GROWTH AND PRODUCTIVITY OF OLIVE TREE AS INFLUENCED BY FOLIAR SPRAY OF SOME MICRONUTRIENTS

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ABSTRACT

This work was executed during the two growing seasons (2008 and 2009) on "Picual" olive trees cultivar planted in a private orchard located at Nubariya (about 80 Km from Alexandria). This work aimed at studying the effect of foliar sprays with boric acid and a mixture of chelated (Fe, Zn and Mn) alone or in combination on growth, productivity, and fruit quality of olive trees grown in sandy soil. The trees, under study, were irrigated using fresh Nile water through drip irrigation system. Results revealed that boric acid alone or with a mixture of chelated (Fe, Zn and Mn) treatments significantly improved vegetative growth (shoot length and diameter, number of leaves/shoot and leaf area). Boric acid alone, or mixture chelated (Fe, Zn and Mn) and their combinations significantly increased fruit set and yield and fruit quality (average fruit weight, fruit diameter, fruit length, pulp weight). All treatments, except boric acid, at all concentrations improved seed weight and fruit oil percent in both seasons. As related to the leaf nutrients content, boric acid alone or with a mixture of chelated nutrients (Fe, Zn and Mn) when applied to foliage caused a pronounced increase in leaf N, Fe, Zn, Mn and B contents, compared to the control during the two growing seasons. On contrary, leaf P decreased in both experimental seasons while leaf K was not significantly affected by boric acid and chelated mixture alone treatments as compared with the control. Meanwhile, boric acid combined with chelated mixture treatments decreased leaf K. Application mixture of (Fe + Zn + Mn) at 500 ppm + H₃BO₃ at 500 ppm was more effective that found with other treatments in both seasons.
INTRODUCTION

Olive cultivation has an important role in agricultural production since it increases the land value especially where soil is unsuitable for many other fruit crops due to its capability to grow under several conditions (Sansoucy, 1984). Olive is one of the fruit crops that can grow in sandy soil due to its capability to tolerate drought stress. The production of olives in these areas is generally low due to the poor soil fertility and low water holding capacity. According, it seems that trees are not only in need of macronutrients application but also the application of some microelements (Ahmed and Morsey, 2001).

The problem of olive bud survival has been studied by Emlen Scott et al. (1943) and HU and Yang (1982). They reported that characteristics of shoot and branches buds dieback of the olive trees were reduced by boron treatment.

All nutrients play an important role in activating growth and fruiting through encouraging cell division and stimulating the biosynthesis of organic foods (Nijjar, 1985 and Blevins and Lukaszewski, 1998). Thus, foliar application seems to be valuable in correcting the widespread occurrence of certain micronutrients deficiency symptoms (Marschner, 1995 and Taiz and Zeiger, 1998). Boron as a micronutrient plays an important role in growth behavior and productivity of trees. It increases pollen grains germination and pollen tube elongation, consequently fruit set percentage and finally the yield (Tsalias et al., 1994). Moreover, Eassa (2000) indicated that, boron foliar application influenced significantly the survival of Manzanillo and Picual olive cvs. bud percentage. Meantime, Maksoud et al., (2004) showed that, boron sprays increased olive tree growth and yield. Effect of fertilization with some major elements on the productivity and fruit quality of olive trees has been widely reported by some workers (El-Khawaga 2007a and Desouky et al., 2009). Despite, minor elements greatly affect the physiological process and play an important role in fruit retention of many fruit trees, as well as, improving the yield and fruit quality (Salem et al., 1995; El-Khawaga 2007b and Abd El-Megeed et al., 2007).

Thus the aim of the present investigation was to study the effect of foliar spray of chelated Fe, Zn and Mn and / or boric acid on yield, fruit quality and leaf mineral content of "Picual" olive trees under sandy soil conditions.
MATERIALS AND METHODS

Field experiment was conducted in a private orchard located at Nubariya (about 80 Km from Alexandria) during two successive seasons 2008 and 2009 on 10 years old "Picual" olive (Olea europea, L.) trees grown in sandy soil and irrigated with drip irrigation from Nile water. The trees were planted at 6 x 6 meters apart. These trees were received the same horticultural management. Healthy, uniform and regular bearing olive trees were used in this study. The selected trees received normal fertilization and cultural practices in the farm. Annual fertilizers per feddan: 20 m³ organic manure, 200 Kg super phosphate (15% P₂O₅), 500 Kg ammonium sulphate (20.5 % N) and 200 Kg potassium sulphate (45 % K₂O). The soil of the experimental orchard was classified as sandy soil and analyzed by the methods of (Jackson, 1967). Physio-chemical properties of the soil are shown in Table (1).

