Effect of Soil Conditioners and Irrigation Frequency on the Growth of Manzanillo Olive Seedlings

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ABSTRACT

The present study was designed to investigate the effects of two different soil conditioners (polyacrylamide (PAM) at 0.0, 0.1 and 0.2% with or without sewage sludge compost (SSC) at 0.0, 12.5 and 25.0%) on the dry weight basis of soil under two irrigation frequencies (IF) regime; i.e., once/week or once every ten days on the growth of Manzanillo olive seedlings cultivated on sandy soil. This research was carried out during 2003and 2004 at El-Sabahia Experimental Station in Alexandria.Generally, the incorporated PAM at 0.1-0.2% combined with SSC at 12.5% into the sandy soil, under the IF regime of once/ 10days enhanced most of plant growth indices; i.e., growth rate, trunk cross sectional area, leaf area, leaf dry weight, root dry weight, total dry weight, leaf carbohydrates and N% in leaves. While the incorporated PAM at 0.1-0.2% combined SSC at 25.0% under the same IF (once/ 10days), enhanced the produced top dry weight and leaf chlorophyll. The content of K in the leaves was increased by the split incorporating of SSC at 12.5% under IF regime of once/ 10days, while that of P was enhanced by the incorporated PAM at 0.1% together with SSC at 12.5% under the IF regime of once/week application. As a general, the incorporated PAM and SSC, singly or combined, enhanced most of plant growth indices, comparing with the control under any regime of IF. All the used treatments did not significantly affect the leaf proline content.

INTRODUCTION

Olive is considered one of the important fruit crops in Egypt. The Spanish cv. Manzanillo is the most important commercial variety in the world (Hartamnn and Papaioannou, 1971). Manzanillo is early ripening cultivar, good for table olives and for oil production and a heavy bearer (Bailey, 1961).

Cultivation on arid sandy soil requires large quantities of water. The low water holding capacity of this soil causes rapid infiltration and deep percolation below the root zone. For a high crop production, especially on the sandy soils, the physio-chemical properties of these soils must be modified. The addition of conditioners to such soils enhanced their properties, leading to increasing the efficiency of the used water and fertilizers. Lentz et al. (2001) found that treating the soil with anionic polyacrylamide (PAM) led to reducing the runoff, preventing soil nutrients losses, and decreasing the leached amounts of organic and inorganic solutes, especially that of N and P. Also, Grula et al. (1994) cleared that

PAMs are xenobiotic polymers consisting of covalently linked carbon atoms (CH_2-CH_2), unlike the anhydrobonds of many biological polymers. Although the carbon chains are resistant to microbial breakdown, field observation suggest that polyacrylamides can stimulate the growth of microorganisms. PAMs can provide nitrogen (as ammonia) for several species of Pseudomonas isolates from soil. Similarly, Kay-Shoemake et al. (2000) stated that PAM contains amide- N and PAM application to soil has been correlated with increasing activity of soil enzymes such as urease and amidase, involved in N cycling. Also owing to increasing population and the consequent need of Agriculture expansion, the utilization of every source of organic matter is necessary (Riad, 1982).

Sewage sludge (a native soil conditioner) has been used for many years on soil. It can be beneficially applied to different soils with a range of crops. There are many studies revealed that sludge caused improvements in chemical and physical properties of soil and subsequently plant growth (Amoozegar, 1994, Smith et al., 1994, Darwish et al., 1996 and Frossard et al., 1996).

El-Keiy (1983) found that the application of composed sewage sludge to the sandy soils cultivated with different crops results in a salinity increase at the highest rate of application which did not reach the hazard limits to crops. In addition, N, P, K, Fe, Mn, Zn and Ca contents increased with increasing rate of sludge addition. Also, the water holding capacity increased with increasing rate of sludge application. As a results of sludge application trace elements were taken up by plants and accumulated in the roots with amounts transferred to other plant parts being small enough in leaves and fruits to be considerably less than toxic (El-Kiey, 1983 and Darwish et al., 1997). In addition, no phytotoxic effects due to contamination of the composed materials with heavy metals, irrespective of the level incorporation into soil (Smith, 1993). Wallace and Wallace (1986a) found that applying the combinations of organic source and PAM gave additive and synergistic effect on the growth of tomato and wheat plants. Similarly, increasing the water holding capacity of PAM-treated soil reduces the frequency and total amount of irrigation required for several crops. Where, Tripepi et al. (1991) cleared that the irrigation frequency (daily or once every 3 or 5 days) significantly affected all plant growth indices and stomatal parameters. The seedlings of some plants when irrigated daily, grew the most and had the highest stomatal conductance and transpiration. Although polymer-amended medium had more water than medium without polymer (hydrogel) at all measured tensions, this moisture was retained in the expanded gel rather than being available for plant uptake at higher tensions.

