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A STUDY OF WATER AND FERTILIZATION REQUIREMENTS OF *Jatropha curcas*, L. UNDER SEWAGE WATER IRRIGATION CONDITIONS

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ABSTRACT

Jatropha curcas L. was cultivated in Abou Rawash, 6th October Governorate, Egypt. The plants were irrigated at three different intervals (7, 14 and 21 day) using sewage water receiving primary treatment from Abou Rawash Station and were fertilized with calcium superphosphate (15% P_2O_5) and potassium sulphate (50% K_2O) every 2 months at rates of 0:0, 50:25, 75:37.5 and 100:50 g/plant.

The obtained results indicated that 7-day irrigation intervals gave the best vegetative growth, fruit yield and oil percentage in seeds, followed by 14-day intervals but 21 days intervals gave the lowest value.

Plants fertilized by 100:50 and 75:37.5 g/plant P_2O_5:K_2O gave the highest values for vegetative growth, fruit yield and oil percentage as compared to other fertilizer treatments.

The fertilization treatment of 100:50 g P:K/ plant combined with 7-day irrigation intervals increased vegetative growth, fruit yield and oil percentage as compared to other treatment combinations.

Key words: *fertilization, irrigation, Jatropha, curcas, sewage water.*

1. INTRODUCTION

Jatropha curcas L., Jatropha or Physic nut, is a multipurpose drought resistant large shrub or small tree. Jatropha is native to tropical America, and has been distributed to South East Asia, particularly India (Cano-Asseleih, 1986). It can grow in the desert without water and fertilizers, but using them gives high yield of seeds, A tree can produce 4-5 kg seeds from the 5th year and seeds can be obtained for up to 40-50 years from the date of plantation (Kumar and Sharma, 2008). Depending on the variety, seed kernels contain 40-60% oil (Gubitz *et al.,* 1997 and Liberalino *et al.,* 1988).The seed of *Jatropha curcas* contains 19% oil (Augustus *et al*.,2002) and (Singh *et al*.,2007) showed that after extraction from expeller Jatropha seeds contains about 28-29% oil.

Jatropha can be used in other purposes as hedges for protection of agricultural field, animal feed, making charcoal and as a fertilizer .

Jatropha tree cultivated on an experimental level in Abou Rawash, 6th of October Governorate, Egypt, aiming at define the optimal water and fertilization requirements under sewage water irrigation.

2. MATERIALS AND METHODS

This investigation was carried out at Abou Rawash, 6th October Governorate, during the 2008 and 2009 seasons, with the aim of defining the optimal water, as well as phosphorus and potassium fertilization requirements and their effect on vegetative growth, yield of fruits and seeds, and oil percentage of *Jatropha curcas* L.

The plants were planted by seeds on 15th March, 2008 on ridges at a spacing of 3x3 m between the plants and rows. Fully mature seeds were selected for sowing, and two seeds were sown per pit, the seedlings were thinned after germination, leaving one seedling per pit.

2.1. Treatments

2.1.1. Irrigation intervals

The plants were irrigated with primary treatment municipal waste water (primary sedimentation) effluent taken from dwelling aggregations of Abou Rawash 6th October Governorate. The treatments were initiated after 4 months from planting (which irrigated once weekly). The used irrigation system was furrow irrigation. The plants were irrigated at three different intervals (7, 14 or 21 days). The total number of irrigation intervals were calculated:

The plants irrigated every 7, 14 and 21 days were irrigated 70, 35 and 24 times, respectively.

2.1.2.Chemical fertilization The plants were fertilized by

2.1.2.1. Calcium superphosphate (15% P_2O_5) every 2 months at rates of 0, 50, 75 and 100 gm/plant.

2.1.2.2. Potassium fertilization was applied to plants using potassium sulphate (50% K_2O) every 2 months at rates of 0, 25, 37.5 and 50 gm/plant. The doses were applied on the soil directly before irrigation.

2.2. Soil and water analysis

Physical and chemical properties of the soil, were determined using Jackson (1958), (Table a).

Water analysis, was determined using Chapman and Pratt (1961), (Table b).

2.3. Experimental layout

The layout of the experiment was a split plot design, with the main plots arranged in randomized complete blocks. The main plots were assigned to irrigation intervals (7, 14 or 21 days), while the sub-plots were assigned to the four fertilization treatments. Each replicate included 12 treatment combinations (3 irrigation intervals x 4 fertilization treatments). Each treatment had three replicates and each replicate had three shrubs. The recorded data were analyzed statistically using the method described by Snedecor and Cochran (1982). The means of different treatments were compared using L.S.D. at 0.05.

