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Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2019 16(1):356-366. **OPEN ACCESS**

Impact of algae extract foliar application on two wheat varieties with using two irrigation systems

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The use of algae extract as a biofertilizer will reduce our use of chemical fertilizers and improve productivity as well as our choice the irrigation system appropriate to rationalize the use of water and fertilizers, which is reflected positively on the crop and quality. To maximize the use of the two previous goals, two field experiments were carried out at Experimental Station of National Research Centre, Nubaria, El-Beheira Governorate during the two winter seasons, 2016/2017& 2017/2018 to study the effect of two rates of algae extract foliar application (0.0g/L and 1.5g/L) on two wheat varieties i.e., Gemiza-9 and Misr-1 under two irrigation systems i.e., drip and sprinkler grown in sandy soil. The results showed significant differences between Gemiza-9 and Misr-1 varieties in all investigated traits. Gemiza-9 recorded the superior with some parameters, Whereas, Misr-1 had favorable values of other traits. Moreover, the varieties showed significant effects on all investigated characters and most of micronutrients. However, the irrigation systems and algae foliar were significantly effects on all characters of study. It is apparent that the superiority of irrigation system was drip irrigation with Gemiza-9 variety under the rate, 1.5g/L of algae extract, gained the highest results. On the other hand, the results of the first and second order interactions between the tested factors in the two trials emphasized that, most of the interactions had significant effects on that character. Also, the significant interaction effect was found between irrigation systems, algae foliar extract and wheat varieties during the two season's .It can be concluded that the results confirmed difference between the two varieties in response to spraying with algae under the irrigation system used and the superiority of irrigation system was drip irrigation. Moreover, the enhanced yield and its components yield performance was accompanied by using 1.5 g/L of algae extract.

Keywords: Wheat varieties, foliar spraying, algae extract, drip and sprinkler irrigation, sandy soil.

INTRODUCTION

Wheat is considered one of the strategic crops in Egypt. Deposit the increase in national production of wheat year after year, it reached about 8 million tons/year...However, production is not enough for domestic consumption. Therefore, the use of new high productivity varieties and modern irrigation methods that guide the use of water and fertilizer has become an urgent. As for varieties many investigators indicated that species and varieties adapted better to unfavorable soil condition than others as well as there are significant differences between varieties and some in their nutritional needs (Rezk et al., 2008; El-Eila et al., 2014 and El-Nasharty et al., 2015).

The studies indicated that using algae either soil foliar application lead to improve the physiological performance of plants (Dela et al., 1988). Where, it contains of all the nutrients and plant growth hormons which are essential for

plants to improve yield (Prasad et al., 2010 and Latique et al., 2013).While, Karthikeyan and Shanmugam (2015) reported that applied algae extract as foliar spray showed relative increase 51% in seed yield.

One of the main challenges of world is water and food security. This challenge in arid regions of the world, such as Egypt, is more complicated.

In case of surface irrigation in large quantities with limited water, it is preferable to use irrigation system such as sprinkler and drip irrigation methods (Goldhamer and Peterson, 1984). Moreover, using the suitable irrigation system can be maximized the quantity and quality of any crop (Mahmoud, 2014). Furthermore, Erkan et al., (2007) cleared that the positive effect of sesame plant was obtained with using drip irrigation in comparing sprinkler irrigation may be attributed to the long time of drip irrigation which allows the plant to obtain enough nutrients.

Therefore, the purpose of this study to evaluate the effect of algae extracts foliar application on two wheat varieties under two irrigation systems.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Station of National Research Centre, Nubaria District, El-Behira Governorate during the two winter seasons 2016/2017& 2017/2018 to study the effect of algae foliar application on two wheat varieties i.e. Gemiza-9 and Misr-1 under two irrigation systems i.e., drip and sprinkler. The soil surface (0-30 cm depth) samples were taken representative before adding fertilizers and during soil preparation. The physical and chemical properties of soil samples were as follows : sand 87.0% , silt 7.4% and clay 5.6% , pH 7.3, E.C 1.8 dSm^{-1}, organic matter 0.13%, Field capacity(F.C) 12 ,Permanent Willing Point (P.W.P) 4.1,Available Water (A.W) 7.9, Hydraulic Conductivity (HC) 6.76 (m/h) and Bulk Density(BD) 1.57 (g/cm^3). While, N, P, K, Fe, Mn, Zn and Cu contents were (3.87, 0.87, 16.7 mg/100 soil), (6.34, 3.11, 2.45 and 0.32 ppm) respectively.

