J. Agric. Sci. Mansoura Univ., 27(9): 6393 - 6399, 2002

RESPONSE OF WHEAT PLANTS TO MYCORRHIZAL INOCULATIO AND/OR OLIVE WASTES AMENDMENT

Al-Kahal, A. A.; Clair N. Fares; G. A. A. Mekamer and A. A. Abo El-Soud
Soils, Water and Environment Res. Instit., Agric. Res. Centre, Giza, Egypt.

ABSTRACT

Response of wheat plants to VA-mycorrhizal inoculation in presence or absence of 1% olive oil waste water (O.O.W.W.) or olive cake (O. Cake) as an organic fertilizers was investigated in a pot experiment. The results showed that inoculation with VAM improved all growth pararneters at 60 and 120 days after planting e.g. plant height, number of tillers, dry weight of shoots and roots compared to those amended with olive wastes but not inoculated. Regarding to straw and seed yield of wheat plants, the maximum straw and seed yield was obtained by addition of O.O.W.W. at a rate of 1% combined with inoculation with VA-mycorrhiza. Nitrogen and phosphorus contents of shoots, roots, straw and seed yield were also significantly increased due to VAM inoculation. Concerning the effect of VAM inoculation in presence of olive wastes on VAM rate of infection and spore densities, data revealed that there was a significant improvement in VAM colonization and spore density, compared to which not inoculated with VA-mycorrhizae. This indicated that VAM inoculation could reduce the toxicity caused by olive wastes. Generally from the abovemented results, it can be concluded that inoculation of wheat with VAM considered a biological trial to reduce the inhibition effect of olive wastes as an organic fertilizers.

Key words : Wheat (*Triticum aestivum*), Inoculation, Organic fertilizer, Olive oil waste water, Olive cake, VM-Mycorrhizal.

INTRODUCTION

Vesicular – arbuseular mycorrhizal (VAM) fungi are an integral part of the root system of most plants and constitute an important group of organisms in the soil microbial community. Arbuscular mycorrhizas are known to enhance plant uptake of phosphate (P) and other mineral nutrients (Abbott and Robson, 1984).

Organic matter can stimulate the growth of fungal hyphae. The fungi can survive saprophytically on organic particles (Warner, 1984). On the other hand, organic matter can reduce colonization and spore density of VAM. Al-Kahal *et al.* (2001) found that VA-mycorrhizal colonization and spore density were decreased significantly during the successive growth stages of soybean plants amended with different levels of sewage sludge as an organic fertilizer.

Olive oil waste water and olive cake are produced as waste products in olive oil factories. The advantage of using olive wastes as organic fertilizers is their high content of nutrients such as N, P, K and supply of organic matter. On the other hand, the disadvantage mainly is the high contents of polyphenols which are highly toxic to soil and plant (Tomati and Galli, 1992). Al-Kahal *et al.* (2001) stated that wheat plants amended with different levels of olive wastes led to reduce densities of total bacteria, fungi and actinomycetes in the rhizosphere of the soil. No information is available in

Egypt about the influence of olive wastes amendment as an organic fertilizer on colonization and spore density of VAM in the soil. Therefore, the aim of the present study is to investigate the response of wheat plant to mycorrhizal rate infection and spore density in presence of different levels of olive wastes as an organic amendment.

MATERIALS AND METHODS

A homogenized mixture of soil (texture, clay loam; organic matter, 0.5%; pH, 7.4; EC, 0.6 dSm^{-1}) was used in this study. Olive oil wastes water (O.O.W.W.) and crude olive cake (O. Cake) were provided from the Olive Oil Extraction Factory, ARC, Giza. The physical and chemical properties of O.O.W.W. and O. Cake are presented in Table (1). The soil was passed through a 2 mm sieve and distributed into pots (10 kg pot^{-1}). Air dried crude olive cake is grinding and incorporated into the soil at rates of 1.0% (w/w) which represents 10 ton fed^{-1}. Plants treateated with O.O.W.W. at a rate of 1.0% (v/w). The soil was well mixed with olive cake. All pots received superphosphate at a rate of 1 g pot^{-1} (100 kg fed^{-1}). The pots were left for 2 weeks to give the chance for partial decomposition of olive cake.

