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Effect of Foliar Sprays with Potassium Nitrate and Mono-Potassium Phosphate on Leaf Mineral Contents, Fruit Set, Yield and Fruit Quality of Picual Olive Trees Grown Under Sandy Soil Conditions

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Abstract: The present investigation was carried out during two successive seasons of 2008 and 2009 on Picual olive trees grown in private orchard at Giza Governorate, Egypt. Potassium nitrate (KNO_3) and mono potassium phosphate (MPK) at different concentrations were applied through spraying on the trees either pre or post bloom. Results showed that all treatments of potassium nitrate (KNO_3) or mono potassium phosphate (MPK) caused a remarketed promotion in leaf mineral status, yield and fruit quality compared with the control trees. The best results with regard to foliar application were obtained with KNO_3 at 3% concentration which superior to improve nutrional status, flowering, fruit set, yield and fruit quality.

Key words: Picual olive trees · Leaf mineral contents · KNO_3 · MPK · Flowering · Fruiting · Fruit quality.

INTRODUCTION

Olive (*Olea europea* L.) is one of the oldest horticultural crops of remarkable cultural and economic importance in Mediterranean Basin and it also represents as widely distributed fruit trees in the world [1]. Current olive groves are estimated approximately 960 million olive trees, of which 945 million (98 % of the total) are found in the Mediterranean Basin countries where they cover approximately 9.3 million hectares. In Egypt, 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. Most of the new reclaimed areas in Egypt are planted with fruit trees and the majority of these areas are sandy soil. Olive is one of the fruit crops that can grow in such soil due to its capability to tolerate drought and stress. The production of olive under these areas condition is generally low due to the poor soil fertility. Accordingly, it seems that trees are in need to mineral nutrition for growth, flowering and fruiting. The total acreage grown with olive reached about 150.000 feddans, with fruiting acreage about 110.000 feddans and total production of about 48.000 tons fruits [2].

Picual olive trees are the most important commercial variety in Egypt. It can be used for both oil and table olive. Foliar fertilization is a widespread application method used in these rain fed orchards as it provides good nutritional results and increases olive yield [3].

Potassium is known by its influence many enzymatic reactions and is associated with almost every major plant functions. It improves the efficiency of plant water and sugar use for maintenance and normal growth functions. Potassium works with phosphorus to stimulate and maintain rapid root growth of plants [4]. Restrepo *et al.* [5] didn't find differences between foliar and soil applications of potassium salt, they recommend using foliar K fertilization in olive orchards growing in the dry lands due to its lower application cost compared to injecting K fertilizers into the soil. Moreover, the lack of moisture in the soil during the growing period could limit K uptake by roots. K is easily adsorbed and distributed through leaf tissues. Recent studies have shown that K plays an important role in growth and water-use efficiency in olive[6,7] and could be useful in ameliorating biotic stresses effects in olive plants [8] have been reported in other species [9,10]. Phosphorus is necessary for many life processes such as photosynthesis; synthesis, breakdown of carbohydrates and the transfer of energy within the plant. Deficiencies of P are unusual in olive orchards, except in soils that are deficient in this element [11]. Nevertheless, the foliar application of P may have a positive effect

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by increasing fruit set [3]. Mono-potassium phosphate (MKP) is a cost effective and readily available fertilizers used in foliar applications, MKP is the formulation with the lowest salt index and thus it considered the choice of foliar fertilizer for many crops [12]. It is an excellent and fast source of P and K when applied as a foliar fertilizer.

The aim of this experiment was to investigate the effect of foliar application with potassium nitrate and mono-potassium phosphate on leaf mineral contents, flowering, fruit set, yield and fruit quality of Picual olive trees grown under sandy soil conditions.

MATERIALS AND METHODS

The present investigation was carried out during two successive seasons on Picual olive trees of 10-12 years old grown in a private orchard at Giza governorate. The trees were planted six meters apart mixed with another cultivars under drip irrigation system. The experiment was set in a completely randomized block design and the normal agricultural practices that used in the farm were applied. Potassium nitrate (KNO_3) and mono potassium phosphate (KH_2PO_4) (MPK) at different concentrations were applied through spraying on trees either pre or post bloom as follow:

- Control (untreated trees).
- Spraying (KNO_3) at 1, 2 and 3% twice at the second half of December and again after fruit set (mid May) during the two seasons.
- Spraying (MPK) at 0.5, 1 and 1.5% twice at the second half of December and again after fruit set (mid May) during the two seasons.