A split-split design with three replicates was used. The main plots were devoted to the two irrigation systems, drip and sprinkler. The sub plots were randomly devoted to the two wheat varieties i.e.,Gemiza-9 and Misr-1.The sub-sub plots were randomly assigned to the two rates,0.0g/L and 1.5g/L of algae extract foliar as showing in Figure (1) of layout of the field experiment. Wheat grains cv. Gemiza-9 and Misr-1 were sown at the fifth of Dec. 2017, 2018 at the rate of 60 kg/fed for each. The normal agricultural practices for wheat were applied as recommended. Irrigation networks include the following components are:

Control head:

It was located at the water source supply. It consists of centrifugal pump 3`` /3``, driven by electric engine (pump discharge of 100 m3/h and 50 m lift), sand media filter 48`` (Two tanks), screen filter 2`` (120 mesh), back flow prevention device, pressure regulator, pressure gauges, flow-meter, control valves and chemical injection,

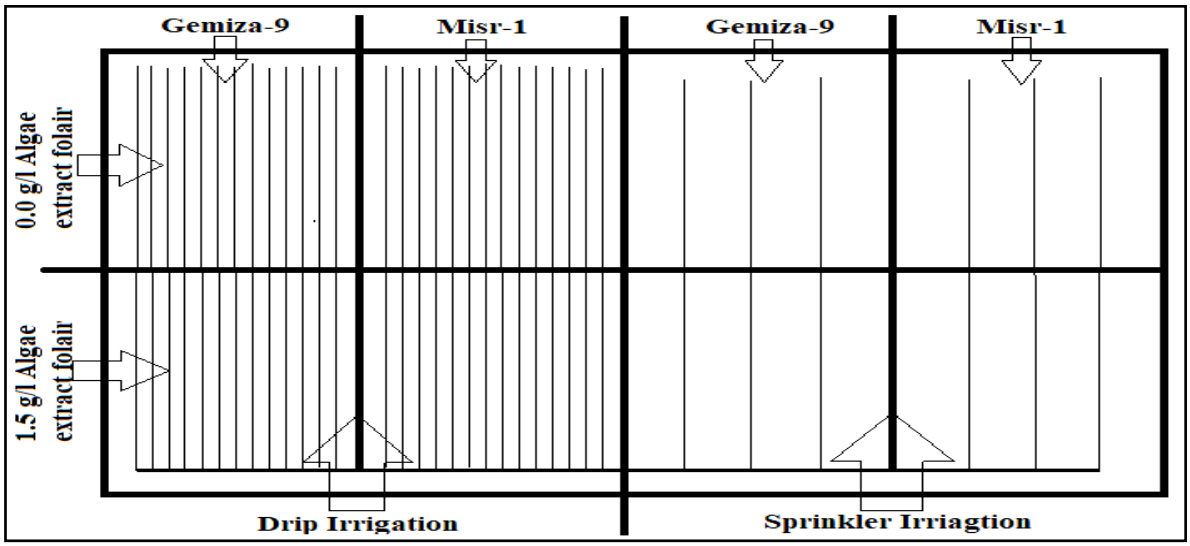


Figure (1) Layout of the farm experiments during seasons 2016/2017 and 2017/2018

2. Main line:

PVC pipes of 75mm in (ID) Ø to convey the water from the source to the main control points in the field,

3. Sub-main lines:

PVC pipes of 75mm in (ID) Ø were connected to with the main line through a control unit consists of a 2`` ball valve and pressure gauges,

