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Response of Two Egyptian Cotton Cultivars to the Balanced Fertilization Between Macro and Micro Nutrients as Foliar Application

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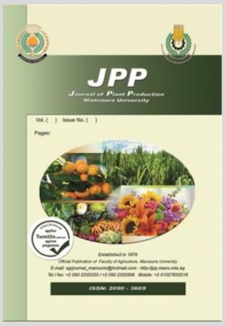

ABSTRACT

Two field experiments were conducted at Agricultural Research and Experimental Station, Faculty of Agriculture, Cairo University, Giza, Egypt during 2017 and 2018 seasons to evaluate the response of two Egyptian cotton cultivars to the balanced between macro and micro fertilization as foliar application. The experiment included 14 treatments which were the combination of two cultivar and the foliar application of six chemical nutrient solutions (zinc 100 mg/L, zinc 200 mg/L, boron 500 mg/L, boron 1000 mg/L, novatreen 1L/fed and citreen 1 L/fed) in addition to control treatment. The experiment was laid out in a randomized complete block design with split plot arrangement with three replications. The cultivars were allocated in the main plots and the foliar application of nutrient were distributed in sub-plots. The two cultivars significantly varied in almost of studied traits. Giza 196 cultivar significantly exceeded Giza 195 in plant height, number of sympodial branches/plant, total number of bolls/plant, boll weight, seed index, lint%, seed cotton yield. Also, Giza 196 significantly surpassed Giza 195 in fiber length, fiber strength, fiber elongation and micronaire. Compared with control, the foliar of nutrient solutions significantly increased growth characters, seed cotton yield and yield components. Furthermore, spraying of nutrient solutions significantly improved fiber technology characters, macro and micronutrients contents of cotton leaves, biochemical compositions of leaves and both oil and protein contents of cotton seed in both seasons. Generally, novatreen recorded the best for all studied characters. The interaction between cotton cultivars and nutrient solutions was significant regarding most of studied traits.

Keywords: Cotton (*Gossypium barbadence* L) cultivars - foliar nutrient solutions - micronutrients - fiber technology

INTRODUCTION

Cotton (*Gossypium barbadence* L.) in Egypt is grown as an irrigated crop, solid culture or relay intercropped with onion. Throughout the early development of Egyptian cotton cultivars, increased productivity, fiber quality, regional adaptation, earliness and pests resistance have been primary objectives of improving efforts in modern Egyptian cotton cultivars. The increasing use of more productive cultivars worldwide, with a higher nutrient demand, requires a better knowledge for the nutritional relationships in cotton (Rochester and Constable, 2015). The achievement of higher cotton yield was more limited by nutrients supply than other crop management practices such as water, diseases, and pests. So, understanding cotton nutrition demands and enhancing nutrient use efficiency through better nutrient management practices should be a high priority for current cotton production (Constable and Bange, 2015). In this regard, a better understanding of the nutritional dynamics is important for the establishment of an efficient fertilization program. Sawan, (2016) in Egypt, stated that soil fertilization is the markedly limiting factor affecting growth and production under intensive land use for two or more crops per year. Furthermore, recently released cultivars have high yielding ability, which mainly depends on ensuring the plant's essential nutritional requirements (*e.g.* N, P, K, Ca; Zn). In west Africa, low cotton yield being accompanied by a drop in the soil organic matter and a deficiency in micronutrients such as Mg, Fe, Cu and Zn (Kidron and Zilberman, 2019). Under Egyptian conditions, some soil are perceived as being likely to induce micronutrients deficiencies such as high pH, low organic matter and high calcium carbonate, (Hamissa and Abdel-Salam, 1999). The deficiency of boron and zinc is a common nutrient problem in crop production in arid and semi arid regions whereas always soil pH is high and organic matter is low. Nutritional deficiency is serious abiotic stress factors in Egypt, whereas the soil is also generally low in plant available B and Zn concentration (Eleyan, *et al*., 2014). Zinc deficiency is a worldwide nutritional constraint for crop production (Fageria *et al*., 2002). Cotton in compared to some other crops such as wheat, oat and pea is reported to be particularly sensitive to Zn deficiency (Alloway, 2008). The symptom of zinc deficiency can be observed in cotton grown in high pH soils, particularly where topsoil has been removed in preparing fields for irrigation and thereby exposing the Zn-deficient subsoil. In addition, Zn deficiencies have occurred where high rates of phosphorus are applied. High rates of phosphorus in the plant interfere with the utilization of zinc. (Oosterhuis, *et al*.,1991).

Boron (B) is the most deficient micronutrient in cotton (Bogiani, *et al*., 2014). Cotton responds positively to boron fertilization under boron deficient soils (Howard, *et al*., 2000; Görmüş, 2005 and Dordas, 2006). Cotton needs a relatively high requirement for boron and many times boron is applied

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as soil or foliar application (Shorrocks, 1997; Bell, 1997; Zhao and Oosterhuis, 2002). Boron deficiency in cotton reduced leaf photosynthesis and carbohydrate transport from leaves to developing fruit, depressed total dry matter production, plant height, number of reproductive structures, plant growth resulting in increased fruit abscission (Rosolem and Costa, 1999 as well as Zhao and Oosterhuis, 2003). On the other hand, boron deficiency in cotton may cause small deformed bolls, poor fruit retention and decreased lint yields (Roberts, *et al*., 2000). While B is essential for all stages of cotton plant growth, an available supply is most important through flowering and boll development stages (Görmüş, 2005). Ahmad, *et al*., (2019b) reported that deficiency soil of boron affects the yield potential of cotton to the greatest extent. Furthermore, boron is in crucial position in the uptake and translocation of other macro- and micronutrients (N, P, K, Zn, Fe, and Cu) in plants (Day and Aasim, 2020). For example decreasing in nitrogen and calcium and increment of phosphorus and potassium depending on B excess were observed in cotton by Ahmed *et al*., (2008).