Table 1: Some physical and chemical characteristics of olive oil waste water and crude olive cake

Characteristics	O.O.W.W.	O.cake
Moisture content %	84.5	7.0
pH	4.93	4.74
E.C. ($dS\ m^{-1}$)	18.16	2.49
Organic matter %	39.96	55.85
Protein content %	6.2	8.2
Available - P %	14.0	15.0
Available - K %	5.2	12.0
Organic carbon %	19.93	32.47
C/N ratio	13.66	33.82
Fat %	0.5	6.8
Carbohydrate %	3.2	3.52
Total phenols %	1.2	0.9

Pots were arranged in a randomized complete block design with 7 treatments and 9 replicates. The treatments were untreated soil (control plants); plants supplied with the recommended doses of NPK; soil amented with either O.O.W.W. 1%. or O. Cake 1%; plants inoculated with VAM only; plants inoculated with VAM and treated with either O.O.W.W. 1%. or O. Cake 1%.

O.O.W.W. at a rate of 1% was added at the time of sowing wheat grains. In each pot eight seeds of wheat (*Triticum aestivum*) variety Sids 1 were sown. One week later, they were thinned to five plants. VA-mycorrhizal inoculant consisted of 10 ml of wet-sieving suspension of VAM fungus containg 90 spores ml^{-1}. The mycorrhizal inoculant was applied to the planting hole-before sowing the wheat seeds. Nitrogen fertilizer was added two weeks

after sowing at a rate of 1g pot^{-1} as ammonium sulphate (20.5% N) and potassium sulphate 48% at a rate of 0.5 g pot^{-1}. Plant samples of three replicates were uprooted after 60 and 120 days of planting to assay for plant height, number of tillers, dry weight of shoots and roots, nitrogen & phosphorus contents. At harvest, the plant samples (three samples) were removed to estimate the same growth parameters besides grain yield, N and P contents in seeds. Nitrogen and phosphorus contents were determined according to Page *et al.* (1982). Mycorrhizal infection of roots was examined using the procedure of Phillips and Haymam (1970). Data were subjected to analysis of variance (Senedecor and Cochran (1980) using the statistical analysis system computer package M- Stat-C

RESULTS AND DISCUSSION

1. Response of wheat plants to olive wastes application and VA-mycorrhizal inoculation :

Wheat growth parameters e.g, plant height, number of tillers, dry weight of shoots and roots as well as N-content and P-uptake responded to addition of O. Cake or O.O.W.W. at a rate of 1% in presence or absence of VAM inoculation are shown in Table (2). The results showed that plants received 1% either O. Cake or O.O.W.W in absence of VAM inoculation scored lower values in all growth parameters compared to plants fertilized with the recomended dose of N PK after 60 and 120 days from planting. On the other hand, plants grown in soil inoculated with VA-mycorrhizae showed better growth in both periods than which were not inoculated one. Data also revealed that soil amended with 1% O. Cake or O.O.W.W. combined with inoculation with VAM gave a significant increase in all growth parameters in both periods compared to plants amend with olive wastes only. These results indicate the importance of VAM inoculation to improve growth of wheat plants amended with olive wastes as an organic fertilizers.

In this respect, several investigators observed a significant increase in plant growth due to mycorrhizal inoculation in presence or absence of organic fertilization (Mikhaeel *et al.*, 1997 and Al-Kahal *et al.*, 2001).

Additional significant increase in nitrogen and phosphorus content of shoots and roots were gained in response of VAM inoculation alone or combined with application of olive wastes after 60 and 120 days from planting. Data in Table (2) showed that inoculation of wheat with VAM improved significantly N-content in all plants treated with olive wastes combined with VAM inoculation compared to unioculated ones. The same trend was observed in P-contents. In all treatments which supplied with olive wastes the best results in terms of P-content were obtained in plants inoculated with VAM and supplied by 1% O.O.W.W. as an organic fertilizer. It is known that VAM fungi stimulate the growth of many plants by improving their ability to absorb more phosphorous (Al-Kahal *et al.*, 2001; Mikhaeel *et al.*, 1997).

Table (2) : Effect of olive wastes amendment on wheat plants after 60 and 120 days from planting.

