EFFECT OF IRRIGATION WITH SEWAGE WATER AND DIFFERENT SOIL ON JATROPHA PLANTS

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ABSTRACT

This study was conducted in the nursery of El Orman garden At Giza – HRI-ARC ministry of Agriculture during two successive seasons of (2011/2012 and 2013/2014), respectively.

The present study was conducted to investigate the effect of using waste water as an alternative for irrigation of Jatropha plants grown in different growing media (sand – clay or calcareous soils).

Data on vegetative parameters were (Plant height, number of leaves/Plant, number of branches/Plant and fresh and dry weight as well as chemical composition (contents of chlorophyll a, b and a + b, total carbohydrates, fatty acids and composition of seeds oil.

Data indicated that irrigation with sewage water led to the best vegetative growth parameter and chemical of Jatropha plants grown in sandy soil compared to control.

Key words: Jatropha integerrima (Jacq) - Sewage water – Irrigation - Soil types - Pollution

INTRODUCTION

Jatropha Enteggirma (Jacq), is a large soft – wood, deciduous shrubby resistant, perennial plant belonging to family Euphorbiaceae. It is a tropical plant that can be grown well even in the marginal or poor soils and keeps yielding seeds for 50 years.

Nowadays there are tendency in international energy sources decline as well as an increase of herbal therapy by using substituted medicine.

In many parts of the world the ancient systems have included Jatropha as a local source of medicine. Jatropha must be recognized for more than its traditional value as a hedge species in many areas in the world.

It is valuable as a soil conservation and landscape plant, high way shoulders, city parks and the other places that can not afford much care. It was disseminated as a valuable hedge plant to Africa by the Portuguese traders. Jatropha is gaining lot of importance for the production of biodiesel (Ashwani and Styawait, 2008).

Soil texture is important as Jagropha grows best in sandy or decomposed granite and slowest in heavy soils.

Even if the fertility of the soil is marginal, Jatropha is still able to produce well without the use of fertilization and to tolerate high temperature (Augustus *et al*., 2002).

At present, application of waste water is considered the best solution for disposal problems (Selem *et al*., 2000). The use of waste water for land irrigation is usually recommend, as it is an allowable method for the disposal of waste water and it permits the reclamation and reuse of valuable resources such as water and nutrients (Wang, 1984).

Water requirements of Jatropha will not conflict with the requirements for traditional crops. Undeniably there exists value in its potential for revegitating degraded lands with what is an economically and socially valuable crop. Cultivating Jatropha in the Egyptian desert, rural areas and remote communities is very useful economically, socially and environmentally (Abd-Rabbo *et al*., 2009).

The present trial was conducted to investigate the possibility of using waste water as an alternative for irrigation of jatropha plants grown in different growing media.

MATERIALS AND METHODS

Experiments carried out in three different types of soil (Sand Clay and Calcareous) using two types of irrigation water (normal water and sewage water).

Source of sewage water Znine station – Bolaque El-Dakror. Identical seedlings of Jatropha were brought from private sector. (Eng. Taha El Sheikh nursery).

Soil water and environment research institute ARC (Agriculture Research Center) (Table 1 and 3):

1- Available P.K. Fe, Mn, Zn, and Cu were extracted according to the method of Soltanpour (1991) by mixture solution of Diethylene triamine pentaacetic acid 97% (DTPA) and ammonium bicarbonate with adjusting at pH 7.6. Soil sample (20 g) were shaken with 40 ml from the mixture solution to about 15 minutes then filtered Determination of P. K. Fe, Mn,

Zn, and Cu was carried out in this extract using Inductively Coupled Plasma (ICP) Spectrometry (Ultima 2 JY Plasma), (K) was determined by flame photometer.

2-Total nitrogen was determined using Kjeldahl method according to Chapman and Pratt (1961).

3-Total P, K, Fe, Mn, Zn, and Cu in soil samples were digested by aqua regia (hydrochloric acid and nitric acid) according to Cottenie, *et al.* (1982) and determined by Inductively Coupled Plasma Spectrometry (Ultima 2 JY Plasma), (K) was determined by flame photometer. All of the studied parameters were carried out in.