Cotton being a long-duration crop extracts large quantities of nutrients from the soil whereas, the nutrient removal is greater under irrigated conditions than those under rainfed conditions (Blasé, 2006). Nutrients are directly required for leaf growth and as integral constituents of the photosynthetic apparatus. Nutrient supply indirectly controls photosynthesis and leaf senescence via photooxidation, hydraulic and hormonal signals as well as by sugar signalling. Nutrients also affect respiration as constituents of the respiratory electron chain and by their influence on the efficiency of respiratory ATP synthesis (Engels, *et al*., 2012). Mineral nutrient application affects leaf area and the rate of photosynthesis, and therefore the ability of the plant to deliver photosynthates to the sink organs. The positive effect of mineral nutrient supply on a number of sink organs results not only from an increase in mineral nutrient supply, but also from an increase in the photosynthate supply to the sink sites or from hormonal effects (Borowski, 2001).The mainly function of micronutrients is as constituents of prosthetic groups in metalloproteins and as activators of enzyme reactions. As constituents of prosthetic groups, micro nutrients catalyze redox processes by electron transfer (mainly the transition elements Fe, Mn, Cu, and Mo), they form enzyme-substrate complexes by coupling enzyme and substrate (e.g., Fe and Zn), or they enhance enzyme reactions by influencing the molecular configuration of an enzyme or substrate (e.g., Zn). For the nonmetals, B and CI, there are no well-defined element-containing enzymes or other essential organic compounds known in which these micronutrients are present (Römheld and Marschner, 1991). The imbalanced between macro and micro of applied fertilizers is the main obstacle in the way of increasing average of cotton yield (Rezaei and Malakouti, 2001). Meanwhile, an adequate supply of macro and micronutrients are necessary for ensuring reasonable cotton growth and development (Ahmad, *et al*., 2019a). Sustainable crop production and maintenance of soil health require a balanced fertilizer use which has both economic and environmental implications. An imbalanced fertilization program results in low fertilizer use efficiency leading to less economic returns and greater threat to environment (Zubillaga, *et al*., 2002; Benbi, *et al*., 2006; Saleem, *et al*. 2016 and Ahmad, *et al*., 2019b).

Several investigations documented favorable effect of novatreen as foliar application on the growth, yield and quality of some crops such as green beans, *Phaseolus vulgaris* L. (Nour-Eldin and Sholla,2015), Soybean, *Glycine max* (L.) Merr. (Sharaf, 2019) and Mulberry, *Morus spp* (Fouad and Ahmed, 2020). On the other hand, many studies reported an enhancement in the foliage, yield and quality of some crops when citreen was used as foliar fertilizer (Morsy and Abd EL–Razek, 2013; Saber and Sharaf, 2013; Badr, 2016 as well as Fouad and Ahmed, 2020).

Foliar application provides more rapid utilization of nutrients and permits the correction of observed deficiencies in less time than would be required by soil application. Meanwhile, foliar fertilization is more effective than soil application (Fageria, *et al*., 2009, Khoshgoftarmanesh, *et al*., 2010 as well as Oosterhuis and Weir, 2010). The foliar spray of some micronutrients such as Zn, B, Fe, Mn, and Cu, is usually more efficient than soil application because they are inaccessible to plant roots under the higher soil pH conditions (Rashid and Ryan, 2004). Using smaller quantities of nutrient with foliar fertilization than a soil application is usually necessary, thereby the most important use of foliar fertilization has been in the application of micronutrients where only small quantities of the nutrient is required (Oosterhuis and weir, 2010).

The aim of this investigation was to study the effect of the balanced between macro and micro fertilization as foliar application of two nutrient solutions (novatreen and citreen) and two microelements (Zn and B) on growth, yield and quality of two newly released Egyptian cotton cultivars (Giza 95 and Giza 96).

MATERIALS AND METHODS

Two field experiments were conducted at Agricultural Research and Experimental Station, Faculty of Agriculture, Cairo University, Giza, Egypt (30º N, 31º: 28'E with an altitude of 19 m), during two summer successive growing seasons of 2017 and 2018 to evaluate the productivity and fiber quality response of two new released Egyptian cotton (*Gossypium barbadence* L.) namely Giza 95 (long staple cultivars grown at Upper Egypt) and Giza 96 (extra-long staple cultivars grown at Lower Egypt) to the balanced between macro and micro fertilization as foliar application of some chemical nutrients solutions. The experiment included 14 treatments, which were the combination of two cultivar and the foliar application of six chemical nutrient solutions (Zinc 100 mg/L, Zinc 200 mg/L, Boron 500 mg/L, Boron 1000 mg/L, novatreen 1L/fed and citreen 1 L/fed) in addition to control treatment (tap water). Zinc was applied in the form of zinc sulphate ($Zn\ SO_4$) while boron was applied as borax (11% boron). novatreen and citreen are a foliage fertilizer, a nutrients mixture of a registered brand obtained from bio-fertilizers unit, General Organization of Agriculture Equalization Fund, ARC at Giza, Egypt. Novatreen is containing macro and micronutrients as follow 5% nitrogen, 5% phosphorous (P_2O_5), 0.15% chelated iron, 0.15% chelated zinc, 0.1% chelated manganese, 0.05% boron and 0.02% Molybdate + spreading agents. Citreen consists of 2% iron, 2% zinc, 2% manganese,15% organic acids and 3% spreading agents. Manual sprayers were used at the rate of

200 L water /fed. Foliar spraying was performed twice, at the first commence of flowering and the second was 15 days later.

A composite soil samples (0 - 30 cm) were collected from the site of the experiment during 2017 and 2018 seasons at time of sowing to study the physical and chemical of soil properties according to standard methods outline by Jackson (1973). Available zinc, manganese and iron were determined using Atomic Absorption Spectrophotometer (AAS) after extracting the soil with DTPA as proposed by Lindsay and Norvell (1978). Boron was extracted by hot water and measured colorimetrically using azomethine-H (Keren, 1996). The values of physical and chemical characteristics are presented in Table 1.

Table 1. Some physical and chemical properties of the experimental soil (0-30 cm depth) during 2017 and 2018 growing seasons of cotton .

Soil properties	Season	
	2017	2018
Physical analysis:		
Clay%	33.9	32.5
Silt%	31.2	29.7
Fine Sand%	30.9	35.5
Coarse Sand%	4.0	2.3
Texture	Clay loam	Clay loam
Chemical analysis:		
pH (paste extract)	7.73	7.61
EC (dS/m)	1.91	1.87
Organic matter (%)	2.11	2.15
Total calcium carbonate (%)	3.47	3.67
Available nitrogen (mg/kg)	41.3	34. 8
Available phosphorus (mg/kg)	8.86	9.23
Available potassium (mg/kg)	242	223
DTPA-extractable Zn (mg/kg)	0.52	0.44
DTPA-extractable Mn (mg/kg)	0.75	0.89
DTPA-extractable Fe (mg/kg)	3.17	3.05
Hot water extractable B (mg/kg)	0.49	0.43

The experiment was laid out in a randomized complete block design with split plot arrangement with three replications. The two cultivars were allocated in the main plots and the foliar application treatments were randomly distributed in sub-plots. Each plot consisted of eight ridges. The ridge was four meters long, 60 cm apart and 20 cm between hills on one side of the ridge. The preceding crop was Egyptian clover (*Trifolium alexandrinum* L.) in both seasons. The cotton seeds were planted during the first week of April in both seasons. Thinning till two plants were left per hill was carried out before the first irrigation (21-28 days after planting). The application of NPK fertilizers were applied as follows: Nitrogen at the rate of 60 kg N/fed (Ammonium nitrate 33.5 % N) and Potassium at the rate of 48 kg K_2O/fed as potassium sulphate were split and side-dressed before the second and third irrigation. Phosphorus at 30 kg P_2O_5/fed as super phosphate (15.5 % P_2O_5) was broadcasted during seed bed preparation. Common cultural practices were carried out as recommended in cotton fields.

