EFFECT OF WATER MANAGEMENT AND USE OF DRY BIO GAS FERTILIZER ON THE CORIANDER CROP PRODUCTIVITY

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ABSTRACT

Irrigation is a very important factor as well as fertilization, affecting the growth and yield of plants. Coriander plants have several uses in pharmaceutical and food industries; because of its great importance, more investigations for improving the growth and productivity of this plant are still needed. The aim of this research is to study the effect of dry biogas fertilizer (dry digested biomass resulted from biogas digesters) and irrigation water regime conditions on the Coriander crop (Coriandrumsativum L.) production. The experimental work was conducted during November 2016 at Tractors and Farm machinery Testing & Research Station at Sabahia, Alexandria Governorate, Egypt. Results indicated high significant differences of mean values of the plant growth parameters for all treatments, while the highest significant difference resulted due to the effect of the treatment [irrigation water regime (15) times, depth from surface soil (10) cm and amount of biogas fertilizer (15) m^3/Fed], where the values of plant height H, number of branches (NB), number of umbels (NF) and umbels diameter were 90.03 cm, 6.60, 80.30 and 4.3 respectively compared with the control treatment. Also the results of physical and chemical analysis of soil after harvesting showed high improvements, where the maximum mean values of total porosity, (T.P%) , hydraulic conductivity (Kb Cm/h) , total nitrogen (T.N%) and available nitrogen (Av.N ppm) of soil after the coriander plant harvested, were 57.33 %, 3.17 Cm/h), 2.28% and 128.19 ppm respectively resulted from the treatment [irrigation water regime (15) times, depth from surface soil (10) cm and amount of biogas fertilizer (20) m^3/Fed] compared with all treatments.

Keywords: *Coriander, irrigation regime, biogas solid fertilizer, growth parameters.*

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1. INTRODUCTION

Because of the great importance of coriander (Coriandrum sativumL.) plants in pharmaceutical and food industries, more investigations for improving the growth and productivity of this plant are still needed. It is known that Egypt is a downstream country of the Nile River. Based on this fact, the great challenge for the coming decades will be the task of increasing the productivity of water units **(Abdin and Salem, 2009).** Irrigation as an environmental factor has an important role in plant **growth** and is essential to increase yield and quality of plants **(Singh and Goswamy, 2000)**. Deficit irrigation, one of the environmental stresses, is the most significant factor restricting plant growth and crop productivity in the majority of agricultural fields of the world **(Abedi and Pakniyat, 2010)**. Identifying growth stages of a particular cultivar under local conditions of climate and soil fertility allows irrigation scheduling to maximize crop yield and most efficient use of scarce water resources **(Mahal and Sidhu, 2006)**. Nitrogen fertilization and the correct supply of water play an important role in the quality and yield aspects of coriander **Angeli et al (2016)**. Prolonging the irrigation intervals reduced the growth and yield of various medicinal and aromatic plants **(Eid et al., 1995; Hammam, 1996)**. Irrigation of coriander plants at higher levels resulted in the highest vegetative growth characters and yield component compared to the lower levels **(Osman, 2000; Osman and El-Feky, 2005)**. Reducing the irrigation level reduced the seed yield of coriander **(Tomar et al., 1994; Kumar et al., 2008)**. Increase in irrigation water increased dry matter and yield however water soluble carbohydrate was decreased **(Islam et al., 2012)**. Water deficit severely affected all growth parameters and yield attributes with the exception of the number of branches per caraway plant. Moreover, the seed yield and its components significantly decreased under moderate and severe water deficit **(Laribi et al., 2009)**. **Kamkar et al. (2011)** mentioned that the lower **WUE** was associated with a higher amount of irrigation water. The volatile oil of various medicinal and aromatic plants was affected as a result of applying different irrigation treatments. Limited water supply is an important factor affecting growth and metabolic activities of plant species. It has a generally negative effect on plant growth and development. However there are reports on the positive effect of limited water supply, as far as the biosynthesis of secondary metabolites, enzyme activities and solute accumulation are concerned **(Singh- Sangwan et al., 2001)**. Deficit irrigation can change plant behavior regarding the biosynthesis of primary and secondary metabolites. In addition, drought influences the essential oil biosynthesis **(Laribi et al., 2009; Bettaieb et al., 2011; Bourgou et al., 2011)** and therefore affects the composition of essential oil. Increasing the irrigation intervals increased the volatile oil percentage; however the volatile oil yield was in an opposite manner **(Afify et al., 1993; Eid et al., 1995; Hammam, 1996)**. On the other hand, the maximum volatile oil yield of coriander was obtained when the lowest irrigation rate was applied compared to the highest irrigation rate **(Osman, 2000)**. Irrigation water also affected not only the volatile oil percentage but also oil composition of coriander fruits **(Hassan et al., 2012).** The chemical constituents of medicinal and aromatic plant herbs were also affected by irrigation treatments **(El-Shafie et al., 1994; Hammam, 1996; Osman, 2000). From the previous literature**, it will be beneficial to determine the optimum irrigation level of coriander plants in order to increase the productivity of water unit. Therefore, the aim of this work was to study the effect of irrigation water regime, dry biogas fertilizer rate and fertilization depth on coriander growth parameters and some physical and chemical properties of soil. **(Mohamed 2000);** on Carum carvi L. plants found that both essential oil percentage and oil yield were increased with decreasing the irrigation intervals. Increasing irrigation level from 70% (ETP) to 110 %(ETP) significantly increased the essential oil yield of C. sativum l. plant. **(Halepyati et al., 1996)**. Prolonging the irrigation intervals reduced the growth and yield of various medicinal and aromatic plants.