Each treatment was applied at three replicate trees during both seasons of the study; twenty shoots (one year old) were chosen at random and labeled for every replicate to determine the following:

Leaf Mineral Content: In August of each season, leaf samples were collected, washed with tap water, then distilled water, dried at 70 °C until constant weight, grounded and finally digested by using the method of Piper [13]. The digested solution was used to determine N, P and K using the method described by Chapman and Pratt [14]. N, P and K were determined as percentage on dry weight bases.

Flowering Behavior

Flowering Density: number of inflorescences on the labeled shoots was recorded and number of inflorescences/meter was calculated

Sex Expression: samples of 30 inflorescences were taken from the middle portions of the chosen shoots, the number of total flowers and perfect were counted and then the percentage of perfect flowers to total flowers was calculated.

Germination of Pollen Grains: Pollen grains which collected from inflorescences samples were estimated by the method of Escober and Martin [15].

Fruit Setting: Number of fruit setting on representative labeled shoots per each replicate tree was recorded at the first of June in both seasons (about 45 days after full bloom).

Yield: Yield (kg/tree) was recorded at harvest time (mid October) for each tree in both seasons.

Fruit Physical and Chemical Characteristics: Black mature fruits as samples were collected at the mid of October in the two seasons from examined shoots and subjected to the following measurements: fruit weight (g), fruit volume (cm^3), fruit length (cm), fruit width (cm), fruit shape index, seed weight (g), flesh/fruit ratio and fruit oil content (percentage/ 100 gm dry weight) by means of the Soxhelt extraction apparatus using hexane of 60-80°C boiling point as described by A.O.A.C [16].

Statistical Analysis: The obtained data were statistically tested for analysis of variance using MSTAT-C [17] and the significant differences among the various treatments were compared using L.S.D values at provability of 0.05 according to Waller and Duncan [18].

RESULTS

Leaf Minerals Content: Figs. 1, 2 and 3 indicated the effect of spraying potassium nitrate (KNO_3) and mono-potassium phosphate (MPK) on leaves N, P and K contents of Picual olive trees during the two studied seasons. Nitrogen content in the leaves was significantly affected by different treatments in both seasons (Fig. 1). KNO_3 sprays at 3% gave the highest percentage of leaf nitrogen content (1.58 and 1.58) while control treatment gave the lowest value (1.34 and 1.36) in the first and second seasons, respectively.

Regarding phosphorus content in the leaves (Fig. 2), results showed that all treatments significantly increased leaves phosphorus content at both seasons. No trend was observed between treatments. MPK foliar application at 1.5% had a highest value in the first season (0.197%), while KNO_3 foliar application at 1% recorded the highest value of phosphorus in the second season (0.206%). The control treatment gave the lowest leaf phosphorus content (0.160 and 0.170%) in the two studied seasons.

Concerning potassium content in the leaves (Fig. 3), results indicated that all treatments increased significantly leaves potassium content. KNO_3 raised potassium leaf content in both studied seasons comparing with the control, whereas, the highest significant leaves of potassium in the first season obtained by MPK foliar sprays at 1.5% (1.03%). Meanwhile, the lowest leaf content of potassium was observed at control trees since it was (0.83 and 0.83) during both studied seasons.

Flowering Behavior

Flowering Density: Fig. 4 showed that flowering density as a number of inflorescences per meter significantly affected by different treatments. In the first seasons, foliar spraying with potassium nitrate at 3 % concentration recorded the highest flowering density, since it was 56.40. While, there were no significant differences between treatments could be detected in the second season. On the other hand, control treatment recorded the lowest value in this respect (40.63 and 42.17) during both seasons.

