EFFECT OF CRUDE AND COMPOSTED OLIVE CAKE AS ORGANIC MANURES ON GROWTH OF CORN PLANTS GROWN ON A SANDY SOIL.

El-Ghozoli, M.A. and Kenawy, Mona, H.M.

Soils, Water and Environment Res. Institute, Agric. Res. Center, Giza, Egypt

Journal

J. Biol. Chem. Environ. Sci., 2008, Vol. 3(1): 141-151 www.acepsag.org

ABSTRACT

A greenhouse pot experiment was conducted using a light texture soil as growth media for corn plants (Zea maize) variety Giza-2 grown for 90 days to evaluate olive cake waste as organic manure. Soil samples were taken from rhizosphere area at periods of 0, 60 and 90 days from cultivation to identify influence of phenolic compounds containing crude olive cake on microflora. The main results can be summarized as follows:

The dry matter yield of corn plants was pronouncedly increased due to addition of all treatments compared to the control treatment, except for the treatment of crude olive cake. The percentages of increase in dry weight of corn plants grown for periods of 60 and 90 days from seedling were 37.4% and 29.8%, respectively. On contrary, the dry weight was decreased by percentages of 4.5% and 8.15%, due to addition of crude olive cake, at the same periods, respectively.

The concentrations of N, P and K in corn plants increased due to all treatments. Except the treatment of crude olive cake which negatively effected N, P and K concentrations in corn plants as compared with the corresponding ones of the control treatment.

Total counts of bacteria, actinomycets and fungi were significantly affected with growth periods and different treatments as well as the interaction between them. However, the treatment of crude olive cake decreased the microflora population density at growth periods of 0, 60 and 90 days.

The concentrations of total and free phenols in corn plants were significantly affected with all treatments. High concentrations of phenolic compounds in corn plants were obtained due to application

of the crude olive cake. On the contrary, corresponding lowest values were achieved due to application of the composted olive cake.

Keywords: Total phenols, free phenols, NPK, rhizosphere, corn plants, dry weight, organic fertilizers.

INTRODUCTION

Organic manure and biofertilization are attractive alternatives for chemical fertilizers. The continuous and judicious use of organic manures improve the physical and chemical properties of sandy soils which contain low amounts of organic matter.

Olive cakes are solid wastes generated during processing of olive fruits creating environment pollution.

These wastes are considered biological toxic substances because of their high contents of polyphenolic compounds which are phytotoxic, antimicrobial and resistant to degradation **(Gonzalez *et al.*, 1990 & Tomati and Galli, 1992).**

Olive cakes and olive oil waste water contain high concentrations of essential elements such as NPK as well as high amount of organic matter (80-150 kg /m^3), total nitrogen content is about (0.6-1.0 kg N/m^3), while total potassium is about 4.5-6.0 kg K_2O/m^3 where as total phosphorus ranges from 1.0 – 1.5 kg P_2O_5 /m^3 **(Tomati and Galli, 1992). Al-Kahal *et al.* (2001)** found that using different levels of olive oil waste water or olive cake as organic fertilizers for faba bean plants resulted in insignificant decrease in plant growth parameters and yield. On other hand, they reported that inoculation of wheat seeds with vesicular-arbiscular mycorrhizae efficiently reduced the toxicity produced due to addition of 1% olive wastes. **Al-Kahal *et al.* (2002)** found that addition of olive oil waste water at 1.0, 2.0 and 3% in absence of bacterial inoculation produced a decrease in plant height, number of tillers, shoot dry weight, grains yield and N-content of wheat plants as well as the total counts of bacteria, fungi and actinomycetes in rhizosphere area of wheat plants.

Application of large quantities of olive oil waste water may lead to deterioration in soil structure, salinization and the accumulation of phytotoxic compounds **(Moreno *et al.*, 1990). Kenawy (2003)** found that the inoculated and uninoculated compost made from rice straw, grounded peanut shells and olive cake at different rates led to

increases in the dry matter of tomato shoots and roots and fruit fresh weight/plant as compared to the inorganic fertilizer application.

