THE IMPACT OF LIQUID BIO-GAS FERTILIZER ON FENNEL CROP PRODUCTIVITY AND OIL CONTENT UNDER DIFFERENT LEVELS OF IRRIGATION WATER

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ABSTRACT:

Two experiments were carried out at test and research station of Tractors and Farm machinery at Sabahia, Alexandria Governorate, Egypt during 2016/2017 season to study the effect of liquid Biogas fertilizer on vegetative growth, chemical composition and essential oil% on fennel plants. The remaining mixture of the process of fermentation of organic and exogenous waste from the fermentation is called the name of the biogas fertilizer. This fertilizer can be dried and converted into organic liquid or dry fertilizer and used in the fertilization of various agricultural crops very efficiently and because of its reliable price and dispense with mineral fertilizers which are expensive and harmful to humans .The experimental design was split plot with three replicates. The main plots were conducted for two rates of liquid biogas fertilizer (15) and (25) m^3 / fed with Three levels of concentration of biogas fertilizer level 1 (10%), Level 2 (20%) and Level 3 (30%) the subplots were occupied by three levels of irrigation (50%, 75% and 100%)from the maximum irrigation rate of 4000m3/fed . The main results could be summarized as follows (1) Application biogas liquid fertilizer level at 30% (25m^3/Fed) gave the highest mean values of all studied characters under the third level of water irrigation (50%).Essential oil% and majors compound % for the Foeniculum vulgare tested in the study. The results also showed that the highest value for water use efficiency (WUE) was 0.56 for the treatment ($Z_2Q_3I_3$) and the highest value for nitrogen fertilizer use efficiency (NUE) was 14.5 for the treatment ($Z_1Q_1I_3$).However, all traits under study increased significantly due to biogas liquid fertilizer treatments over the control treatment

Keywords: *fennel, liquid biogas fertilizer levels, irrigation levels, vegetative growth, Seed yield oil%, chemical composition.*

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INTRODUCTION:

Fennel (*Feoeniculum vulgare*, Mill) which belongs to the family umbelliferae (Apiacecie) is a short lived herb, indigenous to Europe and cultivated in India Chino and Egypt **(Whichti and Bissel, 1994)**. It is an aromatic herb whose fruits contain essential of which is used for many purposes by human. The oil of fennel regulates the peristaltic functions of the gastrointestinal trace and relieves the spasms of intestines **(Fathy et al., 2002)**. Extemally, the oil relieves muscular and rheumatic pains. Also, the seeds have a traditional reputation as an acid to weight loss and longevity. The major constituent of fennel oil is Anethole **(Braun and Franz, 1999).** Fertilization is one of the most important factors limiting the productivity of plant. The intensive uses of expensive mineral fertilizers in recent years result in environmental pollution problems. Chemical fertilizers at extremely high rates for a long period decreased the potential activity of microflora and the stability of soil organic matter, **Pokorna (1984).** Biofertilization is one of the most important factors used to produce products free from mineral contamination. On the other hand, the intensive uses of chemical fertilizer cause environmental pollution problems, utilized biofertilizers (phosphorus solubilizing microorganisms (Bacteria and Mycorrhizae) could supply plants with their needs of phosphorus during their growth. Also, bio-fertilizer play vital role for increasing the number of microorganisms and accelerate certain microbial process in the rhizosphare of inoculated soil which can change unavailable pormsto the available forms of nutrients for plants **(Badawi, 2000, Kandell *et al*., 2001 and Massoud, 2007)**. The remaining mixture of the process of fermentation of organic and exogenous waste from the fermentation is called the name of the liquid biogas fertilizer. This fertilizer can be dried and converted into organic liquid or dry fertilizer and used in the fertilization of various agricultural crops very efficiently and because of its reliable price and dispense with mineral fertilizers which are expensive and harmful to humans. Therefore, the liquid manure was selected in this research and its effect on the fennel plant in the different stages of cultivation and on productivity and on the percentage of extracted oil.Many rehearses reported the use of biogas residues as soil fertilizer

