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Effect of Bio Fertilizers and Natural Minerals on Productivity and Fruit Quality of Olive Trees Cv. "Picual"

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Author's contribution

This whole work was carried out by the author MAESE.

Original Research Article

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ABSTRACT

A study was carried out during 2009 and 2010 growing seasons on olive cv. 'Picual', (12 years old), planted in a farm located at 50 kilometer from Cairo. The trees were planted at 6×6meters apart and grown in sandy soil and irrigated with drip irrigation from well (underground water). The effect of Pomace of the olive mill wastes, Compost, Rock phosphate, Feldspar alone or combined with Netropeine, Phosphoreine and Potaseine (bio-fertilizers) on vegetative growth, flowering, yield and fruit characteristics of olive trees cv. "Picual" was studied. Data showed that Compost alone increased shoot length and shoot diameter in the second season whereas, No. of leaves was significantly increased by Compost addition in both seasons compared to the other tested treatments. The addition of Rock phosphate alone followed by Compost plus pomace supported with bio-fertilizers significantly improved No. of inflorescences/m in the first season, only. Perfect flowers percentage and No. of retained fruits/m after June drop were improved by the Pomace provided with bio-fertilizers and Rock phosphate alone during both growing seasons. Feldspar treatment alone gave the superior values in pulp/seed ratio during the first season. Pomace enriched with bio-fertilizers and Compost improved fruit quality (fruit length, fruit diameter and pulp weight) during both seasons. Fruit and pulp weight were enhanced after treateing the plants with Pomace or Compost combined with biofertilizer. As for the yield, the Feldspar alone or Pomace and Compost plus bio-fertilizers gave the highest significant values compared to the control and other treatments.
It is thus recommended to add Feldspar, Pomace and compost in addition to the bio and natural fertilizers to improve production and fruit quality of olive cv. "Picual".

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1. INTRODUCTION

Increasing olive trees productivity under desert conditions must be based on appropriate technical and economic management due to the natural resources scarcity. Furthermore, production and utilization of chemical fertilizers are considered as, air, soil and water polluting agents, in addition to the high costs of their manufacture. Olive trees areas increased rapidly in Egypt and reached about 68602 hectars with total production about 611600 tons, where 20% of the total fruit production produces about 10000 tons of olive oil (according to the latest statistics of [1]. The efficiency of fertilizers used in Egypt is very low, may be due to high pH or calcium carbonate level in the soil which hamper the availability of P-fertilizers, in addition to the leaching of nitrate or ammonia volatilization from the nitrogen fertilizers [2]. Thus, the application of organic fertilizer could avoid these pollutions, reduce the costs of fertilization and would be safe for human, animal and environment. Therefore, the alternative use of natural compounds can improve the soil physical, chemical properties, as well as, increase water uptake and nutrient availability [3,4]**.** Although, composts weakly affected soil properties, they increased soil potentially available nutritive elements to crops [5]. Olive pomace could be used in agriculture as an organic fertilizer and soil conditioner. It has a moderate acidity, a high content of partially humified organic matter (OM) and potassium [6]. Composted waste materials increased tree nutritional status and olive yields [7]. Compost application increased soil OM concentration and cationic exchange capacity [8]. Bio-fertilizers contain microorganisms that help in availability of minerals as well as modification of nutrient uptake by the plant**.** Moreover, some authors studied the effect of bio-fertilizers "Phosphorine" on phosphorous content and dry matter of guava seedlings growing in sandy soil conditioned with composted town waste. They found that with increased application rate of the composting of olive oil processing waste water and solid residue (Pomace) to the soil, the water-holding capacity of this conditioner was almost two times greater than that of the pure soil [9]. There was a decrease in the soil pH, an increase in the specific conductivity, and an increase in the ammonium-nitrogen (NH_4-N) and P concentration of the mixture [10]. Natural elements compounds as feldspar, sulphur and magnetite are used as a source of some nutrient minerals. Their use in nutrients management is considered clean or according to organic agriculture since these compounds improve soil aggregation, structure, permeability, infiltration, electrical conductivity (EC) and may overcome the harmful effect of saline water application. Moreover, Egyptian soils having alkaline pH are low in their available nutrients. Sulphur is frequently considered the most important amendment for soil reclamation and improvement through, reducing soil pH, improving water relations and increasing availability of some nutrient elements needed for growth and yield [11,12]. In order to reduce the dependence on imported potash, feldspar a potash mineral, containing 11.25% K_2O could be a potential K- source for crop production [13]. The use of potassium feldspar or crushed granite gave a yield response, although no greater than for conventional fertilizers [14].