Treatments	Plant height (cm)	No. of Tillers (No/*Pl)	Shoots			Roots		
			DW (g/*Pl)	N-content (mg/*Pl)	P-Uptake (mg/*Pl)	DW (g/*Pl)	N-content (mg/*Pl)	P-Uptake (mg/*Pl)
60 Days of Planting								
Control	54.3 d	2.1 cd	2.47 b	49.3 c	4.2 c	1.11 d	7.3 c	1.4 f
Recommended NPK	74.2 a	3.2 a	5.00 a	125.0 a	9.3 b	1.73 ab	17.3 a	3.4 d
O.Cake 1%	44.4 e	1.0 e	1.07 c	25.3 d	2.0 d	0.47 e	4.0 d	0.8 g
O.O.W.W. 1%	65.3 bc	2.5 bc	2.88 b	54.3 c	5.6 c	1.20 d	10.7 b	2.1 e
VAM	67.9 ab	2.6 d	4.79 a	82.0 b	17.7 a	1.61 b	15.3 a	4.6 b
O.Cake 1% + VAM	58.7 cd	1.8 d	2.90 b	46.7 c	9.1 b	1.37 c	12.7 b	4.1 c
O.O.W.W. 1% + VAM	65.3 bc	2.9 ab	5.05 a	97.3 b	19.2 a	1.78 a	17.7 a	5.4 a
L.S.D. 0.05	2.6	0.2	0.63	1.2	1.6	0.17	2.1	0.44
120 Days of Planting								
Control	71.4 bc	1.7 cd	6.30 c	81.7 cd	9.7 de	1.80 b	11.3 d	2.2 e
Recommended NPK	78.0 a	3.1 ab	11.68 a	267.3 a	21.7 c	3.35 a	32.0 b	6.1 c
O.Cake 1%	58.3 d	1.0 d	3.53 d	43.7 d	6.5 e	0.84 c	7.7 d	1.3 e
O.O.W.W 1%	73.9 ab	2.3 bc	6.71 c	99.7 cd	12.8 d	2.09 b	16.0 c	3.7 d
VAM	79.8 a	2.8 ab	9.09 b	177.3 b	30.7 b	3.40 a	32.7 ab	8.4 b
O.Cake 1% + VAM	66.3 c	1.7 cd	6.38 c	108.0 c	19.3 c	2.18 b	20.0 c	6.3 c
O.O.W.W. 1% + VAM	79.9 a	3.3 a	11.04 ab	215.7 ab	36.4 a	3.52 a	37.0 a	10.6 a
L.S.D. 0.05	2.0	0.3	2.14	2.6	4.8	0.60	4.3	1.1

* Pl : Plant

- **Numbers not followed by the same small letter are significantly different at the P = 0.05 for inoculation treatments.**

Regarding to the influence of olive wastes amendment as an organic fertilizer on wheat straw and seed yield as well as N- and P-content, data presented in Table (3) show that inoculation of wheat with VAM under olive wastes amendment gave a significant increase in plant height, No. of spikes, kerenls weight, straw and grain yield, as well as, N-content and P-uptake of straw and seeds compared to plants amended with olive wastes but not inoculated with VAM. Data in Table (3) also show that among all the treatments which supplied with O. Cake or O.O.W.W.at a rate of 1% combined with inoculation with VAM, the highest seed yield were obtained in treatments which inoculated with VAM and amended with 1% O.O.W.W. These results are in harmony with the work obtained by Al-Kahal *et al.* (2001). They reported that faba bean seeds inoculated with strains of *Rhizobium leguminosarum* bv. *viceae* combined with application of 1% O.O.W.W. gave the maximum seeds yield.

2. Effect of VAM inoculation and/or olive wastes on VAM colonozation and spore density in the rhizosphere of wheat plants :

TheVA-mycorrhizal colonozation and spore density of wheat plants are shown in Table (4). Data show that mycorrhizal root infection by indigenous VAM and spore density was significantly reduced by addition of O.O.W.W. or olive cake at a rate of 1% without VAM inoculation. On the contrary, the decrease was more pronounced in case of addition of olive cake

compared to O.O.W.W. Inoculation of wheat plants with VAM in absence of olive wastes significantly increased VAM colonization and spore density during the all growth stages. The introduced VAM improved the degree of colonization over the level achieved by indigenous ones. These results are in agreement with those reported by Mohammedy *et al.* (1995).