The selected trees received the following treatments:

1- Control (sprayed with water only)
2- Foliar spray with boric acid at 250 ppm
3- Foliar spray with boric acid at 500 ppm
4- Foliar spray with boric acid at 750 ppm
5- Foliar spray with a mixture of chelated (Fe + Zn + Mn) at 500 ppm
6- Foliar spray with a mixture of chelated (Fe + Zn + Mn) at 500 ppm + Boric acid at 250 ppm.
7- Foliar spray with a mixture of chelated (Fe + Zn + Mn) at 500 ppm + Boric acid at 500 ppm.
8- Foliar spray with a mixture of chelated (Fe + Zn + Mn) at 750 ppm

The foliar spraying treatments were applied before blooming at the beginning of March and repeated at the beginning of June. Foliar application was carried out using a pressure sprayer of about 10 liters size. Treatments were replicated three times with two trees for each replicate and arranged in a complete randomized block design. For every tree, twenty new shoots (5
in each direction) were selected randomized and labeled for measuring the following parameters.

**Vegetative growth:**
At the end of growing seasons, the selected shoots were measured for average of shoot length (cm), leaf area (cm$^2$) and No. of leaves / shoot.

**Flowering characteristics:**
Number of inflorescences/ shoot and No. of flowers / inflorescence were counted at full bloom (first week of April).

**Fruit set and yield:**
Fruit set on the treated shoots was counted and recorded 15 days after full bloom date. Yield was collected and weighed (Kg) from every treated tree. The oil content (%) was determined by extracting the oil from the dried flesh samples by means of the soxhlet fat extraction apparatus using petroleum ether of 60-80 boiling point by the method reported in A.O.A.C. (1980).

**Fruit parameters:**
Samples of 25 fruits / tree were collected for the following measurements:
- Fruit dimensions (length and diameter (cm))
- Fruit and pulp weight (gm)
- Seed weight (gm)

**Leaf mineral content:**
Samples of fully expanded mature leaves were taken and dried at 70º C till constant weight and then ground. The ground samples were digested with sulfuric acid and hydrogen peroxide according to Evenhuis and DeWaard (1980). Suitable aliquots were taken for the determined of N, P and K. Nitrogen and phosphorus were determined colorimetrically according to Evenhuis (1976), respectively. Potassium was determined against a standard by flame photometer. Leaf boron content was colorimetrically determined according to Jackson (1973). Fe, Zn and Mn leaf contents were measured by Atomic Absorption Spectrophotometer.
Statistical analysis:-

The experiment included in this study followed a complete randomized design in factorial experiment. The obtained data were subjected to analysis of variance (ANOVA) according to Snedecor and Cochran (1990).

RESULTS AND DISCUSSION

Vegetative growth:-

The data in Table (2) showed that all the foliar spray treatments used in the experiment (Boric acid at 250, 500 and 750 ppm and chelated mixtures at 500 ppm and their combinations) caused an increased in shoot length, shoot diameter, leaf area and No. of leaves / shoot over the control during the two seasons of study. Whereas, foliar spray with H$_3$BO$_3$ at 500 ppm alone or combined with (Fe+Zn+Mn) at 500 ppm were the superior in this respect following by H$_3$BO$_3$ at 750 ppm + (Fe+Zn+Mn) at 750 ppm. Furthermore, chelated mixture application significantly improved the growth characters namely shoot length, shoot diameter and No. of leaves in both seasons and leaf area in the second season only. These positive effects of the treatment on vegetative growth go in line with HU and Yang (1982), Fandi (1987), Eassa (2006) on boron and El-Seginy et al. (2003) who applied on Fe, Zn and Mn. This increment as a result of applying micronutrients may be ascribed to their major effects on increasing leaf area which promoted photosynthesis at an appreciable rate and in turn enhancing carbohydrate formation. In addition to the effect of such elements on formation of proteins and accelerating the uptake of N, P and K (Tisdale et al., 1985). Also, the important role of zinc in building up the natural auxin (IAA) and activation of the cell division in plant tissue can give another interpretation for the present effects.