Soil water and inviroment research institute ARC (Table 2):

1-Electrical conductivity (EC) was determined in water by Electrical conductivity meter according to Chapman and Pratt (1961).

2-pH values were determined by pH meter in water. According to Chapman and Pratt (1961).

3-The following determinations were carried out in water according to Jackson (1967).

a) Sodium and potassium by flame photometer.

b) Calcium and magnesium by titration with verseant (EDTA).

c) Chloride by titration with $AgNO^{-}_{3}$.

d) Carbonate and bicarbonate by titration with HCI.

e) Sulphate was calculated by difference between anions and cations.

4.Soluble $N\text{-}NH_4^+$ and NO_3^- ware determined by Technicion Auto Analyzer according to Markaus *et al.* (1982).

5.Soluble (P, K, Fe, Mn, Zn, and Cu), in water was determination using Inductively Coupled Plasma (ICP) Spectrometry (Ultima 2 JY Plasma). (K) was determined by flame photometer.

Seedlings of 6 months Jatropha were planted in 50 cm plastic pots full of sand or clay or calcareous soils in November at every experimental season.

Plants were arranged randomly in four replicates five plants/each. Plants were held under natural conditions and irrigated with sewage water as needs for 12 months in both growing seasons.

The method analysis of plant growth parameters were as follows:

Take reading of plant height, number of leaves/ plant, Number of branches/plant, Number of flowers per plant throw 12 months in each experimental season.

Chemical analysis:

1-Determination of leaf fresh and dry weights (g/100g) dried weight, branches fresh and dry weight-roots fresh and dry weight.

The fresh leaves of each replicate were weighed, then oven dried at 70ºC until constant weight and average leaf fresh and dry weights (g) was determined as recommended by A.O.A.C (1975).

2-Chlorophyll a. b and total chlorophyll colourmetrically determined in leaf samples (g/ 100 g) fresh matter according to Saric *et al*. (1976).

3-Total carbohydrates: dried samples of the middle part of shoots were used to determine total carbohydrate as described by *Smith et al* (1956).

4-Heavy metals of leaves, branches and roots were recorded

5-Evaluation of fatty acids composition of Jatropha oil by HPLC:

Data were statistically analysis in complete randomized block design according to Henry (1959).

Table (1): Some physical and chemical properties of use soils after washing treatments

Sand soil	Particle size distribution (%)				pH	E.C. (dsm/1)	S.P.	Cations (meq/ $^{-}$1)				Anions (meq/ $^{-}$1)			
	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	k'	CO^{-}	HCO^{-}	Cl^{-}	SO_4^{-}
	45.10	48.40	3.40	2.10	7.53	1.08	2.50	1.50	3.00	5.95	0.35	-	1.00	8.50	1.28
Clay soil	Particle size distribution (%)				pH	E.C. (dsm/1)	S.P.	Cations (meq/ $^{-}$1)				Anions (meq/ $^{-}$1)			
	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	k'	CO^{-}	HCO^{-}	Cl^{-}	SO_4^{-}
	21.30	33.00	27.20	17.40	7.40	1.56	35.00	3.50	5.50	6.15	0.42	-	2.50	9.50	3.57
Calcareous soil	Particle size distribution (%)				pH	E.C. (dsm/1)	S.P.	Cations (meq/ $^{-}$1)				Anions (meq/ $^{-}$1)			
	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	k'	CO^{-}	HCO^{-}	Cl^{-}	SO_4^{-}
	8.30	37.70	31.80	22.20	7.78	9.30	45.00	25.37	19.99	55.77	11.40	-	2.48	58.68	54.37