Sex Expression: Fig. 5 cleared the effect of spraying potassium nitrate (KNO_3) and mono-potassium phosphate (MPK) on sex expression of Picual olive tree. It is clear that different treatments significantly affected sex expression percentage in both seasons compared to the control. The highest value in terms of sex expression was determined with KNO_3 at 3% (68.17 and 67.33 in the first and second seasons, respectively); whereas, the lowest sex expression values (50.43 and 49.23 in the first and second seasons, respectively) were obtained from the control trees. Additionally, no significant differences observed among different KNO_3 and MPK concentrations as sex expression percentage.

Pollen Grains Germination: It is evident through results in Fig. 6 that KNO_3 and MPK treatments were affected pollen grains germination as compared to control in the two seasons. The highest pollen grains germination percentage was recorded with KNO_3 spraying at 3% since it was 54.50 and 57.37 in the first and second seasons, respectively.

Fruit Set: Fig. 7 clearly indicated that different concentrations of foliar spray with KNO_3 or MPK significantly affect on the percentage of fruit set as compared to the control in both seasons. Control trees gave the lowest percentage of fruit set, since it was 28.47 and 29.73 in the first and second seasons, respectively. Meanwhile; it was clear that MPK treatments recorded the highest fruit set percentage in the two seasons of the study, since it recorded 45.20% with 1.5% in the second season.

Yield (kg /tree): All spray treatments increased yield kg per tree as compared with the control (Fig. 8). It was cleared that the highest yield was recorded by foliar sprays with KNO_3 at 3% (40.27 and 43.20) in the first and second season, respectively. On the other hand, control treatment gave the lowest yield Kg per tree; since it was 26.13 and 29.20 during the first and second seasons of study, respectively. Meanwhile, control treatment had the lowest values (36.30 and 36.30) during both seasons of study.

Fruit Weight and Volume: Fig. 9 revealed that MPK treatments at 1 and 1.5% recorded the highest values of fruit weight. These values lacked significance in the first season while they were significant in the second season (6.00 and 5.93 for both MPK at 1.0 and 1.5%, respectively. Control trees recovered the lowest values of fruit weight in the two seasons of the study (4.92 and 4.90, respectively).

Concerning fruit volume, data in (Fig., 10) cleared that fruit volume was significantly affected by MPK sprays during both studied seasons. It can be concluded that mono-potassium phosphate sprays at 1.50% gave the highest fruit volume (6.40-6.17) during both seasons. Meanwhile, control treatment recorded the lowest value in this respect; since it gave 5.0 and 5.13 in the first and second season, respectively.

Fruit Dimension: The effect of different KNO_3 and MPK concentrations on the fruit length and fruit width of olive Picual trees was presented in (Figs. 11 and 12). It was observed that, there were no significant differences obtained among different treatments during the first season. Meanwhile, fruit length in the second season recorded significant differences as compared to control. MPK foliar application at 1.5% recorded the highest fruit length (3.03 cm), while control treatment recorded the lowest one in this respect (2.64 cm).

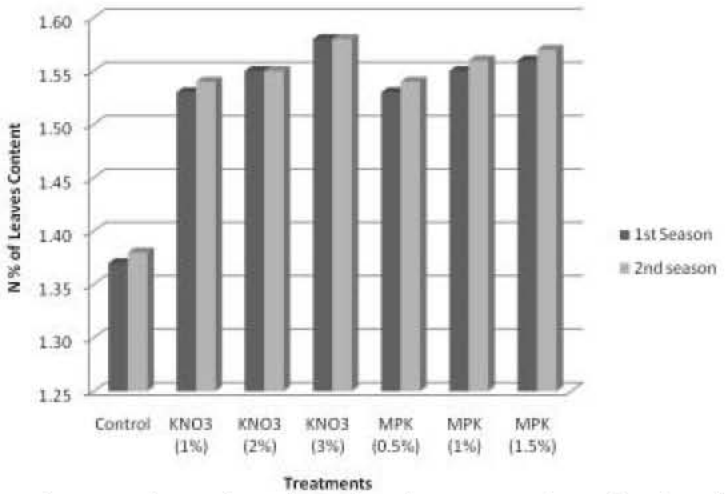

Fig. 1: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Nitrogen Leaves Content (%) of "Picual" Olive Trees

