The Impact of Organic Production System in Olive Grove: Soil, Oil Characteristics, Biodiversity

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Abstract

This research was conducted during period (2014 – 2016), in collaboration between General Commission of Agricultural Scientific Research/ Syria and Food and Agriculture Organization of the United Nations (FAO), in olive orchard that planted of Khodairi variety in Hazour village/ Moseif region. The orchard was divided in to two plots, one of them was managed under organic system according to Syrian Organic Law while conventional practices used by farmer were applied in the second. These plots were separated by row of olive trees. Soil properties were studied before and after applying agro practices to evaluate the impact of organic system on soil characteristics, and the chemical analysis (oil percentage, content of Oleic acids, free acidity, total poly phenols) were carried out in order to verify the difference between two treatments, in addition to evaluating diversity in natural vegetation in both experimental plots. Organic agricultural practices have shown a positive effect in increasing soil fertility and the nutrients available to plants. They also exceeded significantly the conventional ones in term of fruit's oil content the difference was 1.72%, in their contents of oleic fatty acid the difference reached 1.33%, and in polyphenols a difference of 28.7%. The diversity in natural vegetation seemed higher in organic plots, particularly in the spices that belong to leguminous plants such as wild vetch, lupine and types of clover, that allow taking advantage of these spices to enhance the existence of natural enemies, enrich the groove soil and maintain its moisture.

Keywords: Olive, Organic, Conventional, Oil percentage, Oil quality, Natural vegetation diversity.

1. Introduction

A Japanese study on fossils of olive seeds and pollen at the site of Tell –Al Mastuma / west of Idleb city in northern Syria, showed that olive originated in Syria since the beginning of the Bronze Age, i.e.2000-2400 BC [1]. The planted area of olive in Syria is (691769 hectare), and the number of trees is estimated about (104754.3 thousand trees), the fruitful ones are (84152.6 thousand trees), with production of (668441 tone) in season 2016 [2]. The production of organic olive oil in Syria constitutes a great opportunity to export to global markets were the demand for organic products is increasing, and the local production in these countries doesn’t cover this demand, this will improve the income of olive farmer in Syria and the national income as a whole.

Some studies and reports indicated that world today is facing two challenges: providing sufficient food for all earth inhabitants and reducing environmental damage caused by food production process. Thus, it become clear that applying an organic production system ensure the provision of food without sabotaging the components of the ecosystems, animals and humans [3]. It contribute to health and quality of olive oil [4]. Organic treatments have an advantage in achieving sustainability, as manure fertilizer and green cover plant increase the soil content of organic matter and nitrogen and reduced its erosion, so lower inputs especially chemical fertilizer [5], consuming healthy food is the most important motives for buying organic oil in Europe [6].

This research aimed to study the effect of organic treatments on oil percentage and some of its qualitative characteristics, as well as comparing the diversity in natural vegetation in two plots.
2. Material and Methods

2.1 The site

The research was carried out in an olive orchard of 520 m² in Hazour / Mosief region (west central Syria), its height of 650 m, rain-fed agriculture, an annual rainfall of about 1600 mm, with terraces system. The studied trees are 34 that are more than 15 years old, the spacing of planting between trees are 7 m. The orchard was divided into two plots; the first one is managed under the organic system according to Syrian Organic Law, while conventional practices used by farmer were applied in the second, whereas the two plots were separated by row of olive tree, the studied trees in each plots were 16 set in 3 replicates.

2.2 Studied variety

Khodeiri is a Syrian variety, dual purpose (for table olive and oil), its cultivation concentrate in coastal area, the fruit is ovoid, weight about 1.9 - 2.1 g, the oil percentage ranged between 21- 27% according to maturity stage [7].

| Treatment          | Organic plot                                                                 | Conventional plot                                                                 |
|--------------------|------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Pruning            | Annually slight and balanced                                                  | Severe every two years                                                            |
| Fertilization      | Farmyard fertilizer: fermented sheep manure was added at a rate of 30 kg per tree. Green manure: 15 kg per dunum of mixture (vetch and barely) seeds were added in a ratio of 9:1, they were mixed with soil when plants reach 5% flowering [8,9]. | Chemical fertilizer: urea 46% at a rate of 500 g per tree during March and April, Potassium sulphate 300g/ tree in March, super phosphate 48%: 300 g/tree in November [10]. |
| Tillage            | Twice: in autumn when adding farmyard manure and sowing the seed of cover plants, and in spring in order to bury residue of cover plants. | Three times: in autumn, spring, med summer.                                          |
| Pest control       | The fruit olive fly was controlled by using attractive food traps.            | Chemical control: the olive fruit fly (Bactrocera oleae) was controlled by using Dimethoate pesticides 40 at rate of 1.5 L/ 1000 L water during period (July- September). |
| Harvest            | No other controlled was carried out as long as no infections appeared.        | The fruits were collected manually.                                                |

2.3 The studied indicators

2.3.1 Soil properties and nutrient analysis

Soil samples were collected from two depth (0-30 cm and 30-60 cm), in different sites of each plots, the required analysis were carried out in the laboratory of Beit Kamouna, Tartous Research Center: Soil pH was measured in saturated paste by using pH meter [11]. The content of organic matter was estimated according to [12], and electrical conductivity was determined in the saturated paste extract using electrical conductivity meter [13], whereas Calcimeter method used for CaCo₃ estimation [14], and ammonium oxalate to determine the effective calcium determined [15]. Regarding the estimation of nutrients in soil, the nitrogen content was determined using Kjeldahl method [16], Phosphor by Murphy and Riley method [17], and the flame photometric method was used for measured available potassium [18,19].