So, the present study was designed to investigate the effect of two soil conditioners (polyacrylamide and/or sewage sludge compost) and irrigation frequency on the growth and some leaf chemical composition of Manzanillo olive seedlings grown in sandy soil.

MATERIALS AND METHODS

The present investigation was conducted in 2003 and 2004 growing seasons using one- year old Manzanillo olive seedlings (Olea europea, L.). Manzanillo olive transplants were raised from stem cuttings taken from mature trees grown in the experimental station of the Faculty of Agriculture in Alexandria. At the beginning of each growing season; mid-March, olive seedlings were singly planted in pots of 25 cm diameter filled with 3.5 Kg of sandy soil. The chemical and physical properties of the used soil are presented in Table (1). The experimental seedlings were held in the greenhouse of El-Sabahia Experimental Station in Alexandria. Before the commencement of the treatments, the plants were irrigated with tap water and during this period of adaptation, all seedlings seemed healthy, vigorous and well established.

Two soil conditioners; polyacrylamide (PAM) and Sewage sludge compost (SSC) and two regimes of irrigation frequencies (IF) were the chosen factors in this study. The air dried sewage sludge compost (SSC) as a native soil conditioner (brought from the eastern sewage refinery plant in Alexandria). The chemical analysis of the used sewage sludge was done according to the technique of Black (1965) and presented in Table (1).

The PAM and SSC were used at three different levels; i.e., 0.0 (control), 0.1 and 0.2% PAM (Choudhary et al., 1998) and 0.0 (control), 12.5 and 25.0% SSC (El-Kiey, 1983) on the soil weight basis. Each amount from the previous levels was uniformly mixed with the soil of planting singly or combined (Wallace and Wallace, 1986a). The plants were set under the field conditions. The first time of irrigation was practiced by adding 500 ml of water to allow the dry PAM to solubolize and then was allowed to dry for 24 hr before irrigation again to keep the polymer in the bulk of the pot medium (Bowman et al., 1990).

On May 7, 2003, the regime of irrigation frequency was started. Two irrigation frequencies were used; i.e., once/week or once every ten days using the same amount of water. The amount of the used water was 12.0 or 9.0 L/plant/season was used during the once/week or once every ten days of irrigation frequencies, respectively (Tripepi et al., 1991).

The diluted water soluble fertilizer of 19 N: 19 P_2O_5 : 19 K_2O was added at the rate of 100 ppm N, one week after the commencement of the experiment (on May 14, 2003) (Lentz et al., 2001). Also Ca-EDTA (14% Ca), $MgSO_4.7H_2O$ (9.5% Mg) and Fe-EDTA (14.0% Fe) were sprayed on the plant foliage at 100,75 and 50 ppm of Ca, Mg and Fe, respectively, starting three weeks from the beginning of the experiment (on 28 May, 2003), at three-week intervals (Bowman et al., 1990).

The experiment was terminated after 180 days in both seasons. The following parameters were determined in the two successive seasons.

I-Vegetative growth:

Growth rate: of each plant was calculated using the following equation:

$$\text{Growth rate} = \frac{\text{final length} - \text{initial length}}{\text{initial length}}$$

Trunk cross sectional area: was measured at the soil surface, and the trunk cross sectional area of each seedling was calculated

For leaf area determination, 10 mature leaves were taken from the sixth nodes from the base of one year old shoots, cleaned and drawn on a graph paper. The area of each leaf was measured by counting the square to the nearest cm^2.

Total, leaves, top and root dry weight of individual seedlings was determined at the end of the experiment in both seasons.