The main objective of the current study was to compare effect of usage of olive wastes as organic fertilizer with the corresponding ones of farmyard manure and chemical fertilizers on growth parameters, N, P, and K concentrations as well as microflora of rhizoshpere area of corn plants grown on a sandy soil.

MATERIALS AND METHODS

A pot experiment was designed under greenhouse conditions at the Training Center for Recycling of Agricultural Residues, Moshtohor to evaluate the effect of crude olive cake as an organic fertilizer in comparison with farmyard manure and chemical fertilizers on growth of corn plants.

A light textured soil was taken from the surface area (0 – 20 cm) in El-Dair village, Qalubia Governorate. The soil sample was air dried, crushed to pass through a 2 mm sieve then thoroughly mixed to be homogenous. Crude olive cake was obtained from the olive oil extraction factory, ARC, Giza. Some characteristics of the studied soil sample and organic manures were determined according to **Black (1965) and Piper (1950)** and results of analyses are shown in Tables (1 and 2). Crude olive cake, olive cake compost and farmyard manure (FYM) were air dried and finely ground then uniformly packed in plastic pots of 5 kg capacity of and thoroughly mixed.

Each source of the investigated organic manures was added in absence or in presence of the nitrogen mineral fertilizer. Thus, the applied mineral N rate was 120, 60, 30 or 0 combined with 0, 60, 90 or 120 kg N as organic source. Before cultivation the organic source and the inorganic P (30 kg P fed^{-1} as calcium superphosphate) and K (24 kg K fed^{-1} as potassium sulfate) were applied to the soil samples. The N rate was applied at equal doses. The treatments involved could be briefly described in the following:

1- Crude olive cake at a rate equivalent to120 kg N fed^{-1} (crude olive cake 100%).
2- Olive cake compost at a rate equivalent to120 kg N fed^{-1} (composted crude olive cake 100%).
3- Farmyard manure at a rate equivalent to120 kg N fed^{-1} (farmyard manure 100%).
4- Mineral N fertilizer (120 kg N fed^{-1} as ammonium sulfate100%).

5- 75% crude olive cake + 25% mineral N.
6- 75% olive cake compost + 25% mineral N.
7- 75% farmyard manure + 25% mineral N.
8- 50% crude olive cake + 50% mineral N.
9- 50% olive cake compost + 50% mineral N.
10- 50% farmyard manure + 50% mineral N.
11- Control (the soil without any applications of the mineral or the organic fertilizer).

Table (1): Physical and chemical characteristics of the experimental soil.

Practice size distribution (%)		Mg^{2+}	1.44
Sand	93.2	Na^{+}	35.4
Silt	4.7	K^{+}	0.39
Clay	2.1	CO_3^{2-}	0.0
Texture class	Sandy	HCO_3^{-}	2.20
Organic matter (%)	0.61	Cl^{-}	5.20
pH (1: 2.5 soil : water suspension)	7.38	SO_4^{2-}	40.63
$CaCO_3$ (%)	2.53	**Soil moisture constants (%)**	
EC (dSm^{-1})	4.5	Field capacity (%)	13.7
Soluble ions ($m.mol_C\ L^{-1}$)		Wilting point (%)	8.2
Ca^{2+}	10.8	Available water	5.5

Table (2): Chemical analysis of crude olive cake, FYM and composted olive cake.

Manure / Characteristics	**Crude olive cake**	**FYM**	**Composted olive cake**
Moisture content (%)	7.9	11.1	20.2
pH	4.58	6.31	7.20
EC (dSm^{-1})	2.62	2.54	3.76
Organic matter (%)	50.8	13.6	52.1
Organic carbon (%)	29.5	7.9	30.3
Total – N (%)	0.84	0.45	1.9
C / N ratio	35.1	17.5	15.9
Total phenols (%)	1.296	0.342	0.62
Free phenols (%)	0.755	0.204	0.268
Total – P (%)	0.30	0.35	0.71
Total – K (%)	0.68	0.32	1.08

Four grains of corn (Zea maize) variety Giza-2 were sown in each pot. The pots were arranged in randomized complete block design with three replicates for each treatment. After 2 weeks from germination, the seedlings were thinned to two plants and watered daily with distilled water. The plants were harvested after 90 days, dried at 70°C and the dry weights were recorded. The dried plants were ground and acid digested to estimate their contents of N, P and K.