with success **(Maunksela *et al*., 2012Diacono & Montemurro., 2011; Haraldsen *et al*., 2011)**.The residues generated from biogas processes have a higher concentration of NH4 compared with conventional animal manure and compost hence their potential fertilizer value is also higher **(Zhong et al ., 2010)**.In addition most elemental nutrients such as P K Mg and a number of other essential trace elements from the raw material fed to the biogas process ram in the biogas residue **(Abubaker., 2012)**.The organic compounds not broken down during the biogas process increase the carbon content of farmland and improve its biological activity as they break in the soil. The studied factors included irrigation treatment (at three levels of irrigation to 50%, 75% and 100% of reference evapotranspiration Therefore, the objective of this study were: (1) Evaluation the effect of biogas fertilizer and water irrigation levels and their interaction on the fennel growth, yield, essential oil chemical composition. (2) Water use efficiency (WUE). (3) Nitrogen fertilizer use efficiency (NUE).

MATERIALS AND METHODS:

2.1. Experimental site

The experiments were carried out at the Test and Research station of Tractors and Farm machinery (Sabhia), during 2016/2017 season. The applied experimental design was split plot with three replicates. The main plots were conducted for two rate of biogas fertilizer (liquid) by the three levels and the subplots were occupied by the three levels of water irrigation treatments (50% ,75% and 100%) Added recommended dose of NPK fertilizer to control treatment.

2.2. Levels of irrigation

Three levels of irrigation and quantities of water applied **According to the Desert Research Center (2010).**

1- 4000 m^3/Fadden represents the maximum irrigated water rate for Fennel plant (i.e 100 % of water requirements (WR).

2- 3000 m^3/Fadden represents the maximum irrigated water rate for Fennel plant (i.e 75 % of water requirements (WR).

3- 2000 m^3/Fadden represents the maximum irrigated water rate for Fennel plant (i.e 50 % of water requirements (WR).

2.3. Soil description

Soil samples were collected to determine some physical and chemical characteristics of the investigated soil were determined according to **Page *et al*. (1982)** is shown in Table (1).

The chemical analysis of water

Analyzed in Saline and Alkaline research Lab Alexandria

The chemical analysis of water was 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.

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
Total nitrogen, % (T.N)	0.10
Available nitrogen ,ppm (Av.N)	24.24
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

2.4. Planting treatments and experimental design

The experiment was performed in split split- plot design in a randomized complete block design (RCBD) with three replicates.

Treatments consisted of two rates of biogas fertilizer 15 and 25 cubic meters / fed, the subplots were occupied by Three concentrations of liquid fertilizer (10, 20 and 30%) and water regimes (control, i.e. three rates of irrigation: (50% ,75% and 100%) represent(2000, 3000, and 4000 m^3/fed). Fennel plant was sown in the soil in rows of 10 m length and 1.0 m apart. The spacing between rows were 25 cm, the seeds were sown in holes with 25cm within a row, beside 3-4 seeds were sown in every hole. Thinning to one plant per hole was performed 40 days after sowing. The plot area was (3×3m) and contained 3 rows. There were 12 plants in every row 36 plant in each plot. Seeds of fennel were obtained from Medicinal

and Aromatic Plants Department Agricultural Research center, Egypt, seeds were sown on Nov 12th during the successive season 2016/2017. The same design was followed with flooding irrigation system. The plants were irrigated by flooding irrigation up to the field capacity (4000m3/fed). The plants were harvested on 25th April during the season and the following data were recorded: plant height (cm), number of main branches per plant, number of umbels per plant, diameter of umber per plant, weight of fruits per fed (kg).

2.5. Biogas liquid manure application rates

The liquid biogas manure brought from the biogas project located at Test and Research station of Tractors and Farm machinery, Sabahia, Alexandria Governorate, Egypt. The components of the liquid 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 liquid biogas manure.

Sample	N	P	K	Fe	Zn	Cu	Cd	Ni	Cr	Pb
	%			ug/g, ug/ml						
Fresh Dung	1.27	0.48	1.40	1952.00	60.00	20.00	34.00	66.0	0.00	22.00
Liquid fertilizer	1.13	0.52	2.10	124.00	7.60	2.40	3.40	8.00	0.00	5.40

Determination of oil percentage:

The essential oil percentage in the fennel seeds was determined according to **British Pharmacopoeia (1963)**.Satisfactory results were obtained by distilling 100 g seeds for 1.5 – 2.0 hours.

