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Evaluation of Response Sesame Water Productivity to Modern Chemigation Systems in New Reclaimed Lands

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Abstract : Field trials were conducted in successive seasons in the agricultural sectors of the splinter farm research and production center for the National Research Bustan area, in the province of Nubaria lake. Egypt. Experiments investigated the evaluation of some factors affecting the chemical injectors performance under Egyptian conditions and the effect of different drip irrigation systems: (SUR) surface drip irrigation and (SUB) sub-surface drip irrigation irrigation under different ETc levels 100, 80; 60% of (IR1, IR2; IR3), and Fertilization treatments:(traditional method of fertilization; fertigation technique) on sesame yield, water productivity (WP) and the (NUE) nitrogen use efficiency. The obtained results could be abstracted as follows: Fertilizer injection rate increased with increasing the pressure difference percentage at different operating pressures, Fertilizer injection rate by using a venturi effecting to the distance of the venturi from the suction level and also, the fertilizer tank position relation to the injector. The highest seed yield (kg/fed.) and NUE (kg/ kg nitrogen) value were 485 kg/fed. and 5.105kg/ kg N, respectively observed under subsurface drip irrigating using 80% of the ETc and fertigation technique. Meanwhile, the lowest value was 152kg/fed. and 1.6kg/kgN, respectively obtained with 60% of the irrigation water requirements and traditional method under Surface drip irrigation system. The highest and the lowest WP value were 0.292 kg/m^3 and 0.109kg/m^3, respectively. observed under subsurface drip irrigating using 60% of the ETc and fertigation technique and 80% of the irrigation water requirements and traditional method under Surface drip irrigation system.
Keywords: Sesame, deficit irrigation, fertigation, seed yield, water productivity, Sandy soil.

Introduction

The importance of fertigation through drip irrigation system is increased by days. Maintaining nutrients in the effective root zone of plant, saving both fertilizers and irrigation water units, and conserving the environment are potential benefits of fertigation. Even so, fertigation still limited for small farmers because of unavailability of appropriate fertigation technologies for them **El-Gindy**[1]. Three major categories of fertigation equipment are in use in countries of the Near East, namely: Venturi type device, by-bass pressurized mixing tanks and positive displacement pumps **Aboukhaled**[2].

Unit fertilization components are the following: a fertilizer injector, or the so-called (manure pump) which is powered by the pressure between the mixing tank teams, check valve, and a main filter and water meter. Injector and sometimes relies on extra equipment (such as valves and pressure valves regulate flow) preferably having plastic containers are advised that there should be filters Oofilatr **Papadouplos**[3]**.**

Modern techniques for small-scale irrigation systems developed have made Add fertilizer through irrigation water to crops. It has been found that the addition of fertilizer through irrigation water provides 29-78% of normal Addition costs. This leads to improving the efficiency of the use of fertilizers and micronutrients quantity at the right time, leading a significant increase in yield **Alva etl[4] and Papadopoulos[5]**.

Choosing the right system of irrigation and chemical fertilizers that are commensurate with the efficiency of irrigation and plant needs of important and influential factors on the efficiency of fertilization through the irrigation system and fertilizer can be added with more effective ways of irrigation water where fertilizer distribution on the way the flow of water into the soil depends **Hanson etl[6]**.

Adding water to the soil in large quantities leads to the movement of water into the soil due to gravity, which leads to the exchange to the ground water and thus wash large quantities of fertilizer and nutrients with wastewater **Thompson etl[7]**.

Added water to the roots of the plant area and the proportion of fertilizer through irrigation systems barotrauma helps to add nutrients easily and efficiently Add higher. **Boman and Obreza[8]** Efficient irrigation system based on Field not to run a large amount of water into deeper water, unhappy and so the conditions are ideal to add fertilizer so as not to be lost a large amount of them with deep drainage and leaching. Therefore, it advised that there is no runoff and soil erosion or leaching during deep irrigation because it would lead to the loss of fertilizer added. In this case, there are advantageous compared to plus foliar spray fertilizer for leafy plants **Vieira and Sumner[9]**.