Total nitrogen was determined using semi micro-Kjeldahl method; K was estimated by using flamephotometer according to Jackson (1967). Phosphorus was determined colorimeterically using ascorbic acid method according to Murphy and Riley (1962) as modified by John (1970). Total and free phenolic compounds were determined according to the A.O.A.C. (1990), using the Folin Denis reagent.

During the growth season, the soil samples were taken from rhizosphere area at periods of 0, 60 and 90 days from sowing to study the effect of crude olive cake, composted olive cake and farmyard manure on total counts of microflora (i.e. total bacteria, total actinomycetes and total fungi in rhizosphere of corn plants). Total counts of bacteria, actinomycetes and fungi were calculated using pour plate technique (Allen, 1953).

Data were subjected to analysis of variance using least significant difference values (LSD) by Minitab program according to Ryan and Joiner (1994).

RESULTS AND DISCUSSION

Effect of organic and inoraganic fertilizers on dry weight, plant height and concentrations of N, P and K

In general, data presented in Table (3) show the effect of crude olive cake, composted olive cake, farmyard manure, mineral fertilizer and combined mixture between them on dry weight, plant height and NPK concentrations in corn plants grown on a sandy soil. The dry matter yield of corn plants was markedly increased due to all treatments except the crude olive cake (100%) as compared with the control treatment. Highest increases in dry weight of corn plants being 67.25 and 55.8% were obtained due to the treatment of 50% composted olive cake + 50% mineral N fertilizer after growth periods of 60 and 90 days from planting, respectively. However, decreases in

dry weight being 4.5 and 8.15%, respectively were recorded due to the application of crude olive cake at the same periods.

The descending order of dry weight values which were affected due to the different treatments as follows: 50% composted olive cake + 50% mineral N > 75% olive cake compost + 25% mineral N > 50% farmyard manure + 50% mineral N > 75% farmyard manure + 25% mineral N > 75% crude olive cake + 25% mineral N > mineral fertilizer (100%) > olive cake compost (100%) > 25% crude olive cake + 25% mineral N > farmyard manure (100%) > crude olive cake (100%).

Table (3): Effect of organic and inorganic fertilizer on dry weight, plant height and concentration of N, P and K in corn plants grown on sandy soil.

Treatments (T)	Dry weight (g/plant)		Plant height (cm)		N-Conc. (%)		P-Conc. (%)		K-Conc. (%)	
	Periods (P) days									
	60	90	60	90	60	90	60	90	60	90
Crude olive cake (100%)	8.05	9.02	81.2	85.3	1.42	1.60	0.30	0.34	1.49	1.53
Composted olive cake (100%)	10.7	11.5	100.2	101	1.80	2.07	0.39	0.42	1.84	1.71
Farmyard manure (100%)	9.75	10.5	90.5	99.4	1.68	1.74	0.35	0.39	1.70	1.82
Mineral fertilizer (100%)	10.7	11.8	100.4	106	2.15	2.24	0.37	0.41	1.83	1.99
75%crude olive cake + 25% mineral N.	10.9	11.9	104.2	103.1	2.05	2.20	0.48	0.51	1.88	1.93
75% Composted olive cake +25% mineral N.	12.9	14.1	103.2	104.1	2.33	2.47	0.74	0.77	2.66	2.72
75% farmyard manure + 25% mineral N.	12.2	13.9	103.6	104.3	0.07	2.14	0.54	0.56	2.01	2.11
50% crude olive cake + 50% mineral N.	10.4	11.7	95.4	99	1.88	1.97	0.36	0.41	1.82	1.93
50%Composted olive cake+50% mineral N.	14.1	15.3	106.2	104.7	2.29	2.41	0.56	0.62	2.55	2.62
50% farmyard manure + 50% mineral N.	12.6	14.0	102.3	106	1.93	2.01	0.51	0.55	2.60	2.68
Control	8.43	9.82	84	88.3	1.56	1.64	0.33	0.36	1.61	1.64
L.S.D. 0.01										
T =	1.72		16.1		0.135		0.83		0.124	
P =	0.737		6.87		0.057		0.035		0.039	
T x P =	2.44		22.8		0.192		0.117		0.132	

The average values of plant dry weight were 14.7, 13.5, 13.3, 13.05, 11.4, 11.25, 11.1, 11.05, 10.28 and 8.54 g plant^{-1}, respectively. These values were higher than the corresponding ones of the control. The decrease in dry weight of plants treated with crude olive cake could be attributed to phytotoxic compounds mainly phenolic substances which affect growth and yield of crops (Tomati and Galli, 1992). Regarding plant height, the same trends were almost obtained.