Table (2): Chemical analysis of sewage water first and second seasons

	Total soluble salts			Cations (meq/ ¯1)				Anions (meq/ ¯1)				R.C	SAR
First season	EC (dsm ¯1)	ppm	pH	Ca^{++}	Mg^{++}	Na^{+}	k'	CO^{-}	HCO^{-}	Cl^{-}	SO_4^{--}	(meq/l)	(meq/l)
	0.75	480.00	7.45	1.94	0.94	4.37	0.25	-	2.48	2.11	2.91	-	3.64
	Elements (mg/l)												
	Nitrate N	Ammonia N	P	Fe	Mn	Zn	Cu	Cd	Cd	Cr	Ni	Co	B
	0.00	13.12	0.0620	0.091	0.091	0.008	0.002	0.00	0.00	0.00	0.002	0.00	0.070
Second season	Total soluble salts			Cations (meq/ ¯1)				Anions (meq/ ¯1)				R.C	SAR
	EC (dsm ¯1)	ppm	pH	Ca^{++}	Mg^{++}	Na^{+}	k'	CO^{-}	HCO^{-}	Cl^{-}	SO_4^{--}	(meq/l)	(meq/l)
	0.75	480.00	7.45	1.94	0.94	4.37	0.25	-	2.48	2.11	2.91	-	3.64
	Elements (mg/l)												
	Nitrate N	Ammonia N	P	Fe	Mn	Zn	Cu	Cd	Cd	Cr	Ni	Co	B
	0.00	13.12	0.0620	0.091	0.091	0.008	0.002	0.00	0.00	0.00	0.002	0.00	0.070

Table (3): Some physical and chemical properties of use soils before washing treatments

	Particle size distribution (%)				pH	E.C. (dsm¯1)	S.P.	Cations (meq/ ¯1)				Anions (meq/ ¯1)			
Sand soil	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	k'	CO^{-}	HCO^{-}	Cl^{-}	SO_4^{--}
	45.80	46.50	6.40	1.30	7.20	1.60	39.00	7.30	4.60	12.50	0.52	-	1.30	19.20	4.42
	Particle size distribution (%)				pH	E.C. (dsm¯1)	S.P.	Cations (meq/ ¯1)				Anions (meq/ ¯1)			
Clay soil	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	k'	CO^{-}	HCO^{-}	Cl^{-}	SO_4^{--}
	7.90	15.00	39.50	37.60	7.59	1.73	42.00	4.55	3.80	6.95	0.43	-	2.51	9.11	4.11
	Particle size distribution (%)				pH	E.C. (dsm¯1)	S.P.	Cations (meq/ ¯1)				Anions (meq/ ¯1)			
Calcareous soil	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	k'	CO^{-}	HCO^{-}	Cl^{-}	SO_4^{--}
	4.40	18.30	20.60	70.40	6.70	18.87	41.00	48.65	22.05	167.52	1.81	-	1.93	151.70	86.42

RESULTS AND DISCUSSION

Data in Table (4) showed that plant height in clay soil after 13 months from planting using sewage water have significantly highest value (76.40 cm), comparnd with other treatment in the 1st season while as plants grown in sandy soil gave the highest parameter (67.10) significantly comparnd to other treatments. These results are in line with (Khajuria and Cupta, 2007), who found that plant height, number branches/ plants, plants pared $(cm)^3$ and seed yield /plant.

Chemical contents:

Data in Table (5) showed that in the first and 2nd seasons leaves fresh weight of plants grown in sand soil and irrigated with sewage water, gave the highest significant values (65.29 g) and (59.04 g),respectively. Than other treatments. While as in the First season plants grown in calcareous soil and irrigated with normal water showed the lowest values (20.50 g). In Second season, the lowest value were obtained from plants grown in clay soil and irrigated with normal water (10.25 g).

Determination of leaves dry weight (g) that showed plants grown in sand or calcareous soils and irrigated with sewage water, gave the maximum significant value (15.17 and 5.02), respectively. For 1st growing season.

Table (4): Effect of Different Soil Types and Water Types On mean Plant Height (Cm) of Jatropha integerrima (Jacq) plant/ during 2011/2012 and 2013/2014 seasons.