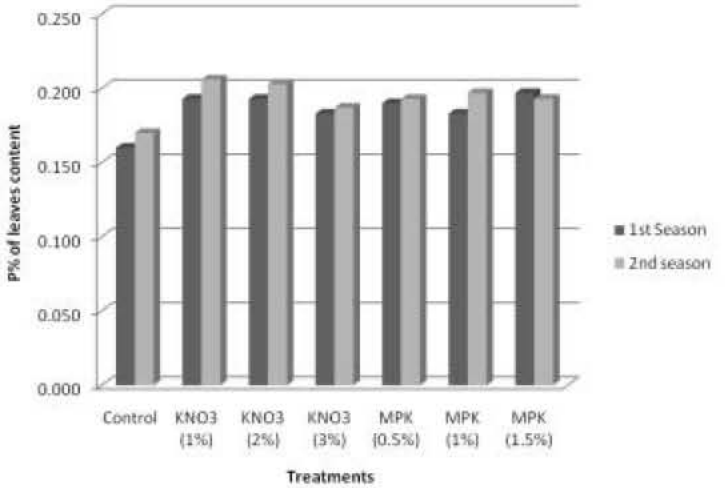

Fig. 2: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Phosphorus Leaves Content (%) of "Picual" Olive Trees

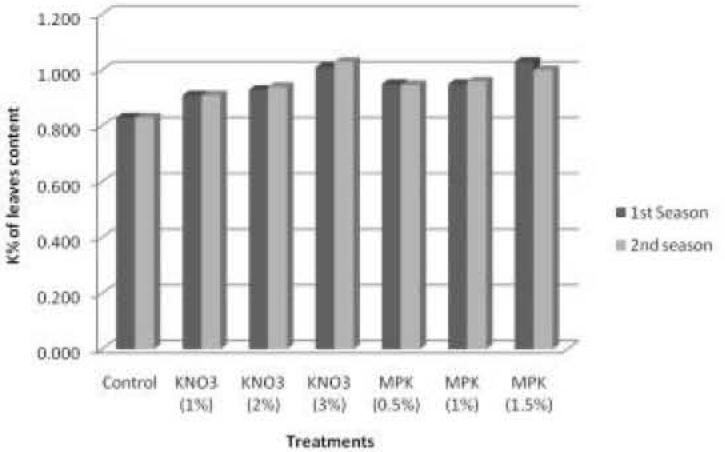

Fig. 3: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Potassium Leaves Content (%) of "Picual" Olive Trees

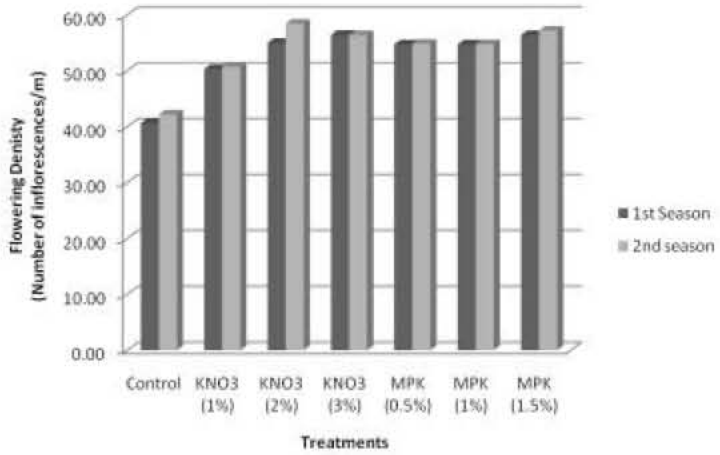

Fig. 4: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Flowering Density of "Picual" Olive Trees

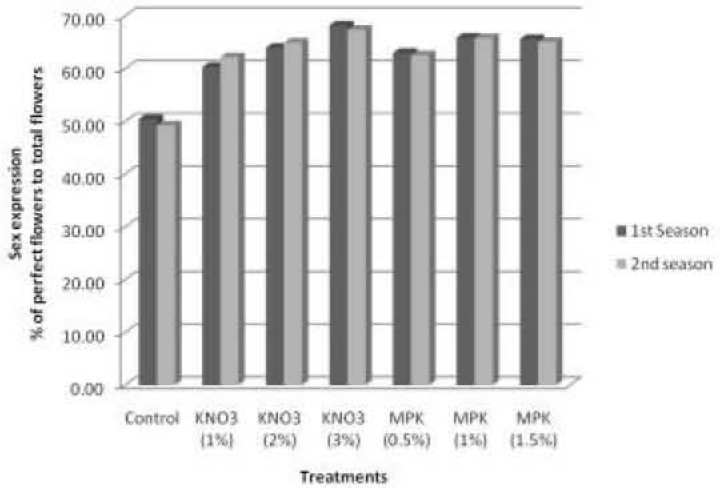

Fig. 5: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Sex Expression of "Picual" Olive Trees

