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EFFECT OF WATER STRESS AND FERTILIZATION ON COTTON PRODUCTIVITY UNDER CALCAREOUS SOIL CONDITIONS

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ABSTRACT: Two field experiments were carried out at the Farm of Nubaria Agricultural Research Station, Agricultural Research Center (ARC), Giza, Egypt, representing the newly reclaimed desert land of North West, Egypt in Nubaria, which located at 46 Km South West of Alexandria city to study the effect of irrigation regimes and NPK fertilization, earliness parameters, seed cotton yield, its components of Egyptian cotton (*Gossypium barbadense* L.) cultivar Giza 94 was used which represent long staple Egyptian cotton category in the two summer growing seasons of 2017 and 2018. The experimental design was a split-split plot with four replications, where the irrigation regime treatments were allocated to the main plots and the sub-main plots included NPK fertilization, while foliar application treatments were taken place in sub-sub plots, where irrigation regimes were irrigation at 50% depletion of available soil moisture. (I1), irrigation at 70% depletion of available soil moisture (I2) and irrigation at 90% depletion of available soil moisture (I3). While NPK-fertilizer rates were 100% of NPK recommended doses (75 kg N, 31 P_2O_5 and 48 K_2O/fad.), 75% of NPK recommended doses (56.3 kg N, 23.3 P_2O_5 and 36 K_2O/fad.) and 50% of NPK recommended doses (37.5 kg N, 15.5 P_2O_5 and 24 K_2O/fad.). Foliar application treatments were control (water), potassium silicate (two times at the rate of 1 kg/fad., before flowering and two weeks later), extractable mixed of algae, amino acids and micronutrients (two times at the rate of 1 L/fad., before flowering and two weeks later).The results revealed that growth and yield attributes of cotton were affected by water stress under NPK fertilization and foliar application, in this respect the highest value of growth, yield characters were achieved under irrigation regime (50% depletion of available soil moisture) and recommended dose of NPK and foliar application of Algal extracts + amino acids + micronutrient) under Nubaria conditions.

Key words: Egyptian, cotton, water stress, NPK, yield, and its components.

INTRODUCTION

Cotton area and production are decreasing from one year to another. In Egypt, it is cultivated in an area of 170.000 fad., with a yield of 6.75 kentars/fad. Cotton area was about 6.832 and 4.738 faddans in West Nubaria Region and Alexandria Governorate, respectively. However, it is cultivated in 81.13 million acres with average yield of 644 Lbs/acre in the world (**FAO, 2016**).

Water is a vital factor for plant growth, development, productivity and quality. So, irrigation level affected significantly cotton plants, with plant height in a range from 56.8 to 105.5 cm. **Hussein *et al.* (2011)** found deficit irrigation at around 80% of full irrigation had the potential to save water and could be a proper irrigation level for producing cotton in arid areas. The close irrigation interval (every 15 days) increased number of days from planting to first flower, days to first opened boll and boll age and consequently decreased earliness percentage as compared to wide irrigation interval (every 21 days). They added that irrigation every 21 days gave the highest mean

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value for each of boll weight and seed cotton yield/faddan (**Beheary *et al.*, 2012)**.

Irrigation and N fertilization affected growth and yield characters of cotton. The highest seed cotton yield (5707 kg/ha) was reached with 130% ETc and 210 kg N/ha. The highest N agronomic efficiency was recorded at 140 kg N/ha. The 70% ETc treatment revealed significant benefits in terms of irrigation water savings, with seed cotton of 0.587 kg/m^3, indicating the possibility of irrigation use to deficit under water scarcity conditions (**Zonta *et al.*, 2016).**

Cotton growth, yield and maturity are greatly influenced by NPK fertilizers application which increases yield and yield components and fiber quality **(Xia *et al.*, 2013; Adnan *et al.*, 2017; Wajid *et al.*, 2017).** Also, **Policepatil *et al.* (2009)** revealed that increased NPK fertilization to cotton may result in more accumulation of photosynthetic assimilates that resulted in higher fruit weight. Also, several studies were done to evaluate the response of cotton to different NPK levels, **Seadh *et al.* (2012) and Hamoda *et al.* (2014)** found that the growth traits and yield increased with increasing rates of NPK. However, **Srinivasan (2007) and Emara *et al.* (2015)** revealed that the high NPK fertilizer level did not exhibit any significant effect on fiber properties. **Elhamamsey *et al.* (2016)** reported that among fertilization rates, maximum number of opened bolls/plants, boll weight and yield/ fad., were recorded with using of high fertilizer rates.