Concerning the N, P and K concentrations, data presented in Table (3) show that the N, P and K concentrations of the corn plants grown on the sandy soil were markedly increased due to all the treatments except for the treatment of crude olive cake as compared with control treatment. This increase of NPK was significant due to the single treatments and growth periods. The combined treatments (rates of fertilizers x growth periods) resulted in non significant. The obtained data cleared that high values of NPK being 2.47, 0.77 and 2.72% were achieved due to the treatment of 75% composted olive cake + 25% mineral N after growth period of 90 days.

The effect of manures (100%) on all parameters of corn plants were in agreement with interaction between them. The obtained results are in agreement with those obtained by Tejada and Gonzalez (2004) and Al-Kahal *et al.* (2001).

Effect of organic and inorganic fertilizers on microflora of rhizosphere area of corn plants:

Data presented in Table (4) reveal the relationship between the different fertilization treatments and total counts of bacteria, actinomycetes and fungi at growth periods of 0, 60 and 90 days. The total counts of bacteria, actinomycetes and fungi were significantly affected with growth periods and types of fertilizers. It is worthy to refer that the microflora populations were negatively affected due to application of crude olive cake at growth periods of 0, 60 and 90 days. This could be attributed to the increase in the concentration of toxic compounds in olive wastes incorporated into the soil. Similar results were reported by Parades *et al.* (1987).

Statistical analysis revealed that the combined effects of all treatments and growth periods on total counts of bacteria, actinomycetes and fungi were highly significant. The maximum increase in total counts of bacteria, actinomycetes and fungi at different growth periods of 0, 60 and 90 days were achieved due to application of 75% composted olive cake + 25% mineral N.

Table (4): Effect of organic and inorganic fertilizers on total populations of microflora in rhisosphere of corn plants.

Treatments (T)	Total count of bacteria ($x 10^6$ / g)			Total count of Actinomycetes ($x 10^4$/ g)			Total count of Fungi ($x 10^3$/ g)		
	Periods (P) days								
	0	60	90	0	60	90	0	60	90
Crude olive cake (100%)	3.11	2.85	2.42	2.17	4.65	3.78	1.42	1.53	1.23
Composted olive cake (100%)	18.9	40.3	29.3	11.3	13.8	14.5	5.72	5.16	6.21
Farmyard manure (100%)	6.75	11.7	13.5	8.90	9.18	10.2	3.61	3.89	3.54
Mineral fertilizer (100%)	3.50	3.41	5.86	3.01	5.22	5.41	1.12	2.74	2.41
75%crude olive cake + 25% mineral N.	7.92	4.78	4.16	4.63	3.82	4.13	2.35	2.04	1.85
75%composted olive cake +25% mineral N.	23.6	42.1	27.2	15.30	20.1	22.4	7.10	7.82	6.94
75% farmyard manure + 25% mineral N.	9.83	26.9	23.8	9.81	11.34	12.6	3.72	3.96	4.17
50% crude olive cake + 50% mineral N.	5.01	3.92	3.24	4.22	4.77	6.13	2.87	2.61	2.14
50% composted olive cake+50% mineral N.	9.43	18.5	20.6	13.1	14.8	14.6	4.01	3.77	4.23
50% farmyard manure + 50% mineral N.	8.32	15.7	16.3	6.35	7.19	7.09	3.19	3.68	3.52
Control	3.99	3.80	3.61	2.41	3.76	4.53	1.68	1.67	1.38
$L.S.D._{0.01}$									
T =	2.85			0.51			0.186		
P =	1.49			0.26			0.097		
T x P =	4.94			0.89			0.322		