2.4. The following data were recorded (after 20 months from planting)

Plant height (cm), stem diameter (cm) 3cm. above the soil surface, branche number, shoot circumference (cm), vegetative fresh weight (kg)(shoots and leaves), fruit yield (gm/plant), seed yield (gm/plant) and seed oil percentage (A.O.A.C., 1950).

3. RESULTS AND DISCUSSION

3.1. Effect of irrigation intervals and chemical fertilizer treatments on vegetative growth of *Jatropha curcas* L.

3.1.1. Plant height

Data presented in Table (1) show that increasing of P:K fertilizer rate from 0:0 to 100:50 gm/plant significantly increased Plant height steadily,and that the application rate of fertilizer 0:0 to 50:25, 75:37.5 and 100:50 gm P:K/plant significantly increased plant height from 137.9 to 144.8 to 155.7 and 166.2 cm., respectively.

On the other hand, prolonging the irrigation intervals significantly decreased plant height as the irrigation intervals 7, 14 and 21 gave plant heights of 197.6, 130.9 and 124.9 cm., respectively.

Regarding the interaction between fertilizer treatments and irrigation intervals the recorded data showed that the fertilization treatment of 100:50 P:K combined with 7 day irrigation intervals significantly increased plant height as compared to all the other treatment combinations, whereas fertilizer treatment of 0:0 gm P:K treatment combined with either 14 or 21 day irrigation intervals significantly decreased plant height as compared to all the other treatment combinations.

3.1.2. Stem diameter

Data presented in Table (2) reveal that

Table (a): Some physical and chemical properties of the used soil.

Particle size distribution (%)				pH	E.c. (ds/m)	S.P.	Cations (meq/L)				Anions (meq/L)			
Coarse sand	Fine sand	Silt	clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
22.5	45.2	20.2	12.1	8.15	3.15	25	15.50	8.07	5.81	2.17	--	3.42	9.6	18.53

Table (b): Chemical analysis of sewage water source.

Total soluble salts			Cations (meq/L)				Anions (meq/L)				RSC (meq/L)	SAR (meq/L)
Ec (ds/m)	ppm	pH	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	$HCO3^{-}$	Cl^{-}	$SO4^{--}$		
0.767	491.0	7.55	3.00	0.57	3.71	0.39	0.3	4.70	2.50	0.17	1.43	2.78

Elements (mg/L)								
Nitrate N	Ammonia N	P	Fe	Mn	Zn	Cu	Pb	Cd
6.22	20.20	3.145	0.038	0.094	0.004	0.005	0.002	0.003

fertilizer treatments of 100:50 gm P:K/plant significantly increased stem diameter (9.05 cm) as compared to 0:0, 50:25 and 75:37.5 gm P:K/plant (7.17, 7.55 and 8.27 cm, respectively). Regarding the effect of irrigation intervals the same data revealed that 7 day irrigation intervals significantly increased stem diameter (9.92 cm) as compared to 14 and 21 day intervals (7.11 and 7.00 cm) with non-significant difference between the last two treatments.

Concerning the interaction between fertilizer treatments and irrigation intervals, data presented in Table (2) show that the fertilization treatment of 100:50 gm P:K/plant combined with 7 day irrigation interval significantly increased stem diameter (10.98 cm) as compared to all other treatment combinations, while the fertilization treatment of 0:0 P:K treatment combined with 21 day irrigation intervals significantly decreased stem diameter (5.75 cm) as compared to all the other treatment combinations.

3.1.3. Branch number

Data presented in Table (3) indicate that fertilizer treatments of 75:37.5 and 100:50 gm P:K /plant significantly increased branch number (5.33 and 5.89, respectively) as compared to 0:0 and 50:25 gm P:K/plant (3.67 and 4.56, respectively), with the exception of the differences between 50:25 and 75:37.5 gm P:K/plant which was insignificant. Also the difference between 0:0 and 50:25 gm P:K/plant was insignificant.

Regarding the effect of irrigation intervals the same data showed that 7 day irrigation intervals significantly increased branch number (6.67) as compared to 14 and 21 day intervals (4.33 and 3.58) with no significant difference between them.

