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Improving fruit quality and quantity of "Aggizi" olive trees by application of humic acid during full bloom and fruit set stages.

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ABSTRACT

This study was carried out during the two seasons 2011, 2012 on olive trees Aggizi cv. the trees were 10 years old growing in sandy soil at private orchard in Ismailia governorate, Egypt. This investigation was performed to study the effect of humic acid as Actosol® (contains 20 % humic acid + NPK 1:5:6) as foliar application on tree (0.125, 0.25 and 0.5 %) at the begging of fruit set stage. At the end of the season, yield (kg/tree) and Fruit quality: average fruit size (volume), weight, shape index (length\ diameter), pulp\pit ratio and moisture percentage also fruit chemical characterizes: fruit oil and acidity percentage were recorded. Aggizi olive trees received one dose of humic acid as Actosol® (150 cm3) as soil application added to the olive tree under drippers at full bloom stage and sprayed with humic acid as Actosol® as foliar application on tree at (0.5 %) at the begging of fruit set obtained the highest yield (kg/tree) as while as fruit physical and chemical properties than low concentration of humic acid, except fruit acidity percentage which decreased with increasing foliar humic acid percentage and retched the lowest value by application humic acid at 0.5% concentration.

Key words: olive Aggizi cv., yield, Fruit quality, fruit oil percentage, fruit acidity percentage, organic fertilizer, humic acid, foliar aplication.

Introduction

Oleaeuropaea europaea L is one of the most important plants and widespread crops of the Mediterranean basin, which has longevity and adaptation to climatic conditions, also the olive fruits, are commercially valuable for oil content or for edible flesh. The olive trees productivity is generally low due to the poor soil fertility and low water holding capacity. Accordingly, it seems that trees need to organic fertilizers avoided pollution and reduced the costs of fertilization. Also, it has drowned the attention of olive growers to use the organic and bio-fertilizers that would be healthy for human and safe for environment (Fayed 2010).

Humic acids are the main fractions of humic substances and the most active components of soil and compost organic matter. Humic acids have been shown to stimulate plant growth and consequently yield by acting on mechanisms involved in: cell respiration, photosynthesis, protein synthesis, water and nutrient uptake, enzyme activities (Vaughan and Malcolm, 1985; Albuzio *et al*., 1986; Chen and Aviad, 1990; Concheri *et al*., 1994; Nardi *et al.,* 1996; Chen *et al.,* 2004). This action of Humic acids has been demonstrated to be dose dependent and particularly effective in a low concentration range (Chen and Aviad, 1990). In particular, optimal concentrations able to affect and stimulate plant growth have been generally found in the range of 50-300 mg L–1, but positive effects have been also exerted by lower concentrations (Chen *et al*., 2004). A distinction on the effects of Humic acids should be made between indirect and direct effects on plants growth. Indirect effects are mainly exerted through properties such as: enrichment in soil nutrients, increase of microbial population, higher action exchange capacity, improvement of soil structure; whereas direct effects are various biochemical actions exerted at the cell wall, membrane or cytoplasm and mainly of hormonal nature (Varanini and Pinton, 2001; Chen *et al.,* 2004). The hormone-like activities of Humic acids is well documented in various papers, in particular auxin-, cytokinin- and gibberellins- like effects (O'Donnell, 1973; Cacco and Dell'Agnola, 1984; Casenave de Sanfilippo *et al.,* 1990; Piccolo *et al.,* 1992; Pizzeghello *et al*., 2002) and, further, the presence of plant hormone-like substances in Humic acids has been recently demonstrated, in particular the high content of indolacetic acid in humic fraction isolated from forest soils (Muscolo *et al*., 1998; Nardi *et al*., 2000).

Humic substances such as humic acid, fulvic acid, are the major components (65-70%) of soil organic matter, increase plant growth enormously due to increasing cell membrane permeability, respiration, photosynthesis, oxygen and phosphorus uptake, and supplying root cell growth (Cacco and Dell Agnolla, 1984, Russo and Berlyn, 1990). Humic acid is complex substances derived from organic matte decomposition. Agricultural humic acid are reputed to enhance nutrient uptake, drought tolerance, seed germination and overall plants performance (Chen and Aviad, 1990, Sanchez-Andreu *et al.,* 1994).

Magdi *et al.,* (2011) reported that, bio-fertigation of microbial inoculums and humic substances could be used as a complementary for mineral fertilizers to improve yield and quality of cowpea under sandy soil conditions which protect the environment chemical pollution and its harmful effect on human and animal health.

