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Research article

Management of two irrigation systems and Algae Foliar application on wheat plant growth

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Abstract: In the light of crop shortage production, water scarcity and environmental pollution. The utilization of biofertilizers as an algae extract and modern irrigation systems has become paramount important to reduce the chemical fertilizers and ensure good distribution for plants. Therefore, two field experiments were conducted in the Nubaria district at the Agricultural Station of the National Research Centre, El-Behira Governorate within the two winter seasons 2015/2016 & 2016/2017 to demonstrate the influence of two irrigation systems, i.e., drip and sprinkler and two rates of algae extract foliar application i.e., 0 g/L and 1.5 g/L on growth parameters and spike characteristics of two wheat varieties i.e., Gemiza-9 and Misr-1 grown in sandy soil.

Results indicated that irrigation systems were significant effective on all characters except leaf area, plant height and spike length. On the other hand, all growth parameters and weight of spike of the two wheat varieties showed significantly differences under the studied treatments. The results clarified that some tested characters of Gemiza-9 variety were considerably improved. However, the Misr-1 variety surpassed Gemiza-9 in all characters in both seasons. While the algae foliar extract was significantly effective on all characters of study. The rate of 1.5 g/L of algae extract gave the highest values of all the studied parameters.

Respecting to the first and second order interacted of factors under study effect on such parameters; the results showed that there were many parameters that improved significantly. According to the results of this study, it could be concluded that the combined treatments of foliar spray with 1.5 g/L of algae extract and two wheat varieties under two irrigation systems were found to be highly effective in improving wheat growth in sandy soil condition.

Keywords: irrigation system; Algae; Foliar; wheat varieties; growth

1. Introduction

The use of modern irrigation systems in development the irrigated agriculture depends not only on enough water being available, but also the appropriate use of that water. Where fertigation permits improved efficiency, plant growth, nutrient use and reduce application costs. In this connection, Taha cleared [1] that fertigation was shown to reduce the contamination surface and ground water, improve the mobility of nutritive elements and their uptake. Moreover, Mansour et al. [2] found that drip irrigation system gained the highest result with wheat (Gemiza-9) under using the rate 1.5 g/L of algae extract as compared with sprinkler irrigation. On the other hand Karabudak et al. [3] reported that the positive effect of algae extract on plant morphology may be led to the presence of many types of plant growth regulators, such as auxins, cytokinins, brassionsteroids, gibberellins and amino acids that have been identified in algae and impact plant growth. Furthermore, algae extract contains of all the nutrients and plant growth hormones which are essential for plant to improve yield [4,5]. Also, Gonzalez et al. showed that alginate and diverse polysaccharides [6], some sulphate, stimulate root growth. In addition, El-Sayed et al. showed that a spirulina extract contained a higher amount of phytohormones as compared with other natural sources [7]. Therefore, this work undertaken to determine the changes in growth parameters and spike characters of two wheat varieties under using two modern irrigation systems.

2. Materials and methods

In the experimental station of National Research Centre, Nubaria District, El-Behira Governorate, Egypt, the study was carried out (Lat. 30°43'30" N, Long. 30°11'30" E). During two consecutive seasons, two field trials were carried out in 2015/2016 and 2016/2017 seasons to find out the effect of algae foliar application on two varieties of wheat i.e., Gemiza-9 and Misr-1 under drip and sprinkler irrigation systems. The design of the experiment was split-split with three replicates, where the plot size was 24 m^2. Concerning the irrigation, the two systems were in the main plots. As for, the two varieties, Gemiza-9 and Misr-1 were in the subplots with randomly assigned to the two rates, i.e., 0 g/L and 1.5 g/L of algae extract as showing in Figure 1 of layout of the field experiment.

Sprinkler irrigation system includes the same previous components from 1-control head to 4-Manifold lines within distances 12 × 12 m with sprinklers fixed by heights supports 1 m and discharge of sprinklers 75 lph. These components of irrigation systems were installed and operated according to [8–16].

Sowing procedure was done on the 25th of Dec. for each season. Soil samples were taken representatively from the surface layer (0–30 cm) for analysis before applying the fertilizers and during preparation soil. Regarding N-fertilizers 50 Kg urea/fed. 70 Kg ammonium nitrate/fed were added after sowing based on soil analysis. However, the recommended fertilizers of P and K were used. Results of physical soil properties were as follows: the classified soil was sandy with high pH, low salinity and organic matter, medium of calcium carbonate. However, field capacity recorded (12), permanent willing point (4.1) and available water (7.9), bulk density was 1.57 g/cm^3 and hydraulic conductivity showed 6.76 m/h.