II-Leaf chemical analysis:

1- Leaf total chlorophyll content: was determined by using MINOLTA CHLOROPHYLL METER SPAD-502 (Minolta camera., LTD JAPAN) according to the method described by Yadava (1986).
2- Leaf total carbohydrate was determined as percent on dry weight basis according to Dubois et al. (1956).
3- Leaf free proline content determination was done according to Bates et al. (1973).
4- Leaf N, P and K contents were determined in the oven-dried leaves at 70°C. A sample of 0.3 g was digested with sulphuric acid by hydrogen peroxide according to Evenhuis and Deward (1980). Nitrogen was determined colourimetrically according to Evenhuis (1976), phosphorus was determined by using spectrophotometer (Murphy and Rily, 1962) and potassium was determined by Flamphotometer (Cheng and Bray, 1951).

The experimental layout for the two seasons at the same date and site was designed to provide complete randomized blocks in Split Split Plot Design containing four replicates. Each replicate contained eighteen treatments and two pots were used as a plot for each treatment. Analysis of variance was calculated according to Snedecor and Cochran, (1990).

RESULTS AND DISCUSSION

I. Vegetative growth:

In general, using PAM and/or SSC at any level alone or combined with each other at any IF level led to improve the recorded vegetative growth data, compared with the control treatment during the two experimental seasons (Table 2 and 3)

1- Growth rate:

Data in table (2) indicate that the growth of Manzanillo olive seedlings was noticeably influenced by incorporating the sandy soil with polyacrylamide (PAM) combined with sewage sludge compost (SSC) at the rate of 0.2 and 12.5% respectively with the irrigation frequency (IF) of the higher intervals (once every ten days), comparing with the other treatments during the two seasons. This result may be due to the synergistic effect of PAM (0.2%) and SSC (12.5%) on increasing the availability of nutrients, especially N via enhacing the activity of soil enzymes (urease and amidase), which involved in N cycling (Kay-Shoemake et al.,2000). Besides, the influence of PAM on reducing the leached amounts of NH_4^+ and NO_3^- (Bress and Weston, 1993), especially under the higher intervals of irrigation (once/ 10days). Thus, the biosynthesis of proteins, DNA and RNA would be enhanced leading to more initiation and division of the apical meristem cells, consequently the plant height and growth increased. (Azzam, 1983 and Pill and Jacono, 1984).

2- Trunk cross-Sectional area:

The data generally revealed that the stem cross-sectional area (cm^2) of the experimental seedlings tended to respond positively to the addition of PAM and SSC at 0.2 and 12.5%, respectively under the regime of IF of once/ 10days, comparing with the other treatments during the two seasons, with one exception in the second season (Table 2). This result may be due to a well- developed and formed root system under the regime of IF of higher intervals (once/ 10days) (Huzulak and Matejka, 1997). Besides, increasing the availability and translocation of nutrients due to the synergistic effect of PAM and SSC (Wallace and Wallace, 1986a), the biosynthesates accumulation would be increased, thus the lateral and longitude division of stem branch cells would be increased, consequently, the branch diameter could be increased. Similar trend of results was found by Cox (1995).

3- Leaf area:

The maximum expansion of the produced leaves of olive seedlings was obtained by amending the soil with PAM at 0.2 % singly or combined with SSC at 12.5% under IF regime at once/ 10days, comparing with the other treatments, with one exception in the second season (Table 2). This result may be due to the increase in leaves number and / or size or both of them. Similar trend of results was stated by Tripepi et al. (1991).

4- Leaf dry weight:

Data of the two seasons in Table (2) showed that the production of the heaviest leaves dry matter was obtained by adding either the highest rate of SSC (25.0%) with using the lower IF regime (once/week) or the medium one (12.5%) combined with PAM at 0.2% with using the IF regime of once every ten days, comparing with the other treatments. This results may be attributed to the reduction of the dissolved organic matter (DOM) molecules under the IF of once/ 10days (Lu and Wu, 2001). Thus enhanced the efficiency of PAM which serves as a nitrogen source (Barvenik, 1994) and accelerates the mineralization of nutrients, especially N of the used SSC and reduces the competition between plants and microorganisms for inorganic N. besides, enhancing the physio-chemical properties of sand and eventually increased the uptake of nutrients (Bowman et al., 1990). Similar trend of results was cleared by Johnson (1984), Wallace and Wallace (1986b), Callaghan et al. (1988) and Woodhouse and Johnson (1991) on different plants.