This study was thus conducted to evaluate the effect of bio-fertilizers and natural minerals on productivity and fruit quality of olive trees cv. Picual.

2. MATERIALS AND METHODS

The present study was carried out during 2009 and 2010 growing seasons on olive trees cv. 'Picual' (12 years old) uniform in shape and size and planted 6x6 meters apart in a olive farm at 52 kilometer from Cairo (Fifa Company for Food Technology, Cairo Alexandria Road). Soil analysis was conducted according to [15] and the result is listed in Table 1.

Table1. The experimental soil macro and micro elements analysis

Total macronutrients (%)			Total micronutrients (ppm)			
N	**P**	**K**	**Zn**	**Cu**	**Mn**	**Fe**
0.072	0.49	0.358	7.62	0.85	3.15	189.0

The experimental trees were grown in a sandy loamy soil and irrigated with drip irrigation from well (underground water) having a salt concentrations of 800 ppm and received normal fertilization.

The annual fertilization of the field was: perhectar 8.4 m^3 organic matter, 150kg superphosphate (15.5%P_2O_5), 500Kg ammonium sulphate (20.6% N) and 200Kg potassium sulphate (48% K_2O). In addition to these amounts, as the usual amounts added for organic and chemical fertilizers, the following products were applied: Pomace (25Kg/tree), Compost (20Kg/tree), Rock phosphate (1.5Kg/tree), Feldspar (3kg/tree), Nitropeine (120g/tree) (a mixture of N-fixing bacteria), Phosphoreine (25Kg/tree) (a mixture of P-solubilizing Bacteria) and Potasseine (134 g/tree) (30 % K_2O and 8 % P_2O_5). These doses were consistent with the recommendations of the Department of the Soil and Water Research Institute, Agricultural Research Center, Giza, Egypt.

2.1 Treatments and Experiment Layout

The following treatments were thus considered in the trials:

1- Control.
2- Pomace NPK (1.52, 0.40, 0.66).
3- Compost NPK (1.80, 0.39, 1.33).
4- Rock phosphate NPK (0, 14.5, 0).
5- Feldspar (0, 0, 9).
6- Pomace + "bio-fertilizers" as (Netropeine + Phosphoreine + Potasseine).
7- Compost + bio-fertilizers.
8- Rock phosphate + bio-fertilizers.
9- Feldspar + bio-fertilizers.
10- Pomace + Compost + bio-fertilizers.
11- Pomace + Compost + Rock phosphate + bio-fertilizers.

2.2 Measurements

2.2.1 Soil analysis

Soil samples were taken from the major root zone at the end of each growing season and were analyzed for electrical conductivity (EC), soluble ions and soil pH. Soil chemical, physical properties and nutrient content were determined according to [16].

In December of both seasons, twenty healthy one year old shoots were randomly chosen and labeled at each direction for carrying out growth, flowering and fruit yield and quality parameters as follows.

2.2.2 Growth parameters

In the first week of August of both seasons, the following parameters were measured:
Shoot length (cm) starting from the base, shoot diameter (cm) 10cm from the base, number of leaves per shoot (average number of one year old from twenty shoots representing the four direction of the tree).

2.2.3 Flowering parameters

2.2.3.1 Flowering density

At full bloom of both seasons, the following measurements were determined i.e., number of inflorescence per meter and inflorescence length (cm), number of total flowers per inflorescence, perfect flowers %: the percentage of perfect flowers to total flowers/ inflorescences later was calculated.

2.2.4 Fruiting parameters

1- **Fruit:** set percentage was determined 15 days after full bloom as initial set fruit and number of remained fruits was determined 60 days after full bloom.
2- **Yield:** average yield (Kg)/tree were calculated.

2.2.5 Fruit quality

Thirty fruit per each tree were randomly selected for carrying out the fruit quality measurements namely: fruit weight (g), fruit length (cm), fruit diameter (cm), pulp weight (g.), seed weight (g.), pulp/seed ratio, seed length (cm) and seed diameter (cm).

2.3 Statistical Analysis

The experiment included in this study followed a complete randomized design in factorial experiment. The obtained data was subjected to analysis of variance (ANOVA) according to [17]. Differences between treatments were compared by [18] multiple range tests described in the [19].