In both seasons, five representative hills (10 plants/plot) were randomly chosen and 50 bolls picked at random at harvest from the outer four ridges to determine growth attributes and some yield components respectively. Growth attributes included; plant height(cm), number of sympodial branches/plant, position of first sympodial node and total number of bolls/plant while, yield components included; boll weight (g) and seed index (g): weight of 100 seeds and lint percentage: sample lint weight to seed cotton weight expressed as percentage. The inner four ridges of each plot were hand harvested (picking) twice to determine seed cotton in kilogram/plot and transformed to Kentar/fed (one Kentar = 157.5 kg). Picking of cotton seed was started when more than 50 % bolls were opened.

Fiber properties were estimated as fiber length at upper half means (U.H.M) mm, length uniformity index (U.I), fiber strength in grams/tex, fiber elongation % (the percentage of elongation, which occurs before a fiber bundle breaks), micronaire value and color attributes values i.e. Reflectance (Rd %) and Yellowness (+b %). The previous fiber tests were determined using high volume Instrument (HVI) according to (A.S.T.M: D 46050 – 1998). All fiber tests were performed at the laboratories of the Cotton Research Institute, Agricultural Research Center, under constant conditions of temperature (70° F ± 2) and relative humidity (65 % ± 2).

Chemicals analysis

Ten fully expanded new leaves with petioles (fourth upper leaf) were randomly taken from plants of each plot after two weeks from the last spraying of nutrient solutions. Leaf samples were washed with distilled water and blotted dry with tissue papers before oven dried at 70° C for 48h and finely ground to pass a 1 mm sieve. Total nitrogen (N) was determined by a modified Kjeldahl procedure which included a salicylic acid pretreatment to aid in the reduction of NO_3 (Eastin, 1978). While phosphorus (P) was determined according to the procedure of vanadate-molybdate spectrophotometric (Jones *et al*., 1991). potassium (K) and Calcium (Ca) were determined by a flam photometer (Chapman, and Pratt, 1961). The concentration of zinc (Zn), iron (Fe), manganese (Mn) and copper (Cu) in leaf of cotton were determined according to Jones *et al*., (1991). Boron (B) was determined on a spectrophotometer (Gaines and Mitchell, 1997). Total Phenolics were estimated using the Folin−Ciocalteu colorimetric method of (Swain and Hillis,1959) . Total carbohydrate contents in the dried leaf samples were determined as described by Herbert, *et al*., (1971).

Sample of fuzzy seeds for each treatment in the two seasons was used to measured seed crude protein content (A.O.A.C., 1985) and seed oil content in which oil was extracted three times with chloroform/methanol (2:1, vol/vol) mixture according to the method described by Kates (1972). The oil content and crude protein content were expressed as percentages of the fuzzy seed mass.

Data analysis: Data collected on different parameters were subjected to analysis of variance according to Steel *et al*., (1997). Treatment means, at probability level of 0.05 were compared based on least significant difference (LSD). Finally, all statistical analysis was carried out using "MSTAT-C" program 1991.

RESULTS AND DISCUSSION

Growth characters

Cultivars, nutrient solutions and their interaction had a significant effect on the most of growth characters of cotton plant in both seasons (Table 2). With the exception of number of total bolls/plant, plant height, position of first sympodial node and number of sympodial branches/plant significantly differed between both cultivars. Giza 196 cultivar gave higher plants (145.68 and 148.57cm), higher number of sympodial branches/plant (17.05 and 17.77) and lower position of first sympodial node (5.67 and 5.55cm) than Giza 195 cultivar in both seasons. These results could be attributed to variation in genetic constitution of both cultivars. Many Investigations reported varietal differences among Egyptian cotton cultivars (*Gossypium barbadense* L.) regarding growth characters for example, Abdallah and Mohamed, (2013) observed varietal differences between Giza 90 and Giza 92 cultivar, Eleyan, *et al*., (2014) among Giza 88, Giza 90 and Giza 92 cultivar as well as El-Gedwy, *et al*., (2018) between Giza 86 and Giza 88 cultivar.

Table 2. Some growth attributes of two cotton cultivars as affected by the different foliar application of nutritional treatments in 2017 and 2018 seasons.

Treatments		**Plant height (cm)**		**Position of first sympodial node**		**No. of sympodial branches /plant**		**No. of total bolls /plant**	
Cultivars (A)	**Nutrients solutions (B)**	**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**
Giza 96	Control(tap water)	138.95	136.83	6.82	6.14	15.66	16.83	11.17	11.84
	Novatreen	156.63	158.18	5.20	5.72	18.78	18.76	12.78	13.14
	Citreen	148.50	152.32	5.55	5.17	17.14	18.04	12.18	13.03
	Zinc 100 mg / L	142.11	145.87	5.61	5.33	17.10	17.51	11.41	12.45
	Zinc 200 mg / L	145.22	149.40	5.44	5.43	17.42	17.82	11.63	12.83
	Boron 500 mg/L	141.14	147.13	5.57	5.64	16.27	17.49	11.84	12.50
	Boron 1000 mg/ L	147.18	150.24	5.51	5.42	16.98	17.96	12.01	12.92
Mean of cultivars (A)		145.68	148.57	5.67	5.55	17.05	17.77	11.86	11.24
Giza 95	Control(tap water)	126.54	129.61	8.16	8.91	12.22	13.01	9.33	10.04
	Novatreen	140.90	140.11	7.11	7.13	15.74	16.81	11.97	12.34
	Citreen	136.62	137.14	7.46	7.72	15.07	16.07	11.74	12.10
	Zinc 100 mg / L	129.33	131.67	7.93	7.90	13.93	15.20	10.87	11.14
	Zinc 200 mg / L	132.66	133.93	7.58	7.41	14.10	15.47	11.13	11.72
	Boron 500 mg/L	133.44	132.16	7.37	7.46	14.46	15.58	11.08	11.43
	Boron 1000 mg/ L	135.34	135.73	7.25	7.33	14.71	16.01	11.51	11.81
Mean of cultivars (A)		133.55	134.34	7.55	7.79	14.32	15.45	11.09	11.51
Means of Nutrients solutions (B)	Control(tap water)	132.75	133.22	7.49	7.53	13.94	14.92	10.25	10.94
	Novatreen	148.77	149.73	6.16	6.43	16.94	17.79	12.38	12.74
	Citreen	142.56	149.15	6.51	6.45	16.43	17.06	11.96	12.54
	Zinc 100 mg / L	135.72	138.77	6.77	6.62	15.52	16.36	11.14	11.80
	Zinc 200 mg / L	138.94	141.67	6.51	6.42	15.76	16.65	11.38	12.28
	Boron 500 mg/L	137.29	139.65	6.47	6.55	15.37	16.54	11.46	11.97
	Boron 1000 mg/ L	141.26	142.99	6.38	6.38	15.85	16.99	11.76	12.37
Mean		139.61	141.45	6.61	6.62	15.68	16.61	11.48	12.09
$L.S.D_{0.05}$	A	1.94	2.07	0.07	0.09	0.45	0.53	NS	NS
	B	2.03	2.13	0.10	0.13	0.37	0.42	1.57	1.66
	A×B	2.71	2.84	0.14	0.17	0.75	0.81	1.37	1.41