4. Manifold lines:

PVC pipes of 50mm in (ID) Ø were connected to the sub main line through control valves 1.5``,

5. Lateral lines:

PE tubes of 16 mm in (ID) Ø were connected to the manifolds through beginnings stalled on manifolds lines,

6. Emitters:

These emitters (GR) built in PE tubes 16mm in (ID) Ø, emitter discharge of 4 lh^{-1} at 1 atm, nominal operating pressure and 30 cm spacing in between. The components of sprinkler system include, the same components from 1-control head to 4- Manifold lines within distances 12X12m with sprinklers fixed by heights supports 1m and discharge of sprinklers 75 lph. These component of irrigation systems were installed and operated according to Mansour et al., (2016 a, b; c). The varieties cultivated in randomized split-split plot design less than two irrigation systems, drip and sprinkler where the plot size was 24 m^2. The annual time of fertilization was 25/12 for each season with 50 kg urea/fed. -70 kg ammoniums nitrate/fed. However, P and K fertilization were added according to recommended by the Egyptian Agricultural Ministry.

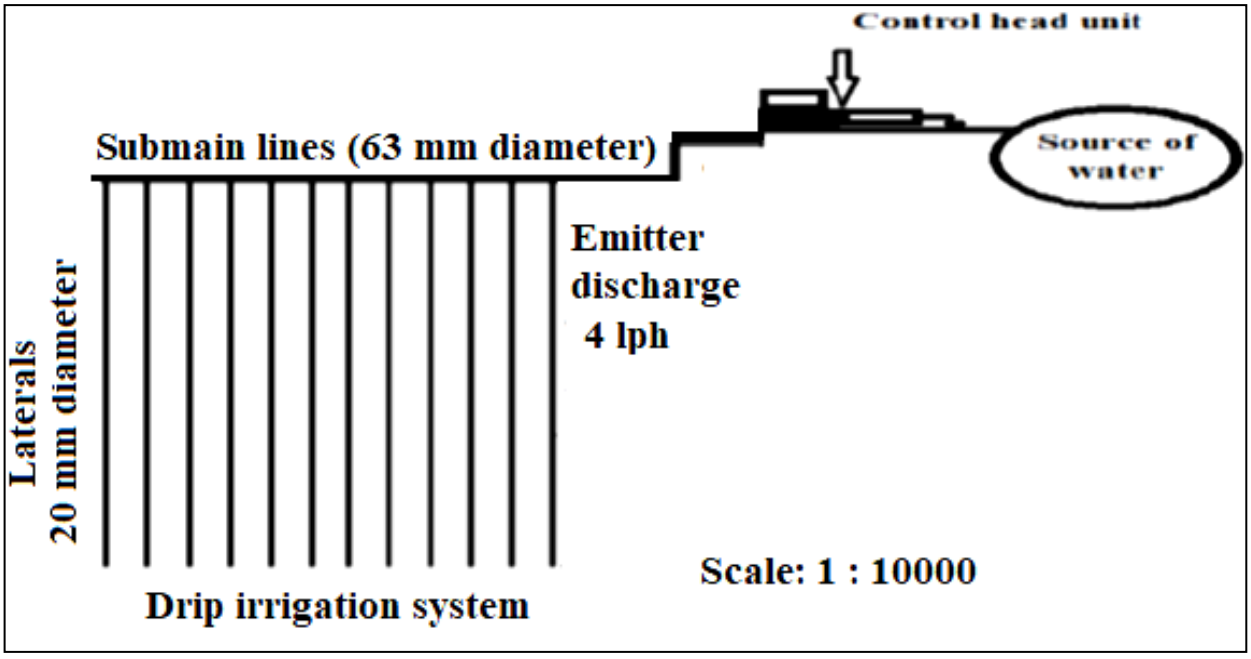
The experimental field was included two treatments, 0.0 g/L and 1.5 g/L (300g/ 200 L/fed.) algae extract were applied by foliar before and after heading stages by two weeks.