Apart from being an important source of edible oil, sesame seeds and kernels are used for the preparation of sweets, confectionery and bakery products **Salunkhe etl[10]**.Sesame seed contains 40-50% oil, 20-25% protein, 20-25% carbohydrate and 5-6% ash **Salunkhe etl[10]**. Because of its composition, it has become one of the main sources of edible oil. It is also a good source of protein. Some studies have already been done showing how to prepare sesame protein for sesame meal using various methods of alkaline or salt extraction and isoelectric precipitation (pI) **Dench etl[11], Inyang; Iduh[12], Gandhi; and Srivastava[13], Onsaard etl[14]; Cano-Medina etl[15]** or aqueous enzymatic sesame protein extraction **Latif; Anwar[16]**. A few paper on the modification of sesame proteins have also reported **Das etl[17]**.

Sesame is one of the important oil crops in Egypt because of its adaptability to Egyptian environmental conditions. Increasing number of irrigations for growing sesame plants at different growth stages increased seed yield **Ayasmy; Kulandivelu[18]** and **Mathew; Kunju[19]**.Sesame seed yield was significantly reduced as a result of low soil moisture content, when the number of irrigations was reduced.

In this paper, we will investigate the evaluation of the chemical injectors, irrigation systems: Drip irrigation system surface (SUR) and drip irrigation system subsurface (SUB), and irrigation levels 100, 80; 60% of ETc on sesame yield, water productivity (WP) and nitrogen use efficiency (NUE).

Material and method

Field experiments were conducted in two successive growing seasons to study the effect of irrigation regimes and two methods of fertilizer applications on plant characters, yield, water and nitrogen use efficiency under subsurface and surface drip irrigation in a sandy soil.

Table (1): Some soil physical properties of the experiment at site.

Sample depth, cm	Particle Size Distribution, %					θ_w (w/w)		O.M. (%)			Texture class
	Coarse Sand	Fine Sand	Clay and Silt	$CaCo_3$ (%)	F.C S. P		W.P		pH (1:2.5)	EC (dSm^{-1})	
0-20	57.76	50.70	2.45	7.02	10.1	4.7	21.0	0.65	8.7	0.35	Sandy
20-40	56.99	39.56	3.75	2.34	13.5	5.6	19.0	0.40	8.8	0.32	Sandy
40-60	36.78	59.40	3.84	4.68	12.5	4.6	22.0	0.25	9.3	0.44	Sandy

Where:

F. C: Field capacity	**B.D:** Bulk density	**W.P:** Welting point	**A.W:** Available water

The experiments were carried out in split-split plot design with three replicates. The main, sub main and sub-sub main plots were devoted for irrigation methods, method of fertilizer applications and irrigation regimes, respectively. Shandweel 3 was sown in hills, 10 cm a part. Thinning to two plants per hill was done at 14 days after planting. The normal agricultural practices for growing sesame were followed as recommended in the region. Calcium super phosphate (15.5% P2O5) and potassium sulphate (48% K2O) at the rates of 300 and 100 kg/fed., respectively, were added before planting. Nitrogen fertilizer at the rate of 150 kg N/fed .as ammonium nitrate33.5 .

- Surface and subsurface drip irrigation method was used. Standard drippers were spaced 0.5 m apart along 50 m lateral. Dripper discharge is 4 Lh-1.
- Three irrigation rates were 100, 80, and 60 % of ETc (2710, 1736 and 1302 m3/fed) (IR_1, IR_2 and IR_3).
- Traditional method of fertilization (broadcasting) using the recommended rate of fertilizer.
- Ferigation technique (venturi tube 1.5″ inlet and outlet) through irrigation systems using the recommended rate of fertilizer. These amounts of fertilizers were divided into 10 doses and applied injecting with irrigation water during the growing season.