5- Top dry weight:

As general, data in Table (3) indicated that the heaviest top dry weight was obtained by adding either the highest rate of SSC (25.0%) with the IF regime (once/week) or PAM at 0.1% either alone or combined with SSC at rate of (25.0%) with the IF regime once every ten days, comparing with the other treatments. These results may be related to that using PAM and / or SSC at suitable rates led to an increase in branches diameter or length or both, consequently the top dry weight could be increased. Similar trend of results was found by El-Kiey (1983) and Klock-Moore (2000).

6- Root dry weight

As general, the rate of PAM at 0.1% combined with SSC at 12.5% with the IF regime of once/10days gave the heaviest roots dry matter as compared with the other treatments during the two seasons, with one exception in the second season (Table 3). The previous result may be due to that PAM and SSC act simultaneously under the IF of once/10days on enhancing the phsico-chemical properties of the used sand; i.e. redistributing soil pore size, leading to retaining moisture longer with well aeration (Lentz et al., 2001), hence the growth of root hairs would be enhanced, thus the roots size or length or both of them could be increased. Similar trend of results was cleared by Tripepi et al. (1991) on birch seedlings and Huzulak and Matejka (1997) on wheat plant. Moreover, as result of PAM treatment could be interpreted on the basis of root aggregation around the gel fragments of PAM. Woodhouse and Johnson (1991) pointed out that root aggregation allowed good contact of root with the moisture source in the polymer and played a major part in increasing the dry weights and water use efficiency of olive seedlings grown in polymer treated growing system.

7- Total dry weight

The heaviest total dry weight was given by amending of the sandy soil with PAM combined with SSC at rate of 0.2 and 12.5%, respectively with the IF of the higher intervals (once every ten days), comparing with the other treatments during the two seasons (Table 3). The results obtained here are in harmony with the findings of Johnson (1984), Wallace and Wallace (1986b), Callaghan et al., (1988) and Woodhouse and Johnson (1991). They reported that PAM; as an effective soil polymer, combined high water amounts with minimal high-tension binding force. They stressed that a significant proportion of the polymer – absorbed water was available to the growth processes, since young trees survival, establishment and final dry weights were all higher in the polymer – treated soils.

II. Leaf chemical analysis

1- Total leaf chlorophyll content

The highest content of total chlorophyll was obtained by adding PAM and SSC together in combination at 0.1 and 25.0%, respectively with the IF of once / 10days as compared with the other treatments during the two seasons (Table 4). This result may be attributed to the influence of PAM which acts simultaneously with SSC on enhancing the availability of nitrogen, magnesium and leaf water potential, especially under the IF regime of once/10days, leading to enhancing the metabolic process and biosynthesis of green pigments (Barvenik, 1994). Consequently, the total chlorophyll content could be increased. Similar results was found by Zeid and Askar, (1987).

2- Leaf total carbohydrates

As general, the addition of PAM at 0.1 or 0.2% combined with the medium rate of SSC (12.5%) with using the IF of once every ten days, gave the highest leaf total carbohydrates, comparing with the other treatments during the two seasons (Table 4). These results might be attributed to the effect of the soil conditioners in supplying young treated trees by adequate amounts of water than those grown in media free from PAM (Bevacque and Mellano, 1994 and Al-Harbi et al., 1999). Noteworthy, such conditions would tend to diminish the magnitude of metabolic changes that occurred in the different carbohydrate fractions under drought conditions. Besides, the influence of PAM in increasing the concentration of leaf N and Mg might also participate in interpreting this result. Hellal (1998) reported that both these nutrients positively affect the leaf chlorophyll content and consequently the carbohydrates synthesis.

3- **Leaf free proline content**

Data of the two seasons in Table (4) cleared that all used treatments (IF and PAM and/or SSC) did not significantly affected leaf free proline content of Manzanillo olive seedlings. These results may be as a result of PAM treatment which could be interpreted on the basis of the capability of PAM in increasing the water holding capacity of the soil and increasing water availability to olive seedlings (Silberbush et al., 1993).