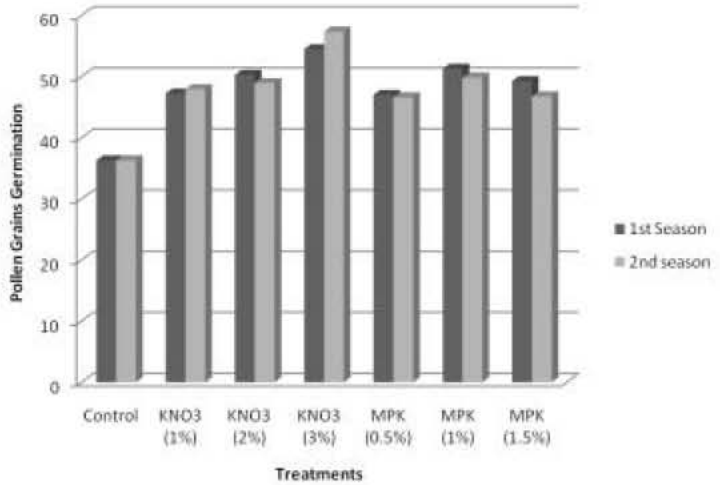

Fig. 6: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Pollen Grains Germination of "Picual" Olive Trees

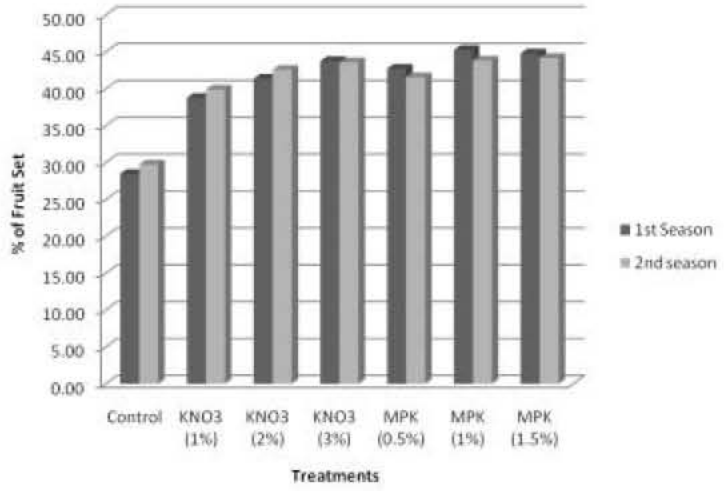

Fig. 7: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Fruit Set of "Picual" Olive Trees

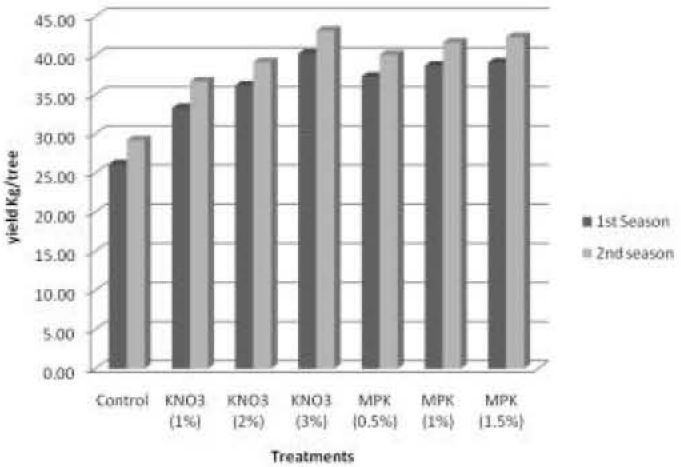

Fig. 8: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Yield (Kg/Tree) of "Picual" Olive Trees.