Plant Height (Cm)																
Treatments	First Season (2011-2012)								Second Season (2013-2014)							
	10 Months Old		13 Months Old		16 Months Old		19 Months Old		10 Months Old		13 Months Old		16 Months Old		19 Months Old	
	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W
Sand	28.90	26.25	32.32	29.30	35.77	32.15	39.12	34.95	39.00	36.60	40.45	39.25	44.70	42.40	48.45	45.47
Clay	27.10	25.80	30.35	28.85	33.62	31.70	37.15	34.47	35.40	34.95	38.87	30.14	40.97	39.37	44.92	41.72
Calareous	26.90	23.65	30.22	26.65	32.20	29.50	36.07	32.25	27.75	26.02	30.70	28.52	34.47	31.70	36.70	33.07
L.S.D 0.05																
Soil type				1.29									1.19			
Water type				1.05									0.97			
age				1.49									1.37			
Sxw				1.82									1.68			
Wxa				2.11									1.94			
s x a				2.58									2.38			
Sxwxa				3.65									3.36			

Water Type = Sewage Water and Normal Water
S x W = Sewage Water x Water Type
W x a = Water Type x age
S x a = Sewage Water x age
S x W x a = Sewage Water x Water type x age

Table (5): Effect of different soil types and water types on mean of leaves fresh and dry weight (gm/plant) of Jatropha integerrima (Jacq) plant / during 2011-2012 and 2013-2014 seasons.

Treatments	Fresh weight (g) of Leaves				Dry weight (g) of Leaves			
	First Season (2011-2012)		Second Season (2013-2014)		First Season (2011-2012)		Second Season (2013-2014)	
Water types	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W
Sand	65.29	41.44	59.04	40.40	15.17	8.96	13.82	11.01
Clay	57.7	40.23	56.73	10.25	12.94	10.25	13.18	2.35
Calcareous	40.11	20.5	39.39	18.84	15.02	5.13	9.35	4.43
L.S.D 0.05								
Soil type		5.23					0.860	
Water type		4.27					0.70	
age		4.27					0.24	
Sxw		5.23					0.860	
Wxa		6.04					0.99	
s x a		7.39					1.21	
Sxwxa		10.96					1.72	
L.S.D 0.05		5.23					0.860	
Soil type		4.27					0.70	
S.W: sewage Water								
N.W: Normal Water								

While as the minimum significant value (5.13 g) obtained from plants grown in calcareous soil and irrigated with normal water.

In the second season plants grown in sand or clay soils and irrigated with sewage water, gave the highest significant value (13.82 and 13.18), respectively.

For the minimum value, it was clear that plants grown in clay soil and irrigated with normal water, gave the minimum significant value (2.35 g).

Data presented in Table (6) showed the effect of different soil types and water types on pigment leaves content (chlorophyll a. b, total chlorophyll and carbohydrate %) of Jatropha Integerrima (sacq) plants.

Results cleared that plants grown in sand soil and irrigated with sewage water, gave the highest significant value of chlorophyll a (9.05), than the other treatments while as plants grown in calcareous soil and irrigated with normal water, showed the lowest value (4.10).In Second season, the lowest value was obtained from plants grown in calcareous soil and irrigated with normal water. Which gave (2.15).

The first season determination of chlorophyll (b) in leaves, showed that plants grown in sand or clay soils and irrigated with sewage water gave the maximum significant values (6.8 and 6.20), respectively.

While as the minimum significant value was obtained with normal water, (5.11). In the second season plants grown in sand or calcareous soils gave the highest significant values (32.73 and 35.00), respectively. For the minimum value, it's clear that plants grown in clay soil and

irrigated with normal water, gave the minimum significant value (12.99).