Effect of the pressure difference percentage on chemical injection rate . One pressure gauge was installed on inlet of venturi discharge line and another pressure gauge was installed on the outlet of venturi delivery line. A stop watch and graduate cylinder are required for the injector calibration .The chemical suction rate was measured volumetrically at different percentages of pressure difference and different operating pressures (1.3,1.9 and 2.5 bar) . Pressure difference percentage was calculated using the following equation: $\% \Delta P = (A - B) / A$ --------------------------(1), Where: ΔP = pressure difference, A = Inlet pressure, bar; and B = outlet pressure, bar

- Effect of the suction static head of the injector on the chemical injection rate . Additive tank was placed on different distances (20, 40and60 cm) above the injector. The injection rate of the fertilizer was measured for each position

At harvesting total sesame yield in Kg per feddan was estimated for each treatment.

- Plant height,cm.
- Number of capsules per plant
- Weight of capsules, g/plant.
- Total yield, ton/fed.

This terminology refers to sesame yield/ cubic meter of irrigation water (kg m^{-3}). It was calculated according to [20]as follows:

WP = Y / W -- (2)
Where:
WP = water productivity(Kg m^{-3}),
Y = total grains yield (Kg grains fed^{-1}), and
W = total water applied (m^3)

This terminology refers to the production of Sesame yield / kilogram of N. It was calculated according to **Israelson and Hanson**[20], as follows:

NUE = Y / N ---(3)
where:
NUE = nitrogen use efficiency (Kg grains kg^{-1} N),
N = Amount of N fertilizer applied (kg N $fed.^{-1}$).

All data collected were statistically analyzed as a split-split plot design with three replications using analysis of variance to evaluate main and interaction effects as described by **Snedcor and Cochran**[21]. Means among treatments were compared using Least Significant Difference (LSD) at P 0.05 probability.

Results and Discussion

Figures (1, 2, and 3) indicate that by increasing the percentage of pressure difference between the inlet and outlet of the injector, the fertilizer suction rate increased for all different operating pressures. This is due to certain of inside the injector vaccume.

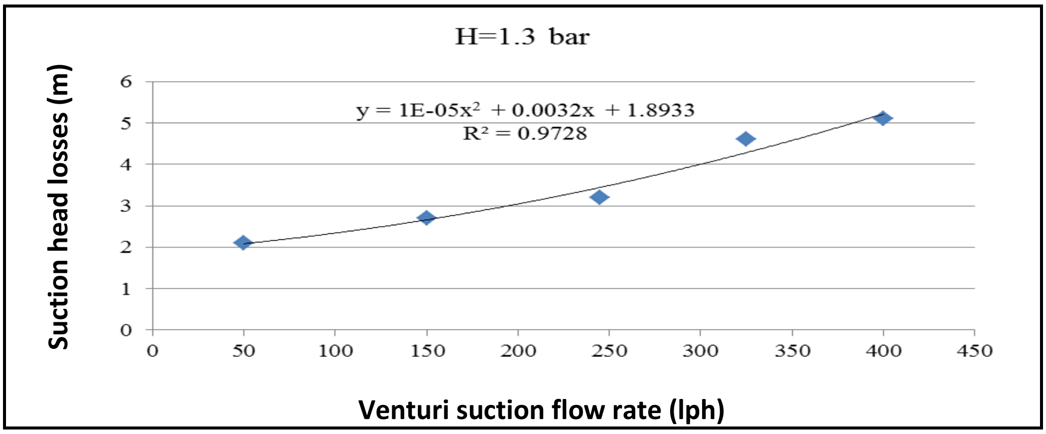

Fig (1): Relationship between suction head losses and venturi suction rate at 1.3 bar inlet pressure