The foliar application of nutrient solutions increased plant height, number of sympodial branches/plant and number of total bolls/plant in both seasons compared to the control (tap water). In contrast, position of first sympodial node decreased when the plants of cotton sprayed by nutrients solutions over control treatment (Table 2). Over all nutrient solutions novatreen recorded the highest plant (148.77 and 149.73 cm), the highest number of sympodial branches/plant (16.94 and 17.79) and number of total bolls/plant (12.38 and 12.74) in 2017 and 2018 seasons respectively. In this context, El-Gazzar and El-Kady (2000) concluded that novatreen and citreen application significantly increased crop growth rate and relative growth rate of flax. On the other hand, the lowest position of first sympodial node in the first seasons achieved by using novatreen (16.6 cm) while, in the second seasons obtained by using boron 1000 mg/L (6.38 cm) as foliar application. This may be attributed to better uptake and translocation of plant nutrients and more photosynthesis which in turn increased plant height, leaf area /plant, number of functional leaves /plant, number of sympodial branches/ plant and total dry matter /plant. These results are confirmed with those obtained by Sankaranarayanan, *et al*., (2010); Singh, *et al*., (2012); Ahmed, *et al*., (2013); Abdallah and Mohamed, (2013); Gebaly, (2013); Yaseen, *et al*., (2013); Eleyan, *et al*., (2014); Ahmad, *et al*., (2016); Buriro, *et al*., (2016); Emara, (2016); Emara, and Abd El-All, (2017); Ibrahim, and El-Hafeez, (2017); Nafiu, *et al*., (2017); El-Ashmouny, and El-Naqma, (2018); El-Gedwy, *et al*., (2018); More, *et al*., (2018) and Haliloglu, (2019) who reported that cotton micronutrients fertilization had a positive effect on growth characters of cotton plant such as plant height, number of sympodial branches/plant, number of internodes/plant and number of total bolls/plant.

The interaction between the two cultivars and nutrient solutions had a significant effect on plant height, position of first sympodial node, number of sympodial branches/plant and number of total bolls/plant in 2017 and 2018 seasons (Table 2). The highest plants (156.63 and 158.18 cm), number of sympodial branches/plant (18.78 and 18.76) and number of total bolls/plant (12.78 and 13.14) were recorded with the application of novatreen with Giza 196 cotton cultivar in both seasons. The higher position of first sympodial node (8.16 and 8.91 cm) were obtained when the plants of Giza 195 cultivars untreated in 2017 and 2018 seasons. The lowest value of plant height (126.54 and 129.61cm), number of sympodial branches/plant (12.22 and 13.01) and number of total bolls/plant (9.33 and 10.04) were observed for the plants of Giza 195 cultivar with control treatment in both seasons. The lower position of first sympodial node (5.20 and 5.17 cm) were obtained when the plants of Giza 196 cultivars sprayed by novatreen and citreen in 2017 and 2018 seasons respectively (Table 2).

Yield and yield components

Results in Table (3) indicated that yield and yield components characters studied in this experiment significantly influenced by the two cultivars, the foliar application of nutrient solutions and their interaction in both seasons. The two cultivars significantly varied in seed index, boll weight, lint % and seed cotton yield in 2017 and 2018 seasons. Giza 196 cotton cultivar exceeded Giza 195 cotton cultivar in seed index (10.14 and 10.25 g), boll weight (2.30 and 2.35 g), lint % (36.30 and 36.93 g) and seed cotton yield (9.76 and 10.01 Kentar/fed) in both seasons. Such results are mainly due to the differences in genetic make-up of the assessment of both cotton cultivars. In this context, Soomro *et al*., (2000) concluded that cotton genotypes differs in their susceptibility and tolerant to micronutrient-deficient conditions. On the other hand, these results are in agreement with those obtained by Eleyan, *et al*., (2014), Saleem, *et al*., (2016) and El-Gedwy, *et al*., (2018) who found that varietal differences regarding seed index, boll weight, lint percentage and seed cotton yield. In contrast, Abdallah and Mohamed, (2013) observed that there was no significant difference between Giza 90 and Giza 92 Egyptian cotton cultivars (*Gossypium barbadense* L.) concerning boll weight, lint percentage and seed cotton yield.

Table 3. Some yield characters of two cotton cultivars as affected by different foliar application of nutritional treatments in 2017 and 2018 seasons.

Treatments		Seed index (g)		Boll weight (g)		Lint %		Seed cotton yield/fed	
Cultivars (A)	Nutrients solutions (B)	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Giza 96	Control (tap water)	9.88	9.93	2.23	2.29	34.86	35.34	9.15	9.24
	Novatreen	10.50	10.66	2.39	2.43	38.02	38.30	10.26	10.33
	Citreen	10.31	10.43	2.30	2.37	36.94	37.11	9.97	10.12
	Zinc 100 mg / L	9.93	10.05	2.25	2.30	35.16	35.86	9.58	9.91
	Zinc 200 mg / L	10.04	10.11	2.31	2.36	36.77	37.08	9.80	10.03
	Boron 500 mg/L	10.13	10.23	2.28	2.32	35.40	36.97	9.63	9.96
	Boron 1000 mg/ L	10.21	10.34	2.37	2.41	36.96	37.82	9.91	10.5
Mean of cultivars (A)		10.14	10.25	2.30	2.35	36.30	36.93	9.76	10.01
Giza 95	Control (tap water)	9.06	9.12	2.15	2.19	30.44	31.32	7.95	8.07
	Novatreen	9.95	10.04	2.34	2.35	33.90	34.18	8.46	8.91
	Citreen	9.87	9.98	2.30	2.27	32.87	33.37	8.23	8.32
	Zinc 100 mg / L	9.10	9.36	2.17	2.23	31.42	32.51	8.12	8.14
	Zinc 200 mg / L	9.23	9.50	2.21	2.31	32.88	33.16	8.19	8.25
	Boron 500 mg/L	9.17	9.42	2.24	2.29	31.92	33.10	8.13	8.17
	Boron 1000 mg/ L	9.35	9.61	2.28	2.33	32.98	33.57	8.21	8.29
Mean of cultivars (A)		9.39	9.58	2.24	2.28	32.34	33.03	8.18	8.31
Means of Nutrients solutions (B)	Control (tap water)	9.47	9.53	2.19	2.24	32.65	33.33	8.55	8.66
	Novatreen	10.23	10.35	2.37	2.39	35.96	36.24	9.36	9.62
	Citreen	10.09	10.21	2.30	2.30	34.91	35.24	9.10	9.22
	Zinc 100 mg / L	9.52	9.71	2.21	2.27	33.29	34.19	8.85	9.03
	Zinc 200 mg / L	9.64	9.81	2.26	2.34	34.83	35.12	9.00	9.14
	Boron 500 mg/L	9.65	9.83	2.26	2.31	33.66	35.04	8.88	9.07
	Boron 1000 mg/ L	9.78	9.98	2.33	2.37	34.97	35.70	9.06	9.40
Mean		9.77	9.91	2.27	2.32	34.32	34.98	8.97	9.16
$L.S.D_{0.05}$	A	0.43	0.55	0.01	0.03	1.58	1.63	0.95	0.68
	B	0.85	0.96	0.02	0.10	1.29	1.47	0.48	0.61
	A×B	0.37	0.52	0.14	0.12	1.87	1.90	0.81	1.93