Seed cotton yield significantly enhanced by increasing N application rate. The highest seed cotton yield (4363 kg/ha) was recorded in a case of 200 kg N/ha treatment and there was no significant difference between 200 and 300 kg N/ha treatments **(Singh *et al.,* 2010)**. **Awad (2012)** studied the effect of full recommended doses of NPK (75 kg N, 31 kg P_2 O_5 and 48 kg K_2O/faddan) vs. seven bio-fertilizer + half the amount of the recommended doses of NPK (37.5 kg N, 15.5 kg P_2O_5 and 24 kg K_2O/faddan) on cotton yield, they found that there were significant effects ($P< 0.05$) due to mineral bio-fertilization treatments on all plant growth attributes, all earliness parameters, all yield components expect number of plants at harvest/ faddan, lint (%), fiber length in both seasons and fiber strength and fiber fineness, only in one season. They added that the interaction effects was significant for the most of characteristics, it is obvious that application of Microbein and Potassiomage bio-fertilizers with half the amount of the recommended doses of N, P and K under the high level of farmyard manure (F Y M) significantly increased yields of seed cotton/ faddan (9.32 and 7.89 kentars) in both seasons, respectively Dry matter yield, number of opened bolls/plant, boll weight, seed index, lint index, seed cotton yield/plant, seed cotton and lint yield/ha and earliness of harvest were increased with the application of K, Zn and P **(Sawan, 2014)**.

Phosphorus (P) is an essential nutrient required for structural and metabolic functions. It is mobile element in the plant as that young leaves or developing bolls can be nourished from the labile P of older tissues; *i.e.*, P is redistributed from older to younger parts (**Cox and Barnes, 2002; Crozier *et al.*, 2004)**. P-is the second nutrient in cotton production after nitrogen. It is a constituent of cell nuclei, essential for cell division and development of meristematic tissue **(Russell, 2001)** and has known effect on photosynthesis as well as synthesis of nucleic acids, proteins, lipids and other essential compounds **(Guinn, 1984; Taiz and Zeiger, 1991)**.

Potassium (K) is essential for the growth and development of cotton crop. It is vital for many of the enzyme systems in plants. Potassium enhanced water efficiency, affects the speed of value almost all plant biological systems, and affects fiber properties such as micronair, length, and strength. In addition, K also plays a significant role in photophosphorylation, turgor maintenance, photoassimilate transport from source tissues *via* phloem to sink tissues, stress tolerance and enzyme activation in plants. Crops translocate potassium to all parts of plant and in turn yield per plant is increased. The uptake of potassium increases during early boll set with some 70% of total uptake occurring after first bloom (**Ashfaq *et al.,* 2015)**. K-treatments had a significant effect on plant height at harvest, No. of sympodia/plant, and first sympodia/position. There was a significant effect on days to first flower appearance as well as to first opened boll, number of opened bolls/plant, boll weight, seed cotton yield per plant and per fad. Foliar spray of 2.4 kg K_2O/fad., three times at squaring, start and peak of flowering stages, respectively, significantly increased No. of opened bolls/ plant, boll weight, seed cotton yield/plant and seed cotton yield/fad (**Abou-Zaid *et al.,* 2009**).

Algae extracts has beneficial effects on growth and stress adaptation. Algal extracts and other compounded mixtures have properties beyond basic nutrition, often increasing growth and stress tolerance. Non-pathogenic bacteria capable of colonizing roots and the rhizosphere also have a number of positive impacts. These impacts included higher yield, increased nutrient uptake and use, increased photosynthetic activity, and resistance to biotic and abiotic stresses (**Van Oosten *et al.*, 2017**). The seaweed extract (SWE) has recently gained much confirmation as foliar application for inducing faster growth and yield of plants **(Dwivedi *et al.*, 2014)**. Use of seaweed extracts has gained popularity due to their potential use inorganic and sustainable agriculture **(Layek *et al.,* 2015)**. SWE have been largely used for similar purposes. SWE increased fresh weight, and dry weight in spinach plants under drought stress with some adverse effects on the nutritional value through reduced ferrous ion chelating ability (**Xu and Leskovar, 2015**). Foliar application of potassium silicate can provide reduction in water stress effects. Its application resulted in reduction from 32,7% to 21.6% in the number of eggs laid on papaya from 29.5% to 14.1% **(Silveira, 2013).** Potassium silicate ($K_2O_4SiO_2$) caused very good results to improve the growth and yield of plants under water and saline stress conditions **(Salim, 2014).**

The best concentrations of macronutrients were obtained by the algal extract or the higher dose of the micronutrient fertilizer. However, the best uptake, nutrient balance and dry matter accumulation was recorded by combined algal extract and micronutrient fertilizer treatment **(Shaaban et *al.*, 2010)**. Application of micronutrients like iron and zinc each at 50 kg/ha recorded the highest mean values of seed cotton yield **(Mamatha and Ramesh, 2015).**

The objective of this study was to investigate the effect of irrigation regimes and NPK fertilization and their interaction on growth, yield and its components of Egyptian cotton.

MATERIALS AND METHODS

Two field experiments were carried out at the Farm of Nubaria Agricultural Research Station, Agricultural Research Center (ARC), Giza, Egypt, representing the newly reclaimed desert land of North West, Egypt in Nubaria, which located at 46 Km South West of Alexandria city, the station coordinates are at 30^0 45^- N latitude and 29^0 30^- E longitude, it has an elevation of about 21 meters above the sea level. The present investigation was carried out to study the effect of irrigation regimes and NPK fertilization on, earliness parameters, seed cotton yield and its components of Egyptian cotton (*Gossypium barbadense* L.) Giza 94 cotton cultivar during 2017 and 2018 seasons.