Flowering characteristics:-

Table (3) presented the flowering characteristics (No. of inflorescences / shoot and No. of flowers / shoot) of Picual olive cultivar affected by foliar spray with boric acid and chelated mixture during 2008 and 2009 growing seasons. Data revealed that, spraying olive trees with boric acid at 250 ppm + (Fe + Zn + Mn) at 500 ppm treatment significantly
increased No. of inflorescence / shoot and No. of flowers / shoot in both seasons followed by boric acid at 250 ppm or (Fe+Zn+Mn) at 500 ppm. These results coincide with Rai and Tewari (1988), Osman and Abo-Taleb (1999), Eassa (2000 & 2006) and El-Khawaga (2007a).

**Fruit set and yield:**

Generally in both seasons, the obtained data in Table (3) showed that all treatments significantly increased fruit set (%) and yield (Kg/tree) over the control during the study. In addition, H$_3$BO$_3$ at 500 ppm spray alone or combined with (Fe + Zn + Mn) at 500 ppm was the superior in this respect. These findings agreed with (Eassa (2000 & 2006), and Chatzissavvidis et al. (2004) on boron and by El-Seigny (2003) and Abd-Ella and El-Sisi (2006). This increment could be explained in the light of the effect of micronutrients on controlling the nutritional status of the trees and reducing preharvest drop, beside to the effect of such elements on improving uptake and retaining capacity of water (Pelevina, 1981) as well as increasing fruit set (Barney et al., 1984). Fe had an important function in enzymatic systems and chlorophyll formation and consequently increased photosynthesis which finally increased the yield (Smith, 1957). In addition Mn spray is a minor constituent of plant chlorophyll which is responsible for photosynthesis. (Mengel and Kirkby, 1987). Also, the improvement of yield as a result of Zn spray may be explained by the role of Zn in tryptophan synthesis which is the precursor of endogenous natural hormone (IAA) which is necessary for all plants metabolic processes and the possible role of Zn in plant metabolism involved in starch formation (Price, 1970).

**Fruit quality:**

In this regard, the data obtained in Tables (4 & 5 ) showed that all investigated treatments significantly increased the average fruit weight, pulp weight, fruit length and fruit width than the control. Furthermore, the most effective treatments were H$_3$BO$_3$ at 500 ppm alone or combined with (Fe +Zn + Mn) at 500 ppm followed by H$_3$BO$_3$ at 750 ppm combined with (Fe +Zn + Mn) at 500 ppm in both seasons. On the other hand, foliar application with H$_3$BO$_3$ at 250 or 500 and 750 ppm had unsignificant effect on seed weight and fruit oil in both seasons. In the same time, application of chelated mixture (Fe + Zn + Mn) at 500 ppm foliar spray alone or combined with H$_3$BO$_3$ caused a significant decrease in seed weight during the two seasons of study. The beneficial effect of these nutrients in synthesis of various organic foods and activating both cell division and cell enlargement
Table (4): Effect of foliar application of boric acid and / or some micronutrients on fruit, pulp and seed weight of Picual olives in 2008 and 2009 seasons.

<table>
<thead>
<tr>
<th>Treat.</th>
<th>Fruit weight (gm)</th>
<th>Pulp weight (gm)</th>
<th>Seed weight (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1: Control</td>
<td>4.45</td>
<td>5.11</td>
<td>3.49</td>
</tr>
<tr>
<td>T2: H₃BO₃ at 250 ppm</td>
<td>4.92</td>
<td>5.52</td>
<td>3.97</td>
</tr>
<tr>
<td>T3: H₃BO₃ at 500 ppm</td>
<td>5.12</td>
<td>5.57</td>
<td>4.17</td>
</tr>
<tr>
<td>T4: H₃BO₃ at 750 ppm</td>
<td>4.78</td>
<td>5.44</td>
<td>3.84</td>
</tr>
<tr>
<td>T5: Fe+Zn+Mn at 500 ppm</td>
<td>4.82</td>
<td>5.49</td>
<td>3.95</td>
</tr>
<tr>
<td>T6: Fe+Zn+Mn at 500 ppm + H₃BO₃ at 250 ppm</td>
<td>5.37</td>
<td>6.32</td>
<td>4.52</td>
</tr>
<tr>
<td>T7: Fe+Zn+Mn at 500 ppm + H₃BO₃ at 500 ppm</td>
<td>5.97</td>
<td>6.43</td>
<td>5.13</td>
</tr>
<tr>
<td>T8: Fe+Zn+Mn at 500 ppm + H₃BO₃ at 750 ppm</td>
<td>5.57</td>
<td>6.26</td>
<td>4.70</td>
</tr>
<tr>
<td>L. S. D. (0.05)</td>
<td>0.345</td>
<td>0.095</td>
<td>0.343</td>
</tr>
</tbody>
</table>