The irrigation starting (drip and sprinkler) was 25/12/2017 until 20/5/2018 for the two seasons. The interval: 4-5 days – time 75 – 90 min. During vegetative growth, random sample of ten guarded plants in each plant were taken to determine the nutrient contents based on dry weight according to Chapman and Pratt (1978).

At harvest, random samples of ten guarded plants in each plot were taken estimate the following characters, yield components and yield parameters for two irrigation methods.

In addition, the protein % in grain was determined and calculated according to A.O.A.C (2005).All data of the two experiments were subjected to statistical analysis according to Snedecor & Cochran, (1981).The combined analysis was conducted for the data of the two seasons according to Cochran and Cox, (1968). The least significant difference (LSD) was used to compare the means.

Figure (2) Layout of drip irrigation system



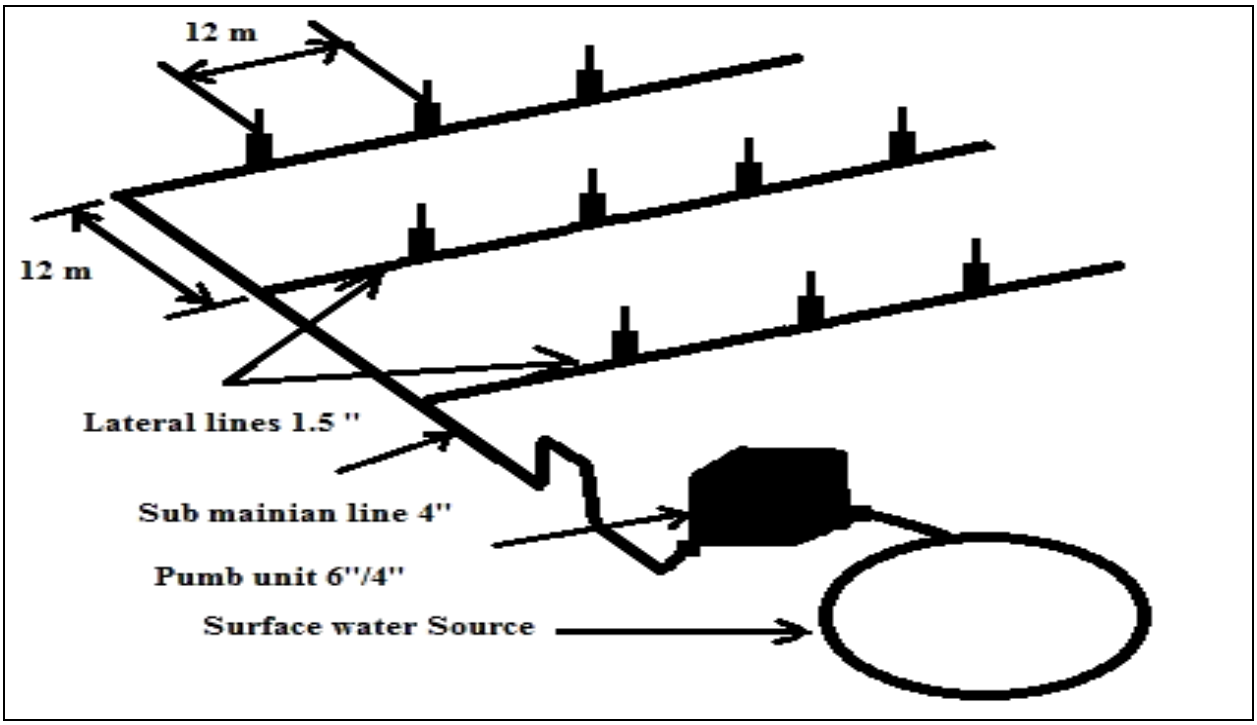


Figure (3) Layout of sprinkler irrigation system

RESULTS

Yield and yield components:

The collected data in Table (1) shows the effect of foliar spray with algae on two wheat varieties under two irrigation systems and their interaction on wheat yield and its components.