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Benefits ascribed to the use of humic acid, particularly in low organic matter, alkaline soil, include increased nutrient uptake, tolerance to drought and temperature extremes, activity of beneficial soil micro-organisms and availability of soil nutrients (Russo and Berlyn, 1990), (Senn and Kingman, 1973). Humic materials may also increase root growth in a manner similar to auxins (Donnell, 1973), (Tatini *et al.*, 1991). Fernandez-Escobar *et al.* (1999) mentioned that, under field conditions, foliar application of leonardite extracts (humic substances extracted) stimulated shoot growth and promoted the accumulation of K, B, Mg, Ca and Fe in leaves

Cavalcante *et al.,* (2011) demonstrated that humic substances sprayed positively affect aerial part and root system of papaya seedlings and seedling quality of papaya are improved by humic acids foliar spray. Khaled and Fawy (2011) stated that, "economical levels of application should be determined and should not exceed 2 g humus/kg in soil and 0.1% in foliar".

Results have been demonstrated to be C rate dependent and particularly effective at low concentration (Chen and Aviad, 1990). Optimal concentrations capable to affect and stimulate plant growth have been generally found in the range of 50-300 mg L–1, but positive effects have been also seen with lower concentrations (Chen *et al.*, 2004a).

Studies related to the effects of Humic acids on plant growth have been generally conducted in controlled environments, such in the case of herbaceous species grown hydroponically or on specific substrates (Malik and Azam, 1985; Lulakis and Petsas, 1995; Loffredo *et al.*, 1997; Ferrara *et al.*, 2001; Atiyeh *et al.*, 2002). Fewresearches deal with foliar applications of Humic acids in the open field, in species such as strawberry (Neri *et al.*, 2002), rice (Tejada and González, 2004) and durum wheat (Delfine *et al.*, 2005). Applications of Humic acids to fruit species are very scarcely reported in the literature and some investigations have been conducted in olive (Fernández-Escobar *et al.*, 1996), lemon (Sánchez- Sánchez *et al.*, 2002) and apple (Neilsen *et al.*, 2005).

The aim of this study is evaluating fruit physical and chemical properties and yield of Aggizi trees sprayed with of humic acid during fruit set stage under.

Material and Methods

This study was conducted during two successive seasons, 2011 and 2012, on 10 years old olive trees Aggizi cv. Grown in a private orchard in Ismailia – Egypt. The trees spaced 5 x 5 meter apart (168 trees/acre) in a sandy soil (Table1). The trees received the same cultural practices that were recommended. The farm is depending on wells in irrigation (Table 2). Humic acid as Actosol® (contains 20 % humic acid + NPK 1:5:6) was added in this study to the trees as foliar application at three concentrations (0.125, 0.25 and 0.5 %) in the begging of fruit set stage. Also, one dose of Actosol® (150 cm3) as soil application added to the olive tree under drippers at full bloom stage for all " Aggizi " olive trees used in this experiment include the control trees.

Table 1: Chemical characteristics of sandy soil used for the present study.

parameters	Depth of simple (cm)		
	Surface sample	30 cm Depth	60 cm depth
pH	8.02	8.70	8.11
EC(dSm-1)	3.80	0.80	1.70
	Soluble cations (meq\l)		
Ca++	6.00	2.50	3.00
Mg++	4.00	1.50	1.50
Na+	28.60	4.40	12.90
K+	0.12	0.14	0.78
	Soluble anions (meq\l)		
CO3=	-	-	-
HCO3-	4.40	2.40	2.00
Cl-	27.20	5.00	13.00
SO4=	7.12	1.14	3.18

Complete randomized design was applied. Three treatments were applied in four replicates all of the 12 trees conducted in this study were vigorous and similar in growth and canopy.

The investigation aimed to study the effect of different doses and applications time of Actosol® as the following:

Without humic acid application (control)

1- 0.125 % humic acid as Actosol® added in this study to the trees as as foliar application at the First week of April (during full bloom).

2- 0.25 % humic acid as Actosol® added in this study to the trees as as foliar application at the First week of April (during full bloom).

3- 0.5 % humic acid as Actosol® added in this study to the trees as as foliar application at the First week of April (during full bloom).