Concerning the interaction between fertilizer treatments and irrigation intervals, data presented in Table (3) indicate that fertilizer treatments of 50:25, 75:37.5 and 100:50 gm P:K/plant, combined with 7 day irrigation intervals significantly increased branches number (6.00, 7.33 and 8.00,respectively) as compared to most of the other treatment combinations. On the other hand, the fertilization treatment of 0:0 P:K treatment combined with 21-day irrigation intervals significantly decreased branch number as compared to most of the other treatment combinations, with insignificant differences with same interactions.

3.1.4. Shoot circumference

Data presented in Table (4) show that fertilizer of 100:50 gm P:K/plant significantly increased shoot circumference (325.00 cm.) as compared to the other fertilizer treatments. As for the effect of irrigation intervals the same data revealed that 7-day irrigation intervals significantly increased shoot circumference (472.70 cm) as compared to 14 and 21 days intervals (205.10 and 181.60 cm, respectively).

Concerning the interaction between fertilizer treatments and irrigation intervals, the effect on Jatropha shoot circumference the same data indicated that the fertilizer treatment of 100:50 gm P:K/plant combined with 7 day irrigation intervals significantly increased shoot circumference as compared to all other treatment combinations. On the other hand, the fertilizer treatment of 0:0 P:K combined with 21-day irrigation intervals significantly decreased shoot circumference as compared to all the other combinations.

3.1.5. Vegetative fresh weight /plant

Data presented in Table (5) reveal that fertilization with 100:50 gm P:K/plants significantly increased vegetative fresh weight (16.94 kg) as compared to 0:0, 50:25 and 75:37.5 gm P:K/plant (7.65, 9.70 and 13.80 kg, respectively), regardless of the effect of irrigation intervals.

Regarding the effect of irrigation intervals the same data showed that vegetative fresh weights of Jatropha plants were severely influenced by prolonging the irrigation intervals, since irrigation at 21 day intervals (water stress) significantly diminished vegetative fresh weight to a minimum value of 5.81 kg, while plants irrigated every 7 days (no water stress) showed significantly higher vegetative fresh weight (21.59 kg). The differences among the three irrigation intervals were significant, irrespective of the effect of fertilizer treatments.

Data recorded on the interaction between fertilizer treatments and irrigation intervals indicated that the fertilizer treatment of 100:50 gm P:K/plant combined with 7-day irrigation intervals significantly increased vegetative fresh weight as compared to all other interactions. On the other hand, the fertilizer treatment of 0:0 P:K treatment combined with 21-day irrigation intervals significantly decreased vegetative fresh weight as compared to all the other interactions.

The results of plant height (cm), stem diameter (cm), branch number, shoot circumference (cm) and vegetative fresh weight (kg) were in line with those of Munch and Kiefer (1989) reported that *Jatropha curcas* L. has low requirements of soil quality and can grow under low rainfall conditions , Singh *et al.* (1991) observed that height of *Eucalyptus tereticornis* was increased by an increase in irrigation, Verma

Table (1): Effect of irrigation intervals and chemical fertilizer treatments on plant height (cm) of *Jatropha curcas* L.

Fertilizer treatments (F)	Irrigation intervals (I)			Mean (F)
	7 days	14 days	21 days	
P:K (0:0 g/plant)	186.20	115.20	112.30	137.90
P:K (50:25 g/plant)	190.40	120.10	124.00	144.80
P:K (75:37.5 g/plant)	199.50	126.30	141.20	155.70
P:K (100:50 g/plant)	214.30	162.20	122.10	166.20
Mean (I)	197.60	130.90	124.90	
L.S.D. I.= 2.78 **L.S.D. F.**= 3.80 **L.S.D. I. x F**.= 6.59				

I= Irrigation
F= Fertilization
I x F= Irrigation x Fertilization

Table (2):Effect of irrigation intervals and chemical fertilizer treatments on stem diameter (cm) of *Jatropha curcas* L.

Fertilizer treatments (F)	Irrigation intervals (I)			Mean (F)
	7 days	14 days	21 days	
P:K (0:0 g/plant)	9.35	6.42	5.75	7.17
P:K (50:25 g/plant)	9.44	6.68	6.52	7.55
P:K (75:37.5 g/plant)	9.92	7.27	7.61	8.27
P:K(100:50 g/plant)	10.98	8.06	8.11	9.05
Mean (I)	9.92	7.11	7.00	
L.S.D. I.= 0.14 **L.S.D. F.**= 0.14 **L.S.D. I. x F**.= 0.24				

I= Irrigation
F= Fertilization
I x F= Irrigation x Fertilization

Table (3) :Effect of irrigation intervals and chemical fertilizer treatments on branch number of *Jatropha curcas* L