Results cleared significant differences between the two studied irrigation systems concerning the yield and its components yield. However, drip irrigation gained the highest result of all yield and its component than sprinkler irrigation except, no. of grains/spike and weight of 100 grains. On the other side, the differences between the two wheat varieties reached to the level of significance in all yield and its components. It is worthy to mention that the superiority of gemiza-9 variety in all yield and its components had happened except with harvest index. However, algae foliar spray significantly affected all the traits of wheat yield and its component. Generally, spraying algae with 1.5g/L resulted in high values of yield and its components compared with control except, harvest index. So, it could be concluded from the obtained results that foliar spray of algae with 1.5g/L found to be the most effective dose to achieve the maximum yield and its components.

With respect to the interaction effect between the irrigation systems and varieties in Table (1), data stated that there were significant effects with all yield components and yield parameters. The interaction of sprinkler irrigation X Gemiza-9 variety and drip irrigation X Gemiza-9 variety were the best interaction treatments which recorded the highest values of (no. of grains /spike and weight of 100 grains) and (no. of spikes/m^2, straw yield and grain yield), respectively. While the highest value of harvest index obtained by drip irrigation with Misr-1. Regarding the interaction effect between the different irrigation systems and algae foliar gave significant effect on all the studied characters except with weight of 100 grains .It is obvious from the data that the application of drip irrigation X algae foliar with 1.5g/L gave the highest values of no. of spikes/m^2, straw yield and grain yield but the highest values of no. of grains /spike gained by sprinkler irrigation X algae foliar with 1.5g/L. In addition, the interaction between varieties and algae foliar caused a significant effect only with no. of grains/ spike, straw yield and grain yield. Gemiza-9 wheat variety X algae foliar with 1.5g/L scored the greatest values for no.of grains/spike, straw yield and grain yield.

Table 1: Effect of irrigation methods, varieties and algae foliar spray on yield components and yield parameters of two wheat varieties Grown on sandy soil (Combined analysis of two seasons).

Irrigation (I)	Varieties (V)	Yield Components									Yield Parameters								
		No. of grains/ spike			No. of spikes /m²			Weight of 100 grains (gm)			Straw yield (ton /fed)			Grain yield (ard./fed)			Harvest index (%)		
		Algae foliar (A)			Algae foliar(A)			Algae foliar (A)			Algae foliar (A)			Algae foliar (A)			Algae foliar (A)		
		Cont.	1.5 g / l	Mean	Cont.	1.5 g / l	Mean	Cont.	1.5 g / l	Mean	Cont.	1.5 g / l	Mean	Cont.	1.5 g / l	Mean	Cont.	1.5 g / l	Mean
Drip irrigation	Gemiza-9	32	33	32.5	172	186	179.0	4.5	5.3	4.9	7.4	12.9	10.1	16.1	19.9	18.0	24.7	18.9	21.8
	Misr-1	30	30	30.0	136	140	138.0	3.8	4.7	4.3	4.0	7.6	5.8	11.8	19.6	15.7	30.6	27.8	29.2
Mean		31	32	31.3	154	163	158.5	4.2	5.0	4.6	5.7	10.3	8.0	13.9	19.8	16.8	27.7	23.3	25.5
Sprinkler irrigation	Gemiza-9	52	60	56.0	102	142	122.0	4.4	5.6	5.0	7.4	8.3	7.9	9.5	13.3	11.4	16.0	19.3	17.6
	Misr-1	26	42	34.0	96	148	122.0	4.8	5.3	5.1	6.8	8.8	7.8	9.4	11.7	10.5	17.0	16.6	16.8
Mean		39	51	45.0	99	145	122.0	4.6	5.5	5.0	7.1	8.6	7.8	9.4	12.5	10.9	16.5	17.9	17.2
Mean for Varieties	Gemiza-9	42	47	44.3	137	164	150.5	4.5	5.5	5.0	7.4	10.6	9.0	12.8	16.6	14.7	20.4	19.1	19.7
	Misr-1	28	36	32.0	116	144	130.0	4.3	5.0	4.7	5.4	8.2	6.8	10.6	15.6	13.1	23.8	22.2	23.0
Mean		35	41	38	127	154	140.3	4.4	5.2	4.8	6.4	9.4	7.9	11.7	16.1	13.9	22.1	20.6	21.4

