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# Determination of Some Micro and Macro Elements of Bean *(Phaseolus vulgaris* L.*)* and Sunflower *(Helianthus annuus* L.*)* Plants after Addition of Olive Oil Solid Waste to Soil

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**ABSTRACT**
In this study, effects of olive oil solid waste (OSW) applications on bean and sunflower macro and micro element contents were investigated. Olive oil solid waste mixed with soil at the rates of 0, 3, 5 and 7 % by weight. Plants were grown in the pots under controlled conditions throughout 45 days for sunflower and 30 days for bean. Plant carbon/nitrogen (C/N), some macro elements; nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and micro elements; boron (B), iron (Fe), manganese (Mn) contents were determined and their relations with the application of olive oil solid waste have been investigated. As a result, while phosphorus, calcium, and boron have increased, nitrogen has decreased in sunflower plants. On the other hand, phosphorus, potassium, magnesium, and boron have increased but nitrogen, calcium, and manganese have decreased in bean plants.
**Keywords**: Olive oil solid waste, sunflower and bean, some macro and micro elements

## INTRODUCTION

The average world production of olive oil is $2.5\times10^6$ tons, most of which comes from the Mediterranean countries (Alburquerque et al., 2004). The olive oil extraction industry has great economic and social importance in many Mediterranean countries such as Spain, Italy, Greece, Tunisia, Turkey and Morocco, but this is often associated with the generation of wastes and by-products that provoke adverse environmental problems. Improving the appropriate management of these materials urgently needs more intensive research (Cegarra et al., 2006).

Soil organic matter, and especially the humified fractions, constitute an important source of nutrients, and are also a key factor in maintaining or improving soil structure. Although changes in total soil organic matter (SOM) content induced by agricultural practice are important, changes in organic matter quality (the organic matter fractions) are also significant (Graham et al., 2002).Locally available organic wastes and by-products from agriculture and agro-food industries may be processed and converted to value-added products (Bernal et al., 1998; Madejon et al., 1998 and Paredes et al., 2000), which contribute to the sustainability and productivity of agro ecosystems in the Mediterranean region (Madejon et al., 1995; Martinolmedo et al., 1995; De Monpezat and Dennis, 1999; and Manios, 2004).

The end products such as compost can be used as soil conditioner and fertilizer, thereby recycling nutrients back to agriculture and horticulture. However may contain a wide range of organic pollutants (Brändli et al., 2005, 2007a, 2007b). The problem of olive solid waste (OSW) disposal, then, has not been fully resolved and research into new technological procedures that permit its profitable use is needed. One possibility to use compost is a method for the preparation of soil organic fertilizers and amendments, since the direct application of OSW to the soil has been shown to have a detrimental effect on the soil structural stability (Tejada et al., 1997). It may also negatively affect seed germination, plant growth and microbial activity. In fact, several studies have reported the phytotoxic and antimicrobial effects of both olive-mill wastes and by-products due to the phenol, organic and fatty acid contents ( González et al., 1990; Riffaldi et al., 1993; Linares et al., 2001).

Piñeiro et al. (2008) reported that application of two - phase olive mill waste (TPOMW) caused significant increases ($P < 0.05$) in organic carbon, total N, available P and K, and aggregate stability were observed in the amended soils after two years and raw TPOMW has the potential to be valuable soil amendments and source of organic matter, with a positive effect on olive yield, and closing the cycle of residues-resources.

In this study we used OSW with high C/N ratio, and it was applied to soil directly for growing sunflower and bean.

## MATERIALS and METHODS

### Applications and Experimental Design

Two pot experiments were conducted for characterization of plant response to direct application of OSW to the soil. Soil samples were taken from field at 0-20 cm depths and sieved through 9 mm sieve. Some chemical and physical properties of soil are presented in Table 1. Olive oil solid wastes (two-phase centrifugation) have been provided from the Elta Agriculture enterprise in Gökçeada, Çanakkale. OSW was sieved through 6 mm and mixed with soil at the rates of 0, 3, 5, and 7% w/w.

Experimental design was randomized block design with four replications. There were four different levels (0%, 3%, 5%, and 7%) of OSW applications.

Five sunflower (Syngenta Sanay variety) and five bean (Asgrow variety) seeds were sown in each pot. Plants were thinned after the germination

Table 1. Some chemical and physical properties of soil sample

| EC (µS/cm) | pH | N % | $CaCO_3$ % | OM % | Texture | | |
|---|---|---|---|---|---|---|---|
| | | | | | Clay % | Silt % | Sand % |
| 235 | 8.1 | 0.1 | 15.4 | 1.6 | 36.98 | 31.99 | 31.03 |
| | | | | | CL | | |

Table 2. Some properties of OSW

| EC (µS/cm) | pH | N (%) | C (%) | C/N | P (%) | K (%) | Ca (%) | Mg (%) | B (ppm) | Fe (ppm) | Mn (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 822 | 5.7 | 1.12 | 49.1 | 43.8 | 0.04 | 0.57 | 0.50 | 0.06 | 16.9 | 1243.91 | 32.75 | 17.34 |

## METHODS

Dried plants were ground with plant grinder, and then total nitrogen was determined by using Leco TruSpec 2000 CN elemental analyzer. EC: Samples mixed with DI water at 1:2.5 ratio, set overnight and then EC was determined using WTC brand EC-meter model LF 320.(Richards, 1954). pH: Samples mixed with DI water at 1:2.5 ratio, set overnight and then pH was determined using Orion brand pH-meter, model 420A.(Richards, 1954). Lime: Scheibler calcimeter was used to measure $CaCO_3$ (Soil Survey Laboratory Methods Manual, 1996). Macro and micro element contents of OSW and plants were determined in dry ash (Peters, 2003) by using ICP-AES. Hydrometer method was used to determine soil texture (Gee and Bauder, 1986). Statistical analyses were computed using SAS software.