Table 2: Chemical characteristics of water weal used for the present study.

parameters	values
pH	7.49
EC(dSm-1)	4.40
Soluble cations (meq\l)	
Ca++	7.50
Mg++	5.00
Na+	33.10
K+	0.16
Soluble anions (meq\l)	
CO3=	-
HCO3-	1.60
Cl-	40.00
SO4=	4.16

Yield and Fruit Quality:

In both seasons samples of 100 random mature fruits per tree were used for the determination of average fruit size (volume), weight, shape index (length\ diameter) pulp\pit ratio and moisture percentage was measured.

Fruit chemical characteristics:

- Fruit oil percentage: Fruit oil content was determined by means of the Soxhlett fat extraction apparatus using Hexan of 60-80°C boiling point as described by (A.O.A.C. 1975).
- Fruit acidity percentage: Fruit juice total acidity % as Malic acid (mgs/100 gm fruit juice) according to A.O.A.C (1975).

Data Analysis:

All the obtained data during the two seasons of the study was statistically analyzed of variance method, differences between means were compared using Duncan's multiple range test at 0.05 level according (Duncan, 1955).

Results and Discussion

Yield and Fruit Quality:

Fruit Properties:

Data in **Table (3)** showed the effect of humic acid rates on physical and chemical fruit properties of " Aggizi " olive trees during first season (2011), results cleared that most fruit quality parameters were significantly affected by foliar humic acid concentrations, it clear that highest average fruit size (volume), weight, shape index (length\ diameter) pulp\pit ratio and moisture percentage were recorded from fruits harvested from trees sprayed with 0.5 % humic acid. With respect to fruit weight of trees not sprayed with humic acid achieved the lowest fruit weight (7.38 kg/tree) followed in an increasing order by humic acid concentration at 0.125, 0.25 and 0.5 %; the values detected 8.19, 8.31 and 9.41 kg/tree respectively.

Concerning Fruit volume followed the same trained that obtained in fruit weight were highest fruit volume was obtained by 0.5 % treatment (12.93 cm3) followed by 0.25 % (11.03 cm3) then 0.125% humic acid treatment (10.99).

For the pulp\pit ratio, highest ratio was obtained from fruits harvested from trees sprayed with 0.25 and 0.5 % humic acid (7.01 and 7.65) respectively , while the lowest value was detected from fruit of olive trees sprayed with water (control) and trees sprayed with humic acid at 0.125 % humic acid.

With respect to shape index (length\ diameter), the same trained that obtained in fruit weight were highest fruit volume was obtained by 0.5 % treatment (1.41 cm3).

With respect to fruit moisture percentage data cleared that all humic treatment significantly increased fruit moisture percentage comparing with that of the control, however the increment in moisture percentage than the control depended on concentration of humic acid sprayed. The highest fruit moisture percentage was recorded in trees sprayed with humic acid at 0.5 % followed by trees sprayed with 0.25% and 0.125% humic acid.

By studding fruit oil percentage, it is clear from the data in Table (3) that, sparing humic acid to olive " Aggizi " trees affecting significantly fruit oil percentage. With increasing foliar humic acid concentration percentage, fruit oil percentage successively .Highest value (22.35) was obtained from fruits harvested from trees sprayed with 0.5% humic acid.

Concerning fruit acidity percentage, it is clear that trees not sprayed with humic acid achieved the highest fruit weight (0.76 %) followed in an decreasing order by humic acid concentration at 0.125, 0.25 and 0.5 %; the values detected 0.61,0.56 and 0.43 % respectively.

Data in **Table (4)** showed the effect of humic acid rates on physical and chemical fruit properties of "Aggizi" olive trees during first season (2012), Data cleared that fruit physical parameters (average fruit size (volume), weight, shape index (length\ diameter) pulp\pit ratio and moisture percentage) followed the same trained in the first season, similarly fruit oil and acidity percentage.

Yield:

From data in **Table (5)** it is clear that, "Aggizi" olive trees greatly responded to humic acid treatments, where all humic treatment significantly increased tree average yield (kg/tree) of the two seasons comparing with that of the control, however the increment in yield than the control depended on concentration of humic acid sprayed. The highest yield in the first and second season as well as the average yield of the two seasons was recorded in trees sprayed with humic acid at 0.5 % followed by trees sprayed with 0.25% or0.125% humic acid.

Table 3: Effect of spraying humic acid with different concentrations on some physical and chemical fruit properties "Aggizi" olive during season (2011).