	L.S.D. at 5% for					
Irrigation (I)	3.29	11.85	0.19	0.20	0.17	0.69
Varieties (V)	4.74	8.85	0.20	0.21	0.42	0.75
Algae foliar (A)	1.41	5.95	0.19	0.24	0.55	0.09
I * V	4.72	10.41	0.23	0.21	0.41	0.77
I * A	2.53	9.27	NS	0.21	0.25	0.64
V * A	4.65	NS	NS	0.24	0.42	NS
I *V* A	4.79	NS	NS	0.32	0.47	0.99

Table 2: Effect of irrigation methods, varieties and algae foliar spray on protein content in grains and macronutrients concentration in straw of two wheat varieties grown on sandy soil (Combined analysis of two seasons).

Irrigation (I)	Varieties (V)	%											
		protein in grains			N			P			K		
		Algae foliar (A)			Algae foliar (A)			Algae foliar(A)			Algae foliar (A)		
		Cont.	1.5 g / l	Mean	Cont.	1.5 g / l	Mean	Cont.	1.5 g / l	Mean	Cont.	1.5 g / l	Mean
Drip irrigation	Gemiza-9	8.33	9.00	8.67	1.33	1.44	1.39	0.12	0.14	0.13	0.14	0.15	0.15
	Misr-1	8.61	9.13	8.87	1.38	1.46	1.42	0.13	0.15	0.14	0.14	0.16	0.15
Mean		8.47	9.07	8.77	1.36	1.45	1.40	0.13	0.15	0.14	0.14	0.16	0.15
Sprinkler irrigation	Gemiza-9	6.13	6.88	6.51	1.07	1.20	1.14	0.11	0.16	0.14	0.10	0.15	0.13
	Misr-1	6.46	7.84	7.15	1.12	1.36	1.24	0.12	0.15	0.14	0.11	0.14	0.13
Mean		6.30	7.36	6.83	1.10	1.28	1.19	0.12	0.16	0.14	0.11	0.15	0.13
Mean for Varieties	Gemiza-9	7.23	7.94	7.59	1.20	1.32	1.26	0.12	0.15	0.13	0.12	0.15	0.14
	Misr-1	7.54	8.49	8.01	1.25	1.41	1.33	0.13	0.15	0.14	0.13	0.15	0.14
Mean		7.38	8.21	7.80	1.23	1.37	1.30	0.12	0.15	0.14	0.12	0.15	0.14

L.S.D. at 5% for				
Irrigation (I)	0.17	0.03	0.04	0.01
Varieties (V)	0.11	0.02	0.01	0.01
Algae foliar (A)	0.09	0.02	0.01	0.02
I * V	0.14	0.02	NS	NS
I * A	0.13	0.02	0.03	NS
V * A	0.12	0.02	NS	NS
I *V* A	0.17	0.03	NS	NS

Table 3: Effect of irrigation methods, varieties and algae foliar spray on micronutrients concentration in straw of two wheat varieties grown on sandy soil (Combined analysis of two seasons).