2.3.2 Oil content in fruits%

A laboratory mill was used to extract oil, the oil percentage was calculated according to the following equation [20]:

\[
\text{Oil content relative to wet weight\%: } \frac{\text{dry weight of oil } \times \text{ dry matter}}{100}.
\]

2.3.3 Some qualitative properties of oil

The Oleic acid content was determined using gas chromatography according to commercial specification for olive oil [21], phenols were evaluated on the basis of caffeqe acid (mg/kg) as indicated by [22], and the free acidity expressed as a percentage of free oleic acid by AOCS method. Chemical Analysis were carried out in laboratory of Olive Research Department at General Commission of Scientific Research.
2.3.4 Diversity of natural vegetation

The species and plants growing in the natural cover were counted in two plots by using a wooden frame with an area of one square meter as indicated by [23].

2.3.5 NPK content in leaves of wild legumes

The dried leaves content was analyzed in Al-Hanadi laboratory of the General Commission for Scientific Agricultural Research; the nitrogen content was calculated according to [24], phosphorus by murphy method [17], and potassium as method indicated by [25].

2.4 Experiment design and statistical analysis

The experiment was designed according to randomized complete blocks, three replicates were taken in each plot, and the least significant difference at a confidence level of 95% was calculated to compare the averages according to ANOVA analysis by using GenStat program.

3. Results and Discussion

3.1 The soil property and its content of nutrients

The soil of the experiment site is alkaline, non-saline, and free of total carbonates, as shown in table (2), this is due to the heavy rain and snow in the region, while the electrical conductivity is low, many of the salts lost by washing and withdraw to nearby basins. The soil content of organic matter and nitrogen is low, as well as potash and nitrogen.

| Table 2. Soil analysis data in tow plots before applying treatments. |
|-------------------------|---------|---------|---------|---------|---------|---------|
| Treatment               | Soil depth | pH | EC | CaCO₃ | Ca | Organic matter | N | P | K |
| Unit                    | cm | Saturated paste | g/100 g soil | % | ppm | ppm |
| Conventional            | 0-30 | 7.93 | 0.55 | – | 1.77 | 0.68 | 0.034 | 5.26 | 25.78 |
|                         | 30-60 | 7.81 | 0.5 | – | – | 0.88 | 0.044 | 4.79 | 23.44 |
| Organic                 | 0-30 | 7.82 | 0.45 | – | – | 0.55 | 0.028 | 10.71 | 25.78 |
|                         | 30-60 | 7.76 | 0.65 | 5.5 | 1.77 | 0.68 | 0.034 | 8.28 | 24.12 |

Soil fertilization treatments with chemicals (balanced NPK) in conventional plot, or with farmyard and green manure in organic one led to improve electrical conductivity in two soil horizons (0-30, 30-60 cm) and to slight increase in pH soil, this in turns increases the nutrients available to the plant. The soil content including organic matter, total nitrogen, phosphorus and potash was increased in both treatments, but the increase was greater in organic one.

| Table 3. Soil analysis data in tow plots at the end of experiment. |
|-------------------------|---------|---------|---------|---------|---------|---------|
| experiment              | Soil depth | pH | EC | CaCO₃ | Ca | Organic matter | N | P | K |
| Unit                    | cm | Saturated paste | g/100 g soil | % | ppm | ppm |
| Conventional            | 0-30 | 7.9 | 0.9 | – | – | 1.34 | 0.067 | 11.92 | 38.56 |
|                         | 30-60 | 7.89 | 1 | – | – | 1.47 | 0.074 | 8.15 | 27.76 |
| organic                 | 0-30 | 7.85 | 0.9 | – | – | 1.47 | 0.074 | 14.30 | 39.76 |
|                         | 30-60 | 7.87 | 0.9 | – | – | 1.74 | 0.087 | 11.2 | 29.94 |

This effect of the organic treatment is due to gradually release of nutrients because of fermentation of farmyard and green manure and therefore to release of organic acids in the soil, which will reflect positively on the production parameter quantitatively and qualitatively, confirm that the trees benefit from fertilization treatments in two plots. This feature of organic treatments, especially the green manure crop, in improving the soil properties and its content of nutrients available to the plant has been mentioned by many previous studies [26-28].