Fertilizer treatments (F)	Irrigation intervals (I)			Mean(F)
	7 days	14 days	21 days	
P:K(0:0 g/plant)	5.33	3.33	2.33	3.67
P:K(50:25 g/plant)	6.00	4.33	3.33	4.56
P:K (75:37.5 g/plant)	7.33	4.33	4.33	5.33
P:K (100:50 g/plant)	8.00	5.33	4.33	5.89
Mean (I)	6.67	4.33	3.58	
L.S.D. I.= 1.65 **L.S.D. F.**= 1.32 **L.S.D. I. x F**.= 2.29				

I= Irrigation
F= Fertilization
I x F= Irrigation x Fertilization

Table (4) :Effect of irrigation intervals and chemical fertilizer treatments on shoot circumference (cm) of *Jatropha curcas* L.

Fertilizer treatments (F)	Irrigation intervals (I)			Mean (F)
	7 days	14 days	21 days	
P:K (0:0 g/plant)	420.10	185.20	156.40	253.90
P:K(50:25 g/plant)	440.30	191.70	167.20	266.40
P:K(75:37.5 g/plant)	476.10	207.20	218.10	300.50
P:K (100:50 g/plant)	554.20	236.30	184.50	325.00
Mean (I)	472.70	205.10	181.60	
L.S.D. I.= 16.49 **L.S.D. F.**= 5.80 **L.S.D. I. x F.**= 10.04				

I= Irrigation
F= Fertilization
I x F= Irrigation x Fertilization

Table (5) :Effect of irrigation intervals and chemical fertilizer treatments on vegetative fresh weight (kg) of *Jatropha curcas* L.

Fertilizer treatments (F)	Irrigation intervals (I)			Mean (F)
	7 days	14 days	21 days	
P:K(0:0 g/plant)	14.53	5.02	3.39	7.65
P:K(50:25 g/plant)	17.78	6.63	4.68	9.70
P:K(75:37.5 g/plant)	24.47	10.02	6.93	13.80
P:K(100:50 g/plant)	29.57	13.05	8.22	16.94
Mean (I)	21.59	8.68	5.81	
L.S.D. I.= 0.35 **L.S.D. F.**=0.51 **L.S.D. I. x F.**= 0.89				

I= Irrigation
F= Fertilization
I x F= Irrigation x Fertilization

et al. (1991) found that irrigation with untreated sewage water promoted better growth than irrigating with well water in *Eucalyptus tereticornis* and *Leucaena leucocephala*, Samarappuli (1992) on *Hevea brasiliensis*, observed a quadratic response by the plants to K application at 0, 33 or 66 g/plant with 4 levels of watering (10, 30, 50 or 70% of field capacity) and found that increasing the amount of K alleviated moisture stress. Plant diameter and height obtained with a combination of watering of 50% of field capacity and an application of 33 g K were almost equal to those at a combination of watering at 10% of field capacity and 66 g K/plant, Shehata (1992) showed that high soil moisture content (80% of field capacity) increased seedling height, Alavi (1996) on *Picea abies* reported that stem thickness increased with increasing irrigation water, Salem (2002), on jojoba (*Simmondsia chinensis*), reported that the interaction treatments between complete fertilization and irrigation levels increased each of the change value and the change percentage of plant height, number of shoots/plant, number of leaves/plant and fresh and dry weights of jojoba leaves. The highest values were obtained by using the highest concentration of complete fertilization under the highest level of irrigation, Shehata (2002), on *Khaya senegalensis* , revealed that seedling height was decreased with decreasing soil moisture content ,Thomas *et al.* (2005) and Corina *et al.*(2006) who found that increasing P supply increased height of *Eucalyptus grandis* seedlings.

3.2. Effect of irrigation intervals and chemical fertilizer treatments on fruit, seed yield and seed oil percentage of *Jatropha curcas*

3.2.1. Fruit yield/plant, (gm)

Data in Table (6) demonstrate that fruit yield was influenced by the fertilizer treatments. Plants fertilized with the highest level (100:50 g P:K/plant) showed produced fruit yield (220.40 gm/plant) as compared to the other fertilizer

treatments (fertilization rates of 50:25 and 75:37.5 gm P:K/plant, which gave 136.00 and 150.90 g/plant, respectively), while the lowest value 86.79 had been obtained from the control plants.