4- **Leaf mineral content:**

a- **Leaf nitrogen content**

Data of the two seasons in Table (5) cleared that the highest percentage of nitrogen content (N%) in the leaves of Manzanillo olive seedlings was given by the IF regime at once/ 10days with adding PAM at 0.2% singly or combined with SSC at 12.5%, comparing with the other treatments, with one exception in the second season. These results may be due to that PAM reduced the leached amounts of N as NH_4^+ and less as NO_3^- , especially under the IF of once/10days (Bress and Weston, 1993), serves as a nitrogen source (Grula et al., 1994) and improves the conditions of soil which enhanced the decomposition rate of SSC (Wallace and Wallace, 1986a) with increasing the activity of soil enzymes such as urease and amidase (Kay-Shoemake et al.,2000), thus nitrogen availability and translocation would be increased consequently the N% in the leaves could be increased. Similar trend of results was stated by Abed et al. (1981), Azzam (1985), Johnson and Veltkamp (1985). Silberbush et al. (1993) reported that large amount of water absorbed by PAM materials (80-85%) stored in vacuoles within its matrix. Diffusion of water into the soil solution would render water available to olive seedlings. Undoubtedly, increasing available soil moisture would ultimately increase nutrients absorption and translocation by olive seedlings.

b- Leaf phosphorus content

Data of the two seasons in Table (5) showed that the highest percentage of phosphorus (P%) in the leaves was obtained by adding PAM at 0.1% and SSC 12.5% in combination with using the IF regime once/week compared with the other treatments. This result may be due to that the moderate dose of SSC (12.5%) may contain less amounts of metals, especially Fe and Al, which their presence in the bulk of medium may be reduced under the influence of lower irrigation regime, (once/week), also PAM may act on chelating some, thus their precipitating effect on P would be reduced. Besides, PAM may accelerate the decomposition of SSC (Barvenik, 1994) and keeps it in the medium bulk (Lentz et al., 2001), thus the availability and absorption of P would be enhanced. Consequently the content of P in leaves could be increased. Similar trend of results was found by Bjorneberg et al. (2000), they stated that P loss was reduced when PAM and surface residues were used individually and to a greater extent when used together.

c- Leaf potassium content

The highest percentage of potassium content in the leaves was found by the split addition of the medium rate of SSC (12.5%) under the IF regime once/ 10days comparing with the other treatments during the two seasons (Table 5). This result may be probably due to that SSC contains high level of potassium, with respect to the reduction of the leached K under the irrigation frequency regime of higher intervals (once/ 10days), consequently the absorbed amount of k would be increased. Thus the content of K% could be increased. Similar results were found by El-Kiey (1983) and Klock-Moore (2000).

Table (1): Some chemical and physical properties of the used soil and sewage sludge.

Variable	Soil	Sewage Sludge
Ec (ds/m^{-1})	2.02 (1:1, soil:water)	2.59 (1:10, soil:water)
pH	7.78 (1:1, soil:water)	7.44 (1:10, soil:water)
Total carbonate (%)	1.75	5.53
Organic matter (%)	0.43	38.8
N g/kg	1.6	19.6
P_2O_5 g/kg	0.4	4.5
K_2O g/kg	2.8	10.8
Particle size distribution:		
Sand (%)	97.38	-
Silt (%)	2.23	-
Clay (%)	0.39	-
Water holding capacity (%) (W/W)	10.46	16.65

Table(2): Effect of polyacrylamide (PAM), sewage sludge compost (SSC) and irrigation frequency (IF) on the growth rate, trunk cross sectional area, leaf area and leaf dry weight of Manzanillo olive seedling during 2003 and 2004 seasons.