Egyptian clover Barseem (*Trifolium alexandrinum* L.) was the preceding crop in the two seasons, which was removed after two cuttings before bloughing. Barseem is a favorite crop before summer sowings especially, in newly reclaimed or calcareous soils.

Some physical and chemical analyses of the soil at the experimental Farm in Nubaria Agricultural Research Station is given in Tables 1 and 2 according to **Chapman and partt (1978) and Page *et al*. (1982).** In both seasons, the soil texture was sandy loam, low content of organic matter, very high calcium carbonate and non-saline. The available amounts of macro elements were moderate for nitrogen, low for phosphorus and potassium. Regarding, available amounts of micro-nutrients Fe, Cu and Mn were of medium levels in the soil, while Zn and B existed in moderate amount. Initial soil physicochemical characteristics of the surface layer (0 - 40 cm) for the two experimental seasons were determined and recorded in Tables 1 and 2. Soil layer to 40 cm had a light texture of sandy loam with high content of total $CaCo_3$ (%) was 21.94 and 22.13% in 2017 and 2018 seasons, respectively, Soil pH around alkalinity ranged between 8.23 and 8.22. Soil of both seasons were non- saline (EC 1.84 and 1.79 dS/m) with low available NPK and organic matter content (0.25 and 0.27%) indicating their deficient fertility status. Soil moisture while available water was about 21.40% content to 40

Table 1. Some physical properties of the experimental site for the two seasons of 2017 and 2018

Experimental year	Soil depth (cm)	Mechanical analysis			Soil texture	Soil moisture (%)		
		Sand (%)	Silt (%)	Clay (%)		Field capacity	Wilting point	Available water
2017	0-40	57.67	24.11	18.22	Sandy loam	36.12	14.71	21.41
2018	0-40	57.13	23.93	18.94	Sandy loam	35.91	14.51	21.40

Table 2. Some chemical properties of the experimental site for the two seasons of 2017 and 2018

Experimental year	Soil depth (cm)	Soil EC (ds/m)	Soil pH (1: 2.5)	Total $CaCO_3$	Organic matter (%)	Available macronutrients			Total N (%)
						N	P	K	
2017	0-40	1.84	8.23	21.94	0.25	37.9	4.7	87	0.13
2018	0-40	1.79	8.22	22.13	0.27	39.3	5.1	93	0.14

cm was moderately to low, field capacity ranged between 36.12 and 21.4 for the two experimental seasons, respectively **(Page *et al.,* 1982).**

The experimental design was a split-split plot with four replications, where the irrigation regimes treatments were allocated to the main plots and the sub-main plots included NPK fertilization, while foliar application treatments were taken place in sub-sub plots. The treatments were as follows:

1- Irrigation regimes (Main plots):

I1 Irrigation at 50% depletion of available soil moisture.

I2 Irrigation at 70% depletion of available soil moisture.

I3 Irrigation at 90% depletion of available soil moisture.

2- NPK- fertilization (Sub-main plots):

F1 100% of NPK recommended doses (75 kg N, 31 P_2O_5 and 48 K_2O/fad.).

F2 75% of NPK recommended doses (56.3 kg N, 23.3 P_2O_5 and 36 K_2O/fad.).

F3 50% of NPK recommended doses (37.5 kg N, 15.5 P_2O_5 and 24 K_2O/fad).

3- Foliar application treatments (Sub-sub plots):

T1 Control (water).

T2 Potassium silicate (two times at the rate of 1 kg/fad., before flowering and two weeks later).

T3 Extractable mixed of algae, amino acids and micronutrients (two times at the rate of 1 L/fad., before flowering and two weeks later).

The area of sub- sub- plot was 16.25 m^2, in both seasons. Each sub sub plot was consisted of five ridges, 0.65 m apart and 5 m long each and a distance of 25 cm between hills.

The cotton plant seeds of Egyptian long staple cotton cultivar Giza 94 (*Gossypium barbadense* L.) at the rate of 30 kg/fad., were planted on 1st and 10th May in 2017 and 2018 seasons, respectively. Before the second irrigation, plants were thinned to two vigorous seedlings per hill. Hand hoeing was carried out three times, during the two seasons before the first, second and third irrigations, respectively. Other cultural practices either pest or weed control were followed during the two growing seasons as usual application in commercial production, recommended for South West Alexandria Region.

Cotton plants were irrigated, during the growing season, eight times in addition to planting irrigation according the irrigation regime at 15 days interval. The first irrigation (Mohayat) was applied after 21 days from planting.

Prior to land preparation, phosphorus fertilizer was added in the form of calcium superphosphate (15.5% P_2O_5). Nitrogen fertilizer rate in the form of ammonium nitrate (33.5% N) was applied in two equal doses, the first dose was applied after thinning and before the second irrigation, and the second dose was added before the third irrigation. Potassium fertilizer was added before the 2nd irrigation in the form of potasium sulfate (48%).

Applied of irrigation water treatments were started from the third irrigation (about 36 days from seed cultivation). The seasonal amount of applied irrigation water was calculation and illustrated in Table 3.