Chemical composition of essential oil:

Chemical composition of the extracted essential oil of fennel was identified using a Thermo scientific GC/MS version (5) 2009 system with TG-5MS column (30mX0.32mmID). Helium was used as a carrier gas at a flow rate of 1ml/min. Five µl essential oil was diluted to 1ml with dichloromethane, then 2 µl was injected on splitless mode for 1 min. followed by a split flow with ratio 1:10. GC oven temperature was held at 45ºc for 2min then was programmed from 45ºc to 165ºC at 4ºC/min; from 165ºC to 280ºC at 15ºC/min. after which was kept constant at 280ºC for 10 min. Both the interface and injection temperatures were adjusted at

250ºC. The ionization voltage was 70eV with a mass range between 40-800mandz. The essential oil components were identified by mass fragmentation patterns, which were compared with NIST mass spectral database (version 2) and their relative percentages were calculated based on GC peak areas .

Water use efficiency (WUE):

Water use efficiency is the measure of a cropping system's capacity to convert water into plant biomass or grains. Water use efficiency (WUE) was determined according to **Michael (1978)** by using the following equation,

Water use efficiency = Crop yield, (kg/ Fed) /Water applied, ($m^{3/}$ Fed)

Nitrogen fertilizer use efficiency (NUE):

Table (3) shows: quantities of nitrogen units per treatment Fertilizer use efficiency was calculated for each treatment according to the following relation by **Jensen (1983)**:

NUE = Total Fresh Yield (kg) / Total Applied Nitrogen Fertilizer (kg-N)

Statistical Analysis:

All the data obtained were statistical subjected to analysis of variance as described by **Gomez and Gomez (1984)**; using L.S.D. at 0.05.

Table (3) shows: quantities of nitrogen units per treatment Fertilizer

Treatments		unit's of nitrogen
Z_1	Q_1	169.5
	Q_2	113
	Q_3	56.5
Z_2	Q_1	282.5
	Q_2	188.33
	Q_3	94

RESULTS AND DISCUSSION

Plant height and Seed yield:

Data presented in Table (4) showed that with increasing liquid fertilizer levels significantly, increased the plant height with significant difference for the most liquid fertilizer levels under all irrigation level compare with control treatment However, the tallest plants were observed for the application (Z_2 at Q_3 in I_3 = 145.01 cm/plant), As well as the highest productivity was for the application (Z_2 at Q_3 in I_3 = 1120kg/fed).

While the shortest plants and Less productive were recorded by applied the control treatment = 110 cm/plant, 670kg/fed, respectively.

Table (4): Effect of Liquid Bio-Gas Fertilizer on Fennel crop productivity under different levels of irrigation water

Treatments			Plant Height (cm)	Branches Number	Inflorescences Number/Plant	Seed Yield /Fed (kg)
Control			110.00	4.33	18.88	670
Z_1	Q_1	I_1	121.31	4.21	29.76	746
		I_2	122.23	4.38	31.15	785
		I_3	125.96	4.96	32.13	821
	Q_2	I_1	128.17	4.17	35.23	776
		I_2	128.12	4.83	36.15	811
		I_3	129.11	5.17	33.86	766
	Q_3	I_1	128.98	4.98	33.21	776
		I_2	130.29	5.33	33.17	893
		I_3	131.26	5.81	34.83	911
Z_2	Q_1	I_1	132.16	5.36	35.45	793
		I_2	132.36	5.78	35.83	825
		I_3	135.86	6.1	36.13	827
	Q_2	I_1	133.50	5.9	35.22	963
		I_2	137.09	6.2	36.99	980
		I_3	138.20	6.9	43.93	1033
	Q_3	I_1	137.30	6.8	43.07	997
		I_2	141.60	7.5	47.17	1080
		I_3	145.01	8.0	48.34	1120
L.S.D $_{0.05}$			4.05	1.21	2.20	10.09

Where in:

Rate of liquid fertilizer:

Z_1 = 15 m^3/fed Z_2 = 25 m^3/fed

Concentrations of liquid fertilizer

Q_1 = 10% Q_2 = 20% Q_3 = 30%

Water rate of transpiration evaporation:

I_1 = 100% I_2 = 75% I_3 = 50%

Branches Number, Inflorescences Number/Plant and seed yield:

Data presented in Table (4) showed that, also with increasing liquid fertilizer levels significantly, increased the Branches Number, Inflorescences Number/Plant and seed yield with significant difference

for the most liquid fertilizer levels under all irrigation level compare with control treatment. The promoting effect of liquid fertilizer levels on plant height could be attributed to the fundamental role of fertilizer factors as a structural [art of many compounds as nucleic acid and phospholipids **(Weier,*et. Al.* 1993)**. This may be due to the increase of growth root net – zone. Also, the solubilization of mineral nutrients synthesis of vitamin, phospholipids, nuclic acid and gibberellins **(Sadej, W. & Przekwas, K. ,2008).** Data presented in Table (5) showed that with increasing liquid fertilizer levels significantly, increased essential oil percentage in seed fennel.