Table (5): Effect of foliar application of boric acid and / or some micronutrients on fruit length and width and oil content of Picual olives in 2008 and 2009 seasons.

<table>
<thead>
<tr>
<th>Treat.</th>
<th>Fruit length (cm)</th>
<th>Fruit width (cm)</th>
<th>Fruit oil %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008</td>
<td>2009</td>
<td>2008</td>
</tr>
<tr>
<td>T1: Control</td>
<td>1.88</td>
<td>1.93</td>
<td>1.66</td>
</tr>
<tr>
<td>T2: H₃BO₃ at 250 ppm</td>
<td>2.11</td>
<td>2.23</td>
<td>1.79</td>
</tr>
<tr>
<td>T3: H₃BO₃ at 500 ppm</td>
<td>2.24</td>
<td>2.28</td>
<td>1.80</td>
</tr>
<tr>
<td>T4: H₃BO₃ at 750 ppm</td>
<td>1.96</td>
<td>2.14</td>
<td>1.73</td>
</tr>
<tr>
<td>T5: Fe+Zn+Mn at 500 ppm</td>
<td>2.00</td>
<td>2.05</td>
<td>1.82</td>
</tr>
<tr>
<td>T6: Fe+Zn+Mn at 500 ppm + H₃BO₃ at 250 ppm</td>
<td>2.32</td>
<td>2.36</td>
<td>1.91</td>
</tr>
<tr>
<td>T7: Fe+Zn+Mn at 500 ppm + H₃BO₃ at 500 ppm</td>
<td>2.38</td>
<td>2.38</td>
<td>1.92</td>
</tr>
<tr>
<td>T8: Fe+Zn+Mn at 500 ppm + H₃BO₃ at 750 ppm</td>
<td>2.19</td>
<td>2.30</td>
<td>1.90</td>
</tr>
<tr>
<td>L. S. D. (0.05)</td>
<td>0.124</td>
<td>0.089</td>
<td>0.042</td>
</tr>
</tbody>
</table>
Table (6): Effect of foliar application of boric acid and/or some micronutrients on nitrogen, phosphorus and potassium of Picual olives in 2008 and 2009 seasons.

<table>
<thead>
<tr>
<th>Treat.</th>
<th>Nitrogen (%)</th>
<th>Phosphorous (%)</th>
<th>Potassium (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008</td>
<td>2009</td>
<td>2008</td>
</tr>
<tr>
<td>T1: Control</td>
<td>1.27</td>
<td>1.42</td>
<td>0.280</td>
</tr>
<tr>
<td>T2: $\text{H}_3\text{BO}_3$ at 250 ppm</td>
<td>1.39</td>
<td>1.55</td>
<td>0.251</td>
</tr>
<tr>
<td>T3: $\text{H}_3\text{BO}_3$ at 500 ppm</td>
<td>1.44</td>
<td>1.70</td>
<td>0.233</td>
</tr>
<tr>
<td>T4: $\text{H}_3\text{BO}_3$ at 750 ppm</td>
<td>1.40</td>
<td>1.64</td>
<td>0.214</td>
</tr>
<tr>
<td>T5: Fe+Zn+Mn at 500 ppm</td>
<td>1.34</td>
<td>1.51</td>
<td>0.253</td>
</tr>
<tr>
<td>T6: Fe+Zn+Mn at 500 ppm + $\text{H}_3\text{BO}_3$ at 250 ppm</td>
<td>1.48</td>
<td>1.75</td>
<td>0.225</td>
</tr>
<tr>
<td>T7: Fe+Zn+Mn at 500 ppm + $\text{H}_3\text{BO}_3$ at 500 ppm</td>
<td>1.63</td>
<td>1.78</td>
<td>0.203</td>
</tr>
<tr>
<td>T8: Fe+Zn+Mn at 500 ppm + $\text{H}_3\text{BO}_3$ at 750 ppm</td>
<td>1.66</td>
<td>1.76</td>
<td>0.197</td>
</tr>
<tr>
<td>L. S. D. (0.05)</td>
<td>0.054</td>
<td>0.030</td>
<td>0.015</td>
</tr>
</tbody>
</table>