PAM (%)	SSC (%)	Growth rate				Trunk cross sectional area (cm^2)				Leaf area (cm^2)				Leaf dry weight (g)			
		2003		2004		2003		2004		2003		2004		2003		2004	
		IF		IF		IF		IF		IF		IF		IF		IF	
		Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days
0.0	0.0	0.63	0.56	0.65	0.61	0.50	0.58	0.59	0.54	2.67	2.64	2.83	2.93	10.1	9.7	10.4	10.0
	12.5	0.66	0.73	0.81	0.85	0.66	0.65	0.65	0.66	3.18	2.78	3.25	2.94	11.3	11.3	11.9	11.6
	25.0	0.82	0.72	0.86	0.84	0.70	0.66	0.72	0.75	3.02	2.82	3.03	2.95	12.0	11.8	12.4	11.9
Mean		0.70	0.67	0.77	0.77	0.62	0.63	0.65	0.65	2.96	2.75	3.04	2.94	11.1	10.9	11.6	11.2
0.1	0.0	0.70	0.79	0.74	0.81	0.61	0.60	0.64	0.57	2.93	2.81	3.50	3.20	11.3	11.7	10.9	12.0
	12.5	0.77	0.80	0.75	0.87	0.60	0.66	0.52	0.67	2.98	2.78	3.41	2.75	11.7	12.1	10.9	12.1
	25.0	0.65	0.73	0.75	0.85	0.61	0.64	0.62	0.65	3.07	2.91	3.03	2.95	11.6	11.0	11.5	10.8
Mean		0.71	0.77	0.75	0.84	0.61	0.63	0.59	0.63	2.99	2.83	3.31	2.97	11.5	11.6	11.1	11.6
0.2	0.0	0.68	0.72	0.72	0.82	0.63	0.67	0.64	0.68	3.30	3.55	3.31	3.62	11.2	12.1	10.5	11.8
	12.5	0.65	0.83	0.79	0.88	0.58	0.74	0.65	0.74	3.37	3.59	3.61	3.60	11.5	12.3	11.2	12.4
	25.0	0.69	0.69	0.79	0.82	0.59	0.65	0.68	0.69	3.35	3.10	3.19	3.18	11.3	11.5	10.5	11.8
Mean		0.67	0.75	0.77	0.84	0.60	0.69	0.66	0.70	3.34	3.41	3.37	3.47	11.3	12.0	10.7	12.0
Mean		0.69	0.73	0.76	0.82	0.61	0.65	0.63	0.66	3.10	3.00	3.24	3.13	11.3	11.5	11.1	11.6
L.S.D.$_{0.05}$ for:																	
PAM		0.02		0.03		NS		0.03		0.12		0.07		0.3		0.3	
SSC		0.02		0.03		0.04		0.03		NS		0.07		0.3		0.3	
IF		0.05		0.04		0.03		NS		NS		0.06		NS		0.2	
F		0.03		0.02		0.07		0.05		0.20		0.30		0.5		0.5	
		0.03		0.02		NS		NS		0.17		0.10		0.4		0.4	
		0.03		0.02		NS		0.04		NS		0.10		0.4		0.4	
				NS		NS		NS		NS		0.18		NS		0.7	

Table(3): Effect of polyacrylamide (PAM), sewage sludge compost (SSC) and irrigation frequency (IF) on the top, root and total dry weight of Manzanillo olive seedling during 2003 and 2004 seasons.

PAM (%)	SSC (%)	Top dry weight (g)				Root dry weight (g)				Total dry weight (g)			
		2003		2004		2003		2004		2003		2004	
		IF		IF		IF		IF		IF		IF	
		Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days
0.0	0.0	49.4	44.5	50.0	48.1	22.6	21.2	24.5	22.8	72.0	65.7	74.5	70.9
	12.5	45.2	56.4	63.0	59.0	29.8	26.5	27.4	35.6	75.0	82.9	90.4	94.6
	25.0	59.1	45.4	65.6	60.8	32.0	36.2	29.9	32.5	91.1	81.6	95.5	93.3
Mean		51.2	48.6	59.5	56.0	28.1	28.0	27.3	30.3	79.4	76.7	86.8	86.3
0.1	0.0	54.9	65.4	50.3	55.8	24.7	22.9	33.1	34.5	79.6	88.3	83.4	90.3
	12.5	52.8	52.8	50.5	58.0	33.8	37.0	33.8	38.0	86.6	89.8	84.3	96.0
	25.0	41.7	46.1	50.6	61.2	33.1	36.0	33.4	33.2	74.8	82.1	84.0	94.4
Mean		49.8	54.8	50.5	58.3	30.5	32.0	33.4	35.2	80.3	86.7	83.9	93.6
0.2	0.0	51.1	56.1	46.4	55.8	26.8	25.8	34.6	35.4	77.9	81.9	81.0	91.2
	12.5	48.6	57.0	57.0	57.7	25.9	33.7	31.8	39.6	74.5	92.5	88.8	97.3
	25.0	50.5	53.8	53.8	53.4	27.6	28.2	35.0	38.0	78.1	78.1	88.8	91.4
Mean		50.1	55.6	52.4	55.6	26.8	29.2	33.8	37.7	76.8	84.2	86.2	93.3
Mean		50.4	53.1	54.1	57.6	28.5	29.7	31.5	34.4	78.8	82.5	85.6	91.1
L.S.D.$_{0.05}$ for:													
PAM		2.6		1.9		1.3		1.5		4.0		2.3	
SSC		2.6		1.9		1.3		1.5		4.0		2.3	
IF		2.1		1.0		1.0		1.2		3.3		0.7	
PAM × SSC		4.6		3.0		2.2		2.5		7.0		4.0	
PAM × IF		2.2		2.2		NS		NS		5.7		3.3	
SSC × IF		2.2		2.2		1.8		2.1		5.7		3.3	
PAM×SSC×IF		NS		NS		3.1		NS		NS		NS	

Table(4): Effect of polyacrylamide (PAM), sewage sludge compost (SSC) and irrigation frequency (IF) on the leaf chlorophyll, carbohydrates and proline content of Manzanillo olive seedling during 2003 and 2004 seasons.