Table (6): Effect of different soil types and water types on Leaves pigment content of (chlorophyll a, b - total chlorophyll, and charbohydrates) of *Jatropha integerrima* (Jacq) plants during 2011-2012 and 2013-2014 seasons

Treatments	Chlorophyll-a				Chlorophyll-b				Total Cholophylls				Total - Charbohydrate %			
	First Season (2011-2012		Second Season (2013-2014)		First Season (2011-2012		Second Season (2013-2014)		First Season (2011-2012		Second Season (2013-2014)		First Season (2011-2012		Second Season (2013-2014)	
Water Ty[pe	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W
Sand	9.05	7.57	16.14	9.88	6.82	6.12	32.73	29.40	63.57	53.01	45.61	42.54	21.23	20.58	35.25	32.23
Clay	8.05	6.17	28.78	26.03	6.20	6.11	41.24	12.99	45.88	14.25	70.02	39.02	22.23	20.50	28.33	21.83
Calareous	6.50	4.10	26.00	2.15	8.20	5.11	35.00	21.45	16.21	12.32	47.54	32.15	23.05	20.11	30.92	29.55
L.S.D 0.05																
Soil type			0.320		1.351				1.367					0.770		
Water type			0.260		1.103				1.116					0.632		
age			0.260		1.103				1.116					0.632		
Sxw			0.320		1.351				1.36					0.770		
Wxa			0.370		1.560				1.57					0.890		
s x a			0.456		1.911				1.93					1.095		
Sxwxa			0.343		2.70				2.73					2.735		
S.W: sewage Water																
N.W: Normal Water																

The first determination of total chlorophylls of leaves, it's clear that with first season plants grown in sand or clay soils and irrigated with sewage water gave the maximum value (63.57 and 45.88), respectively.

While as the minimum significant value was (12.32) for plants grown in calcareous soil and irrigated with normal water. In the second season plants grown in clay soil gave the highest significant value (70.02). For the minimum value, It's clear that plant grown in calcareous soil and irrigated with normal water gave the minimum significant value (32.15).

The First determination of total carbohydrate % of leaves. It's clear that in the first season plants grown in calcareous or clay soil sand irrigated with sewage water, which gave the maximum (23.05 and 22.23), respectively.

While as the minimum significant value were (20.58 and 20.50 and 20.11), respectively, for plants grown in sand or clay or calcareous soils and irrigated with normal water. In the second season plants grown in sand or calcareous soils gave the highest value (35.25 and 30.92), respectively.

For the minimum value, it's clear that plants grown in clay soil and irrigated with normal water gave the minimum significant value (21.83).

These results are in line with Follett *et al.* (1981) who found that increase in total carbohydrates with irrigation may be related to more favorable conditions necessary for carrying out metabolic processes, beside the greater mass of green photosynthetic tissue (Bannister, 1981).

Oil yield and its components:

Data presented in Table (7): showed the effect of different soil types and water types on fatty acid of oil Jatropha Integerrima (Jacq) plants. The results clear that in the First season for palmatic (A) plant grown in sand soil and irrigated with sewage water, gave the highest significant value (34.80) compared to other treatments, while as plants

grown in clay soil and irrigated with normal water gave the lowest value (13.0) .

Data presented in Table (7) showed that in the first season for linoleic (A) plants grown in sand or clay soils and irrigated with sewage water, gave the highest significant value (8.80 and 7.50), respectively. Compared to other treatments.

While as plants grown in calcareous soil and irrigated with normal water showed the lowest value of (1.50). In the Second season, gave the same trend as the lowest value /plants grown in calcareous soil and irrigated with normal water gave the lowest value. (1.50).

Data in Table (7): showed that in the first season for lionlenic (A) plants grown in clay or calcareous or clay soils and irrigated with sewage water, gave the highest significant value (22.50 and 17.20), respectively.

Than Other treatments, while as plants grown in clay soil and irrigated with normal water showed the lowest value (2.50) In the second season for the highest value (23.40) plants grown in calcareous soil and irrigated with sewage water.

Results take the same trend, for the lowest value plants grown in clay soil and irrigated with normal water gave (4.50).

Table (7): Effect of different soil types and water types on fatty acid in oil of Jatropha integerrima (Jacq) plant / during 2011-2012 and 2013-2014 seasons.