The treatment of nutrient solutions application had a significant effect on seed index, boll weight, lint % and seed cotton yield in 2017 and 2018 seasons (Table 3). With a few exceptions, seed index, boll weight, lint % and seed cotton yield significantly increased by the application of all nutrient solutions over untreated treatments in the first and second seasons. The highest values of seed index (10.23 and 10.35), boll weight (2.37 and 2.39g), lint % (35.96 and 36.24) and seed cotton yield (9.36 and 9.62 Kentar/fed) when the plant of cotton applied by novatreen in both seasons followed by the application of citreen for seed index (10.09 and 10.21) and seed cotton yield (9.10 Kentar/fed) in both and first season respectively while, followed by the application of boron 1000mg/L for boll weight (2.33 and 2.37g),), lint % (34.97 and 35.70) in both seasons and seed cotton yield (9.40 Kentar/fed) in the second season only. These results could be attributed to an increase of micronutrient contents in leaves thereby, increasing the production of metabolites synthesized and thus increased the chance to promote fruiting branches. Seed cotton yield increase was the consequence of enhanced fruiting branches, number of bolls/plant and boll weight. The superiority of novatreen over the other nutrient solutions may be due to the formulation of novatreen as a mixture of macro and micronutrients which providing an adequate and balanced supply of nutrients resulting in higher nutrients uptake promoting hormones especially, the production of auxins resulting in enhanced growth and development of plant organs. These results are in harmony with those reported by Ishag, (1992); Soomro, *et al*., (2000); Rezaei, *et al*., (2001); Soomro, *et al*., (2001); Sawan, *et al*., (2001); Görmüş, (2005); Dordas, (2006); Sawan, *et al*., (2007); Temiz, *et al*., (2009); Sankaranarayanan, *et al*., (2010); Ali, *et al*., (2011); Abdallah and Mohamed, (2013); Yaseen, *et al*., (2013); Eleyan, *et al*., (2014); Singh, *et al* ., (2015); Buriro, *et al*., (2016); Emara, (2016); Kharagkharate, *et al*., (2017); Ibrahim, and El-Hafeez, (2017); Nafiu, *et al*., (2017); Ajmal, *et al*., (2018); El-Ashmouny, and El-Naqma, (2018); El-Gedwy, *et al*., (2018) and More, *et al*., (2018) who reported that application of micronutrients increased seed cotton yield and yield components such as boll weight, seed index and lint percentage.

Seed index, boll weight, lint % and seed cotton yield significantly affected by the interaction between cotton cultivars and the application of nutrient solutions in both seasons (Table 3). The highest value of seed index (10.50 and 10.66 g), boll weight (2.39 and 2.43 g), lint % (38.02 and 38.30) and seed cotton yield (10.26 and 10.33 Kentar/fed) were obtained when the plants of Giza 196 cultivar applied with novatreen as a nutrient solution in 2017 and 2018 seasons.

Technology characters

Except brightness (Rd%) and yellowness (+b), cultivars, nutrient solutions and their interaction had a significant effect on the studied technology characters of cotton fiber in both seasons (Table 4 and 5). Results clearly indicated that Giza 196 cultivar surpassed Giza 195 cultivar in fiber length UHM (34.79 and 34.93 mm), fiber uniformity ratio (86.69 and 87.22%), fiber elongation (7.19 and 7.46%) and fiber strength (46.08 and 46.33 g/tex) in 2017 and 2018 seasons.

The results of micronaire reading (fiber fineness) were inconsistent in both seasons while Giza 195 surpassed Giza 196 in the first seasons and vice versa in the second season. Such difference may be due to differences in genetic constitution of both cultivars meanwhile, as previously mentioned Giza 96 is an extra-long staple cultivar while Giza 95 is a long staple cultivar. The above mentioned results agreed with those reported by Barakat, *et al*., (1975), Ahmad, *et al*., (2009), Abdallah and Mohamed, (2013), Eleyan, *et al*., (2014) and El-Gedwy, *et al*., (2018) who reported a significant genetic variability existed for technology characters.

Fiber length UHM (mm), fiber uniformity ratio (%), fiber elongation and fiber strength significantly increased with the application of the six nutrient solutions compared with control treatment. On the contrary, micronaire reading significantly decreased with the application of novatreen, citreen, zinc and boron compared to untreated treatment in both seasons (Table 3 and 4).

The highest values of fiber length UHM (33.21 and 33.34mm), fiber uniformity ratio (88.68 and 88.82%), fiber elongation (7.76 and 8.20%) and fiber strength (44.03 and 44.17 g/tex) were obtained when the plants of cotton sprayed by novatreen in both seasons. Also, the lowest value of micronaire reading (2.92 and 2.84) produced by using novatreen in 2017 and 2018 seasons (Table 3 and 4). These observations are in confirmation with the findings of other researchers (Ahmad, *et al*., (2009); Başbağ, *et al*., (2012); Abdallah and Mohamed, (2013); Gebaly, (2013); Eleyan, *et al*., (2014); Buriro, *et al*., (2016); Emara, (2016); Khan, *et al*., (2016); Emara, and Abd El-All, (2017); El-Ashmouny, and El-Naqma, (2018) and El-Gedwy, *et al*., (2018) who observed an enhancement in cotton fiber quality such as fiber length, fiber uniformity ratio (%), fiber elongation, fiber strength and fiber fineness). On the other hand, according to Sawan, et al. (1997); Görmüş, (2005); Temiz, et al., (2009) and Sawan, et al., (2007) no significant effect of micronutrients application on aforementioned fiber quality.

Table 4. Some technology characters of two cotton cultivars as affected by different foliar application of nutritional treatments in 2017 and 2018 seasons.