Essential oil and major's components %:

Table (5): Effect of Liquid Bio-Gas Fertilizer on Fennel oil and majors components % under different levels of irrigation water

Treatments			Essential Oil %	Anethol %	Fenchone %	Methyl chavicol %
Control			1.56	42.52	8.03	4.19
Z_1	Q_1	I_1	1.59	52.51	8.05	3.56
		I_2	1.62	57.45	8.29	3.39
		I_3	1.59	58.01	9.12	3.35
	Q_2	I_1	1.58	58.31	9.04	3.31
		I_2	1.62	58.24	9.35	3.25
		I_3	1.61	60.01	9.55	3.25
	Q_3	I_1	1.68	59.14	9.64	3.21
		I_2	1.69	60.08	9.64	3.18
		I_3	1.69	60.55	9.67	3.15
$_{Y}Z$	Q_1	I_1	1.68	61.81	9.70	3.06
		I_2	1.76	61.05	9.70	3.03
		I_3	1.62	63.51	9.82	3.02
	Q_2	I_1	2.00	65.12	9.79	3.04
		I_2	2.00	66.23	9.81	3.05
		I_3	2.01	67.61	9.84	3.05
	Q_3	I_1	2.02	64.23	9.83	3.04
		I_2	2.06	68.08	9.88	3.07
		I_3	2.11	68.81	9.93	3.09
L.S.D $_{0.05}$			0.03	1.07	0.28	0.02

The mean of essential oil percentage per plant increased due to increasing up to Fertilizer rate of 25 m^3 / fed and the contrition of liquid fertilizer up to Q_3= 30% under third irrigation level = 50%, while the lowest one was

recorded by control treatment, respectively. These may be due to the increase availability of fertilizer factors up take by plants at considerable rate to build up more metabolites necessary for including the volatile oil synthesis.

Effect of liquid Biogas fertilizer and different levels of irrigation water on soil after harvesting:

Effect of liquid Biogas fertilizer and different levels of irrigation water on total nitrogen (T.N) and available nitrogen (Av.N) and some soil sample properties collected from rhizosphere area of grown fennel plant after harvesting showed in table (6).

The obtained data showed, the effect of two rates of liquid biogas fertilizer (15) and (25) m3 / fed, three levels of concentration of biogas fertilizer [level 1 (10%), Level 2 (20%) and Level 3 (30%)] and three levels of irrigation **(50%, 75% and 100%)**) respectively on soil, which caused a pronounced amelioration effect on available nitrogen (Av.N), total nitrogen (T.N) and some soil properties as, soil PH, available water (Av.W) and as a shown in table (6). Data illustrated in table (6) showed a progressive significant increase in the all treatments compared the control treatment. The greatest mean value of available nitrogen (Av.N) was 132.25 ppm with $Z_2Q_3I_3$. The positive response of applied organic manure and mineral fertilizer as well as water requirements was displayed by many authors such as **Mohamed** (2006) and beside its beneficial effect on some soil chemical these finding were confirmed by the results founded by **Saker** et al (1992).

Point of view, the combined treatment of $Z_2Q_2I_1$ which is considered the superiority over than the other treatments was great enough to reach the level of significance under the prevailing conditions of current experiment. The greatest mean value for $Z_2Q_3I_3$ was 26.48% for values (Av. W) **(Ewees et al 2008)**. Table (5) represent the mean values of total nitrogen (T.N) and available nitrogen (Av.N) in all treatments in soil. Data indicated a progressive significant increase in all treatments where the greatest mean value of total nitrogen (T.N) and available nitrogen (Av.N) were 2.15% and 132.25 ppm respectively with $Z_2Q_3I_3$.