The first pick of seed cotton yield was performed by hand, on September 22, while the second pick was on October 9 for the first season. The respective dates of picking for the second season were September 28 and October 15. The other standard agricultural practices for West Nubaria region were followed throughout the two growing seasons.

Plant height at harvesting (cm), Number of sympodia/plant, the first sympodial position in nodes, number of days from sowing to the first flower appearance (DFF), number of opened bolls/plant, Boll weight in grams, Seed-cotton yield (g/plant) and Seed-cotton yield/faddan in Kentar were studied (Kentar = 157.5 kg).

All collected data were subjected to analysis of variance according to **Gomez and Gomez (1984).** All statistical analysis was performed using analysis of variance technique by means of CoStat computer software package **(CoStat, Ver. 6.311., 2005).** The least significant differences (LSD at 0.05) were used to compare the treatment means.

RESULTS AND DISCUSSION

Table 4 show the effect of the three factors *i.e.* irrigation regimes (A), NPK fertilization rates (B), foliar application treatments (C) and their interactions on plant height at harvesting (cm), number of sympodia/plant, the first sympodial position in nodes, number of days from sowing to the first flower appearance (DFF) and number of opened bolls/plant (DFB) in both seasons.

The results showed that there was significant effect due to irrigation regimes on each of plant height at harvesting (cm), number of sympodia/ plant, the first sympodial position in nodes, number of days from sowing to the first flower appearance (DFF) and number of opened bolls/ plant (DFB), where the highest value for each of plant height at harvesting (cm), number of sympodia/plant, the first sympodial position in nodes were recorded with irrigation at 50% depletion of available soil moisture. Meanwhile, the lowest ones were obtained with irrigation at 90% depletion of available soil moisture. On the other hand, irrigation at 90% depletion of available soil moisture increased number of days from sowing to the first flower appearance (DFF) and number of opened bolls/plants (DFB) in both seasons. These results are in agreement with those reported by **Abou-Zaid *et al.* (2009), Singh *et al*. (2010), Hussein *et al.* (2011) and Deshish *et al.* (2015).** The effect of water stress explained by **Zhao *et al.* (2006)** who revealed that drought affected plant due to hormonal imbalance (cytokinin, abscisic acid) that affected growth due to changes in cell wall extensibility.

The results in the same Table revealed the effect of NPK fertilization rates on plant height at harvesting (cm), number of sympodia/plant, the first sympodial position in nodes, number of days from sowing to the first flower appearance (DFF) and number of opened bolls/plant (DFB), whereas soil application of 100% NPK as recommended dose (RD) recorded the highest mean value for each of plant height at harvesting (cm) and number of sympodia/plant, while the lowest ones were recorded with 50 % from recommended dose of NPK which increased number of days from sowing to the first flower appearance (DFF) and number of opened bolls/ plants (DFB) in both seasons. These results are in harmony with those showed by **Waraich *et al.* (2011), Emara (2012), Dewdar (2013)**, **Sawan (2014), Geng *et al*. (2015) and Emara (2016)** who revealed that different combination of NPK gave an increase in growth and yield of cotton.

The same Table showed the effect of foliar application, where foliar application with Algal extract + amino acids and micronutrients gave the highest value for each of plant height at harvesting (cm) and number of sympodia/plant, while the lightest

Table 3. Values of seasonal applied water for cotton crop during 2017 and 2018 seasons

Water irrigation regime	No of irrigation		Mean amount of applied water m3/fad/irrigation		total amount of applied water m3/fad.		Mean amount of applied water for two seasons m3/fad.	Mean amount of applied water for1 est and2 nd irrigation		Seasonal applied water		Mean seasonal of applied water for two season m3/fad
	1 st season	2 nd season	1 st season m3/fad.	2 nd season m3/fad.	1 st season	2nd season		1 st season m3/fad	2nd season m3/fad.	1st season m3/fad.	2nd season m3/fad.	
50% depletion of A.W	13	13	258.6	249.4	3361.8	2942.2	3302	940	951	4301.8	4193	4247.4
70% depletion of A.W	10	10	296.5	297.1	2965	2971	2968	940	951	3905	3922	3913.5
90% depletion of A.W	7	7	340.1	339.0	2381	2373	2377	940	951	3321	3324	3322..5

Table 4. Yield attributes of cotton cv. Giza 94 as affected by NPK fertilization and foliar application treatments under irrigation regimes and their interactions in both seasons