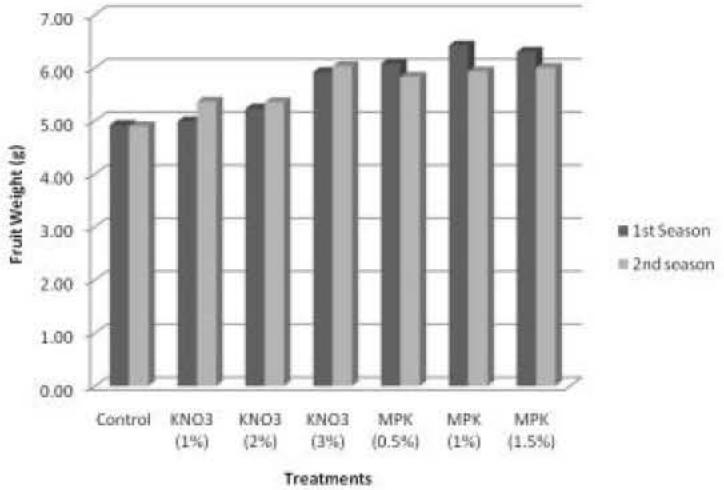

Fig. 9: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Fruit Weight (g) of "Picual" Olive Trees

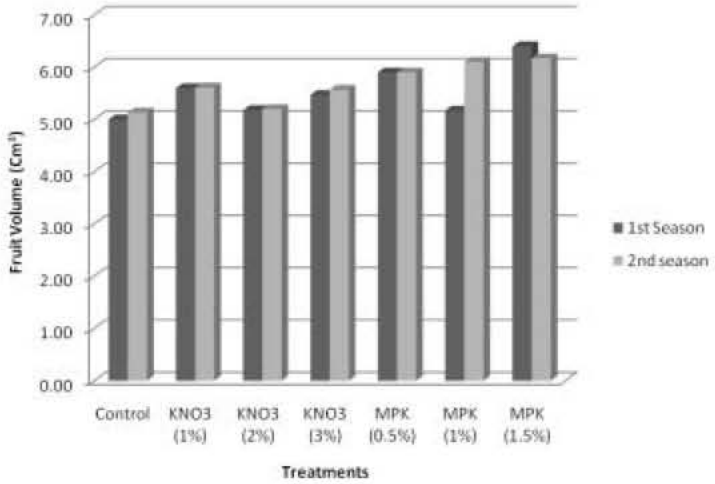

Fig. 10: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Fruit Volume (cm^3) of "Picual" Olive Trees

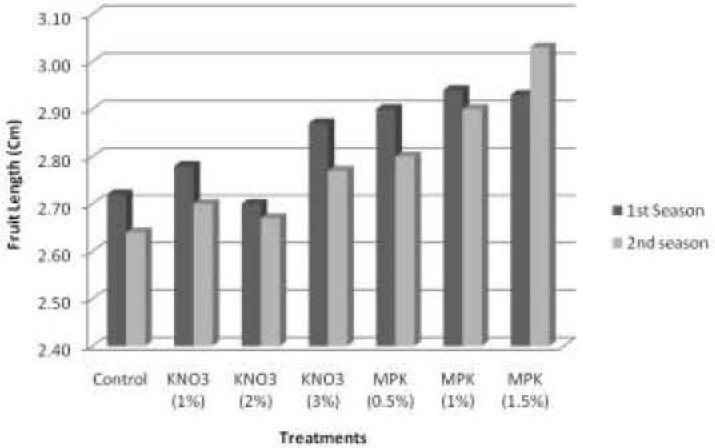

Fig. 11: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Fruit Length (cm) of "Picual" Olive Trees.