3. RESULTS AND DISCUSSION

3.1 Vegetative Growth

Table 2, shows the effect of bio and natural fertilizers on shoot growth during 2009 and 2010 growing seasons. Data revealed that Compost alone or Feldspar gave the highest significant values of shoot length compared to the control and other treatments in the second season only. On the other hand, Rock phosphate provided with bio-fertilizers treatment performed the least significant value, in this respect. The other treatments performed intermediated values. However, the same treatments did not show any significant difference in the first season.

Table 2. Effect of (bio) and natural fertilizers on shoot length, shoot diameter, No. of leaves/shoot and No. of inflorescences/m of olive trees cv. Picual during 2009 & 2010 growing seasons

Treatments	Shoot length (cm)		Shoot diameter (cm)		Number of leaves/shoot		No. of inflorescences/m	
	2009	2010	2009	2010	2009	2010	2009	2010
Control	11.67	14.73a-c	0.22	0.18a	16.30b-d	23.27ab	38.33bc	63.40
Pom.	12.20	16.16a-c	0.23	0.16ab	17.53bd	20.70ab	26.87c	65.80
Com.	11.43	20.60a	0.17	0.19a	24.93a	25.50a	35.90bc	39.03
Roc.	12.50	13.90bc	0.18	0.18a	21.13ab	23.63b	53.70a	63.03
Fel.	10.53	16.83ab	0.18	0.16ab	21.13b	24.67b	33.40bc	57.57
Pom + A	11.53	15.17a-c	0.21	0.15ab	16.73bd	19.07ab	34.20bc	58.07
Com. + A	11.00	14.40bc	0.18	0.16ab	21.13ab	21.33b	33.90bc	54.93
Roc. + A	9.60	10.16c	0.20	0.15ab	14.23d	19.27b	41.60ab	50.83
Fel. + A	10.70	12.06bc	0.20	0.17a	20.63a-c	16.80b	42.30ab	56.67
Pom.+Com.+A	13.33	10.67bc	0.22	0.13b	15.90cd	19.20ab	46.00ab	66.47
Pom.+Com.+ Roc.+A	12.87	11.76bc	0.18	0.17a	15.27d	20.30b	40.20bc	58.00
LSD	NS	5.392	NS	0.032	4.581	6.814	12.21	NS

Means followed by the same letter(s) within the same column are not significantly different, at p = 0.05 Pom. (Pomace) *Com. (Compost), *Roc. (Rock phosphate), *Fel.(Feldspar). *A (bio-fertilizers)*

As for shoot diameter, the treatments of Rock phosphate or Compost solely, Feldspar supported with bio-fertilizers and Compost enriched with Pomace, Rock phosphate and bio-fertilizers besides the control gave the highest significant values compared to the other treatments during 2010 season, whereas during 2009 season there were not significant differences.

Concerning number of leaves/shoot, Compost treatment only provided better results in comparison to all treatments including the control in both seasons. In contrast, Rock phosphate provided with bio-fertilizers and Feldspar supported with bio-fertilizers treatments recorded the least values during 2009 and 2010, respectively.

In regard to the number of inflorescences/m, Rock phosphate solely, gave the highest significant values, in this respect compared to other treatments including the control. On the contrary, Pomace treatment performed the least significant value during the first season. Meanwhile, there were not any significant differences during 2010 season.

3.2 Flowering and Set Fruit

Table 3 demonstrates that inflorescence length was significantly increased by the addition of Rock phosphate and the Compost provided with Pomace, Rock phosphate & bio-fertilizers treatments during 2009 and 2010 growing seasons, respectively. On the other hand, the control and the Pomace treatments showed the least significant values, respectively.

Regarding number of flowers/inflorescence, reported data shows that all tested treatments induced a higher significant value as compared with control during the first growing season. Whereas, the Compost combined with Pomace, Rock phosphate besides bio-fertilizers treatment detected the highest significant values as compared with control and other treatments during the second season. The reverse was true for the control and Pomace

treatments hence they gave the least significant values compared to other treatments in both seasons.

Concerning perfect flowers percentage the control and the Pomace combined with bio-fertilizers treatments produced the highest significant values compared to other treatments during the first season. On the contrary, Rock phosphate and bio-fertilizers showed the least significant values in this respect. There were not significant differences between treatments during the second season.