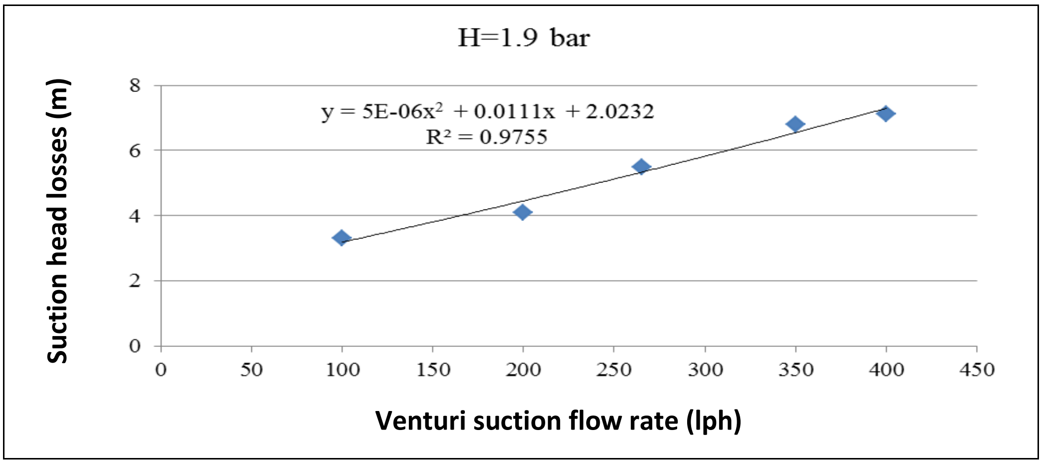

Fig (2): Relationship between suction head losses and venturi suction rate at 1.9 bar inlet pressure

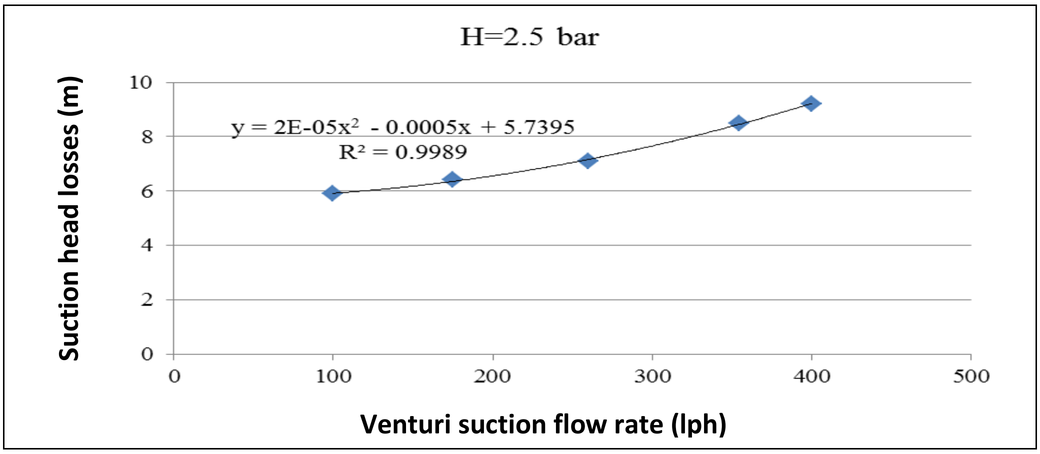

Fig (3): Relationship between suction head losses and venturi suction rate at 2.5 bar inlet pressure.

The results shows that when the additive tank was placed higher than the venturi injector, the injection rate increased with increasing the vertical distance between the suction static head of the injector and the additive tank, because of the effect of position energy which resulted by gravity.

On the other hand, when the additive tank was placed lower than the injector, the injection rate decreased with increasing the vertical distance between the venturi injector and fertilizer tank, therefore, the liquid liables to a big resistance with increasing the tank distance from the injector.

Data in Fig.(4 ; 5) and table (2 ; 3) illustrate the effect on seed yield and NUE of sesame. Results indicated that the highest seed yield (kg/fed.) and NUE(kg/ kg nitrogen) value were 485 kg/fed and 5.105kg/ kg N , respectively. Observed under subsurface drip irrigating using 80% of the ETc and fertigation technique. Meanwhile, the lowest value were 152kg/fed and 1.6kg/kgN, respectively obtained with 60% of the irrigation water requirements and traditional method under the Surface drip irrigation system.

Main and sub-main treatments could rank in the following ascending order: 60% of the ETc <100% of the ETc <80% of the Etc, traditional method < ferigation technique and surface irrigation< subsurface irrigation.

Table3. The first interaction between irrigation, fertilizer method and water applied on Plant height(cm), number of capsules per plant and weight of capsules.