## RESULTS and DISCUSSION

Table 3 shows that the nitrogen content of sunflower decreased gradually when the rate of applied OSW was increased. Phosphorus and calcium contents increased potassium and magnesium contents of sunflower did not change. Using of OSW that have high C/N ratio may cause low nitrogen content of sunflower. The application of organic materials showing C-to-N ratios around 25–35 into soils is generally expected to result in no direct net N mineralization or immobilization (Harris, 1988; Paul and Clark, 1996). Changes in micro element contents by applications of OSW on sunflower were presented in Table 4. It shows that the highest boron content was determined in %5 OSW application and it is statistically significant ($P < 0.05$). Iron and manganese contents did not change significantly by OSW applications.

Nitrogen and calcium contents decreased with the application of OSW in the bean while phosphorus, potassium, and magnesium contents increased (Table 4). On the other hand, the highest boron content was found in %7 OSW application in bean (Table 5) and boron content of bean was significant statistically ($P < 0.05$). The highest manganese value was found in the control treatment. Although it is statistically significant ($P < 0.001$) iron content was found not statistically significant ($P > 0.05$).

As a result directly application of OSW to soil has positive impact on phosphorus, calcium and boron contents of sunflower. While nitrogen content of sunflower reduced by OSW application, potassium, magnesium, iron and manganese contents did not change. Nitrogen content of bean reduced in OSW treatment. Other element contents statistically increased except calcium, iron and manganese. While calcium and manganese contents decreased by OSW application, iron content did not statistically change. Potassium content in bean increased consistently as it was also reported by Piñeiro et al. (2008). They reported that application of OSW increased available potassium content. The results showed that direct application of OSW as raw material to soil is unfavorable for annual plants. Some studies reported that composting OSW balances C/N ratio and transforms the plant nutrients to available forms. Also as an alternative way OSW may be mixed with soil several months before sowing. But ideal application time of OSW must be determined by incubation studies in laboratory or field experiments.

Table 3. Effect of OSW on some macro element contents of Sunflower

| Applications | N% | | P% | | K% | Ca% | | Mg% |
|---|---|---|---|---|---|---|---|---|
| 0 % OSW | 0.96 | A | 0.07 | C | 2.02 | 1.74 | C | 0.28 |
| 3 % OSW | 0.64 | B | 0.19 | A | 2.35 | 2.44 | A | 0.29 |
| 5 % OSW | 0.49 | C | 0.16 | A | 2.24 | 2.41 | BA | 0.31 |
| 7 % OSW | 0.41 | C | 0.12 | B | 1.88 | 2.03 | BC | 0.26 |
| Significant | *** | | *** | | ns | ** | | ns |

*: P < 0.05, **: P < 0.01, ***: P < 0.001, ns: Not Significant

Table 4. Effect of OSW on some macro element contents of Bean

| Applications | N% | | P% | | K% | | Ca% | | Mg% | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 % OSW | 4.21 | A | 0.23 | B | 3.49 | CB | 3.44 | A | 0.44 | B |
| 3 % OSW | 1.76 | B | 0.29 | A | 3.29 | C | 2.78 | B | 0.43 | B |
| 5 % OSW | 1.75 | B | 0.29 | A | 3.65 | B | 2.73 | B | 0.47 | BA |
| 7 % OSW | 1.70 | B | 0.32 | A | 4.00 | A | 2.64 | B | 0.52 | A |
| Significant | *** | | *** | | *** | | *** | | * | |

*: P < 0.05, **: P < 0.01, ***: P < 0.001, ns: Not Significant

Table 5. Effect of OSW on some micro element contents of Sunflower and Bean

| Applications | Bean | | | | | Sunflower | | | |
|---|---|---|---|---|---|---|---|---|---|
| | B(ppm) | | Fe(ppm) | Mn(ppm) | | B(ppm) | | Fe(ppm) | Mn(ppm) |
| 0 % OSW | 33.44 | B | 179.68 | 118.77 | A | 33.83 | B | 53.55 | 30.65 |
| 3 % OSW | 39.38 | BA | 169.86 | 70.41 | C | 41.84 | A | 54.30 | 30.25 |
| 5 % OSW | 37.15 | B | 207.63 | 86.96 | B | 43.98 | A | 61.48 | 31.75 |
| 7 % OSW | 44.56 | A | 173.76 | 87.07 | B | 40.75 | BA | 49.72 | 32.38 |
| Significant | * | | ns | *** | | * | | ns | ns |

*: P < 0.05, **: P < 0.01, ***: P < 0.001, ns: Not Significant

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