed the same values of shoots number and this values were high in comparison with the other treatments. Whereas 100% organic fertilization (poultry manure) gave the highest value (13.14 and 18.20) in both seasons respectively.

Table 3: Effect of organic and bio-fertilization on vegetative parameters of Picual olive trees in 2005 and 2006 seasons

	No. Shoots		No. Leaves/Shoot		Leaf area (cm^2)	
Treatment	2005	2006	2005	2006	2005	2006
100 % MF	13.10a	17.77a	17.40c	28.97ab	3.917a	4.393b
75 % MF+BF	10.50d	15.30a	16.70c	22.61c	3.833a	3.970b
50 % MF+50% OF (compost)	11.80c	15.33a	17.32c	28.90ab	4.097a	4.317b
50 % MF+50% OF (poultry manure)	12.92ab	15.10a	21.10b	27.25b	4.337a	4.340b
75 % OF (compost)+BF	10.43d	15.87a	19.30bc	28.33b	3.780a	3.900b
100 % OF (compost)	12.17b	16.43a	21.47b	28.03b	4.077a	4.177b
75 % OF (poultry manure)+BF	12.95ab	17.73a	25.70a	31.03ab	3.920a	4.330b
100 % OF (poultry manure)	13.14a	18.20a	25.75a	33.47a	4.297a	5.303a

Mean in each column with similar letters are not significantly different at 5% level, MF = Mineral Fertilization, BF = Biofertilization, OF = Organic Fertilization

Table 4: Effect of organic and bio-fertilization on macro elements of Picual olive leaves in 2005 and 2006 seasons

	N (%)		P (%)		K (%)	
Treatment	2005	2006	2005	2006	2005	2006
100% MF	1.788a	1.868a	0.132a	0.159a	0.888ab	0.954ab
75% MF+BF	1.515ab	1.549c	0.132a	0.152a	0.888ab	0.779cd
50% MF+50% OF (compost)	1.355b	1.719b	0.123a	0.160a	0.870ab	0.877bc
50% MF+50% OF (poultry manure)	1.422b	1.847a	0.114a	0.166a	0.771bc	0.935ab
75% OF (compost)+BF	0.942c	1.538c	0.122a	0.150a	0.673c	0.770d
100% OF (compost)	1.054c	1.644bc	0.122a	0.156a	0.772bc	0.900bc
75% OF (poultry manure)+BF	1.549ab	1.863a	0.130a	0.170a	0.650c	0.953ab
100% OF (poultry manure)	1.793a	1.950a	0.141a	0.194a	0.968a	1.030 a

Mean in each column with similar letters are not significantly different at 5% level, MF = Mineral fertilization, BF = Biofertilization, OF = Organic fertilization

Number of leaves per shoot: Results in Table 3 display that number of leaves per shoot were significantly responsed to organic fertilization (poultry manure), whereas the highest value was obtained with 100% poultry manure followed by 75% (poultry manure)+ biofertilization in both seasons.

Leaf area (cm^2): Table 3 shows that no significant difference was observed in leaf area in the first season, however in the second season 100% organic fertilization (poultry manure) gave the highest value of leaf area (5.303 cm^2).

The positive effects of organic manure on the vegetative characteristics could be attributed to their effects on supplying the trees with their requirements of various nutrients as a relatively long times, as well as, their effect on lowering soil pH which could aid in facilitating the availability of some nutrients in the soil and improving physical characters of soil in favour of root development [19]. However Abou El-Khashab [20] reported that, the enhancement of plant growth due to inoculation with N fixing bacteria could be attributed to the capability of these organisms to produce growth regulators such as auxins, cytokinines and gibberillins which affect production of root biomass and nutrients uptake. These results are in agreement with those reported by Abd El-Naby and Gomaa [21] on banana, Maksoud [22] on olive and Abd El-Naby *et al.* [23] on banana.

Leaf chemical composition

Leaf nitrogen content (%): Results in Table 4 showed that, leaf content of N was significantly affected by different treatments in both seasons. Also, leaf content of N was increased in the second season than in the first one. In addition, 100% N fertilization in poultry manure form or mineral form increased leaf content of N in both seasons (1.793 and 1.950) or (1.788 and 1.868) respectively.