2. MATERIALS AND METHODS

2.1. Experimental site

The experimental work was conducted during November 2016 at Tractors and Farm machinery Testing & Research Station at Sabahia, Alexandria Governorate, Egypt, to study the effect of dry bio gas fertilizer rate, fertilization depth and irrigation water regime on the coriander growth parameters as well as some physic-chemical properties of soil.

2.2. Soil description

Soil samples were collected and analyzed to determine some physical and chemical characteristics of the investigated soil according to the standard methods outlined by **black et. al. (1965), Jackson (1967)** and page et al.

(1982). Total nitrogen(T–N) and available(Av–N) were extracted and determined according to the methods **under taken by Soltanpour and Schwab (1977) and Jackson (1973).** Data were represented in Table 1.

Table (1). some physical and chemical properties of the tested soil.

Properties	The values
Chemical properties	
PH (1:2.5) soil : water	7.95
EC,d S m-1 (1:2.5)	2.60
Soluble Cations (meq/L)	
1. Na	4.80
2. K^+	0.10
3. $Ca^{+}2$	11.5
4. $Mg^{+}2$	5.66
Soluble anions (meg/L)	
1. HCO_3	7.00
2. CL^+	5.50
3. SO^{-2}_4	9.66
Total nitrogen, % (T.N)	0.10
Available nitrogen ,ppm (Av.N)	24.24
Total Carbonat % ($CaCo_3$)	4.85
Cation exhangable capacity (CEC) meg/100 soil	9.55
Physical properties	
Total porosity, (T.P) %	51.25
Hydraulic Conductively (HC) (cm/h)	01.75
Available water, (Av.W) %	17.95
Texture class	Sand clay loam
Particle size distribution, %	
1- Sand	44.20
2- Silt	26.10
3- Clay	29.76
Soil bulk density (gm/cm^3)	1.31

Chemical analysis of water

The chemical analysis of water was carried out at Analyzed in Saline and Alkaline research Lab Alexandria, which were 0.9, 0.25, 0.00, 0.3, 0.8,15 and 8 (meq/L) for Ca, Mg, CO3, HCO3, CL, Na and K, respectively.

