International Meeting on Soil Fertility Land Management and Agroclimatology. Turkey, 2008. p:593-598

The Effects of Olive Oil Solid Waste Applications on the Some Physiological and Morphological Parameters of Bean (*Phaseolus vulgaris* L.) and Sunflower (*Helianthus annuus* L.) Plants

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ABSTRACT
By considering the storage problems and the environmental harms caused by agricultural by-products and industrial wastes, researches on reusing these wastes are gaining great importance. In this study we investigated the olive oil solid waste applications on beans and sunflower growth. Olive oil solid waste (OSW) mixed with soil at the rates of 0, 3, 5 and 7 % by weight. Some physiological and morphological parameters such as chlorophyll contents, plant height, plant thickness etc. have been examined. As a result, it is determined that direct applications of olive solid waste negatively affect bean and sunflower growths.
Keywords: Olive Oil Solid Waste, morphological properties, bean, sunflower

INTRODUCTION

Olive oil extraction is one of the most traditional agricultural industries in the Mediterranean region, and is still of primary importance for the economy of most of the Mediterranean countries (Owen et al., 2000). The average world production of olive oil is 2.5×10^6 tons, most of which comes from the Mediterranean countries (Alburquerque et al., 2004).

Locally available organic wastes and by-products from agriculture can be processed and converted to other products (Bernal et al., 1998), which contribute to the sustainability of agro ecosystems in the Mediterranean region (Manios, 2004). Final products and compost can be used as soil conditioner and fertilizer, for recycling nutrients to agriculture and horticulture. However, compost contains a wide range of organic pollutants (Brändli et al., 2005; Brändli et al., 2007a and 2007b) and care must be taken before apply them to soil.

Soil organic matter is the most sensitive component to characterize soil quality, to reduce its erosion and improve crop production (Stevenson, 1994; Reeves, 1997). Moreover, Hachicha et al. (2006) studied that composting of olive mill wastes with poultry manure and noticed that olive mill wastes compost can be used as an organic fertilizer for agricultural soils, without any phytotoxic effect. Studies have indicated that various sources and forms of composted and raw wastes can be used effectively as organic support media, a fertilizer source with reduced cost (Ingelmo et al., 1998; Riberio et al., 2000,). One possibility is to use OSW compost is the preparation of soil organic fertilizers and amendments, since the direct application of OSW to the soil has detrimental effect on seed germination, plant growth and microbial activity. Composting of olive mill wastes can be used as organic fertilizers or soil amendments (Tomati et al., 1995; Madejón et al., 1998; Paredes et al., 2001, Paredes et al., 2002).

Application of OSW increased soil aggregate stability of sandy and loamy soils (Kavdir and Killi, 2008). On the other hand when plant growth considered, direct application of OSW reduced tomato plant growth while OSW compost increased it (Killi, 2008). Therefore influences of OSW on various plant growths must be determined in order to overcome these negative effects.

In this research, we studied the suitability of OSW as an organic amendment, 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 system) 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)	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	0.5	0.06	16.9	1243.91	32.75	17.34

METHODS

Plant height was determined by using a ruler and stem thickness was determined by an absolute digital caliper (Mitutoyo). Chlorophyll readings were measured by using Chlorophyll Meter-Spectrum CM

1000 (BRT 1) under light source (Unit 1347 pro lamb). 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 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

The results were statistically analyzed and they showed that direct application of OSW to soil inhibited bean and sunflower plants growth (Tables 3, 4). Plants height, leaf numbers, dry weight, wet weight, stem thickness and chlorophyll meter readings of bean and sunflower were greater in control treatments than other treatments. Plant height of bean in the 7% OSW treatment was the lowest as compared to all other treatments. Stem diameter was lower in the OSW application than control measurement.

Bean plant height reduced significantly ($P<0.001$) in the OSW treated soils. Respectively bean stem thickness, leaf numbers, wet weight, dry weight and chlorophyll meter readings reduced significantly by using OSW too. ($P<0.01$, $P<0.05$, $P<0.001$, $P<0.001$, $P<0.001$)

Sunflower plant height, stem thickness, leaf numbers, wet weight and dry weight significantly reduced by using OSW ($P<0.001$, $P<0.001$, $P<0.001$, $P<0.001$, $P<0.001$). But OSW application effect on chlorophyll meter readings was not significant ($P> 0. 05$).

Some morphological measurements showed that using OSW directly to the soil negatively effected sunflower and bean growth in short term. Although informed 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; 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 also, a general increase in olive production was observed in the treated plots and reported that 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.

As a result direct application of OSW to soil has negative impact on morphological growth of sunflower and bean. Using this waste is unfavorable for annual plants. Some studies reported that by composting OSW balances C/N ratio and transform the plant nutrients to available forms. Also another alternative can be mixing this material with soil several months before sowing. But its time must be determined by incubation studies in laboratory or field experiments.

Table 3. Effects of OSW on some morphological properties of bean

Applications	Plant Height (cm)		Stem Thickness (mm)		Leaf numbers		Wet weight (gr)		Dry weight (gr)		C.M. Readings	
0 % OSW	138.50	A	3.42	A	11.75	A	12.16	A	1.23	A	120.53	A
3 % OSW	113.25	B	2.89	B	11.00	BA	6.36	B	0.72	B	52.52	B
5 % OSW	95.50	C	3.09	BA	11.00	BA	6.00	B	0.59	C	52.62	B
7 % OSW	84.50	C	2.81	B	10.25	B	4.98	C	0.48	D	52.82	B
Significant	***		**		*		***		***		***	

*: P < 0.05, **: P < 0.01, ***: P < 0.001, ns: Not Significant, C.M: Chlorophyll Meter

Table 4. Effects of OSW on some morphological properties of sunflower

Applications	Plant Height (cm)		Stem Thickness (mm)		Leaf numbers		Wet weight (gr)		Dry weight (gr)		C.M. Readings
0 % OSW	51.65	A	5.97	A	18.25	A	22.74	A	4.92	A	95.92
3 % OSW	38.15	B	3.45	B	9.75	B	4.08	B	0.78	B	67.39
5 % OSW	31.58	B	3.38	B	7.50	C	3.14	B	0.70	B	70.45
7 % OSW	34.83	B	3.60	B	7.00	C	3.43	B	0.81	B	50.14
Significant	***		***		***		***		***		ns

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

ACKNOWLEDGEMENTS

This project was supported by BAP 2007-60 and partly supported by TUBITAK TOVAG 106O371.

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