Treatments		Fiber length UHM (mm)		Fiber uniformity ratio (%)		Fiber elongation (%)		Fiber strength (g/tex)	
Cultivars (A)	Nutrients solutions (B)	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Giza 96	Control (tap water)	33.87	33.93	85.14	86.55	6.19	6.97	41.02	41.17
	Novatreen	36.18	36.22	89.91	90.02	8.10	8.45	48.13	48.32
	Citreen	35.17	35.81	87.15	87.93	7.55	7.86	47.21	47.45
	Zinc 100 mg / L	34.10	34.41	85.56	85.97	7.03	7.11	46.04	46.12
	Zinc 200 mg / L	34.25	34.37	86.04	86.14	7.12	7.19	46.95	47.01
	Boron 500 mg/L	34.37	34.56	86.13	86.88	7.13	7.24	46.13	46.92
	Boron 1000 mg/ L	35.04	35.24	86.91	87.07	7.20	7.42	47.07	47.35
Mean of cultivars (A)		34.79	34.93	86.69	87.22	7.19	7.46	46.08	46.33
Giza 95	Control (tap water)	27.93	28.04	83.51	83.97	6.02	6.11	33.20	33.65
	Novatreen	30.24	30.45	87.44	87.61	7.42	7.95	39.92	40.02
	Citreen	29.54	29.90	85.13	85.37	7.10	7.28	34.41	34.85
	Zinc 100 mg / L	28.11	28.39	84.93	85.10	6.15	6.57	36.22	36.89
	Zinc 200 mg / L	28.94	29.03	85.14	85.38	6.52	6.92	36.93	37.10
	Boron 500 mg/L	28.70	28.91	84.85	85.02	6.34	6.74	37.07	37.31
	Boron 1000 mg/ L	29.05	29.13	85.17	85.33	6.87	7.04	37.88	38.11
Mean of cultivars (A)		28.93	29.12	85.17	85.40	6.63	6.94	38.77	36.85
Means of Nutrients solutions (B)	Control (tap water)	30.90	30.99	84.33	85.26	6.11	6.54	37.11	37.41
	Novatreen	33.21	33.34	88.68	88.82	7.76	8.20	44.03	44.17
	Citreen	32.63	32.86	86.14	86.65	7.33	7.57	40.81	41.15
	Zinc 100 mg / L	31.11	31.40	85.25	85.54	6.59	6.84	41.13	41.51
	Zinc 200 mg / L	31.60	31.70	85.59	85.76	6.82	7.06	41.94	42.06
	Boron 500 mg/L	31.54	31.74	85.49	85.95	6.74	6.99	41.60	42.12
	Boron 1000 mg/ L	32.05	32.19	86.04	86.20	7.04	7.23	42.48	42.73
Mean		31.86	32.03	85.93	86.31	6.91	7.20	41.62	41.59
$L.S.D_{0.05}$	A	0.44	0.52	1.25	1.31	0.35	0.47	0.77	0.81
	B	0.88	0.97	1.33	1.19	0.74	0.82	0.64	0.75
	A×B	0.76	0.83	2.54	2.37	0.63	0.77	1.32	1.68

Table 5. Some technology characters of two cotton cultivars as affected by different foliar application of nutritional treatments in 2017 and 2018 seasons.

Treatments		Micronaire reading		Values of color			
				Brightness (Rd%)		Yellowness (+b)	
Cultivars (A)	Nutrients solutions (B)	1st season	2nd season	1st season	2nd season	1st season	2nd season
Giza 96	Control (tap water)	3.82	3.71	75.91	76.93	9.11	9.33
	Novatreen	2.81	2.66	75.88	76.88	9.14	9.27
	Citreen	3.00	2.97	75.73	76.45	9.22	9.22
	Zinc 100 mg / L	3.32	3.10	75.86	76.61	9.10	9.34
	Zinc 200 mg / L	3.14	3.02	76.11	76.40	9.23	9.41
	Boron 500 mg/L	3.21	3.15	76.14	76.52	9.17	9.32
	Boron 1000 mg/ L	3.06	3.04	75.94	76.63	9.16	9.32
Mean of cultivars (A)		3.19	3.09	75.91	76.93	9.11	9.33
Giza 95	Control (tap water)	4.30	4.13	67.91	68.11	11.96	11.68
	Novatreen	3.03	3.01	68.03	67.85	11.87	11.65
	Citreen	3.12	3.07	67.93	67.69	11.83	11.42
	Zinc 100 mg / L	3.47	3.31	67.55	68.10	11.92	11.61
	Zinc 200 mg / L	3.32	3.14	68.02	68.15	11.90	11.64
	Boron 500 mg/L	3..35	3.26	67.92	67.93	11.89	11.47
	Boron 1000 mg/ L	3.23	3.12	67.89	67.97	11.90	11.58
Mean of cultivars (A)		3.41	3.03	67.91	68.11	11.96	11.68
Means of Nutrients solutions (B)	Control (tap water)	4.06	3.92	71.91	72.52	10.54	10.51
	Novatreen	2.92	2.84	71.96	72.37	10.51	10.46
	Citreen	3.06	3.02	71.83	72.07	10.53	10.32
	Zinc 100 mg / L	3.40	3.21	71.71	72.36	10.51	10.48
	Zinc 200 mg / L	3.23	3.08	72.07	72.28	10.57	10.53
	Boron 500 mg/L	3.21	3.21	72.03	72.23	10.53	10.40
	Boron 1000 mg/ L	3.15	3.08	71.92	72.30	10.53	10.45
Mean		3.29	3.19	71.92	72.52	10.53	10.51
$L.S.D_{0.05}$	A	0.09	0.13	NS	NS	NS	NS
	B	0.11	0.16	NS	NS	NS	NS
	A×B	0.16	0.22	NS	NS	NS	NS

With the exception of brightness (Rd%) and yellowness (+b), the interaction between cotton cultivar and nutrient solutions had a significant effect on fiber length UHM (mm), fiber uniformity ratio (%), fiber elongation and micronaire reading in 2017 and 2018 seasons (Table 3 and 4).The combination between Giza 96 cultivar and novatreen achieved the highest fiber length UHM (36.18 and 36.22mm), fiber uniformity ratio (89.91 and 90.02%), fiber elongation (8.10 and 8.45%) and fiber strength (48.13 and 48.32g/tex) as well as the lowest micronaire reading (2.92 and 2.84) in both seasons (Table 3 and 4).

Chemical compositions of macro-elements

Results in Table (6) revealed that there was no significant difference between the two cultivars regarding N, P, K and Ca chemical content in leaf of cotton plants in both seasons. the concentration of N, P, K and Ca in the leaf significantly influenced by the application of the nutrient solutions and the interaction between cotton cultivars and nutrient solutions in 2017 and 2018 seasons.