2.3 Planting treatments and experimental design

The experiment was performed in split split- plot system in a randomized complete block design (RCBD) with three replicates. Treatments consisted of two amounts of biogas fertilizer 15 and 20 m^3/fed, three fertilization depths of 5, 10 and 15 cm from the surface of the earth, and three irrigation water regimes as three periods of irrigation 7-10-15 times at the season as well as the control.

Coriander seeds were sown in the soil in row 10.0 m length and 0.6 m apart, the spacing between plants 0.25 m. Seeds were sown in holes at space of 25 cm in between, about 3-4 seeds were sown in every hole. Thinning process to one plant per hole was performed 40 days after sowing. The total area of the experiment was about 360 m2, divided into 72 plots; each plot area was (3m x1 m). There were 12 plants in every row, 36 plants in each plot. Plants were irrigated by flooding irrigation up to the field capacity (1200 m^3/fed). The plants were harvested and its growth parameters data were recorded: plant height, number of main branches per plant, number of umbels per plant, diameter of umber per plant and yield.

2.4. Dry biogas manure application:

The dry biogas manure brought from the biogas project located at Tractors and Farm machinery Testing & Research Station, Sabahia, Alexandria Governorate, Egypt. The components of the dry biogas manure were analyzed in the laboratories of the services unit of soil analysis, Soil Department, Faculty of Agriculture, Alexandria University, Egypt. Table (2) shows characteristics of the investigated dry biogas manure. The dry fertilizer was added to each treatment by scaling the surface of soil at depths of 5, 10 and 15 cm respectively then adding the dry biogas fertilizer and then creating the lines.

Table (2): Characteristics of dry biogas fertilizer.

Item	Value
Bulk density	450 kg/m^3
Moisture content	7-10%
Nitrogen content	22 kg/ton
Phosphorus content	27 kg/ton
Potassium content	61.5 kg/ton
Organic matter	50%

3. RESULTS AND DESCUSSION

Effect of dry biogas fertilizer, fertilization depth and irrigation water regime on the growth parameters of coriander:

Table 3 shows the effect of dry biogas fertilizer rate 15 and 20 (m^3/fed), three fertilization depth of surface soil 5, 10 and 15 (cm) and three levels of irrigation 7, 10 and 15 (irrigations times) on the coriander growth parameters.

Table (3): Effect of irrigation water regime, dry biogas fertilizer rate and fertilization depth on the coriander growth parameters.

biogas fertilizer rate, m^3/fed	Depth ,cm	Irrigation regime	yield, kg/fed	Branch. No.	Plant Height , cm	Flower Diam. , cm	No. of fruits
15	5	7	933.6	5.18	63.78	3.43	61.3
		10	1019.2	5.37	65.83	3.62	66
		15	1041.4	5.66	66.77	3.87	66.9
	10	7	1104	5.21	68.76	3.03	69.1
		10	1171.2	6	71.8	3.7	78.5
		15	1208	6.6	90.03	4.3	80.3
	15	7	1000	5.31	68.22	2.98	62.29
		10	1038.4	5.66	71.12	3.13	63.71
		15	1052.8	5.88	75.8	3.79	66.11
20	5	7	955.2	5	76.95	2.75	61.19
		10	980.8	5.23	71.61	3.09	63.33
		15	1004.8	5.79	74.35	3.31	64.1
	10	7	1132	5.21	64.46	3.19	67.2
		10	1169.6	5.33	66.39	3.45	71.4
		15	1120.8	6.33	87.5	3.77	73.7
	15	7	960.9	5.21	70.09	2.89	61.12
		10	974.4	5.49	71.65	3.41	64.47
		15	1000	5.73	83.91	3.79	65.97
Control		15	665.6	4.37	60	2.93	54.67
Means			1033.2	5.48	74.10	3.29	65.83
L.S.D. of Fertilizer rate			30.5	0.16	2.99	0.24	2.51
L.S.D. of fertilization Depth			26.42	0.14	2.59	0.21	2.17
L.S.D. of irrigation			20.57	0.12	2.11	0.17	1.77