Leaf phosphorous content (%): No significant difference was observed between treatments on leaf P content,

Table 5: Effect of organic and bio-fertilization on micro elements of Picual olive leaves in 2005 and 2006 seasons

	Fe (ppm)		Zn (ppm)		Mn (ppm)	
Treatment	2005	2006	2005	2006	2005	2006
100% MF	126bc	139b	25.33b	44.33a	15.33b	22.67ab
75% MF+BF	110c	135b	26.67b	44.33a	28.00a	25.00a
50% MF+50% OF (compost)	130abc	131b	33.67a	35.00c	17.00b	17.33cd
50% MF+50% OF (poultry manure)	137abc	148ab	26.33b	38.33bc	23.00ab	22.00ab
75% OF (compost)+BF	112c	137b	26.00b	34.33c	17.33b	15.67d
100% OF (compost)	153ab	148ab	34.00a	33.33c	15.33b	20.00bc
75% OF (poultry manure)+B.F.	132abc	142ab	29.33ab	41.67ab	23.00ab	25.67a
100% OF (poultry manure)	156a	160a	25.33b	37.00bc	23.00ab	26.67a

Mean in each column with similar letters are not significantly different at 5% level, MF = Mineral fertilization, BF = Biofertilization, OF = Organic fertilization

Table 6: Effect of organic and bio-fertilization on blooming (inflorescence Length, flowering density and no. of total flowers/inflorescence) of Picual olive trees in 2005 and 2006 seasons

	Infl. length (cm)		Flowering density No. infl. m^{-1}		No. total flower $infl.^{-1}$	
Treatment	2005	2006	2005	2006	2005	2006
100% MF	1.72bcd	2.70a	60.60ab	87.37b	6.64bc	8.94bc
75% MF+BF	1.56d	2.13c	55.53ab	85.70b	6.17c	9.05bc
50% MF+50% OF (compost)	1.68cd	2.40abc	50.63b	86.73b	6.27c	9.29abc
50% MF+50% OF (poultry manure)	1.99a	2.56ab	59.00ab	93.50ab	8.53a	9.91ab
75% OF (compost)+BF	1.86abc	2.11c	49.90b	89.90b	6.97 b	9.19abc
100% OF (compost)	1.57d	2.26bc	52.68ab	92.23b	6.53bc	8.21c
75% OF (poultry manure)+BF	1.98ab	2.24bc	62.67a	104.8a	7.17b	10.40ab
100% OF (poultry manure)	1.95ab	2.43abc	62.23a	96.90ab	8.20a	10.72a

Mean in each column with similar letters are not significantly different at 5% level, MF = Mineral fertilization, BF = Biofertilization, OF = Organic fertilization

which 100% organic fertilization (poultry manure) gave the highest P content (0.141 and 0.194) in both seasons respectively as compared with other treatments. Also, leaf content of P was increased in the second season than in the first one.

Leaf potassium content (%): Potassium in leaf was significantly affected by all treatments. Whereas, 100% organic fertilization (poultry manure) had similar value with 100% mineral fertilization and gave the highest values of leaf K content in both seasons. Also, leaf content of K was increased in the second season than in the first one.

The outstanding role of organic fertilization on reducing the loss of nutrients through drainage water could explain the present results. Similar results were reported by Marshaniya and Mikeladze [24] and El-Sayed [25]. Also, Kassem and Marzouk [2] found that adding organic manure increase leaf mineral content due to availability of nutrients in the soil. However El-Kramany [8] found that, biofertilizers helps in availability of minerals and their forms in the composted material and increases levels of extractable N, P, K, Fe, Zn and Mn.

Leaf iron content (ppm): Data presented in Table 5 showed that, leaf content of Fe was significantly affected by different treatments in both seasons, the highest leaf content of Fe in both seasons were obtained with organic fertilization especially 100% poultry manure.

Leaf zinc content (ppm): It is noticed from the obtained results in Table 5 that, leaf zinc content was significantly responsed to the treatments, in the first season organic fertilization (compost) at 100% rate followed by 75% poultry manure+biofertilization gave the highest value. However in the second season 100% mineral fertilization only or 75% mineral fertilization+biofertilization gave the highest value followed by 75% organic fertilization (poultry manure)+biofertilization.

Leaf manganese content (ppm): As shown in Table 5 in the first season 75% mineral fertilization+biofertilization

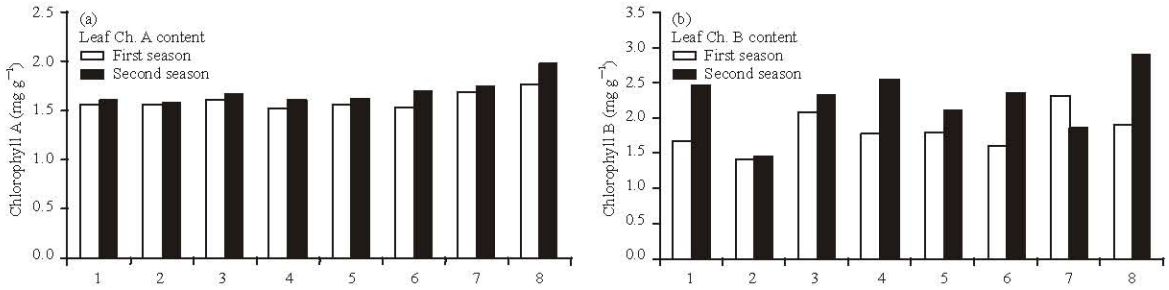

Fig. 1a, b: Effect of organic and bio-fertilization on leaf chlorophyll A and B content of Picual olive trees in 2005 and 2006 seasons