The concentration of N, P, K and Ca in the leaves significantly increased with the foliar application of nutrient solutions compared to untreated plants of cotton in 2017 and 2018 seasons. The highest concentration of N content in leaves of cotton plants recorded with the application of citreen (3.43%) and novatreen (3.61%) in 2017 and 2018 seasons respectively without a significant difference between both materials. The application of novatreen produced the highest concentration of P (0.50 and 0.55%) as well as K (2.18 and 2.27%) in the first and second seasons. Regarding the highest content of Ca content in leaves of cotton plants novatreen (3.48%) produced the highest value in 2017 seasons while, citreen (3.46%) recorded the highest value in the second season. Meanwhile, untreated plants produced the lowest concentration of N (2.79 and 2.92%), P (0.20 and 0.27%), K (0.80 and 0.94%) and Ca (2.21 and 2.34%) in 2017 and 2018 seasons (Table 6). Except K concentration, there was no a significant difference between novatreen and citreen regarding the content of N, P and Ca in the leaves of cotton plants. Also, the differences between the two doses of Zn (100 and 200mg/L) and B (500 and 1000mg/L) concerning the content of N, P, K and Ca in the leaves of cotton plants were insignificant in 2017 and 2018 seasons (Table 6). In this connection, Li, *et al*., (1991); Temiz, *et al*., (2009); Abdallah and Mohamed, (2013); Yaseen, *et al*., (2013); Ahmad, *et al*., (2016); Khan, *et al*., (2016); El-Ashmouny, and El-Naqma, (2018) and Deshmukh, *et al*., (2019) found that an increase in N, P, K, Ca in cotton leaves content under the application of the micronutrients fertilization.

Results in table (6) revealed that the interaction between cotton cultivars and nutrients solutions was significant regarding the concentration of N, P, K and Ca in the leaves of cotton plants in the first and second seasons. The highest concentrations of N (3.55 and 3.62%), P (0.56 and 0.62%), K (2.20 and 2.33%) and Ca (3.53 and 3.60%) in the leaves of cotton plants were recorded when the plants of Giza 96 cultivar were sprayed by novatreen in 2017 and 2018 seasons while the lowest concentrations of this elements were observed under untreated plants of Giza 95 cultivar in 2017 and 2018 seasons (Table 6).

Table 6. Macro-elements chemical compositions of two cotton cultivars as affected by different foliar application of nutritional treatments in 2017 and 2018 seasons.

Treatments		N %		P %		K %		Ca %	
Cultivars (A)	Nutrients solutions (B)	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Giza 96	Control (tap water)	2.85	2.97	0.21	0.29	0.82	0.91	2.23	2.39
	Novatreen	3.55	3.62	0.56	0.62	2.20	2.33	3.53	3.60
	Citreen	3.43	3.53	0.32	0.38	1.04	1.09	3.48	3.51
	Zinc 100 mg / L	3.11	3.19	0.37	0.41	0.86	0.93	2.56	2.69
	Zinc 200 mg / L	3.25	3.31	0.34	0.39	0.96	1.02	2.77	2.81
	Boron 500 mg/L	3.12	3.22	0.36	0.40	1.01	1.13	2.56	2.61
	Boron 1000 mg/ L	3.32	3.37	0.40	0.46	1.08	1.21	2.90	2.97
Mean of cultivars (A)		3.22	3.32	0.36	0.42	1.14	1.23	2.86	2.49
Giza 95	Control (tap water)	2.72	2.86	0.19	0.25	0.77	0.96	2.19	2.28
	Novatreen	3.42	3.59	0.43	0.47	2.15	2.21	3.42	2.52
	Citreen	3.31	3.47	0.29	0.32	1.01	1.15	3.29	3.40
	Zinc 100 mg / L	3.14	3.19	0.31	0.38	0.72	0.80	2.42	2.53
	Zinc 200 mg / L	3.25	3.41	0.35	0.36	0.81	0.95	2.63	2.58
	Boron 500 mg/L	3.17	3.44	0.22	0.31	0.91	1.17	2.46	2.50
	Boron 1000 mg/ L	3.22	3.51	0.36	0.39	1.02	1.12	2.72	2.78
Mean of cultivars (A)		3.18	3.35	0.31	0.35	1.05	1.20	2.73	2.66
Means of Nutrients solutions (B)	Control (tap water)	2.79	2.92	0.20	0.27	0.80	0.94	2.21	2.34
	Novatreen	3.42	3.61	0.50	0.55	2.18	2.27	3.48	3.06
	Citreen	3.43	3.50	0.31	0.35	1.03	1.12	3.39	3.46
	Zinc 100 mg / L	3.29	3.19	0.34	0.40	0.79	0.87	2.49	2.61
	Zinc 200 mg / L	3.18	3.36	0.35	0.38	0.89	0.99	2.70	2.70
	Boron 500 mg/L	3.21	3.33	0.29	0.36	0.96	1.15	2.51	2.56
	Boron 1000 mg/ L	3.17	3.44	0.38	0.43	1.05	1.21	2.81	2.88
Mean		3.21	3.33	0.34	0.39	1.10	1.22	2.80	2.80
$L.S.D_{0.05}$	A	NS	NS	NS	NS	NS	NS	NS	NS
	B	0.44	0.84	1.30	1.15	0.47	0.46	0.64	0.55
	A×B	1.27	1.44	2.44	2.30	1.20	1.30	1.37	1.49

Chemical compositions of micro-elements

The chemical content of Zn, B, Mn and Fe in leaves of cotton plants significantly affected by cotton cultivars, nutrient solutions and their interaction in 2017 and 2018 seasons (Table 7).

Table 7. Micro-elements chemical compositions of two cotton cultivars as affected by some nutrient components in 2017 and 2018 seasons.