3.2 Oil percentage and some qualitative properties

The oil content in fruits was higher in the organic plot than conventional one by a difference of 1.7% as shown in table (4), this effect of the organic system was proven in a previous experiment conducted on a Syrian olive variety named “Sorani” [9]. This may explained by the response of the olive to organic additives, which improved the soil fertility and thus the
nutrient content of plants as they can be substitutes for mineral fertilization [29]. The olive oil obtained from organic plot exceeded significantly the conventional one in all studied qualitative traits; the main fatty acid Oleic was higher in it with difference of 1.33%. It is unsaturated fatty acid, gives oil the property of preservation and storage for a long time, compared to other oils [30]. The organic oil was also superior in terms of its content of total polyphenols, and free acidity in it was lower than oil produced in conventional plot, these results are consistent with many studies conducted on organic olive oil [31,32].

| Table 4. Oil content %, oleic%, free acidity, and polyphenols in two experimental plots. |
|---------------------------------------------------------------|
| **Treatment**       | **Maturity degree** | **Oil%** | **Oleic%** | **Free acidity%** | **Poly phenols** |
|---------------------|---------------------|----------|------------|-------------------|-----------------|
| organic             | Green               | 17.94±0.12 | 72.90±0.23 | 0.37±0.04         | 395.4±1.7       |
| Conventional        | Green               | 16.22±0.15  | 71.57±0.31 | 0.42±0.04         | 366.7±1.5       |
| LSD 5%              |                     | 1.5       | 1.3        | 0.04              | 26.7            |

3.3 Survey some spices of natural vegetation

It has been observed that plant species grow naturally in the olive grove at the end of spring were more diverse in the organic plot and denser compared to the conventional one. The organic plot contained legume plants such as wild grass pea (Lathyrus sativus), clover (Trifolium), lupine (lupines), table (5). As is known, these spices provide an incubator environment for the natural enemies of pests that infect the olive tree, and they fix atmospheric nitrogen through root rhizobia nodules of these plants, which contributes to increasing soil fertility and maintaining its moisture. Scientific studies have indicated the role of organic production system in increasing biodiversity in both domesticated and wild plants [33, 34], has shown that number of species of nature grass growing in the organic olive orchards was 40% more than conventional ones, [35] attributed this to use of appropriate number of tillage and reducing the use of chemicals in fertilization and weed control.

| Table 5. Natural cover plants: presence and numbers in both treatments. |
|---------------------------------------------------------------|
| **Plant** | **Latin name** | **Conventional plot** | **Organic plot** |
|------------|---------------|-----------------------|------------------|
| wild oats  | *Avena fatua* | ✓                     | ✓                |
| mallow     | *Malva Sylvestris* | ✓                 | ✓                |
| Coco-grass | *Cyperus rotundus* | ✓                   | ✓                |
| Johnson grass | *halepense Sorghum* | ✓         | ✓                |
| Wild chicory | *Cichorium intybus* | ✓                | ✓                |
| cheat grass | *Bromus tectorum* | ✓                | ✓                |
| False yellow | *Inula Viscosa* | ✓                | ✓                |
| Thorny burnet | *Sarcopoterium Spinosum* | ✓            | ✓                |
| Bermuda grass | *Cynodon dactylon* | ✓         | ✓                |
| - papaver postii | *plantago psyllium* | ✓       | ✓                |
| lupine     | *Lupinus varius* | ✓                | ✓                |
| Wild vetch | *Lathyrus Vernus* | ✓                | ✓                |
| Yellow clover | *Trifolium alexandrinum* | ✓            | ✓                |
| Red clover | *Trifolium pratense* | ✓              | ✓                |
| White clover | *Trifolium repens* | ✓            | ✓                |

When studying the density of vegetative cove plants, it was found that the number of plant species per square meter ranged between 3 and 5 species in the conventional plot, while it reached 5 and 8 in some cases in organic one. In term of the total number of plants per unit area, the organic plot exceeded conventional one (12-24, 36-45 respectively). The results show that studied natural plants (lupines, wild vetch, yellow, red and white clover) differ clearly in term of its dried leaves content of essential nutrition NPK. As shown in table (6), the highest content of N was in yellow clover leaves follow by white clover, and P content was the highest level in these two spices but better in white clover, which indicates the feasibility to chop and buried these plant in the soil.

| Table 6. The NPK content percentage in dried leaves of natural cover plants. |
|---------------------------------------------------------------|
| **Sample** | **N** | **P** | **K** |
|------------|-------|-------|-------|
| *Lupinus varius* | 2.4965 | 0.1471 | 0.2971 |
| *Lathyrus Vernus* | 2.1825 | 0.1072 | 0.9842 |
| *Trifolium alexandrinum* | 3.4484 | 0.1878 | 1.4853 |
| *Trifolium pratense* | 2.1820 | 0.1399 | 1.2900 |
| *Trifolium repens* | 2.4106 | 0.1564 | 1.5301 |
Conclusions

- Organic management of olive orchards improves the yield and quality properties of oil, so this production system is recommended.
- The organic system preserve biodiversity in farm, and thus protects the components of micro environment and ensure better sustainability.

Recommendation

- Continuing to evaluate the results of organic practices in olive orchards cultivated with local varieties, and for many seasons to evaluate the cumulative effect of these practices.
- Take all measures to facilitate conversion to organic olive production in Syria, especially in areas where farmers provide the lowest service and used less chemicals, thus the conversion will be lower cost and more profitable.

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