Table 3. Effect of (bio) and natural fertilizers on flowering and set fruit of olive trees cv. Picual during 2009 & 2010 growing seasons

Treatments	Inflorescence length(cm)		No. of flowers /inflorescence		Perfect flowers (%)		Set Fruit / m	
	2009	2010	2009	2010	2009	2010	2009	2010
Control	2.17c	1.60bc	7.37b	13.73ab	38.37a	15.07	28.07b	26.40cd
Pom.	2.23bc	1.57c	11.07ab	1347b	36.53ab	11.97	22.90e	32.27ab
Com.	2.50bc	1.77ab	12.60a	14.80ab	33.17 a-c	14.83	24.63c-e	35.77a
Roc.	3.20a	1.60bc	12.43a	14.27ab	22.30bc	13.87	25.03b-e	22.00e
Fel.	2.57bc	1.73a-c	10.77ab	13.87ab	24.47a-c	10.53	22.17e	31.93ab
Pom + A	2.27bc	1.77ab	12.00a	14.80ab	37.70a	14.03	37.80a	28.57b-d
Com. + A	2.57b	1.73a-c	12.47a	14.13ab	28.43 a-c	13.70	23.80de	31.63ab
Roc. + A	2.60bc	1.70a-c	12.70a	15.67ab	20.97c	11.90	27.67bc	26.40cd
Fel. + A	2.23bc	1.77ab	11.87a	15.07ab	22.47a-c	15.60	17.57f	30.40bc
Pom. + Com.+A	2.43bc	1.70a-c	12.13a	14.13ab	29.50a-c	14.10	26.57b-d	31.00b
Pom.+Com.+Roc .+A	2.30bc	1.80a	10.43ab	16.40a	32.80a-c	12.53	25.33b-e	25.27de
LSD	0.383	0.169	3.597	2.33	12.8	NS	2.98	3.93

**Means followed by the same letter(s) within the same column are not significantly different, at p = 0.05.* Pom. (Pomace) * Com. (Compost).* Roc. (Rock phosphate) * Fel. (Feldspar). * A bio-fertilizers*

As for number of fruits set/m, data show that pomace plus bio-fertilizers treatment and compost alone induced a higher positive effect in comparison to the control and other treatments during 2009 and 2010 seasons, respectively. Reversely, Feldspar alone gave the least significant difference in the 1st season and Rock phosphate gave analogous effect in the second one.

3.3 Fruiting, Fruit Quality and Yield

The number of remained fruits/m (60 days after full bloom) data revealed that Rock phosphate treatment significantly increased this parameter in comparison to the control and other treatments during the second season, whereas in the first one there were not significant differences (Table 4). On the contrast Pomace supported with bio-fertilizers treatment showed the least significant value.

As for yield, the Feldspar treatment showed the superiority in enhancing tree yield followed by the Feldspar provided with bio-fertilizers and the Pomace supported with bio-fertilizers during the first season, with the control performed the worst. Meanwhile, there were not significant differences between treatments in the second season.

Effect of bio and natural fertilizers on the fruit characteristics is presented in Table 4. It is evident that Pomace provided with bio-fertilizers and Compost supported with bio-fertilizers

significantly increased fruit weight during 2009 and 2010 growing seasons, respectively compared with other treatments including the control.

It is shown that Pomace provided with bio-fertilizers and Compost enriched with bio-fertilizers treatments gave the highest values of fruit length (cm) compared to the control and other treatments. On the other hand, Compost supported with bio-fertilizers treatment performed the least significant values during the first growing season.

Table 4. Effect of (bio) and natural fertilizers on No. of remained fruits/m, yield and fruit quality of olive trees cv. Picual during 2009 & 2010 growing seasons

Treatments	No. of remained fruits/m		Yield (kg)/tree		Fruit weight (g)		Fruit length (cm)	
	2009	2010	2009	2010	2009	2010	2009	2010
Control	16.67	13.43b	21.80b	46.67	7.40ce	8.60ab	2.90a-c	2.83
Pom.	11.77	14.77ab	36.67ab	56.67	7.77bd	8.97a	2.90a-c	2.97
Com.	12.90	15.90ab	28.33ab	48.33	8.20ab	8.93a	3.03a	2.93
Roc.	17.73	21.73a	30.00ab	50.00	8.07a-c	7.70c	2.97ab	2.83
Fel.	14.87	17.87ab	43.33a	50.00	8.03a-c	8.13bc	2.90a-c	2.87
Pom+A	10.53	13.20b	28.33ab	48.33	8.53a	7.63c	3.13a	2.73
Com.+A	15.40	17.40ab	25.00b	45.00	6.93e	9.13a	2.70d	2.90
Roc.+A	14.07	16.73ab	24.00b	44.00	7.37ce	8.10bc	2.80cd	2.80
Fel.+A	16.80	19.80ab	38.37ab	51.67	7.47ce	8.57ab	2.87bc	2.90
Pom.+Com.+A	14.43	17.43ab	28.00ab	50.00	7.10de	8.60ab	2.77cd	2.90
Pom.+ Com.+ Roc.+A	14.10	16.43ab	31.67ab	45.00	7.77bd	8.73ab	2.87bc	2.83
LSD	N.S	6.280	14.384	NS	0.651	0.630	0.125	NS