PAM (%)	SSC (%)	Leaf chlorophyll (mg/100g fresh weight)				Leaf total carbohydrates (%)				Leaf free proline contents (mg/g dry weight)			
		2003		2004		2003		2004		2003		2004	
		IF		IF		IF		IF		IF		IF	
		Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days
0.0	0.0	47.1	46.6	49.7	48.8	8.52	8.01	8.06	7.82	13.3	13.3	13.1	13.1
	12.5	57.6	59.3	58.3	61.5	9.06	13.03	11.35	11.11	13.1	13.0	13.2	13.0
	25.0	60.4	60.5	62.8	60.3	10.07	13.35	11.51	12.32	13.0	13.0	13.0	12.8
Mean		55.0	55.5	56.9	56.9	9.22	11.46	10.31	10.42	13.1	13.1	13.1	12.9
0.1	0.0	58.3	62.5	55.1	61.2	9.20	13.22	9.38	10.87	13.2	12.9	12.9	13.1
	12.5	58.8	63.0	52.9	63.7	10.49	15.10	9.80	14.01	13.0	12.8	13.0	12.9
	25.0	55.2	65.0	59.5	66.0	10.00	14.48	9.21	11.31	13.0	12.8	13.0	12.9
Mean		57.4	63.5	55.8	63.6	9.90	14.27	9.46	12.06	13.1	12.8	12.9	12.9
0.2	0.0	61.6	59.2	57.7	63.0	10.45	12.75	10.56	11.39	13.0	13.2	13.0	13.0
	12.5	59.0	62.9	60.6	65.8	9.35	14.77	9.52	15.58	13.0	13.2	12.9	12.9
	25.0	57.7	57.4	58.2	60.5	10.97	13.06	9.05	11.74	13.0	12.8	13.0	12.9
Mean		59.4	59.8	58.8	63.1	10.26	13.52	9.71	12.90	13.0	13.0	12.9	12.9
Mean		57.3	59.6	57.2	61.2	9.79	13.09	9.83	11.79	13.1	13.0	12.9	12.9
$L.S.D._{0.05}$ for:													
PAM		0.8		0.9		0.55		0.64		NS		NS	
SSC		0.8		0.9		0.55		0.64		NS		NS	
IF		0.6		0.7		0.45		0.52		NS		NS	
PAM × SSC		1.4		1.6		0.95		1.11		NS		NS	
PAM × IF		1.1		1.3		0.78		0.91		NS		NS	
SSC × IF		1.1		1.3		0.78		0.91		NS		NS	
PAM×SSC×IF		1.9		NS		1.35		1.57		NS		NS	

Table(5): Effect of polyacrylamide (PAM), sewage sludge compost (SSC) and irrigation frequency (IF) on the leaf mineral content of Manzanillo olive seedling during 2003 and 2004 seasons.