Table (3) : Effect of olive wastes amendment on straw and grain yield of wheat plants.

Treatments	Plant height (cm)	No. of Spikes (No/Pl)	Straw			Grain		
			DW (g/Pot*)	N-content (mg/Pot)	P-Uptake (mg/Pot)	DW (g/Pot)	N-content (mg/Pot)	P-Uptake (mg/Pot)
Control	70.9 c	1 6 c	28.15 c	200.0 d	32.0 e	37.30 d	22 6 b	102.0 e
Recommended NPK	78.3 ab	3.2 a	49.00 a	475.0 c	72.0 d	87.55 ab	26.5 a	290.0 c
O.Cake 1%	61.8 d	1.0 d	13.05 d	116.5 e	24 5 e	27.65 d	22.3 b	103.5 e
O.O.W.W. 1%	74.1 bc	1.8 bc	32.50 c	171.5 de	64.0 d	56.95 c	23.5 b	203.5 d
VAM	79.9 ab	2.3 b	39 15 b	610 0 b	116.0 b	79 10 b	23.6 b	370.5 b
O.Cake 1% + VAM	72.4 c	1.7 c	29.95 c	443.5 c	90.0 c	39.25 d	22.8 b	199 5 d
O.O.W.W. 1% + VAM	82.7 a	3.1 a	46.35 a	770.0 a	139.5 a	96.65 a	25 4 a	527 0 a
L.S.D. 0.05	2.4	0.2	5.85	56.0	13.0	15.3	4 1	5.8

** Each pot five plant*

Table (4) : The influence of VAM inoculation and /or olive wastes amendment on VAM rate infection and spore densities of wheat plants.

Treatments	1st intervales		2nd intervales		3th intervales	
	Rate of infection (%)	No. of spores ($X10^2$/kg soil)	Rate of infection (%)	No. of spores ($X10^2$/kg soil)	Rate of infection (%)	No. of spores ($X10^2$/kg soil)
Control	23.4 b	0.61 c	28.6 ab	0.72 b	40.5 bc	1.31 b
Recommended NPK	42.1 c	0.82 d	53.3 d	0.95 c	66.7 d	1.77 c
O.Cake 1%	16.5 a	0.44 a	23.1 a	0.59 ab	28.3 a	0.93 a
O.O.W.W. 1%	18.7 a	0.53 b	30.4 b	0.54 a	38.0 b	1.17 b
VAM	54.3 d	9.81 g	65.2 e	10.92 f	83.8 e	13.00 f
O Cake 1% + VAM	26.6 b	2.33 e	31.5 b	2.53 d	37.4 b	3.41 d
O.O.W.W. 1% + VAM	40.2 c	4.25 f	48 4 c	5.64 e	61.9 c	6.92 e

Numbers not followed by the same small letter are significantly different at the P = 0.05 for inoculation treatments.

Incculation of wheat with VAM in presence of O.O.W.W. or olive cake at a rate of 1% improved VAM rate of infection and spore density in the soil compared to plants treated with olive wastes but not inoculated. On the other hand, from the results in Table (4) it is obvious that VAM inoculation without addition of olive waste gave the best results in terms of VAM rate of infection and spore density in the soil during the whole growth period of wheat. VAM inoculation in soil amended with 1% O.O.W.W. scored better values in spore density in all growth periods compared to plants which fertilized with N P K fertilizers. In conclusion, the results suggested that inoculation of wheat plants with VAM could reduce the toxicity which caused by using oliver wastes only as an organic fertilizer.

REFERENCES

Abbott, L.K. and A.D. Robson (1984). The effect of mycorrhizas on plant growth. In: Powell, C.L. and D.J. Bagyaraj (eds) VA-mycorrhizae. CRC. Boca Raton Fla., 113-130.

Al-Kahal, A.A.; G.A.A. Meckemar and A.A. Abo El-Soud (2001). Response of faba bean plants to organic fertilization with olive wastes. Annals Agic. Sci., Ain Shams Univ., Cairo, 46 (2): 565-578.