Phenolic compounds:

Results in Table (5) show that the concentrations of total and free phenols in corn plants were significantly affected with all treatments. The high concentration of total phenols in corn plants was achieved due to application of the crude olive cake (100%) where reached 1.23%, while the lowest concentration being 0.216% was achieved due to application of the composted crude olive cake. This may be attributed to biodegradation of lignin and tannins (Kenaway, 2003). The obtained results also revealed, decreases in total and free phenol of corn plants whether those fertilized with organic or inorganic fertilizer after 90 days of planting in slightly alkaline soil as shown in Table (5). This decrease could be attributed to oxidation of phenolic compounds at natural and slightly alkaline pH. Similar results were reported by Salfed (1961) and Kenawy (2003).

Table (5): Changes in soil pH and phenolic compounds in corn plants as affected by different levels of organic and inorganic amendments.

Treatments (T)	Total phenols (%)		Free phenols (%)		pH(1:2.5 suspension)	
	Periods (P) days					
	60	90	60	90	60	90
Crude olive cake (100%)	1.23	0.407	0.920	0.322	7.61	7.56
Composted olive cake (100%)	0.54	0.216	0.221	0.187	7.52	7.49
Farmyard manure (100%)	0.74	0.260	0.226	0.221	7.58	7.53
Mineral fertilizer (100%)	0.51	0.218	0.213	0.208	7.71	7.67
75%crude olive cake + 25% mineral N.	0.88	0.309	0.290	0.283	7.63	7.55
75% composted olive cake +25% mineral N.	0.72	0.231	0.200	0.195	7.60	7.52
75% farmyard manure + 25% mineral N.	0.76	0.281	0.220	0.211	7.65	7.60
50% crude olive cake + 50% mineral N.	0.89	0.336	0.280	0.270	7.66	7.61
50% composted olive cake +50% mineral N.	0.70	0.235	0.205	0.195	7.64	7.59
50% farmyard manure + 50% mineral N.	0.75	0.276	0.226	0.216	7.69	7.63
Untreated soil	0.42	0.181	0.171	0.102	7.80	7.78
$L.S.D._{0.01}$						
T =	0.127		0.035		0.027	
P =	0.054		0.015		0.013	
T x P =	0.180		0.051		0.045	

Soil pH:

Regarding changes in soil pH, the obtained results cleared slight changes in pH value due to the organic manure decomposition. Similar observations were revealed by El-Ghozoli (2006). Such variations depend mainly on the prevailing processes of soil whether mineralization or immobilization due to the differentiation effects of microbial activity. The average pH values were lowest in the soil treated with composted olive cake (100%).

REFERENCES

Al-Kahal, A.A.; Mekhemar, G.A.A. and Abo El-Soud, A.A. (2001): Response of faba bean plants to organic fertilization with olive wastes. Annals Agric. Sci., Ain Shams Univ., Cairo, 46: 565-578.

Al-Kahal, A.A.; Mekhemar, G.A.A. and Ahmed, S.M. (2002): Effect of diazotrophs inoculation on performance of wheat plants amended with different levels of olive wastes. Annals Agric. Sci., Ain Shams Univ., Cairo, 47 (1): 123-138.

Allen, U.N. (1953): Experiments in soil bacteriology. 1st Ed. Burges Publ. Co. USA.

A.O.A.C. (1990): Official Methods of Analysis of the Association of Official Agricultural Chemists 15th ed. Washington, D.C., U.S.A.

Black, C.A. (1965): Methods of soil analysis. Part I & II Amer. Soc. Agron. Inc. Pub. Madeson Wisc. U.S.A.

El-Ghozoli, M.A. (2006): Effect of some organic and mineral amendments sources on chemical and biological soil properties under different moisture contents. Ann. of Agric. Sc. Moshtohor, 44 (1): 333-354.

Gonzalez, M.D.; Moremo, E.; Quevedo-Sarmiento, J. and Ramos-Cormenzana, A. (1990): Studies on olive oil mills (alpechin) inhibitory activity of phenolic and fatty acids. Chemsphere, 20: 423-432.