Irrigation (I)	Varieties (V)	ppm											
		Fe			Mn			Zn			Cu		
		Algae foliar (A)			Algae foliar (A)			Algae foliar (A)			Algae foliar(A)		
		Cont.	1.5 g / l	Mean	Cont.	1.5 g / l	Mean	Cont.	1.5 g / l	Mean	Cont.	1.5 g / l	Mean
Drip irrigation	Gemiza-9	117.7	133.0	125.4	75.10	76.20	75.65	7.58	9.46	8.52	8.91	12.00	10.46
	Misr-1	123.7	134.7	129.2	76.40	77.10	76.75	7.81	11.33	9.57	9.21	11.97	10.59
Mean		120.7	133.9	127.3	75.75	76.65	76.20	7.70	10.40	9.05	9.06	11.99	10.52
Sprinkler irrigation	Gemiza-9	111.0	124.0	117.5	64.50	78.90	71.70	6.25	8.77	7.51	8.87	11.03	9.95
	Misr-1	113.7	125.7	119.7	63.40	83.10	73.25	8.57	9.27	8.92	6.49	11.7	9.10
Mean		112.4	124.9	118.6	63.95	81.00	72.48	7.41	9.02	8.22	7.68	11.37	9.52
Mean for Varieties	Gemiza-9	114.4	128.5	121.4	69.80	77.55	73.68	6.92	9.12	8.02	8.89	11.52	10.20
	Misr-1	118.7	130.2	124.5	69.90	80.10	75.00	8.19	10.30	9.25	7.85	11.84	9.84
Mean		116.5	129.4	122.9	69.85	78.83	74.34	7.55	9.71	8.63	8.37	11.68	10.02

L.S.D. at 5% for				
Irrigation (I)	4.14	2.17	1.30	0.18
Varieties (V)	2.91	1.57	0.85	0.65
Algae foliar (A)	2.24	0.91	0.57	0.28
I * V	NS	NS	NS	NS
I * A	NS	1.67	NS	0.29
V * A	NS	1.60	NS	0.64
I *V* A	NS	2.07	1.21	0.67

Regarding to the second order interaction between irrigation systems X varieties algae foliar gave significant effects with all the studies characters except no. of spikes /m^2 and weight of 100 grains. Gemiza-9 wheat variety showed its superiority in all the studied characters under the condition of drip irrigation and algae foliar with 1.5g/L except no. of grains /spike gained by sprinkler irrigation X Gemiza-9 variety algae foliar with 1.5g/L.

Protein and macronutrients contents:

The results presented in Table (2) indicated that irrigation systems, two varieties, and two algae foliar treatments had significant effects on all protein and macronutrients contents. With regard to irrigation systems effects on all protein and macronutrient contents, data in Table (2) revealed that application of drip irrigation system gave the highest increase in the protein and macronutrient contents over than sprinkler irrigation system. Concerning the mean values of wheat varieties, the results in Table (2) cleared that Misr-1 wheat variety gave the highest values of protein and macronutrient contents than Gemiza-9 wheat variety. On the other hand, data in Table (2) showed as the general that algae foliar with 1.5g/L gave the maximum values of protein and macronutrient contents compared with the check treatment.

It can be noticed from Table (2) that the interaction between the irrigation systems X varieties X algae foliar and second order interaction between irrigation systems X varieties X algae foliar had significant effect only on protein contents in grains and N contents in straw. However, the interaction between irrigation systems X algae foliar caused significant influence on all studied content except K content. The highest values of protein contents in grains and N contents in straw were obtained by drip irrigation X Misr-1 wheat variety, drip irrigation X algae foliar with 1.5g/L, Misr-1 wheat variety X algae foliar with 1.5g/L and finally drip irrigation X Misr-1 wheat variety X algae foliar with 1.5g/L. While, the highest value of P content in straw was obtained by sprinkler irrigation X algae foliar with 1.5g/L.

Micronutrient contents:

With respect to micronutrient contents in Table (3) data illustrated that the irrigation systems of two varieties and algae foliar treatments had significant affects on all micronutrient contents in straw. concerning irrigation systems , data given in Table(3) showed that drip irrigation system surpassed all micronutrient contents .However results revealed that the most micronutrient contents in straw of Misr-1 variety was more than that obtained by Gemiza-9 variety except , the highest mean value of Cu content in straw gained by Gemiza-9 variety .In addition, algae foliar with 1.5g/L treatment gave the highest all micronutrient contents in straw than control .On the other hand , the interaction between irrigation systems X varieties caused non-significant effect on all the contents of micronutrients (Table 3) .Furthermore, the results in the same table indicated that the interaction between irrigation X algae foliar and between varieties X algae foliar had significantly effects only on Mn and Cu contents.It is worthy to observe in Table (3) that the highest mean value of Mn contents was obtained under sprinkler irrigation X algae foliar with 1.5g/L and Misr-1 wheat variety X algae foliar with 1.5g/L, while the superiority mean value of Cu content in straw was obtained by drip irrigation X algae foliar with 1.5g/L and Misr-1 wheat variety Xalgae foliar with 1.5g/L. On the other hand, the second order interaction between irrigation systems X varieties X algae foliar had significant effect on content of Mn, Zn and Cu except Fe content was no significant differences. The superiority value of Mn content in straw was obtained by sprinkler irrigation X Misr-1 wheat variety X algae foliar with 1.5g/L but, Zn content in straw was gained by drip irrigation X Misr-1 wheat variety X algae foliar with 1.5g/L. While the highest value of Cu content in straw was obtained by drip irrigation X Gemiza-9 wheat variety algae foliar with 1.5g/L