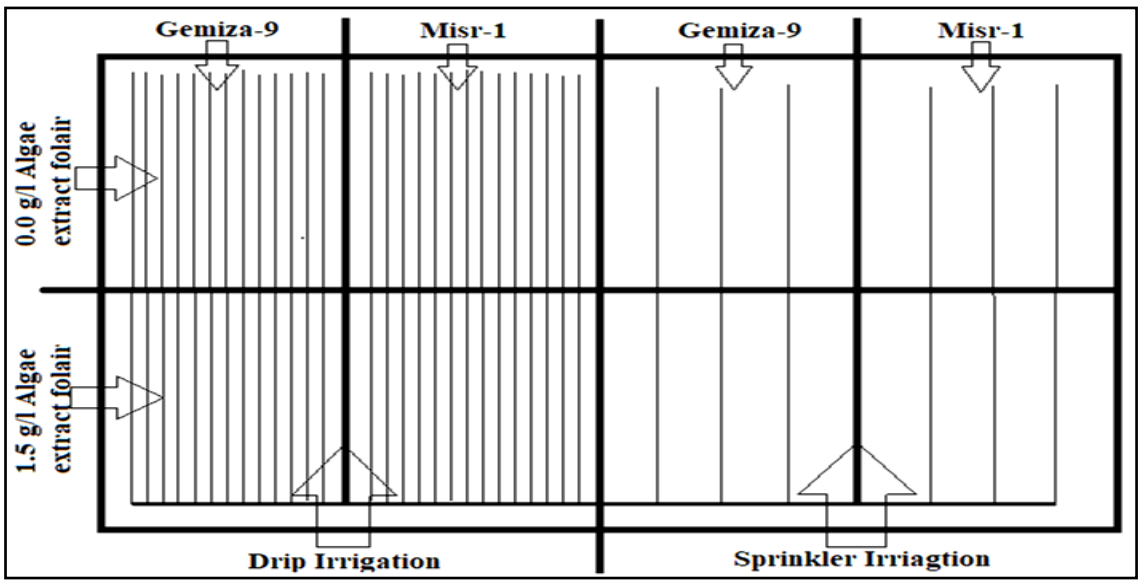

Figure 1. Layout of the farm experiments seasons 2016/2017 and 2017/2018.

The blue green algae, *Spirulina platensis* were used and producted at Algal Biotechnology Unit, NRC.

Before and after heading by two weeks, the treatments used of algae extract were applied, i.e., 0 g/L and 1.5 g/L (300 g/200 L/fed.) as a foliar application. Chemical composition and mineral of algae extract (Table 1) a, b, c. Irrigation start date was from 25/12/2017 until 20/5/2018, during the two growing seasons.

In terms, the irrigation intervals were: 4–5 daytime 75–90 min. At harvest, random samples of ten plants in each plot were taken to estimate the growth parameters and spike characteristics.

Measurements: Dry weight of wheat plants and weight of spikes were measured by sensitive scale device after harvesting, leaf area of the flag leaves of wheat plants were carried out by plan meter device, plant height and spike length were measured by meter.

Statistical analysis

All data were subjected to an analysis of variance (ANOVA) for a split-split plot design [17]. Bartlett's test revealed homogeneity of error and the combined analysis was conducted for all, data of the two seasons using the computer based statistical package MSTATC [18]. The Significant Least Differences (LSD) were used to compare the means (LSD at 5%).

Table 1a. Chemical composition and mineral of algae extract. Available macro and micro-nutrients of used algae extract.

%						ppm			
N	P	K	Mg	Na	Ca	Fe	Mn	Zn	Cu
13.30	2.22	2.13	0.22	0.01	0.33	1936	68	21	18

Table 1b. Chemical composition and mineral of algae extract. Chemical composition and mineral of algae extract. Amino acids content of the used algae extract.

%																
Aspartic	Therionine	Serine	Glutamic	Proline	Glycine	Alanine	Valine	Methionine	Isoleuicne	Leucine	Tyrosine	Phenylalanine	Hisitidine	Lysine	Argnine	Cysteine	Total amino acids
1.9	0.8	0.7	2.2	0.7	1.1	1.6	1.1	0.3	0.7	0.3	0.5	0.9	0.2	0.7	1.0	0.2	16.0

Table 1c. Chemical composition and mineral of algae extract. HPLC chromatogram hormones of algae extract sample.