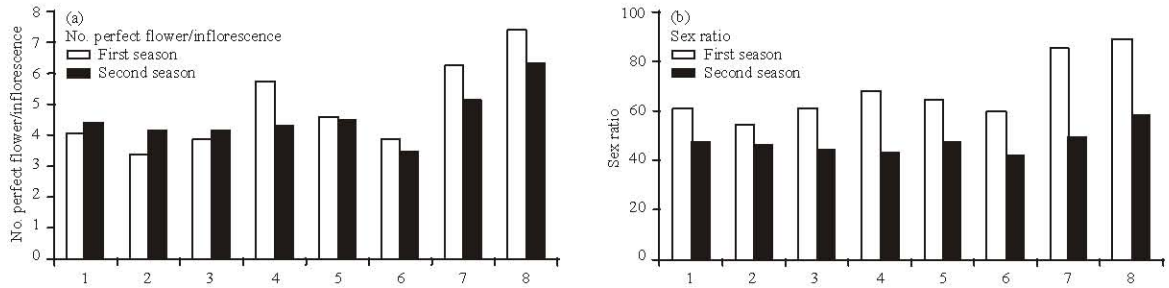

Fig. 2a, b: Effect of organic and bio-fertilization on blooming (no. perfect flowers/inflorescence and sex ratio) of Picual olive trees in 2005 abd 2006 seasons
1-100% Mineral Fertilization 2-75% Mineral Fertilization+Biofertilization
3-50% Mineral Fertilization+50% Organic Fertilization (compost)
4-50% Mineral Fertilization+50% Organic Fertilization (poultry manures)
5-75% Organic Fertilization (compost)+Biofertilization 6-100% Organic Fertilization (compost)
7-75% Organic Fertilization (poultry manures)+Biofertilization
8-100% Organic Fertilization (poultry manures)

followed by 50% mineral fertilization+50% organic fertilization (poultry manure) or 75% poultry manure+ biofertilization or 100% poultry manure gave the highest value of Mn content, however, in the second season 100% organic fertilization (poultry manure) gave the highest value followed by 75% organic fertilization (poultry manure)+biofertilization.

Leaf chlorophyll pigments: As data shown in Fig. 1a and b. no significant differences were observed between treatments on leaf chlorophyll A content in both seasons, however 100% organic fertilization (poultry manure) gave the highest value as compared with the other treatments. While leaf chlorophyll B content was enhanced in the second season than in the first one.

Flowering characteristics

Inflorescences length: Data presented in Table 6 revealed that, inflorescences length was significantly affected by all treatments in both seasons. Inflorescences length was higher in the second season than in the first one. In addition, 50% mineral fertilization+50% organic fertilization (poultry manure) gave the highest value in the first one (1.99 cm), while 100% mineral fertilization gave the highest value (2.70 cm) in the second season.

Flowering density (number of inflorescences per meter): Concerning the results in Table 6 number of inflorescences per meter showed a higher value in the second season than in the first one. The highest number of inflorescences per meter was obtained with 75% organic fertilization (poultry manure)+biofertilization (62.67 and 104.8) followed by 100% organic fertilization (poultry manure) (62.23 and 96.90) in both seasons respectively.

Number of total flowers per inflorescence: Table 6 showed that, in general addition organic manure to the soil increased the number of total flowers per inflorescence in both seasons. Whereas the highest number of total flowers per inflorescence was obtained in the first season with 50% mineral fertilization+50% organic

fertilization (poultry manure) followed by 100% organic fertilization (poultry manure), but in the second season 100% organic fertilization (poultry manure) gave the highest value followed by 75% organic fertilization (poultry manure)+biofertilization or 50% mineral fertilization+50% poultry manure.

Number of perfect flowers per inflorescence: Figure 2 reveals that, the average number of perfect flowers per inflorescence was lower in the second season than in the first, this could be attributed to the "on condition" in the second season. However the highest value was obtained with 100% organic fertilization (poultry manure) followed by 75% organic fertilization (poultry manure)+biofertilization in both seasons respectively.

Sex ratio: Figure 2a and b shows that, ratio of perfect flowers to male flowers was significantly increased in both seasons with almost treatments. However, 100% organic fertilization (poultry manure) gave the highest value (89 and 58.59%) followed by 75% organic fertilization (poultry manure)+biofertilization (85.57 and 49.42%) in both seasons respectively.

Referring to the previously results one can see that all the flowering measurements were almost significantly higher with organic fertilization (poultry manure) as compared with other treatments, except inflorescence length in the second season. The improvement in flowering measures resulted from organic fertilization (poultry manure) may be attributed to the stimulation effect of the absorbed nutrients on photosynthesis process which certainly reflected positively on both vegetative growth and flowering characteristics [2, 4, 22].

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