Generally, the experimental results showed that the three levels of water regime and the applied fertilization rates of solid biogas fertilizer as well as the fertilizer depth had a significant effect on all growth characteristics of the coriander plant compared with the control treatment. It was noticed that the high significant differences were resulted from the treatment [amount of biogas fertilizer (**15**) m^3/Fed + depth from surface soil (**10**) cm + level of irrigation (**15**) times], the maximum mean value of yield, plant height, number of branches, number of umbels and umbels diameter, were 1208 kg/fed, 90.03 cm, 6.60, 80.30 and 4.2 cm respectively compared to the control treatment. These results assure with those of **Mahal and Sidhu (2006), Eid et al. (1995), Hammam, (1996)**. and **Angeli et al (2016)**. The improvement rate in the growth parameters of coriander crop was (40.3 to 80.5)% in the yield, (6.3 to 50.0)% in plant height, (14.4 to 50)% in number of branches, (11.8 to 46.9)% in number of umbels and up to 46.8 % in umbel diameter; which confirms that the dry biogas fertilizer, irrigation water regime and the fertilization depth have a high positive effect.

Effect of irrigation water regime, dry biogas fertilizer rate and fertilization depth on some physical and chemical properties of soil:

Table (4) showed the effect of dry biogas fertilizer rate, fertilization depth and irrigation water regime on total porosity, (T.P %)**,** hydraulic conductivity (Kb Cm/h), total nitrogen (T.N %) and available nitrogen (Av.N ppm) of tested soil planted of coriander plant.

Table (4) Effect of irrigation water regime, dry biogas fertilizer rate and fertilization depth on T-P % , Kb Cm/h , T.N%, Av.N ppm of soil after harvesting coriander plant.

TREATMENTS			T.P %	K.b Cm/h	T.N %	Av.N ppm
m^3/fed	Depth (cm)	Times				
CONTROL		**15**	50.05	1.74	0.107	72.75
15	5	7	55.21	2.6	1.98	121.50
		10	55.36	2.69	1.98	120.41
		15	55.58	2.64	1.96	121.29
	10	7	56.23	2.67	2.07	119.20
		10	56.48	2.74	2.09	120.95
		15	57.2	**3.01**	2.25	127.92
	15	7	55.92	2.76	1.99	120.80
		10	56.07	2.75	2.01	122.58
		15	56.52	2.77	2.02	122.77
S_2	5	7	55.93	2.7	2.03	123.10
		10	56.09	2.72	2.06	121.90
		15	56.18	2.74	2.09	119.50
	10	7	56.26	2.72	2.08	125.40
		10	56.33	2.75	2.10	124.22
		15	57.33	3.17	2.28	128.19
	15	7	56.4	2.8	2.13	120.15
		10	56.58	2.78	2.20	126.98
		15	56.68	2.89	2.21	126.82
L.S.D at 0.05			1.81	0.21	0.19	8.92

The results showed significance differences due to the effect of all treatments comparing with the control treatment. The maximum significant difference resulted from the treatment (15) times, (10) cm and

(20) m^3/fed, where the average values of total porosity, (T.P%), hydraulic conductivity (Kb Cm/h), total nitrogen (T.N%) and available nitrogen (Av.N ppm) were 57.33 %, 3.17 Cm/h), 2.28% and 128.19 ppm respectively.

4.CONCULATIONS

1-The evaluated growth parameters (yield, plant height, number of bunches, number of umbels and umbel diameters) were influenced by irrigation water regime, dry biogas fertilizer rate and fertilization depth.

2- The treatment irrigation water regime (15) times, fertilization depth from surface soil (10) cm and dry biogas fertilizer rate (15) m^3/fed caused the highest average yield (1208 kg/fed).

3- The maximum average plant height (90 cm) was obtained at irrigation water regime (15) times, fertilization depth from surface soil (10) cm and dry biogas fertilizer rate (15) m^3/fed.