PAM (%)	SSC (%)	Leaf nitrogen content (%)				Leaf phosphorus content (%)				Leaf potassium content (%)			
		2003		2004		2003		2004		2003		2004	
		IF		IF		IF		IF		IF		IF	
		Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days	Once/ week	Once/ 10days
0.0	0.0	1.66	1.63	1.82	1.92	0.11	0.12	0.15	0.12	1.56	1.52	1.70	1.51
	12.5	2.17	1.77	2.24	1.93	0.25	0.17	0.21	0.22	1.80	1.96	1.88	2.03
	25.0	2.01	1.81	2.02	1.94	0.21	0.22	0.19	0.23	1.77	1.86	1.87	1.94
Mean		1.95	1.74	2.03	1.93	0.19	0.17	0.18	0.19	1.71	1.78	1.82	1.83
0.1	0.0	1.92	1.80	2.49	2.19	0.18	0.13	0.17	0.16	1.82	1.69	1.90	1.73
	12.5	1.97	1.77	2.40	1.74	0.27	0.15	0.25	0.18	1.69	1.77	1.72	1.63
	25.0	2.06	1.90	2.02	1.94	0.26	0.12	0.24	0.14	1.80	1.72	1.87	1.62
Mean		1.98	1.82	2.30	1.96	0.24	0.13	0.22	0.16	1.77	1.73	1.83	1.66
0.2	0.0	2.29	2.54	2.30	2.61	0.13	0.11	0.14	0.14	1.82	1.62	1.85	1.82
	12.5	2.36	2.58	2.60	2.59	0.13	0.15	0.23	0.23	1.75	1.81	1.79	1.80
	25.0	2.34	2.09	2.18	2.17	0.12	0.12	0.16	0.10	1.67	1.70	1.70	1.77
Mean		2.33	2.40	2.36	2.46	0.13	0.13	0.18	0.15	1.75	1.71	1.78	1.80
Mean		2.09	1.99	2.23	2.12	0.19	0.14	0.19	0.18	1.74	1.74	1.81	1.76
$L.S.D._{0.05}$ for:													
PAM		0.12		0.07		0.03		NS		NS		NS	
SSC		NS		0.07		0.03		0.03		0.03		NS	
IF		NS		0.06		0.03		0.03		NS		NS	
PAM × SSC		0.20		0.30		NS		0.06		0.06		0.11	
PAM × IF		0.17		0.10		0.05		NS		0.05		0.1	
SSC × IF		NS		0.10		NS		NS		0.05		NS	
PAM×SSC×IF		NS		0.18		NS		NS		NS		NS	

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الملخص العربى

تأثير محسنات التربة و فترات الرى على نمو شتلات الزيتون المنزانيللو

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صممت الدراسة الحالية لبحث تأثير نوعان مختلفان من محسنات التربة و هما البولى اكريلاميد عند مستويات صفر، ٠,١ ، ٠,٢ % مع الحمأة أو بدونها عند مستويات صفر، ١٢,٥ ، ٢٥,٠ % على أساس وزن التربة الجافة و ذلك تحت نظامين لأضافة الرى (تكرار الرى) و ذلك مرة كل أسبوع أو مرة كل عشرة أيام على نمو شتلات الزيتون صنف منزانيللو و المنزرعة فى تربة رملية. و قد أجرى هذا البحث بمزرعة محطة بحوث البساتين بالصبحية بالأسكندرية خلال عامى ٢٠٠٣ و ٢٠٠٤ .

و يمكن تلخيص أهم النتائج كما يلى:

١- أدت أضافة البولى أكريلاميد (٠,١ %) مع الحمأة (١٢,٥ %) تحت نظام الرى مرة كل عشرة أيام إلى زيادة المادة الجافة للجذور و محتوى الأوراق من الكربوهيدرات.

٢- أدت أضافة البولى أكريلاميد (٠,١ %) مع الحمأة (٢٥ %) تحت نظام الرى مرة كل عشرة أيـام الي زيادة المادة الجافة للمجموع الخضرى و محتوى الأوراق من الكلوروفيل.

٣- أدت أضافة البولى أكريلاميد (٠,٢ %) مع الحمأة (١٢,٥ %) تحت نظام الرى مرة كل عشرة أيام الى زيادة معدل نمو الشتلات و زيادة مساحة مقطع الساق و المساحة الورقية و الوزن الجاف للأوراق و زيادة المادة الجافة الكلية للشتلات كما زاد من محتوى الأوراق من عنصر النيتروجين.

٤- أدت أضافة الحمأة منفردة بتركيز ١٢,٥ % تحت نظام الرى مرة كل عشرة أيام الى زيادة محتوى الأوراق من عنصر البوتاسيوم بينما زاد محتواها من عنصر الفوسفور باضافة البولى اكريلاميـد (٠,١ %) و الحمأة (١٢,٥ %) معا تحت نظام الرى مرة كل أسبوع.

٥- عموما فان اضافة البولى اكريلاميد و الحمأة (أيا منهما او كلاهما معا) أدى الى تحسن فى معظم القياسات مقارنة بمعاملة (الكنترول) تحت أيا من فترتى الرى.

٦- لم يكن لجميع المعاملات المستخدمة تأثيرا معنويا على محتوى الأوراق من البرولين.