DISCUSSIONS

The aforementioned results revealed that the low organic matter content and high pH together led to reduce the most nutrient contents of the experimental site. These results were confirmed by El-Sayed et al., (1992); Nofal et al., (1999) and Rezk et al., (2005).

Many investigators have shown a substantial increase in yield of wheat plant in reclaimed sandy soil (Hu et al., 2014).The increment of yield and yield components of wheat varieties reflected the positive effect of improved plant nutritive status in response to algae foliar spray. In this connection, Ali and Mostafa (2009) and Nofal et al., (2016) reported that the same results on sesame, peanut and maize.Using algae foliar as biofertilizer in such soil showed a good means in that concern, where it is considered as an important group of microorganisms capable of

fixing atmospheric nitrogen. However, algae extract naturally contain ouxin, cytokines and gibberellic acid (Crouch and Van Stander, 1991). Moreover, Abd El-Baky et al., (2016) showed that the algae foliar extracts application can improve non-enzymatic and enzymatic antioxidant defense systems in potatoes plant cultivated under drought stress conditions.

Furthermore, the results in this study cleared that there were a wide variation between the two varieties of wheat plant in their response of yield and yield components in to algae foliar or irrigation systems.

These finding are agreement with those reported by Zahaieva (1982), Rezk et al., (2005) and El-Nasharty et al., (2015). In this connection, Kung et al., (2015) reported that there are many factors affecting of nutrient concentrations of plants such as cultivar, soil environment, climate and stage of plant maturity.

Regarding the treatments, the results indicated that 1.5g/L (300g / 200L /Fed.) was promising and gave an encouraging result. This result may be attributed to algae extracts fertilizers have after been more beneficial to the crop plants than the conventional chemical fertilizers. In addition, Zhang et al., (2003) and El-Umolari and Rengasamy (2012) showed that seaweed extracts contain macro and micronutrients and amino acids which stimulate the growth and yield plants. However, El Sagan (2015) reported that the using foliar application of algae extract at a level of 1.5g/L caused significant increments in cucumber plant length, plant weight, average of leaf area, fruit weights, no. of fruit/plant , yield and chemical content (leaves N,P and K contents) . Also, El-Nwehy et al., (2018) concluded that foliar application with algae extract enhancing growth and increase both seed yield and oil content, in addition to nutrients content of sunflower.

To differentiate between the effect of two irrigation systems, results showed that drip irrigation system was better than sprinkler system for improving the availability of nutrients in plants.

This finding is confirmed by results reported by Erkan et al., (2007) who noted that this behavior may be due to the longer period of drip irrigation which enable plants to absorb more nutrients. Mansour et al., (2015a) reported that water application has significant effects on drip irrigation system or final grain yield.

CONCLUSION

Finally, it can be concluded that the superiority of irrigation system was drip irrigation. Furthermore, the two varieties of wheat plants showed a wide difference between them as response to algae extract on yield components and yield parameters. In addition, the second treatment (1.5 g/L) recorded an encourage result.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

Authors would to thanks the National Research Centre (NRC) for allowing carrying out the field experiments at the NRC's Farm.

AUTHOR CONTRIBUTIONS

All authors significantly contributed in all parts and aspects of paper.

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