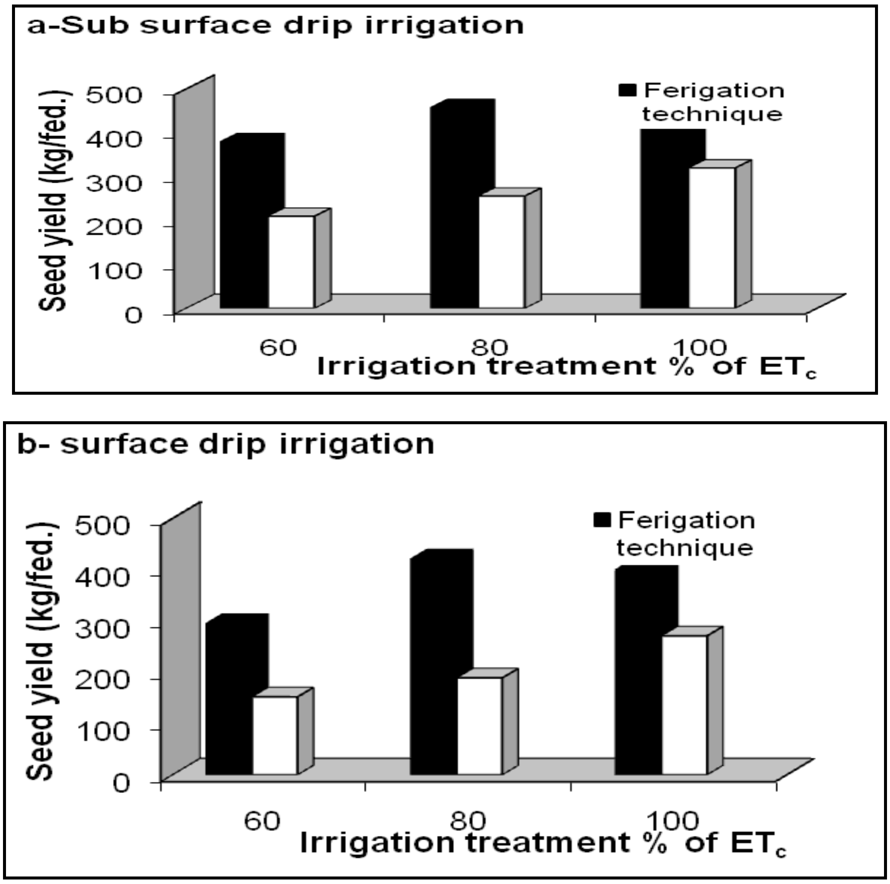

Fig. (4) :Effect of irrigation, fertilizer application method and water applied on seed yield.