Regarding the effect of irrigation intervals the same data showed that 7-day irrigation intervals significantly increased fruit yield (280.00 gm/plant) as compared to 14 and 21-day intervals (103.30 and 62.31 gm/plant), respectively.

Concerning the interaction between fertilizer treatments and irrigation intervals, the data presented in Table (6) reveal that the fertilization treatment of 100:50 g P:K/plant combined with 7-day irrigation intervals significantly increased fruit yield resulting in the highest value (435.10gm/plant) as compared to all other treatment combinations. On the other hand, the fertilizer treatment of 0:0 P:K combined with 21 day irrigation intervals significantly decreased fruit yield as compared to all other treatment combinations.

3.2.2. Seed yield/plant (gm)

Data in Table (7) clear that fertilization with 100:50 gm P:K/plants significantly increased seed yield(127.70 gm/plant) as compared to the other fertilizer treatments (fertilization rates of 50:25 and 75:37.5 gm P:K/plant, which gave 78.88 and 87.07 gm/plant, respectively), while the lowest value 49.25g/plant was obtained from the control plants.

Regarding the effect of irrigation intervals the same data showed that 7-day irrigation intervals significantly increased seed yield (175.60 gm/plant) as compared to 14 and 21-days intervals (50.72and 30.86gm/plant), respectively.

Concerning the interaction between fertilizer treatments and irrigation intervals, data presented in Table (7) reveal that the fertilization treatment of 100:50 g P:K/plant combined with 7day irrigation intervals significantly increased seed yield resulting in the highest value (269.30gm/plant) as compared to all other treatment combinations. On the other hand, the fertilizer treatment of 0:0 P:K combined with 21-day irrigation intervals significantly decreased seed yield as compared to all the other treatment combinations.

3.2.3. Seed oil percentage

Data in Table (8) reveal that fertilizer treatment of 100:50 g P:K/ plant significantly increased oil percentage (26.06%) as compared to other fertilizer treatments. On the other hand, 0:0 P:K treatment gave the lowest oil percentage (21.20%) . Concerning the effect of irrigation intervals the same data showed that 7-day irrigation intervals significantly increased oil percentage (27.32%) as compared to 14 and 21 days sintervals (24.10 and 22.81%, respectively).

As regard to the interaction, data presented in Table (8) show that using fertilizer treatments of 100:50 g P:K/plant combined with 7-day irrigation intervals significantly increased oil percentage of Jatropha seeds (28.88 %) as compared to other treatment combinations. On the other hand, fertilizer treatment of 0:0 g P:K combined with 21 day-irrigation intervals significantly decreased oil percentage of Jatropha seeds (18.59%).

The results of fruit yield/plant (g) ,seed yield (g) and seeds oil percentage (%) are in agreement with the result obtained by Bhosekar (1992) found that seed yield was increased as N rate was increased from 0 to 30, 60 and 90 kg N/ha, El-Shafie *et al.* (1994), on roselle plants, reported that the more frequent irrigation (every 7 days) was necessary for producing taller plants with more branches, higher number of fruits, heavier fruits and sepal yield per plant compared with those irrigated every 14, 21 and 28 days, while the lowest values in this respect were obtained by intervals of 28 days. The produced seed yield/plant was increased with reducing watering intervals, Rao *et al.* (1995), on *Ricinus communis*, found that castor responded positively to fertilizer application (75 kg N + 22 kg P/ha) in terms of seed and oil yields, Dinesh *et al.*(2001) on castor varieties, they showed that increasing fertilizer level enhanced growth characteristics, including seed yield. The role of water in increasing the yield of flowers may be explained by its role in photosynthesis that will be reflected on the relative growth rate and flowering which are the main growth aspects (Dinesh *et al*., 2001), Salem (2002), on jojoba (*Simmondsia chinensis*), showed that the number and seed weight/plant and oil percentage were significantly increased by using the highest concentration of complete fertilization and the highest level of irrigation. Gressel (2008) found that Jojoba and Jatropha can grow in the desert under deficit water and fertilizer, but without commercial yield. Only with inputs of fertilizer and water are there high yields.

3.3. Recommendation

From the results of the current study, it could be recommended to fertilize *Jatropha curcas* L. with 100:50 g P:K/plant combined with irrigation at 7 day by sewage water to get the best growth, fruit and seed yield and oil percentage.