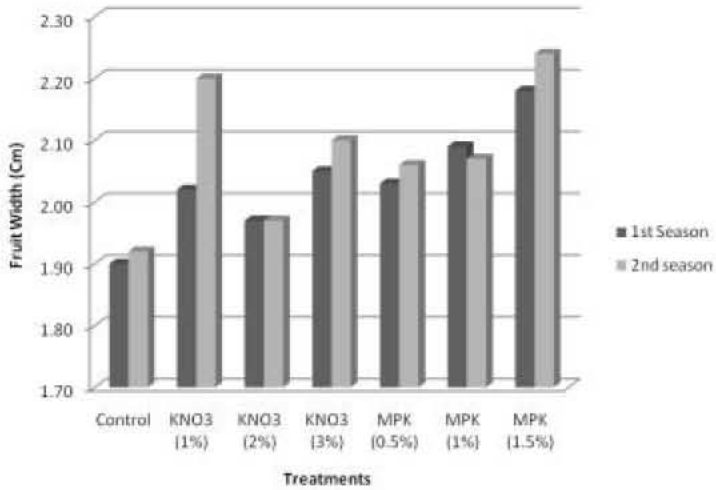

Fig. 12: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Fruit Width (cm) of "Picual" Olive Trees

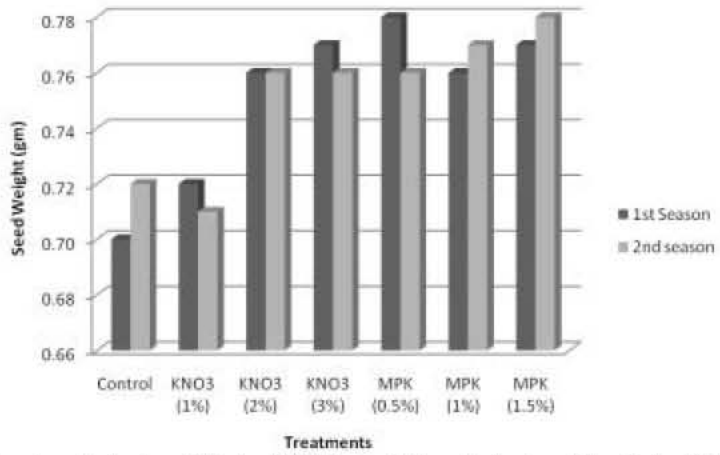

Fig. 13: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Seed Weight (g) of "Picual" Olive Trees

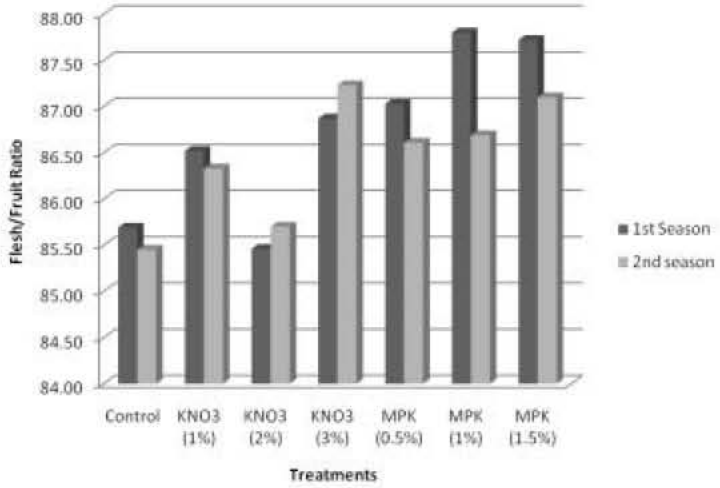

Fig. 14: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Flesh/Fruit Ratio of "Picual" Olive Trees.

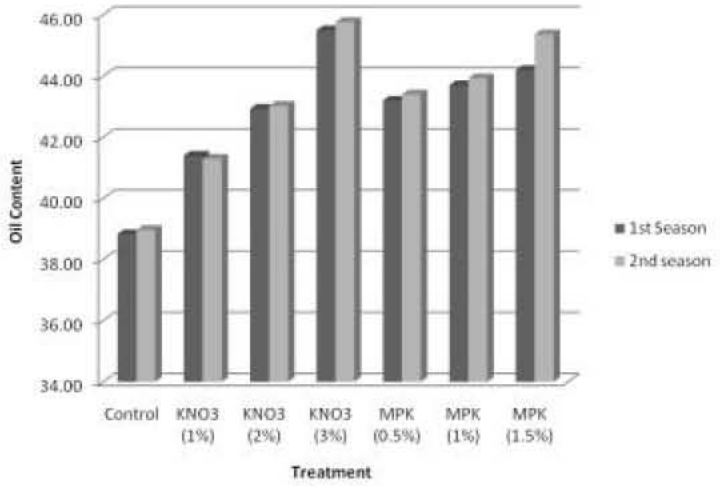

Fig. 15: Effect of Spraying Potassium Nitrate (KNO_3) and Mono-Potassium Phosphate (MPK) on Oil Content of "Picual" Olive Trees