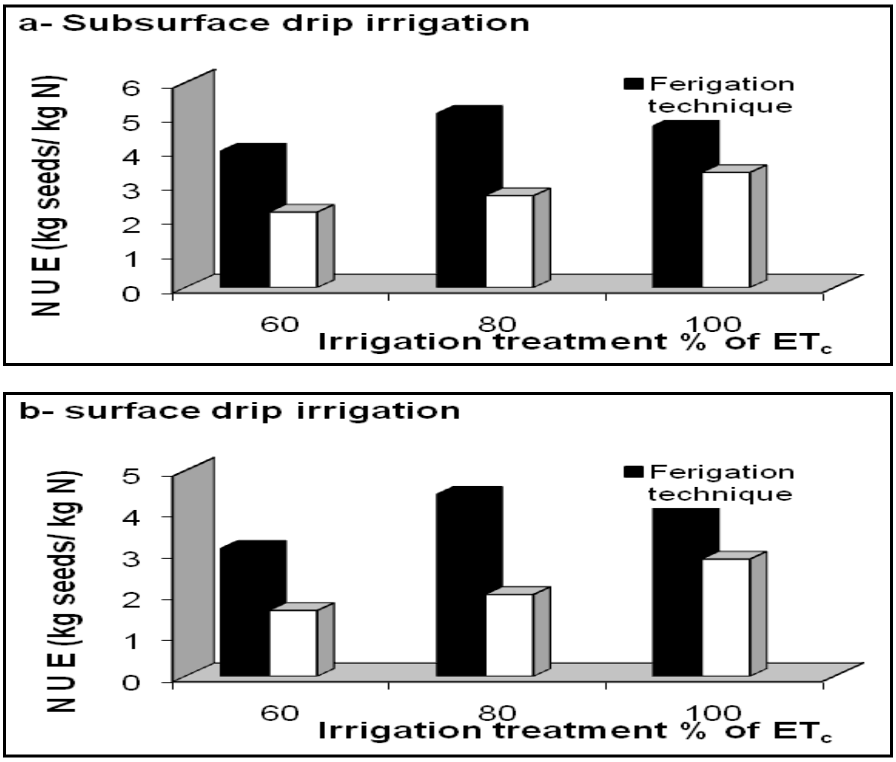

Fig. (5) : effect of irrigation, fertilizer application method and water applied on nitrogen use efficiency

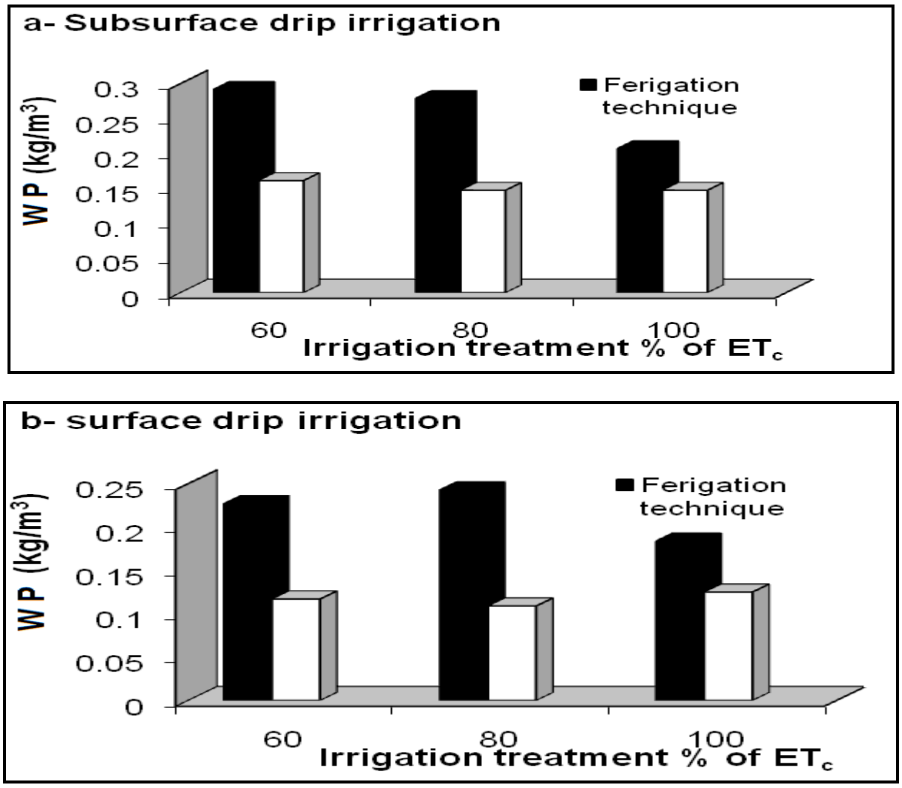

Fig. (6) : effect of irrigation, fertilizer application method and water applied on water Productivity

Table 2. Main effect of irrigation method, fertilizer method and water applied on Seed Yield(kg/fed.) , W.U.E Kg seed m-3 and N.U.E Kg seed/kg n.

Treatments	Seed Yield (kg/fed.)		WP Kg seed m-3		N.U.E Kg seed/kg n	
Sub.	350.17	a	0.181	a	3.69	a
Sur.	288	b	0.168	b	3.03	b
Feri.	405.16	a	0.238	a	4.26	a
Trad.	233	b	0.134	b	2.45	b
IR1	360.25	a	0.165	c	3.79	a
IR2	225.16	b	0.195	b	3.55	b
IR3	259.25	c	0.199	a	2.73	c

Under fertigation method compared with the traditional method of fertilization (broadcasting) under subsurface drip and surface drip irrigation system respectively. The increase in yield may be due to the drip fertigation as attractive, these data agreed with **Bar-Yosef**[22], **Goldberg etl**[23].