The lowest mean values were with control,**(Abou EL-Maged et al 2006)**.

Water use efficiency (WUE):

Table (7) indicates the average values of water use efficiency obtained in all treatments. The higher water use efficiency were 0.56 and 0.52 kg/m^3 gained from the treatment [$Z_2Q_3I_3$], and the treatment [$Z_2Q_2I_3$] respectively compared with the control treatment which was0.17 kg/m^3.

Nitrogen fertilizer use efficiency (NUE):

Table (8) indicates the average values of nitrogen use efficiency obtained in all treatments. The higher nitrogen fertilizer use efficiency was 14.5 and 13.8 gained from the treatment [$Z_1Q_1I_3$], and the treatment [$Z_1Q_1I_2$] respectively compared with the rest of the treatments. While the lowest value of the treatment [$Z_2Q_3I_1$]

Table (6): Effect of liquid Biogas fertilizer and different levels of irrigation water on soil after harvesting:

TREATMENTS			**PH 1:2.5**	**Av.W %**	T.N %	Av.N ppm
m^3 /fed	Depth (cm)	Times				
CONTROL			7.52	14.70	0.105	72.25
Z_1	Q_1	I_1	7.73	20.21	1.59	109.12
		I_2	7.81	21.25	1.62	111.21
		I_3	7.69	22.92	1.65	118.35
	Q_2	I_1	7.61	21.02	1.69	109.16
		I_2	7.96	21.89	1.73	112.52
		I_3	7.75	24.55	1.95	126.85
	Q_3	I_1	7.71	22.12	1.60	112.21
		I_2	7.75	22.82	1.68	118.95
		I_3	7.81	23.03	1.73	121.26
Z_2	Q_1	I_1	7.33	23.86	1.97	116.12
		I_2	7.51	24.56	1.98	117.21
		I_3	7.48	24.78	2.12	122.35
	Q_2	I_1	7.55	25.24	2.04	121.01
		I_2	7.71	25.43	1.88	121.23
		I_3	7.62	26.11	1.98	126.88
	Q_3	I_1	7.59	25.66	1.55	122.56
		I_2	7.66	26.09	2.01	127.33
		I_3	7.89	26.48	2.15	132.25
L.S.D at 0.05			1.81	0.21	0.19	8.92

Table (7): Average values of water use efficiency.

Treatment			Yield kg/Fed	Water irrigation, m3/Fed	W U E kg/m3
Control			670	4000	0.17
Z_1	Q_1	I_1	746	4000	0.19
		I_2	785	3000	0.26
		I_3	821	2000	0.41
	Q_2	I_1	776	4000	0.19
		I_2	811	3000	0.27
		I_3	766	2000	0.39
	Q_3	I_1	776	4000	0.19
		I_2	893	3000	0.30
		I_3	911	2000	0.46
Z_2	Q_1	I_1	793	4000	0.20
		I_2	825	3000	0.28
		I_3	827	2000	0.41
	Q_2	I_1	963	4000	0.24
		I_2	980	3000	0.33
		I_3	1033	2000	0.52
	Q_3	I_1	997	4000	0.25
		I_2	1080	3000	0.36
		I_3	1120	2000	0.56

Table (8): Average values of nitrogen use efficiency.

Treatment			Yield kg/Fed	Nitrogen Fertilizer (kg-N	N U E kg/N. unit
Z_1	Q_1	I_1	746	56.5	13.2
		I_2	785	56.5	13.8
		I_3	821	56.5	14.5
	Q_2	I_1	776	113	6.87
		I_2	811	113	7.18
		I_3	766	113	6.78
	Q_3	I_1	776	169.5	4.58
		I_2	893	169.5	5.27
		I_3	911	169.5	5.38
Z_2	Q_1	I_1	793	94	8.44
		I_2	825	94	8.78
		I_3	827	94	8.80
	Q_2	I_1	963	188.33	5.11
		I_2	980	188.33	5.20
		I_3	1033	188.33	5.49
	Q_3	I_1	997	282.5	3.53
		I_2	1080	282.5	3.82
		I_3	1120	282.5	3.97

4. CONCULATIONS

The results indicated the following:

The treatment ($Z_2Q_3I_3$) was the greatest significant of total nitrogen concentrations (T.N), available nitrogen (Av.N), and (Av.W) of all other treatments as well as control treatment.