Mg/g		
Indole acetic acid	Indole butyric acid	Gibberllic acid
13.7	3.3	1.2

3. Results

Growth and spike characters

It was observed from (Table 2) that dry weight, leaf area, plant height, spike length, the number of spikelet's/spike and weight of spike were affected by foliar spray of algae extract under different irrigation systems.

The obtained results showed that there were no significant differences between irrigation systems, for leaf area, plant height and spike length, whereas, dry weight/plant, the number of spikelet's and weight of spike showed significant differences. It is worthy to mention that the superiority of dry weight and number of spikelet's/spike was achieved by sprinkler irrigation system, while, the highest value of spike weight was gained by a drip irrigation system.

Data in (Table 2) showed that the differences between the two wheat varieties reached to the level of significance in all growth and spike characteristics except spike length however, number of spikelet's/spike did not reach to the level of significance. Furthermore, Gemiza-9 variety obtained the highest results of dry weight and leaf area than Misr-1 variety, and on the contrary of the plant height and weight of spike. On the other side, the differences between the two rates of algae foliar application caused significant increases in all growth and spike characteristics. In addition, the results in (Table 2) indicated that the highest values of growth and spike characteristics were recorded due to the application of algae foliar with 1.5 g/L compared with control. Also, the data in the same Table showed that the interaction effects irrigation system and both varieties on all growth and spike characteristics were non-significant, except for dry weight and plant height. Moreover, data cleared that the highest mean values of dry weight and plant height were obtained by drip irrigation with Gemiza-9 and Misr-1 variety, respectively. While, the interaction effects of irrigation system and foliar application of algae on plant height, spikelet's/spike and weight of spike were

significant. The highest values of plant height, spikelet's/spike and weight of spike gained by drip irrigation X algae foliar with 1.5 g/L, sprinkler irrigation X algae foliar with 1.5 g/L and drip irrigation X algae foliar with 1.5 g/L, respectively. Moreover, the interaction between varieties and algae foliar cleared that the significant effect occurred only in case of dry weight, no. of spikelet's/spike and weight of spike.

The maximum dry weight (10.4 g/plant) and no. spikelet's/spike (17.3) were obtained by Gemiza-9 X algae foliar with 1.5 g/L but the highest value of the weight of the spike was observed by Misr-1 variety X spraying algae with 1.5 g/L. Also, data in (Table 2) emphasized that the interaction between the three factors, irrigation, varieties and algae foliar has significant effect on dry weight, no. of spikelet's/spike and weight of spike.

The highest value of dry weight and no. spikelet's/spike found by sprinkler irrigation X Gemiza-9 algae with 1.5 g/L, while the highest mean value of the weight of spike obtained by drip irrigation X Misr-1 variety algae foliar with 1.5 g/L.

4. Discussions

The results presented gave evidence that the experimental site was sandy soil and characterized by high alkalinity and low organic matter. Such conditions are known that the fertility may be a limiting factor [19].

The stimulating effect of using algae foliar spray on growth and physiological performance of wheat varieties is particularly useful when the growth is limited. Several authors indicated the promotive effect of algae extract [20–22] (Ali and Mostafa; Nofal et al.) where, the fresh and dry weight per plant of feddan were achieved by using the algae extract foliar application at the rate of 300 g/fed. on moringa and alfalfa [23]. Moreover, the vegetative growth of coratina olive transplant was increased as affected by using algae application [24]. The presence of phytohormones such as gibberlins, auxins and cytokinis would promote the endogenous hormonal activity in the plants [25].

In addition, the studies have proved that the amino acids can directly or indirectly influence the physiological activities of the plants. Among other things, amino acids help plants combat stress, increase root mass, activate natural defense mechanisms in plants and enhance photosynthesis. They also, promote nutrient absorption and stimulate the essential metabolic activities in plants, On the other hand, the obtained results indicated to presence a big difference among the two varieties of wheat plants in their response of growth into algae application or irrigation methods [26–32].

Irrespective the treatments, the results showed that 1.5 g/L (300 g/200 L/fed.) achieved the best result of growth and spike characters. In this connection, Fasili et al. [30] reported that the positive impact of plant growth has happened as a result of alginate and diverse polysaccharides. Also, El-Nwehy et al. [31] concluded that foliar application with (1.0 g/L) algae extract enhances growth parameters of sunflower.