**Means followed by the same letter(s) within the same column are not significantly different, at p = 0.05.* Pom. (Pomace) * Com. (Compost). * Roc. (Rock phosphate) * Fel. (Feldspar).* A bio-fertilizers*

3.4 Fruit Characteristics and Yield

Effect of bio and natural fertilizers on the fruit characteristics is presented in Table 5. As for fruit diameter Pomace, Compost and Feldspar alone in addition to Pomace and Rock phosphate enriched with bio-fertilizers besides Pomace plus compost added to Rock phosphate and supported with bio-fertilizers treatments significantly increased fruit diameter of olive tree cv. Picual compared to the control during the first growing season. In the second season Pomace treatment was better than the other treatments, including the control, in enhancing olive fruit diameter.

Concerning pulp weight Pomace provided with bio-fertilizers and Compost gave the highest significant difference in the 1st season compared to the control and other treatments, whereas Pomace alone and Compost enriched with bio-fertilizers gave the same analogous effect in the 2nd season.

In regard to seed weight Pomace enriched with bio-fertilizers, Compost and Compost combined with Pomace, Rock phosphate and bio-fertilizers treatments gave the highest values. Meantime, the control and Pomace combined with bio-fertilizers treatments performed the same analogous effect during the second season.

Table 5. Effect of (bio) and natural fertilizers on fruit quality of Picual olive cv. during 2009 & 2010 growing seasons

	Fruit diameter(cm)		Pulp weight (g.)		Seed weight (g)	
	2009	2010	2009	2010	2009	2010
Control	2.20bc	2.40ab	6.50e	7.30d	0.90ab	1.30a
Pom.	2.30a	2.43a	6.90d	7.74b	0.87ab	1.23ab
Com.	2.30a	2.40ab	7.27b	7.86a	0.93a	1.07ab
Roc.	2.27ab	2.37ab	7.17c	6.53g	0.90b	1.17ab
Fel.	2.30a	2.33b	7.16c	7.10e	0.87ab	1.03b
Pom+A	2.30a	2.33b	7.60a	6.33h	0.93a	1.30a
Com.+A	2.17c	2.40ab	6.03g	7.86a	0.90ab	1.27ab
Roc.+A	2.30a	2.33b	6.50e	6.97f	0.87ab	1.13ab
Fel.+A	2.23a-c	2.37ab	6.57e	7.40cd	0.90ab	1.17ab
Pom.+Com.+A	2.23a-c	2.40ab	6.30f	7.47c	0.80b	1.13ab
Pom.+Com.+Roc.+A	2.30a	2.40ab	6.84d	7.70b	0.93a	1.03b
LSD	0.078	0.078	0.091	0.105	0.088	0.223

[*]Means followed by the same letter(s) within the same column are not significantly different, at p=0.05. Pom. (Pomace) * Com. (Compost). * Roc. (Rock phosphate) * Fel. (Feldspar) * A bio-fertilizers*

Table 6 shows the effect of bio and natural fertilizers on fruit quality of olive trees cv. Picual during 2009 and 2010 seasons. As for pulp/seed ratio Feldspar treatment alone and Pomace in addition to bio-fertilizers gave the highest values significantly different to the control and other treatments during 2009 growing season. Meantime Pomace supported with compost, Rock phosphate, bio-fertilizers performed similarly during 2010 growing season. On the contrary, Compost plus bio-fertilizers and Pomace supported with bio-fertilizers shown the lowest pulp/seed ratio in 1st and 2nd seasons, respectively.

As for seed diameter, Pomace treatment and the control induced the highest significant values compared to the control and other treatments during the 1st and 2nd seasons, respectively.