Regarding fruit width, data in Fig.12 clarified that all KNO_3 and MPK treatments significantly raised fruit width as compared to control. MPK at 1.5% recorded the highest significant values of fruit width in the two seasons of study since it was 2.18 and 2.24 cm in the first and second season, respectively. While the lowest fruit width was obtained at control which recorded 1.90 and 1.92 cm in the two seasons.

Seed Weight and Flesh/Fruit Ratio: Fig. 13 illustrated that seed weight was significantly affected by different treatments. Foliar application of MPK at 0.5% recorded the highest seed weight (0.78 gm) as compared with the control treatment which recorded the lowest seed weight, since it was 0.7 gm during the first season. Meanwhile, MPK at 1.5% gave lowest value in this respect in the second season. Relating flesh/fruit ratio, it was cleared that insignificant differences at different treatments and control was detected. This was true during both studied seasons (Fig. 14).

Oil Content: Fig. 15 showed that oil content was significantly affected by different KNO_3 and MPK foliar application. KNO_3 at 3% recorded the highest fruit oil content 45.50 and 45.77% during first and second seasons, respectively. On the contrary, control treatment gave the lowest fruit oil content 38.83 and 38.97% during both studied seasons, respectively.

DISCUSSION

It is clear from abovementioned results that foliar application of potassium nitrate at 3% concentration was superior treatments to improve nutritional status of olive leaves, enhance flowering fruit set and productivity. These general positive effects of KNO3 and MPK on nutrition status of olive trees and productivity were in the same trend with results obtained by Diego *et al.* [19] who decided that spraying olive trees with MPK had a positive effect of increasing the K levels of olive leaves. The positive effect with different forms of potassium sprays specially potassium nitrate at 1 or 2% may be explained by the improving effect of such treatments on nutritional status of the trees specially the relatively higher minerals contents in the leaves obtained by this treatments [20]. Hegab *et al.* [21] demonstrated that, supply "Balady" orange trees three times via foliage with 1% mono potassium phosphate is suggested for improve the nutritional status of the tree. Also, Mostafa *et al.* [22], Abd El- Kader *et al.* [23] and Abou Aziz *et al.* [24], who worked on banana, they found that potassium fertilization increased leaf N and K contents. Moreover, the obtained results are agreement with those reported on Balady mandarin [25], Hamlin orange [26] and Washington navel and Valencia oranges [27], since spraying potassium from several forms raised N and K levels in the leaves. Additionally, Farahat [28] reported that potassium and phosphorous increased leaf contents of N, P and K. As flowering and fruiting development, Ben Mimoun *et al.* [29] reported that, K fertilization is expected to improve yield and quality as well as fruit weight and flesh to pit ratio. In addition, Ebrahiem *et al.* [30] who reported that foliar sprays with different forms and concentrations of potassium in sandy soil produced favorable fruit quality and enhanced yield. The previous beneficial effect of P and K on growth, yield and fruit quality were attributed to their vital role in stimulating both cell division as well as the biosynthesis and trans-located of organic foods in favour of enhancing growth and fruiting of trees [31].

Moreover, spraying potassium from several forms (KH_2PO_4, K_2HPO_4 and KNO_3) enhanced fruit set and increased yield of orange and mandarin trees as reported by Mostafa *et al.* [25], El-Deeb [27], El-Fangary [32], Ibrahim *et al.* [33] and Shawky *et al.* [34].

CONCLUSION

From the abovementioned results it could be concluded that Picaul olive trees grown under sandy soil condition greatly respond to foliar spray with potassium nitrate at 3% concentration which it increased leaf mineral content, flowering, fruiting and fruit quality.

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