Jackson, M.L. (1967): Soil chemical analysis. Prentice-Hall of India, Private Limited New Delhi.

John, M.K. (1970): Colorimetric determination of phosphorus in soil and plant materials with ascorbic acid. Soil Sci., 19: 214-220.

Kenawy, Mona, H.M. (2003): Biochemical studies on some agricultural wastes. Ph.D. Thesis, Department of Biochemistry, Fac. of Agric. Cairo Univ.

Moreno, E.; Quervedo-Sarmierto, J. and Ramos-Cormenzana, A. (1990): Antibacterial activity of waste-water from olive oil mills. In Hazardous waste: contaminate and treatment cheremisin off. P.N. pp. 731-758. Houston Guff.

Murphy, J. and Riley, I.P. (1962): A modified single solution method for the determination of phosphate in natural water. Anal Chem. Acta, 27: 31-36.

Parades, M.J.; Moreno, E. Rames-Cormenzana, A. and Martinez, J. (1987): Characteristics of soil after pollution with waste water from olive oil extraction plants. Chemosphere, 16: 1557-1564.

Piper, C.S. (1950): Soil and plant analysis. Inter. Pub. Inc., New York.

Ryan, B.F. and Joiner, B.L. (1994): Mintab handbook. Third Edition. An Imprint of Wadsworth Publishing Company Belmont, California.

Tomati, U. and Galli, E. (1992): The fertilizing value of waste waters from olive processing industry. In: Humus, its Structure and Role in Agriculture and Environment. Amesterdam: Elsevier Science. Kubat. J. (ed) pp. 117-126.

Tejada, M. and Gonzalez, J.L. (2004): Effects of application of a by-product of two-step olive oil mill process on maize yield. Agron. J. 96: 691-699.

تأثير تفل الزيتون الخام والمكمور كأسمدة عضوية علي نباتات الذرة النامية على أرض رملية

محمد عبد المؤمن الغزولى – منى حفنى محمد قناوي

معهد بحوث الاراضى والمياه والبيئة – مركز البحوث الزراعية-جيزة – مصر

أقيمت تجربة صوب باستخدام تربة خفيفة القوام كبيئة لنمو نباتات الذرة صنف جيزة-2 لمدة 90 يوم وذلك لتقييم مخلف تفل الزيتون كسماد عضوى ومحاولة تخفيف التأثيرات الضارة للمركبات الفينولية على نباتات الذرة. وخلال موسم النمو أخذت عينات تربة من منطقة انتشار الجذور rhizosphere عند فترات صفر ، 60 ، 90 يوم من الزراعة وذلك لمعرفة تأثيرات المركبات الفينولية الناتجة عن تفل الزيتون الخام على الكائنات الدقيقة فى التربة. وكانت أهم النتائج ما يلى :

- زاد إنتاج المادة الجافة لنباتات الذرة بإضافة كل المعاملات مقارنة بمعاملة الكنترول ، فيما عدا معاملة تفل الزيتون الخام. حيث كان متوسط الزيادة في الوزن الجاف لنباتات الذرة عند فترات نمو 60 ، 90 يوم هي 37.4% ، 29.8% على التوالى. وعلى النقيض انخفض الوزن الجاف بنسبة مئوية 4.5% ، 8.15% عند نفس فترات النمو مع إضافة تفل الزيتون الخام على التوالى.
- زاد تركيز النيتروجين والفوسفور والبوتاسيوم مع كل المعاملات مقارنة بمعاملة الكنترول ، فيما عدا معاملة تفل الزيتون الخام.
- تأثرت الأعداد الكلية للبكتريا والأكتينوميسيتات والفطريات معنوياً بفترات النمو والمعاملات وكذلك التفاعل فيما بين المعاملات. أعطت معاملة تفل الزيتون الخام أقل عدد للكائنات الدقيقة عند فترات النمو صفر ، 60 ، 90 يوم.
- تأثر تركيز الفينولات الكلية والحرة فى نباتات الذرة معنوياً مع كل المعاملات وقد حصلنا على أعلى تركيز مع معاملة تفل الزيتون الخام وأقل تركيز فى حالة كمر composting تفل الزيتون الخام.