Treatment	Plant height (cm)		Number of sympodia/plant		The first of sympodial position in nodes		Number of days from sowing to the first flower appearance		Number of opened bolls/plant	
	Season									
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
A) Irrigation regimes										
I1 = 50 % depletion	14.26 a	13.40 a	13.18a	12.92a	7.1a	6.3a	75.5 c	72.5 b	12.64 c	12.43 c
I2 = 70 % depletion	144.1 a	13.54 a	12.74b	12.45b	7.1a	6.2b	78.4 b	74.9 a	12.93 b	12.73 b
I3 = 90 % depletion	13.93 b	133.5 b	12.51c	12.21c	7.0b	6.2b	79.7 a	75.3 a	13.08 a	12.87 a
LSD at 0.05	2.7	1.0	1.09	0.83	0.05	0.08	0.280	0.855	0.447	0.578
B) NPK fertilization rate										
F1= 100% (RD)	14.38 a	13.09a	13.09a	12.82a	7.1	6.2	75.9 c	72.9 b	12.64 c	12.43 c
F2 = 75% from (RD)	14.13 b	13.92 b	12.92b	12.63b	7.1	6.2	77.9 b	74.5 ab	12.93 b	12.73 b
F3 = 50% from (RD)	14.09 b	13.23 b	12.42c	12.13c	7.1	6.2	79.8 a	75.3 a	13.08 a	12.87 a
LSD at 0.05	1.7	3.0	0.96	1.03	NS	NS	0.726	1.69	0.447	0.578
C) Foliar application										
T1 = Water	13.99 b	12.57 c	12.57c	12.29c	7.1	6.2	80.2 a	75.7 a	13.10 a	12.89 a
T2= Potassium silicates	14.24 a	12.86 b	12.86b	12.59b	7.1	6.2	77.7 b	74.4 a	12.85 b	12.65 b
T3 Algae extracts + amino acids and micronutrients	14.36 a	13.00 a	13.00a	12.71a	7.1	6.2	75.7 c	72.6 b	12.68 c	12.49 c
LSD at 0.05	1.6	2.6	1.08	1.02	ns	ns	0.567	1.39	0.470	0.453
Interaction										
A × B	*	NS	*	*	NS	NS	NS	NS	NS	*
A × C	NS	NS	*	*	NS	NS	*	NS	*	*
B × C	*	*	*	*	NS	NS	*	NS	*	*
A × B × C	*	*	*	*	NS	NS	*	NS	*	*

I1, I2, I3= Irrigation at 50, 70 and 90% depletion of available soil moisture, respectively, Mean values in the same column marked with the same letters are not significantly different, * = Significant difference, NS= not significant difference at 0.05 level of probability, Means of each factor designated by the same letter are not significantly different at 5% using least significant difference (LSD).

yield was obtained by foliar application of water which increased number of days from sowing to the first flower appearance (DFF) and number of opened bolls/plant (DFB) in both seasons. These results are confirmed with **Dwivedi *et al.* (2014), El-Sayed *et al.* (2015), Elansary *et al.* (2016), Emara (2016), Yadav *et al.* (2016), Van Oosten *et al.* (2017) and More *et al.* (2018)** who reported that using Algal extracts or potassium silicate or micronutrients improved the growth and yield of plants under water stress.

The results in Table 4 reveal that there were significant interaction effects on some growth characters of cotton which will not discussed here.

The obtained results in Table 5 show the effect of the three factors *i.e.,* irrigation regimes (A), NPK fertilization rates (B), foliar application treatments (C) and their interactions on boll weight, seed cotton yield/plant (SCYP) and seed cotton yield/fad., during 2017 and 2918 seasons.

The results showed that there was significant effect due to irrigation regimes on seed cotton yield/fad, where irrigation at 50% depletion of available soil moisture (I1) achieved the highest value for each of boll weight, seed cotton yield/plant and seed cotton yield/fad, meanwhile the lightest ones were observed with irrigation at 90% depletion of available soil moisture (I3) in both seasons. These results are in agreement with those reported by **Abou-Zaid *et al.* (2009), Singh *et al.* (2010), Hussein *et al.* (2011), Deshish *et al.* (2015) and Yi *et al.* (2018).** The effect of water stress explained by **Zhao *et al.* (2006)** who revealed that drought affected plant due to hormonal imbalance (cytokinin, abscisic acid) that affected growth due to changes in cell wall extensibility.

The results in the same Table revealed the effect of NPK fertilization rates on cotton yield and its attributes, whereas soil application of 100% NPK as recommended dose (RD) recorded the highest means of boll weight, seed cotton yield/plant (SCYP) and seed cotton yield/fad, while the lowest one was obtained with at 50% from recommended dose of NPK in both seasons. These results are in confirm with those showed by **Emara (2012), Dewdar (2013), Sawan (2014), Geng *et al.* (2015) and Emara (2016)**.

The same Table showed the effect of foliar application, where foliar application with Algal extract + amino acids and micronutrients gave the heaviest value for each of boll weight, seed cotton yield/ plant (SCYP) and seed cotton yield/fad., while the lightest boll weight, seed cotton yield/plant (SCYP) and seed cotton yield/fad., were obtained due to water foliar application (control treatment) in both seasons. These results are confirmed with **Dwivedi *et al.* (2014), El-Sayed *et al.* (2015), Bradáčová *et al.* (2016), Elansary *et al.* (2016), Emara (2016), Yadav *et al.* (2016), Van Oosten *et al.* (2017) and More *et al.* (2018)** who reported that using Algal extracts or potassium silicate or micronutrients improved the growth and yield of plants under water stress.