Addition of Z_2 Fertilizer rate (25m^3/fed), Q_3 concentration (30%)) and I_3 (50% WR) resulted in high significant values of plant height (cm), number of main branches per plant, number of umbels per plant, and weight of fruits per fed (kg)

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الملخص العربى

سماد البيوجاز السائل وتأثيره على انتاجيه محصول الشمر ونسبه الزيت المستخرج تحت مستويات مختلفة من مياه الري

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أجريت تجربة حقلية خلال موسم ٢٠١٧/٢٠١٦ بمحطة ابحاث واختبارات الجرارات والالات الزراعية-معهد بحوث الهندسة الزراعية-مركز البحوث الزراعية-باكوس-الاسكندرية بهدف تقييم دراسة تأثير اضافة سماد البيوجاز االسائل وبعض مستويات الرى على على النمو الخضري والتكوين الكيميائي والزيوت الأساسية لمحصول الشمر. حيث يسمى الخليط التبقى من عمليه تخمير الاسمده العضويه بأسم أسمده الغاز الحيوى وهذة الاسمده اما سائله اوجافه ويمكن استخدامها فى تسميد مختلف المحاصيل الزراعيه بكفاءه عاليه ولرخص سعره يمكن الاستغناء عن الاسمده المعدنيه الاكثر سعرا والضاره بالآنسان . لذلك تم أختيار السماد االسائل فى هذا البحث. التصميم التجريبي تم تقسيم قطعة أرض مع ثلاث مكررات لكل معامله . تم إجراء التجارب على التربه لدراسه تأثير ألسماد الحيوي السائل (سماد البيوجاز السائل) .والمعاملات تشمل الاتى : معدل تسميد (١٥ ، ٢٥ م ٣ / فدان) من السماد المركز وثلاثة مستويات من التركيز (١٠ و ٢٠ و ٣٠ ٪) و ثلاثه مستويات للري (٥٠٪ و ٧٥٪ و ١٠٠٪). بالاضافه لمعامله الكنترول . حيث كانت كل معامله من معدلين السماد المستخدم (١٥ و ٢٥ م^{٣} / فدان) تستعمل مع ثلاثه مستويات من التركيز (١٠ و ٢٠ و ٣٠ %) وثلاثه معدلات للرى (١٠٠ و ٧٥ و ٥٠ %) والتى تمثل (٢٠٠٠م^{٣}/فدان ، ٣٠٠٠ م^{٣}/فدان ، ٤٠٠٠ م^{٣}/فدان) وبذلك يكون عدد المعاملات ١٨ وعدد المكررات ٥٤ بالاضافه لمعامله الكنترول . وقد اخذت البيانات على صفات النبات كالاتى : أرتفاع (طول) النبات - عدد الافرع – عدد الزهور – انتاجيه الفدان بالكيلوجرام/ للفدان . وأوضحت انتائج بما يلى : معاملة الرى وهى 50% وكمية سماد البيوجاز

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وهى ٢٥ متر مكعب للفدان و تركيز ٣٠% ($Z_2Q_3I_3$) أعلى قيم متوسطة لجميع الصفات المدروسة ونسبه الزيت المركب٪ والتى تم اختبارها و لذلك فإن جميع الصفات تحت الدراسة زادت بشكل ملحوظ بزياده معدل السماد وزياده معدل التركيز وكذلك متوسطات قيم كل من النيتروجين الكلى (T.N) والنيتروجين المتاح (Av.N ppm) و الماء المتاح (Av.W%) كانت هى الأكبر معنوية وايضا متوسطات قيم كل من ارتفاع النبات (سم) , عدد الأفرع , عدد الزهور والانتاجية (كج/فدان) كانت هى الأعلى عند نفس المعامله.

كما أوضحت النتائج ان أعلى نسبه لكفاءه استخدام الرى كانت لمعامله الرى ٥٠% وكميه السماد وهى ٢٥ متر مكعب للفدان ونسبه تركيز ٣٠% ($Z_2Q_3I_3$) كانت ٠,٥٦ .

وأعلى نسبه لكفاءه استخدام النتروجين كانت لمعامله الرى ٥٠% وكميه السماد ١٥ متر مكعب للفدان ونسبه تركيز ١٠% ($Z_1Q_1I_3$) كانت ١٤,٥