Leaf mineral content:

The olive leaf macro elements (N, P and K %) and micro elements (Fe, Zn, Mn and B ppm) content as affected by different treatments as foliar spray are shown in Tables (6 and 7). The obtained data revealed that, foliar application with H₃BO₃ and (Fe+Zn+Mn) either singly or in combination were significantly very effective on the leaf N, Fe, Zn, Mn and B concentrations during the two growing seasons. Spraying (Fe+Zn+Mn) at 500 ppm significantly decreased leaf-P and K content. In addition, leaf K content was not affected by the boric acid treatments during the two seasons of study. Generally, the most effective treatment was boric acid at 750 ppm+chelated mixture (Fe+Zn+Mn) at 500 ppm in both seasons in this respect. The effect on plant nutrient status resulted from spraying different solutions might be attributed to quick absorption via leaves and the limited loss of the nutrients when they were sprayed (Marschner, 1995). As for the reduction in leaf P content might be attributed to the antagonism between Fe and P (Nawar 1991). These results agreed to some extent with those of Eassa (2000&2006), Chatzissavvids (2004), Maksoud et al.(2004), El-Seginy et al.(2003) and Abd-Ella et al.(2006). However, it must be mentioned that boron concentration in the control (Table 7) in both seasons indicated to a defficency in that nutrient since olive trees need from 7-8 ppm of boron ,depending on the cultivar.

CONCLUSION

The obtained results in the present research strongly suggest that foliar application of Picual olive trees with H₃BO₃ at 500 ppm and /or chelated (Fe, Zn and Mn) at 500 ppm is recommended to increase fruit set, yield and fruit quality of trees grown in sandy soil. Therefore, it may be recommended to include such micronutrients in the fertilization program of Picual olive cultivar.
REFERENCES


الم.denseعر

تأثير الرش ببعض المغذيات الصغيرة على نمو وانتاجية أشجار الزيتون

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معهد بحث البسائي – مركز البحوث الزراعية

تم إجراء هذا البحث خلال موسمي النمو 2008، 2009 على أشجار الزيتون صنف البيكوال المنزرع في مزرعة خاصة (طريق اسكندرية – القاهرة الصحراوي) لدراسة تأثير الرش بحمض البوريك والمخلوط المخلي من الحديد والزنك والمنجنيز كلاً بفرده أو مخلوطين معاً على نمو وانتاجية الأشجار وصفات جودة الثمار. وقد كانت هذه الأشجار منزرعة في تربة رملية وتروي بزيادة النيل العاينة تحت نظام الري بالتنقيط. أظهرت النتائج أن الرش بحمض البوريك مفرداً أو مخلوط الحديد والزنك والمنجنيز أدى إلى تحسين النمو الحضري (طول، قطر النمو الجديد) عند الأوراق على النمو ومساحة الورقة وقياسات التزهر وإلى زيادة نسبة العقد المحصول وتحسين جودة الثمار (متوسط وزن الثمرة، طول وعرض الثمرة، وزن اللب). أوضحت جميع المعاملات ما عدا حمض البوريك بالتركيزات المختلفة تحسن في وزن الدراسة والثمرة． كذلك، كأن محتوى الأوراق من النتروجين والهيدروجين والزنك والمنجنيز والبوروز مرتقياً، بينما انخفض محتوى الأوراق من الفوسفور خلال عامي الدراسة． كما أوضح النتائج أن معاملات حمض البوريك والمخلوط المخلي مفردة لم يكن لها تأثير معنوي على محتوى الأوراق من البوتاسيوم في حين أدت المعاملات المختلطة من حمض البوريك مع المخلوط المخلي إلى نقص معنوي في عنصر البوتاسيوم في الأوراق． وقد حققت المعاملة (حمض البوريك + المخلوط المخلي) تركيز 50 جزء في المليون لكل منهما أفضل النتائج خلال عامي الدراسة．