Fig. 1 a and b show the first order interaction between irrigation regimes (A) and NPK fertilization rates (B). Irrigation at 50% depletion of available soil moisture (I1) with 100% (RD-NPK) gave the highest value of seed cotton yield/fad., meanwhile the lowest ones were obtained by at 90% depletion of available soil moisture and 50% RD of NPK in 2017 and 2018 seasons, respectively.

The results revealed that irrigation at 50% depletion of available soil moisture with foliar application of Algae extracts + amino acids + micronutrients achieved the highest value of seed cotton yield/ fad., while the lowest value was obtained by irrigating at 90% depletion of available soil moisture and water foliar treatment in the first and second seasons in Fig. 2 a and b.

Table 5 reported that there was significant interaction between the second factor and the third factor on seed cotton yield/fad during the first and second seasons, according to this respect results shown in Fig. 3 a and b show that soil application of 100% NPK (RD) and foliar application of Algae extracts + amino acids and micronutrients recoded the highest seed cotton yield/fad, while the lowest one was observed with soil application of 50 % NPK from RD and water spraying (control) in both seasons.

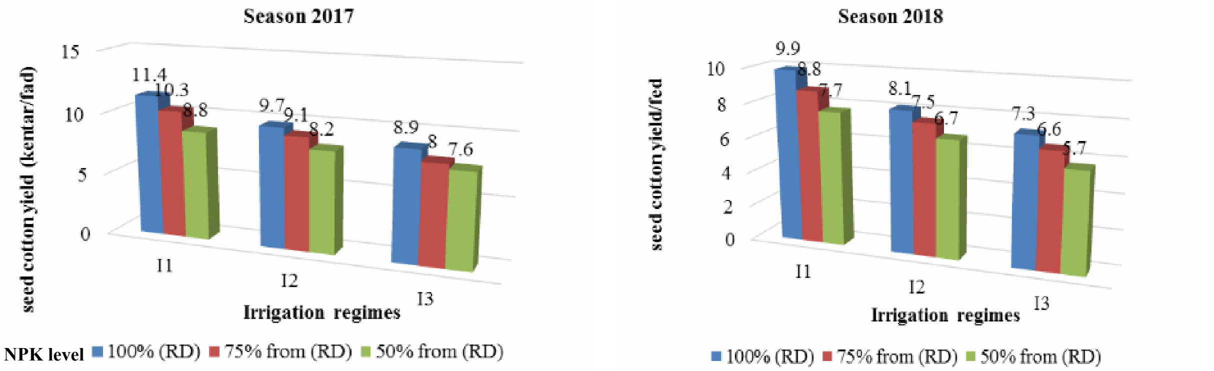
Results in Table 6 reveal the second order interaction between irrigation regimes, and NPK rates and foliar application. Whereas, irrigation at 50% depletion of available soil moisture, soil application of at 100% NPK (RD) and foliar application of Algae extracts + amino acids and micronutrients recoded the highest mean value

Table 5. Yield attributes of cotton cv. Giza 94 as affected by NPK fertilization and foliar application treatments under irrigation regimes and their interactions in both seasons.

Treatment	Boll weight (g)		Seed cotton yield/plant (g)		Seed-cotton yield/fad (Kentar)	
	2017	2018	2017	2018	2017	2018
A) Irrigation regimes						
I1 = 50% depletion	3.12 a	3.05 a	48.9 a	43.3 a	10.2 a	8.8 a
I2 = 70% depletion	3.05 b	2.96 b	43.7 b	37.9 b	9.0 b	7.4 b
I3 = 90% depletion	2.99 c	2.88 c	40.0 c	34.3 c	8.2 c	6.6 c
LSD at 0.05	0.018	0.058	0.344	0.742	0.273	0.205
B) NPK fertilization rate						
F1= 100% (RD)	3.14 a	3.05 a	48.0 a	41.9 a	9.9 a	8.4 a
F2 = 75% from (RD)	3.0 6b	2.98 b	44.3 b	38.6 b	9.1 b	7.6 b
F3 = 50% from (RD)	2.95 c	2.87 c	40.3 c	35.0 c	8.2 c	6.7 c
LSD at 0.05	0.017	0.034	0.317	0.394	0.225	0.107
C) Foliar application						
T1 = Water	2.61 c	2.83 c	39.6 c	34.1 c	8.1 c	6.5 c
T2= Potassium silicates	3.11 b	3.00 b	44.8 b	39.3 b	9.1 b	7.8 b
T3 Algae extracts + amino acids and micronutrients	3.54 a	3.51 a	48.2 a	42.1 a	10.1 a	8.5 a
LSD at 0.05	0.016	0.009	0.342	0.649	0.159	0.154
Interaction						
A × B	*	NS	*	*	*	*
A × C	*	*	*	*	*	*
B × C	NS	NS	*	*	*	*
A × B × C	*	*	*	*	*	*

I1, I2, I3= Irrigation at 50, 70 and 90 % depletion of available soil moisture, respectively, Mean values in the same column marked with the same letters are not significantly different, * = Significant difference, ns= not significant difference at 0.05 level of probability, Means of each factor designated by the same letter are not significantly different at 5% using least significant difference (LSD).

Kentar = 157.5 kg , fad = 4200 m^2.