Table 3.first interaction between irrigation, fertilizer method and water applied on Seed Yield(kg/fed.) , W.U.E Kg seed m-3 and N.U.E Kg seed/kg n.

Treatments	Seed Yield (kg/fed.)		W.U.E Kg seed m-3		N.U.E Kg seed/kg n	
Sub. x Feri.	438.33	a	0.259	a	4.62	a
Sub. x Trad.	262	c	0.152	c	2,76	c
Sur x Feri.	372	b	0.218	b	3.92	b
Sur x Trad.	204	d	0.117	d	2.15	d
Sub. x IR1	385	a	0.177	c	4.055	a
Sub. x IR2	370.5	b	0.213	b	3.89	b
Sub. x IR3	295	e	0.227	a	3.105	e
Sur. x IR1	335.5	c	0.155	f	3.53	c
Sur. x IR2	305	d	0.176	d	3.21	d
Sur. x IR3	223.5	f	0.172	e	1.85	f
Feri. x IR1	425	b	0.196	c	4.48	b
Feri. x IR2	453	a	0.261	b	4.77	a
Feri. x IR3	337.5	c	0.259	a	3.5	c
Trad. x IR1	295.5	d	0.136	e	3.11	d
Trad. x IR1	222.5	e	0.128	f	2.34	e
Trad. x IR1	181	f	0.139	d	1.91	f

Sub.(subsurface drip irrigation) IR1 (100% etc)
Sur. .(surface drip irrigation)IR2(80% Etc)
Feri.(fertigation method) IR3 (60% Etc)

Trad.(traditional method)

Data indicate that the water productivityunder subsurface drip irrigation was higher than that under surface drip irrigation system .This due to the sub surface drip irrigation gives more concentrated wetted area around the roots of vegetable plants than surface irrigation system and consequently higher the water productivity under sub surface drip irrigation system **Badr**[24], **Sabreen etl**[25]; **Tayel etl**[26].

On the other hand, data are illustrated in Fig. (5) Indicated that water productivity by the sesame plants under fertigation method was higher than that under the traditional method of fertilization .

Results show that drip irrigation system under the surface very suitable for the production of sesame crop under drought conditions. This is due to the optimal distribution of water and thus food into the plant root zone. We note that the maximum value of the sesame crop was obtained by the use of irrigation water rate of 80% of the actual evapotranspiration. This is due to the drought in the region. This is because water stress affects the physiological processes of the plant and crop yields. **Rivero etl**[27]**, Farouq etl**[28] **and Ali etl**[29]**.**

The results confirm that the different method of drip irrigation system is useful where you can find out if it is to get maximum yield by adding the amount of irrigation water is limited or not. For example, compared to IR1 IR2 equal the yield of grain for each of the components of the two treatments, and this is due to the use of treatment IR1 led any good localized moisture in the root zone growth is likely to be affected by a cold deep in under the effective root zone. **El-Hendawy etl**[30]**, Mansour etl**[31]**, Mansour** [32] **, Pibars**[33]**.**

Conclusion

The results could be summarized as follows:

- Increase of fertilizer suction rate due to the increase in difference between inlet and outlet pressure of venturi injector.
- Yield: the highest sesame yield (485 kg/ fed.) was obtained with treatment (Sub × IR_2×fer.). (sub surface drip irrigation, 80% of ETc and fertigation method).
- Total yield increased by 11.79 – 12.62% under fertigation method comparing with the traditional method of fertilization (broadcasting)under subsurface and surface drip irrigation system respectively.
- Water productivity: Been getting maximum value for water productivity and unit water was 0.292 kg / m 3 has been obtained to interact sub x fert x IR3 with (drip irrigation subsurface fertilization with irrigation water and 60% of evapotranspiration). While the lowest value was 0.109 kg / m 3 has been obtained to interact Sur x trad X IR2 (drip irrigation shallow with traditional Add and 100% of evapotranspiration)

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