4- The maximum average number of branches (6.6) and maximum average number of fruits (80.3) were obtained at irrigation water regime (15) times, fertilization depth from surface soil (10) cm and dry biogas fertilizer rate (15) m^3/fed.

5- The most important parameter for the farmer is the yield; thus the irrigation water regime (15) times, fertilization depth from surface soil (10) cm and dry biogas fertilizer rate (15) m^3/fed are the recommended for higher coriander yield.

6- Generally, the physical and chemical properties of soil after coriander plant harvesting showed greater improvements comparing with control treatment in total porosity, (T.P%), (Kb Cm/h), total nitrogen (T.N%) and available nitrogen (Av.N ppm) the maximum average improvements values were 66.99 %, 2.99 Cm/h, 1.98% and 126.88 ppm respectively caused by the treatment irrigation water regime (15) times, fertilization depth from surface soil (10) cm and dry biogas fertilizer rate (15) m^3/fed compared the control treatment.

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الملخص العربى

تأثير ادارة مياه الرى باستخدام سماد البيوجاز الجاف على انتاجية محصول الكزبرة

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أجريت تجربة حقلية فى نوفمبر ٢٠١٧ بمحطة ابحاث واختبارات الجرارات والالات الزراعية- معهد بحوث الهندسة الزراعية - مركز البحوث الزراعية - الاسكندرية بهدف دراسة تأثير اضافة سماد البيوجاز الجاف (و هو سماد يتم الحصول عليه من تجفيف ناتج تخمر المخلفات الزراعية) وبعض مستويات الرى على صفات النمو لمحصول الكزبرة .
تم اجراء التجارب على التربه حيث تم استخدام كميتين من السماد الجاف (١٥ - ٢٠) م٣/ فدان وثلاثه اعماق لوضع السماد (٥ - ١٠ - ١٥) سم من سطح التربه و ثلاثه مستويات من الرى (٧ - ١٠ - ١٥) ريه / موسم بالاضافه لمعامله الكنترول. تم قياس البيانات على صفات النبات كالاتى : أرتفاع (طول) النبات - عدد الافرع – عدد الزهور – قطر الزهور – انتاجيه الفدان .

أوضحت النتائج ما يلى :

١- كل المعاملات كان لها تأثير معنوى على صفات نمو الكزبره من حيث الانتاجية و ارتفاع النبات و عدد الفروع و عدد الازهار و قطر الازهار بالمقارنة مع نتائج معاملة الكنترول، و لكن المعاملة معدل تسميد ١٥ م٣/فدان و عمق تسميد ١٠سم من سطح التربة و عدد ١٥ رية/موسم كانت هى الاكثر معنوية مقارنة بكل المعاملات.

٢- المعاملة [معدل تسميد ١٥ م٣/فدان و عمق تسميد ١٠سم من سطح التربة و عدد ١٥ رية/موسم] كانت الأكبر معنوية على الاطلاق من حيث متوسطات قيم كل من ارتفاع النبات , عدد الأفرع ، عدد الزهور ، قطر الزهور ، و كانت قيم المتوسطات هى ٩٠ سم - ٦,٦ - ٨٠,٣ – ٤,٣ .

٣- اكبر انتاجية لمحصول الكزبرة و هى ١٢٠٨كجم/فدان تم الحصول عليها من المعاملة [معدل تسميد ١٥ م٣/فدان و عمق تسميد ١٠سم من سطح التربة و عدد ١٥ رية/موسم] .

٤- اظهرت كل المعاملات تحسين فى بعض الخواص الفيزيائية و الكيميائية للتربة بعد حصاد المحصول مقارنة مع المعاملة الكنترول و كانت نتائج المعاملة [معدل تسميد 20 م٣/فدان و عمق تسميد ١٠سم من سطح التربة و عدد ١٥ رية/موسم] هى الأكبر معنوية لمتوسطات قيم كلاً من المسامية الكلية (T.P) التوصيل الهيدروليكى (Kb), النيتروجين الكلى (T.N) والنيتروجين المتاح (Av.N ppm) .

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