I1, I2, I3= Irrigation at 50, 70 and 90 % depletion of available soil moisture, respectively

Fig. 1. a and b. Interaction effect of irrigation regimes and NPK fertilization on seed cotton yield/fad., (SCYF) in both seasons.

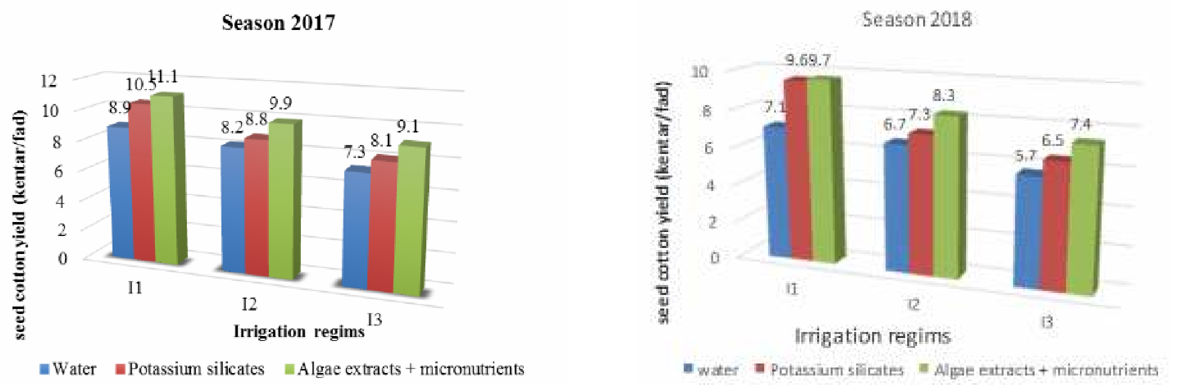


Fig. 2. a and b. Interaction effect of irrigation regimes and foliar application on seed cotton yield/fad., (kentar/fad) in both seasons

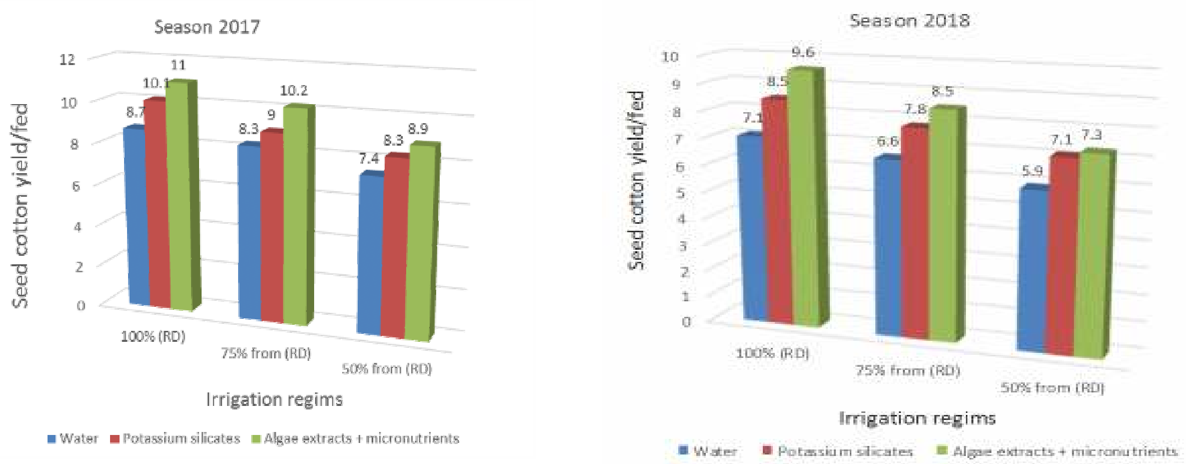


Fig. 3. a and b. Interaction effect of NPK fertilization and foliar application on seed cotton yield/fad., (kentar/fad) in both seasons

Table 6. Interaction effect of irrigation regimes x NPK fertilization x foliar application on seed cotton yield/fad., (kentar/fad.) in both seasons

Treatment			Season	
			Seed cotton yield (kentar/fad.)	
Irrigation regime (A)	NPK fertilization rate (B)	Foliar application (C)	2017	2018
I1	100% (RD)	Water	10.0	8.3
		Potassium silicates	11.9	10.5
		Algae extracts and micronutrients	12.3	10.9
	75% from (RD)	Water	9.4	7.3
		Potassium silicates	10.5	9.6
		Algae extracts and micronutrients	11.2	9.5
	50% from (RD)	Water	7.6	5.8
		Potassium silicates	8.9	8.8
		Algae extracts and micronutrients	9.9	8.6
I2	100% (RD)	Water	8.6	7.0
		Potassium silicates	9.4	7.7
		Algae extracts and micronutrients	11.0	9.5
	75% from (RD)	Water	8.3	6.8
		Potassium silicates	8.7	7.3
		Algae extracts and micronutrients	10.2	8.4
	50% from (RD)	Water	7.7	6.3
		Potassium silicates	8.3	6.8
		Algae extracts and micronutrients	8.5	7.2
I3	100% (RD)	Water	7.6	6.1
		Potassium silicates	8.9	7.4
		Algae extracts and micronutrients	10.1	8.4
	75% from (RD)	Water	7.2	5.7
		Potassium silicates	7.7	6.5
		Algae extracts and micronutrients	9.2	7.7
	50% from (RD)	Water	7.0	5.4
		Potassium silicates	7.6	5.7
		Algae extracts and micronutrients	8.1	6.1
LSD at 0.05			0.553	0.463