Table (6) :Effect of irrigation intervals and chemical fertilizer treatments on fruit yield/plant (g) of *Jatropha curcas* L**.**

Fertilizer treatments (F)	Irrigation intervals (I)			Mean (F)
	7 days	14 days	21 days	
P:K(0:0 g/plant)	158.10	65.55	36.76	86.79
P:K(50:25 g/plant)	257.10	95.46	55.48	136.00
P:K (75:37.5 g/plant)	269.50	110.90	72.24	150.90
P:K(100:50 g/plant)	435.10	141.30	84.76	220.40
Mean (I)	280.00	103.30	62.31	
L.S.D. I.= 2.35 **L.S.D. F.**= 1.09 **L.S.D. I. x F.**= 1.89				

I= Irrigation
F= Fertilization
I x F= Irrigation x Fertilization

Table (7) :Effect of irrigation intervals and chemical fertilizer treatments on seeds yield/ plant, (gm) of *Jatropha curcas* L**.**

Fertilizer treatments (F)	Irrigation intervals (I)			Mean (F)
	7 days	14 days	21 days	
P:K (0:0 g/plant)	97.84	32.40	17.50	49.25
P:K(50:25 g/plant)	162.50	47.30	26.85	78.88
P:K (75:37.5 g/plant)	172.80	52.39	36.05	87.07
P:K(100:50 g/plant)	269.30	70.78	43.04	127.70
Mean (I)	175.60	50.72	30.86	
L.S.D. I. = 0.66 **L.S.D. F.**= 0.53 **L.S.D. I. x F**.= 0.91				

I= Irrigation
F= Fertilization
I x F= Irrigation x Fertilization

Table (8) :Effect of irrigation intervals and chemical fertilizer treatments on seeds oil percentage of *Jatropha curcas* L**.**

Fertilizer treatments (F)	Irrigation intervals (I)			Mean (F)
	7 days	14 days	21 days	
P:K (0:0 g/plant)	24.19 f	20.84 h	18.59 i	21.20 d
P:K (50:25 g/plant)	27.83 c	22.88 g	23.07 g	24.59 c
P:K (75:37.5 g/plant)	28.37 b	25.78 e	24.18 f	26.11 b
P:K (100:50 g/plant)	28.88 a	26.91 d	25.40 e	27.06 a
Mean (I)	27.32 a	24.10 b	22.81c	
L.S.D. I. = 0.66 **L.S.D. F.**= 0.53 **L.S.D. I. x F**.= 0.91				

I= Irrigation
F= Fertilization
I x F= Irrigation x Fertilization

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دراسة الاحتياجات المائية و السمادية لنباتات الجاتروفا *Jatropha curcas* L.
تحت ظروف الري بمياه الصرف الصحي

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ملخص

تم زراعة نباتات الجاتروفا بالبذرة في تربة رملية بمنطقة أبو رواش محافظة السادس من أكتوبر حيث رويت النباتات بنظام الري بالخطوط على فترات مختلفة كل (٧-١٤-٢١ يوما) باستخدام مياه الصرف الصحي المعالجة أولياً و الناتجة من محطة الصرف الصحي بأبو رواش و سمدت النباتات بـأربعة مستويات من السماد المعدني باستخدام سوبر فوسفات الكالسيوم (P_2O_5 ١٥%) و سماد سلفات البوتاسيوم (K_2O % ٥٠) و ذلك بمعدلات صفر و ٢٥:٥٠و ٣٧,٥ :٧٥ و ٥٠:١٠٠ جرام سماد/نبات (جرعة كل شهرين).

و تشير أهم النتائج بالنسبة لفترات الري إلى أن استخدام الري بمياه الصرف الصحي المعالج أولياً كل ٧ أيام أفضل و أعطى أحسن نمو خضري و ثمري و كذلك أعلى نسبة للزيت بالبذور يليه الري كل ١٤ يوما و كان أقلهم في النسب السابقة الري كل ٢١ يوما . بالنسبة للتسميد الفوسفوري و البوتاسي كان استخدام التركيز ٥٠:١٠٠ جرام سماد /نبات أفضل جرعة سمادية يليها ٧٥ :٣٧,٥ جرام/نبات، أما النباتات غير المسمدة كانت الأقل في صفات النمو الخضري و كمية الثمار على النبات الواحد و كذلك أقل نسبة زيت بالبذور .و كان أفضل التداخلات بين الري كل ٧ أيام و التسميد الفوسفاتي و البوتاسي بتركيز ١٠٠ :٥٠ جرام سماد/نبات حيث أعطى ذلك أفضل نمو خضري و ثمري و نسبة زيت بالبذور.

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