Treatment	weight	volume	Pulp/Pit	L/D	Moisture %	Oil % dry weight	Acidity% of fruit
Control	7.38 c	7.18 c	4.35 b	1.05 c	66.78 d	15.04 d	0.76 a
0.125%	8.19 b	10.99 b	5.54 b	1.27 b	68.13 c	16.19 c	0.61 b
0.25%	8.31 ab	11.03 b	7.01 a	1.25 b	70.27 b	19.03 b	0.56 bc
0.5%	9.41 a	12.93 a	7.65 a	1.41 a	71.96 a	22.35 a	0.43 c

Table 4: Effect of spraying humic acid with different concentrations on some physical and chemical fruit properties "Aggizi" olive during season (2012).

Treatment	weight	volume	Pulp/Pit	L/D	Moisture %	Oil % dry weight	Acidity% of fruit
Control	10.95 c	10.45 c	4.10 b	1.06 c	64.46 c	14.37 d	0.72 a
0.125	11.65 b	11.46 b	5.35 b	1.21 b	65.73 b	15.46 c	0.57 b
0.25	11.79 b	11.50 b	6.75 a	1.23 ab	68.71 a	18.20 b	0.52 bc
0.5	12.95 a	13.5 a	7.38 a	1.28 a	68.41 a	21.02 a	0.41 c

Table 5: Effect of spraying humic acid with different concentrations on yield "Aggizi" olive during (2011 – 2012).

Treatment	Yield 2011	Yield 2012	Average yield
control	32.25 c	27.67 c	29.96 d
0.125%	51.35 b	44.33 b	47.84 c
0.25%	54.14 b	47.67 b	50.91 b
0.5%	61.24 a	55.66 a	58.45 a

Discussion:

Humic acid treatments (foliar applications) markedly increased the yield (kg/tree) and Fruit quality and chemical characterizes of "Aggizi" olive trees. These results were in the same trend with those found by reported (Ferrara and Brunetti 2010) that, the application of humic acid caused a significant increase in berry size. In particular, humic acid applied at full bloom significantly increased width and weight of berries collected at harvest with respect to the control treatment. The increase in berry size as a consequence of humic acid application at full bloom is probably ascribed to the uptake of mineral nutrients by the grapevines, but the possible hormone- like activity of the humic acid (i.e.,auxin-, gibberellin- and cytokinin-like activity) should also be taken into consideration. On the other hand, Fathi *et al.* (2002), Eissa Fawzia *et al.* (2003) , Shaddad *et al*. (2005) and Fathy *et al.* (2010) recorded that humic compounds increased growth parameters of 'Canino' apricot. Likewise, Bohme and Lua (1997); Hartwigsen and Evans (2000) and Liu and Cooper (2002) recorded that humic acid has a good influence on plant growth and development. Furthermore, Eissa Fawzia *et al*. (2007a, b and c) illustrated that humic acid promoted peach, pear, apple and apricot to grow better even under salinity conditions.

Humic acid is especially beneficial in freeing up nutrients in the soil so that they are made available to the plant as needed. In several studies, humic and folic acids preparations were reported to increase the uptake of mineral elements, and to increase the yield of crop plants (Kauser *et al.* 1985; Chen *et al.* 2004 a, b). These results are in agreement with data reported in (Ferrara and Brunetti, 2008) and by other authors using

commercial humic acid (Sánchez-Sánchez *et al*., 2006). Also,Tatini *et al*. (1991) and Jianguo *et al.* (1998) showed that humic acid substances increased dry matter of foliage and roots, promoted N uptake and accumulation of nutrients and enhanced photosynthesis of apple trees.

Due to the positive effect of humic substances on the visible growth of plants, these chemicals have been widely used by the growers instead of other substances such as pesticides etc. This, however, has led to growers using higher amounts of these substances.

Conclusion:

From the obtained data it is clear that "Aggizi" olive trees received one dose of Actosol® (150 cm3) as soil application added to the olive tree under drippers at full bloom stage and sprayed with humic acid as Actosol® as foliar application on tree at (0.5 %) at the begging of fruit set obtained the highest yield (kg/tree) as while as average fruit size (volume), weight, and pulp\pit ratio also fruit chemical characterizes: fruit oil and acidity percentage rather than low concentration of humic acid. It seems that, "Aggizi" olive trees at the begging of fruit set needs sufficient amount of nutrients to get good fruit quality parameters which could be reflected on the fruit yield (kg/tree).To increase Yield (kg/tree) and improve fruit oil percentage of olive trees Aggizi cv. Grown under Ismailia condition, humic acid foliar application at 0.5 % per tree at the begging of fruit set with one soil dose (150 cm3) under drippers of Aggizi olive tree at (full bloom) is recommended.

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