I1, I2, I3= Irrigation after exhaustion of 50%, 70 and 90 from the available water, respectively.

of seed cotton yield/fad., meanwhile irrigation at 90% depletion of available soil moisture and soil application of 50% NPK (RD) and foliar application of water (control) gave the lowest value of seed cotton yield/fad., in both seasons.

Conclusion

Growth and yield of cotton were affected by water stress by using NPK fertilization and foliar application. The highest value of growth, yield characters were achieved under irrigation regime (50% depletion of available soil moisture) and recommended dose of NPK and foliar application of Algal extracts + amino acids + micronutrient) under Nubaria conditions.

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تأثير الإجهاد المائي والتسميد علي إنتاجية القطن تحت ظروف الأراضي الجيرية

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أجريت تجربتان حقليتان في مزرعة محطة بحوث النوبارية-الكيلو ٤٦ طريق الصحراوي مصر-الإسكندرية خلال موسمي ٢٠١٧ و ٢٠١٨ لدراسة استجابة صنف جيزة ٩٤ من القطن المصري للتسميد ب NPK والرش الورقي تحت ظروف الإجهاد المائي، استخدم تصميم القطع المنشقة مرتين في أربعة مكررات وكانت المعاملات معاملات الإجهاد المائي فى القطع الرئيسية وهى: الرى بعد استنفاذ ٥٠ % من الماء القابل للأستفادة - الرى بعد استنفاذ ٧٠% من الماء القابل للأستفادة - الرى بعد استنفاذ ٩٠% من الماء القابل للأستفادة، وكانت معاملات التسميد فى القطع الشقية الأولى وهي: التسميد ب ١٠٠% من المعدلات الموصى بها NPK (٧٥ كجم ازوت : ٣١ كجم فو٢أ٥ :٤٨ كجم بو٢أ/فدان)- التسميد بـ ٧٥% من المعدلات الموصى بها من NPK- (٥٦,٣ كجم آزوت : ٢٣,٣ كجم فو٢أ٥ : ٣٦,٠ كجم بو٢أ/فدان)- التسميد بـ ٥٠% من المعدلات الموصى بها من NPK، (٣٧,٥ كجم آزوت : ١٥,٥ كجم فو٢أ٥ : ٢٤ كجم بو٢أ/فدان)، كما كانت معاملات الرش الورقي فى القطع الشقية الثانية وهي: الرش بالماء (مقارنة) الرش بسيليكات البوتاسيوم (قبل بداية الأزهار وبعدها باسبوعين بمعدل ١ كجم/فدان)- رش مستخلص طالحب وأحامض أمينية وعناصر صغري قبل بداية الأزهار وبعدها بأسبوعين (بمعدل ١ لتر/فدان)، وكانت أهم الصفات المدروسة (إرتفاع النباتات عند الجنى- عدد الأفرع الثمرية/ النبات - ميعاد ظهور أول زهرة - ميعاد تفتح أول لوزة ،عدد اللوز المتفتح/النبات، متوسط وزن اللوزة من القطن الزهر، محصول القطن الزهر/النبات، محصول القطن الزهر/فدان)، وكانت أهم النتائج: كان هناك تأثيراً معنوياً لعوامل الدراسة الثلاثة على صفات المحصول ومكوناته خلال موسمي الزراعة، كما يوجد تأثير معنوي لمعاملات الري تحت الدراسة على صفات النمو والمحصول حيث أن الري بعد استنفاذ ٥٠% من الماء القابل للاستفادة حقق أعلى قيم في ارتفاع النبات وعدد الأفرع الثمرية/النبات- عدد اللوز المتفتح/النبات، متوسط وزن اللوزة من القطن الزهر، محصول القطن الزهر/النبات، محصول القطن الزهر/فدان، كما وجد أن التسميد الأرضي بالجرعة الموصى بها من NPK (١٠٠%) حقق أعلى متوسطات في معظم الصفات المدروسة، كما وجد أيضاً أن الرش الورقي لمستخلص الطحالب البحرية مع العناصر الصغري أعطى أعلى قيم لصفات المحصول ومكوناته في القطن المصري، يمكن التوصية بزراعة صنف القطن جيزة ٩٤ باستخدم نظام الري بعد استنفاذ ٥٠% من الماء المتاح مع الإضافة الأرضية للجرعة الموصى بها من السماد المعدني النتروجيني الفوسفوري والبوتاسي والرش الورقي لمستخلص الطحالب + العناصر الصغري حيث أن هذه التوليفة ذات تأثير معنوي على المحصول ومكوناته لنبات القطن المصري تحت الظروف البيئية لمنطقة الدراسة.