Table 6. Effect of (bio) and natural fertilizers on fruit quality of olive trees cvPicual during 2009 & 2010 growing seasons

Treatments	Pulp/seed ratio		Seed length		Seed diameter	
	2009	2010	2009	2010	2009	2010
Control	7.22g	5.61g	1.73ac	1.83ab	0.90b	1.17a
Pom.	7.93b	6.29e	1.67cd	1.90a	1.00a	1.10ab
Com.	7.81d	7.34b	1.77ab	1.73b	0.90b	1.03bc
Roc.	7.96b	5.58g	1.80ab	1.83ab	0.93b	1.13ab
Fel.	8.22a	6.89c	1.80ab	1.80ab	0.90b	1.03bc
Pom + A	8.17a	4.87h	1.80ab	1.80ab	0.90b	1.13ab
Com. + A	6.70h	6.19f	1.70bd	1.90a	0.90b	1.10ab
Roc. + A	7.47e	6.17f	1.63d	1.83ab	0.90b	1.07ac
Fel. + A	7.30f	6.32e	1.80ab	1.73b	0.90b	0.97c
Pom. + Com.+A	7.87c	6.61d	1.67cd	1.83ab	0.83c	1.07ac
Pom.+Com.+Roc.+A	7.35f	7.47a	1.83a	1.80ab	0.90b	0.97c
LSD	0.053	0.074	0.0884	0.1021	0.0417	0.1251

[*]Means followed by the same letter(s) within the same column are not significantly different, at p = 0.05. Pom. (Pomace), *Com. (Compost). * Roc. (Rock phosphate)* Fel. (Feldspar).* A bio-fertilizers*

Seed length showed the highest significant values as affected by the Pomace provided with Compost, Rock phosphate and bio-fertilizers treatments in comparison with other treatments including the control during the first growing season. Meanwhile, Pomace alone and Compost combined with bio-fertilizers treatments significantly increased seed length compared to the control during the second growing season.

4. DISCUSSION AND CONCLUSION

It is suffice to say that, although, feldspar treatment alone gave the superior values in yield during the first season, pomace + (netropeine + phosphoreine + Potasseine) and compost + (netropeine + phosphoreine + Potasseine) treatments improved the olive fruit quality in both seasons. In addition, the yield was almost doubled in one year, although the treatments did not induced a significant difference during the second season.

Being the cv. Picual a table olive, the fruit quality is in need of improvement for fruit and pulp weight [20,21,22]. Both were affected significantly by the addition of olive pomace and compost enriched with bio-fertilizers of phosphoreine, Nitropeine and Potasseine.

The importance of organic materials applications for different soils derives from their contribution in improving the soil physical properties such as: densities, porosities, structure, aggregation, water retention and transmission, due to direct effect on retention water (hydrophilic nature), and indirect effect because of the modification of the soil structure [23]. Using suitable fertilizers, i.e. based on microorganisms, organic or natural elements (single or in mixture), (liquid or solid) is very important [24].

The use of phosphate solubilizing bacteria as inoculants simultaneously increases (P) uptake by the plant and crop yield. Strains from the genera Pseudomonas, Bacillus and Rhizobium are among the most powerful phosphate solubilizers**.** Phosphate-solubilizing bacteria can be used as microbial inoculants with mixed cultures or co-inoculated with other microorganisms. Several studies demonstrate the beneficial influence of combined inoculation of phosphate-solubilizing bacteria and Azotobacter on yield, as well as on nitrogen (N) and (P) accumulation [25,26].

Several trials [5,6,7,8,27,28] have shown that, although Composts weakly affected soil properties, they increased soil potentially available nutritive elements and that two phase olive Pomace can be used successfully in agriculture as an organic fertilizer and soil conditioner. Olive Pomace has a moderate acidity, a high content of organic matter (OM) have a substantial content of potassium and nitrogen and a low content of phosphorus and micronutrients, which subsequently lead to improve tree nutritional status and finally olive yield. Addition of Compost or Pomace combined with natural minerals Feldspare or Rock phosphate besides the combination with bio-fertilizers improved the vegetative growth, flowering, fruit characteristics, set fruit and yield of olive cv Manzanillo [29]. Considering our results, we could this recommend to use organic fertilizers, natural minerals alone or mixed with bio-fertilizers to improve the production and quality of olive cv Picual.

Compost and/or Pomace combined with either bio-fertilizers or natural ones improved vegetative growth [8,11,12].

These results go in line with those of [29] on olive. Enhancement of flowering characteristics may be due to the role of Compost, Pomace, natural minerals and bio-fertilizers, which

increased water through regulating the stomata or through compensating, excessive water loss through transpiration is prevented and thus K improves the water use efficiency.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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