According to the irrigation systems, the results indicated that drip irrigation was the best one which allowed the plant to take enough water and nutrients with high efficiency [8,17,22,29].

Table 2. Effect of irrigation systems, cultivars and algae foliar spray on growth parameters and spike characteristics of two wheat cultivars grown on sandy soil (Combined analysis of two seasons).

Irrigation (I)	Varieties (V)	Growth parameters									Spike characteristics								
		Dry weight (g/plant)			Leaf area (cm^2)			Plant height (cm)			Spike length (cm)			No. of spikelet's/spike			Weight of spike (gm)		
		Algae foliar (A)		Mean	Algae foliar (A)		Mean	Algae foliar (A)		Mean	Algae foliar (A)		Mean	Algae foliar (A)		Mean	Algae foliar (A)		Mean
		Cont.	1.5g/l		Cont.	1.5g/l		Cont.	1.5g/l		Cont.	1.5g/l		Cont.	1.5g/l		Cont.	1.5g/l	
Drip irrigation	Gemiza-9	10.0	10.3	10.1	19.6	20.2	19.9	83.0	92.0	87.5	13.2	14.5	13.9	16.0	16.3	16.2	1.6	1.9	1.8
	Misr-1	4.9	7.5	6.2	17.6	18.2	17.9	109.0	113.7	111.4	12.5	15.1	13.8	15.7	16.3	16.0	2.2	2.5	2.3
Mean		7.4	8.9	8.2	18.6	19.2	18.9	96.0	102.9	99.4	12.9	14.5	13.8	15.8	16.3	16.1	1.9	2.2	2.1
Sprinkler irrigation	Gemiza-9	9.4	10.6	10.0	19.5	20.2	19.9	85.0	97.0	91.0	13.2	14.3	13.8	18.3	18.7	18.5	1.2	1.3	1.3
	Misr-1	7.0	8.6	7.8	17.8	19.2	18.5	88.3	102.0	95.2	12.5	15.0	13.7	15.3	18.0	16.7	1.6	2.2	1.9
Mean		8.2	9.6	8.9	18.7	19.7	19.2	86.7	99.5	93.1	12.8	14.6	13.7	16.8	18.3	17.6	1.4	1.8	1.6
Mean for varieties	Gemiza-9	9.7	10.4	10.1	19.6	20.2	19.9	84.0	94.5	89.3	13.2	14.5	13.9	17.3	17.3	17.3	1.4	1.6	1.5
	Misr-1	6.0	8.1	7.0	17.7	18.2	18.2	98.7	107.8	103.3	12.5	15.0	13.8	15.8	16.8	16.3	2.0	2.2	2.1
Mean		7.8	9.3	8.5	18.6	19.4	19.0	91.4	101.2	96.3	12.9	14.8	13.8	16.6	17.1	16.8	1.7	1.9	1.8
L.S.D. at 5% for																			
Irrigation (I)				0.7			NS			NS			NS			0.6			0.2
Varieties (V)				0.3			0.4			4.9			NS			NS			0.2
Algae foliar (A)				0.5			0.3			2.3			0.6			0.4			0.3
I * V				0.6			NS			6.1			NS			NS			NS
I * A				NS			NS			5.7			NS			0.5			0.2
V * A				0.5			NS			NS			NS			1.1			0.2
I * V * A				0.7			NS			NS			NS			1.1			0.2

5. Conclusions

The results confirmed that the triple interaction between irrigation systems, Egyptian wheat varieties and algae concentrations had a significant effect on dry weight, height and weight of spikes. An increase in the yield of Misr-1 was obtained when algae foliar at 1.5 g/L per liter. The highest dry weight value and the best spikelet per spike number were obtained by sprinkler irrigation and Gemiza-9 algae with 1.5 g/L per liter, while the highest average weight gain value obtained by drip irrigation and Misr-1 variety of algae with 1.5 g/L per liter.

It could be concluded that the best irrigation system was drip irrigation for providing water, fertilizers and good distribution of water and fertilizers used. Moreover, the two wheat varieties showed a big variation among them as the result to algae extract foliar application and the suitable treatment for plant growth and spike characteristics was 1.5 g/L per liter of algae extract.

Conflict of interest

The authors declare no conflict of interest.

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