Treatments	Type of F A									
	Palmatic (A)		Linoleic (A)		Linolenic (A)		Oleic (A)		Stearic (A)	
	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W	S.W	N.W
First-season										
Sand	34.80	21.70	8.80	5.40	10.30	7.20	1.90	1.50	57.70	50.80
Clay	25.40	13.00	7.50	5.90	17.20	2.50	1.50	0.70	77.10	49.10
Calcareous	25.00	20.00	3.30	1.50	22.50	20.00	1.00	0.50	47.80	25.30
Second-season										
Sand	1.90	15.80	6.10	5.70	10.00	4.50	1.80	0.50	73.20	63.50
Clay	37.70	26.50	11.10	8.90	8.70	4.50	1.50	0.80	56.40	43.90
Calcareous	31.10	14.20	1.70	1.50	23.40	20.00	0.40	0.20	43.50	20.00
L.S.D 0.05										
Soil type		1.545		0.536		0.952		0.087		2.047
Water type		1.261		0.274		0.77		0.071		1.671
age		1.261		0.274		0.77		0.071		1.671
Sxw		1.545		0.336		0.952		0.087		2.047
Wxa		1.784		0.388		1.099		0.100		2.364
s x a		2.185		0.475		1.346		0.123		2.895
Sxwxa		3.090		0.672		1.904		0.174		4.094
S.W: sewage Water										
N.W: Normal Water										

Data in Table (7): showed that in the first season for oleic (A) plants grown in sand or clay or calcareous soils and irrigated with sewage water, gave the highest significant value (1.90 and 1.50 and 1.00), respectively. Compared to normal water, while as plants grown in calcareous soil and irrigated with normal water showed the lowest value (0.50). In the second season for the highest value (1.80 and 1.50) with plants grown in sand or clay soils and irrigated with sewage water.

In the Second season , results take the same trend, as the lowest value obtained form plants grown in calcareous soil and irrigated with normal water which gave value (0.20).

Data in Table (7): showed that in the first season for stearic (A) plants grown in clay or sand soils and irrigated with sewage water, gave the highest value (77.10 and 57.70), respectively, compared to other treatments, while as plants grown in calcareous soil and irrigated with normal water, showed the lowest value (25.30).

In the second season results take the same trend, for the highest value (73.20), with plants grown in sand soil and irrigated with sewage water. the lowest value obtained of plants grown in calcareous soil and irrigated with normal water (20.20).

These results are in line with Augusts *et al*. (2002): who found that Jatropha oil freaction consists of both saturated fatty acids, palmatic acid (14.1 %) stearic acid (6.7 %) and unsaturated fatty acid, oleic acid (47.0 %) and linoleic acid (31.6 %).

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تأثير الري بمياه الصرف الصحي والتربة علي نبات الجاتروفا

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المستخلص

أجريت دراسة بمشتل حديقة الأورمان – مركز البحوث الزراعية – وزارة الزراعة خلال موسمي نمو ٢٠١٢/٢٠١١ ، ٢٠١٤/٢٠١٣ بهدف دراسة تأثير الري بمياه الصرف الصحي المعالج وبيئات زراعة مختلفة (تربة رملية – تربة طمية – تربة جيرية) علي نمو والخواص الكيماوية لنباتات الجاتروفا وكانت أهم القياسات (طول النبات – عدد الأوراق / للنبات – عدد الأفرع / للنبات – عدد الأزهار/ للنبات – الوزن الطازج والجاف /للأوراق والسيقان والجذور) إلي جانب قياسات التحاليل الكيميائية لكل من كلوروفيل أ ، كلورفيل ب وأ + ب والأحماض الدهنية والعناصر الثقيلة ونسبة الزيت ومكوناته وخواصه.

تبين من النتائج أن الري بمياه الصرف الصحي للنباتات المنزرعة في التربة الرملية أعطي أعلي القياسات للنمو الخضري والتركيب الكيماوي وخصائص الزيت في كلا الموسمين مقارنة بالكنترول (الري بمياه عادية).