Al-Kahal, A.A.; G.A.A. Meckemar; Clair N. Faris and A.M.A. El-Naggar (2001). Performance of soybean plants as affected by different levels of sewage sludge. Arab Univ. J. Agric. Sci., 9 (2): 595-613.

Al-Kahal, A.A.; N.A. Naguib and G.A.A. Mechemar (2002). Effect of olive wastes amendment on wheat growth and yield . Under press.

Mikhaeel, F.T.; A.M. Estefanous and G.G. Antoun (1997). Response of wheat to mycorrhizal inoculation and organic fertilization. Bull. Fac. Agric., Univ. Cairo, 48: 175-186.

Mohammedy, M.J.; W.L.Pan and A.C. Kennedy (1995). Wheat responses to vesicular arbuscular mycorrhizal fungi inoculation of soils from erodecl toposequence soil. Sci. Soci. of Aer. J., 59: 1086-1040.

Page, A.L.; R.H. Miller and D.R. Keeney (1982). Methods of Soil Analysis, Part 2: Chemical and Microbiological Properties, Second Edition, Am. Soc. Agron. Inc., Soil Sci. Sco. Am. pp. 595-624, 403-430.

Phillips, J.M. and D.S. Haymam (1970). Improved procedures for clearing roots and staining parasitic and vesicular arbuscular mycorrhizal fungi for rapid assessment of infection. Trans. Br. Mycol. Soc., 55: 159-160.

Senedecor, G. W. and W. G. Cochran (1980). Statistical Methods. Seventh ed., Iowa State Univ. Press, Ames, Iowa, USA., PP. 255-269.

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

Warner, A. (1984). Colonization of organic matter by VA-mycorrhizal fungi. Trans. Br. Mycol. Soc., 82 (2): 252-354.

J. Agric. Sci. Mansoura Univ., 27(9), September, 2002

إستجابة نبات القمح للتلقيح بفطر الميكروريزا فى وجود او عدم وجود مخلفات الزيتون

عبد الجواد أحمد ثروت الكحال ، كلير نعيم فارس ، جمال عبدالفتاح أحمد مخيمر ، علاء الدين عبد الحميد أبو السعود

معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر.

تم فى هذا البحث دراسة تاثير التلقيح بفطر الميكروريزا لنبات القمح فى وجود او عدم وجود العصير المتخلف عن صناعة زيت الزيتون وكذلك كسب الزيتون كأسمدة عضوية وذلك تحت ظروف الصوبة. وقد أظهرت النتائج أن التلقيح بفطر الميكروريزا أدى إلى تحسين حالة النمو عند ٦٠ ، ١٢٠ يوم من الزراعة مثل طول النبات ، عدد الافرع ، الوزن الجاف للمجموع الخضرى والجذرى مقارنة بتلك النباتات التى لم تلقح بفطر الميكروريزا وسمدت بمخلفات الزيتون فقط.

بالنسبة لمحصول القش والبذور فكان أعلى محصول للقش وللبذور تنتج عند إضافة مخلف الزيتون السائل بنسبة ١% بالاضافة إلى التلقيح بالميكروريزا كذلك وجود زيادة معنوية فى محتوى النباتات من النيتروجين والفوسفور فى المجموع الخضرى والجذرى ومحصول القش والبذرة وذلك نتيجة التلقيح بالميكروريزا.

بالنسبة لتاثير إضافة مخلفات الزيتون على نسبة العدوى بالميكروريزا وكثافة الجراثيم فى التربة فقد أوضحت النتائج وجود تحسن معنوى فى نسبة الاصابة بالميكروريزا مقارنة بالنباتات التى لم تلقح بفطر الميكروريزا. وهذا يدل على أن التلقيح بفطر الميكروريزا من الممكن أن يقلل من السمية التى تحدث نتيجة اضافة مخلفات الزيتون. بصفة عامة من النتائج السابق ذكرها من الممكن استنتاج أن تلقيح القمح بفطر الميكروريزا يعتبر محاولة بيولوجية لتقليل التثبيط الذى يحدث نتيجة إستخدام مخلفات الزيتون كأسمدة عضوية.