Treatments		Zn ppm		B ppm		Mn ppm		Fe ppm	
Cultivars (A)	Nutrients solutions (B)	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Giza 96	Control (tap water)	20.84	22.78	23.68	24.95	66.11	68.14	96.04	98.10
	Novatreen	44.21	46.69	45.13	42.98	101.05	103.05	122.05	123.24
	Citreen	40.20	41.44	40.28	37.85	99.17	101.16	119.10	120.16
	Zinc 100 mg / L	33.08	34.51	25.75	28.63	81.97	85.22	100.02	103.12
	Zinc 200 mg / L	36.19	37.12	27.88	26.80	94.10	96.14	110.70	108.66
	Boron 500 mg/L	30.44	32.44	27.45	24.93	96.16	99.34	100.82	98.72
	Boron 1000 mg/ L	31.56	33.08	30.33	27.45	98.40	100.05	108.11	105.400
Mean of cultivars (A)		33.79	35.44	31.50	30.51	90.99	93.30	108.12	108.20
Giza 95	Control (tap water)	20.18	20.77	22.00	22.68	66.08	67.05	88.10	86.22
	Novatreen	43.01	42.91	42.45	37.83	100.17	101.98	119.25	117.30
	Citreen	38.78	39.19	37.68	35.13	98.05	100.11	111.13	109.15
	Zinc 100 mg / L	32.07	31.81	24.75	22.65	79.55	85.06	98.18.	96.78
	Zinc 200 mg / L	34.55	35.21	25.63	25.00	94.08	95.41	108.71	106.88
	Boron 500 mg/L	29.17	30.20	25.05	22.70	95.40	96.35	99.02	98.07
	Boron 1000 mg/ L	30.08	32.63	28.85	27.10	97.12	99.08	106.17	104.11
Mean of cultivars (A)		32.55	33.25	29.49	27.58	90.06	92.50	105.40	102.64
Means of Nutrients solutions (B)	Control (tap water)	20.51	21.78	22.85	23.83	66.10	67.60	92.07	92.16
	Novatreen	43.61	44.80	43.80	40.40	100.61	102.52	120.65	120.27
	Citreen	39.49	40.32	38.98	36.50	98.61	100.64	115.12	114.66
	Zinc 100 mg / L	32.58	33.16	25.25	25.65	80.76	85.14	100.02	99.95
	Zinc 200 mg / L	35.37	36.17	26.75	25.90	94.09	95.78	109.71	107.77
	Boron 500 mg/L	29.81	31.32	26.25	23.83	95.78	97.85	99.92	98.40
	Boron 1000 mg/ L	30.82	32.86	29.60	27.28	97.76	99.57	107.14	104.76
Mean		33.17	34.34	30.50	29.05	90.53	92.72	106.37	105.42
$L.S.D_{0.05}$	A	0.74	0.52	1.93	2.03	0.55	0.70	1.25	1.31
	B	0.88	0.97	1.60	1.88	0.47	0.45	1.33	1.19
	A×B	1.76	1.83	3.30	4.20	1.44	1.33	2.54	2.37

Results indicated that Giza 96 cultivar significantly gave higher concentration of Zn (33.79 and 35.44 ppm), B (31.50 and 30.51 ppm) , Mn (90.99 and 93.30 ppm) and Fe (108.12 and 108.20 ppm) in leaf of cotton plants when compared with Giza 95 cultivar in 2017 and 2018 seasons. Such differences may be due to the variation in genetical characteristic. The current view agreed with that obtained by Abdallah and Mohamed, (2013).

The concentration of Zn, B, Mn and Fe in leaves of cotton plants significantly increased with the application of nutrient solutions compared with tap water treatment in both seasons. The highest concentration of Zn (43.61 and 44.80 ppm), B (43.80 and 40.40 ppm), Mn (100.61 and 102.52 ppm) and Fe (120.65 and 120.27 ppm) observed when the plants of cotton were sprayed by novatreen while the lowest concentration recorded under untreated plants in 2017 and 2018 seasons (Table 7). The difference between novatreen and citreen regarding the concentration of Zn, B, Mn and Fe in leaves of cotton plants was significant in the first and second seasons. On the other hand, when the dose of Zn and B were doubled from 100 to 200mg/L and from 500 to 1000mg/L respectively the content of Zn, B, Mn and Fe in leaves of cotton plants significantly increased in 2017 and 2018 seasons (Table 7). In terms of the concentration of Zn, B, Mn and Fe in leaves of cotton plants, many investigations reported higher Zn, B, Mn and Fe of cotton leaves with the application of micronutrients fertilization than untreated plants (Temiz, *et al*., 2009; Abdallah and Mohamed, 2013; Yaseen, *et al*., 2013; Ahmad, *et al*., 2016; Khan, *et al*., 2016; El-Ashmouny, and El-Naqma, 2018 and Deshmukh, *et al*., 2019).

Results in Table (7) indicated that the interaction between cotton cultivars and nutrient solutions had a significant effect on the concentration of microelement studied in this investigation. By using Giza 96 cultivar combined with novatreen the concentration of Zn (44.21 ppm), B (45.13 and 42.98 ppm), Mn (101.05 and 103.05 ppm) and Fe (122.05 and 123.24 ppm) in leaves of cotton plants achieved the highest concentration. On the other hand, The lowest percentage of Zn (20.18 and 20.77 ppm), B (22.00 and 22.68 ppm), Mn (66.08 and 67.05 ppm) and Fe (88.10 and 86.22 ppm) when the plants of Giza 95 cultivar sprayed by tap water only in 2017 and 2018 seasons (Table 7).

Biochemical compositions

Generally cultivars, nutrient solutions and their interaction had a significant effect on total phenolics, total carbohydrates, seed oil content and seed crude protein content in both seasons (Table 8). Results indicated that Giza 95 and Giza 96 varied significantly in total phenolics in the second season only while, total carbohydrates and seed oil contents in both seasons. Meanwhile, for seed crude protein content they significantly varied in the first season only. Giza 96 cultivar gave the highest values of total phenolics (4.55 and 4.78%), total carbohydrates (41.39 and 42.84 µg\g D.W), seed oil content (18.68 and 19.75%) and seed crude protein content (20.73 and 21.42%) compared with Giza 95 in 2017 and 2018 seasons. These differences may be due to the differences in the genetical structure and its interaction with the environmental conditions. In this connection, Abdallah and Mohamed, (2013) detected varietal differences between Giza 90 and Giza 92 Egyptian cotton cultivars (*Gossypium barbadense* L.) concerning total sugars, total free amino acids and total soluble phenol.

Table 8. Biochemical compositions of two cotton cultivars as affected by some nutrient components in 2017 and 2018 seasons.

Treatments		Total phenolics (%)		Total carbohydrates µg\g D.W		Seed oil content %		Seed crude protein content %	
Cultivars (A)	Nutrients solutions (B)	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Giza 96	Control (tap water)	2.90	3.02	27.42	28.33	16.10	16.78	17.02	18.06
	Novatreen	6.71	6.84	52.80	53.98	21.88	22.27	23.54	23.99
	Citreen	5.66	6.12	48.87	50.81	19.92	20.32	22.15	22.77
	Zinc 100 mg / L	3.92	4.11	37.12	39.15	17.13	18.24	19.26	20.10
	Zinc 200 mg / L	4.10	4.45	42.10	43.16	18.55	19.46	20.05	20.84
	Boron 500 mg/L	3.99	4.24	38.15	40.19	18.04	20.09	21.14	20.95
	Boron 1000 mg/ L	4.55	4.67	43.11	44.26	19.15	21.12	21.98	21.98
Mean of cultivars (A)		4.55	4.78	41.37	42.84	18.68	19.75	20.73	21.24
Giza 95	Control (tap water)	2.73	2.94	26.13	27.89	15.45	16.04	16.18	17.46
	Novatreen	5.88	6.14	50.22	51.07	20.17	21.08	22.05	22.92
	Citreen	5.02	5.89	46.70	48.45	18.74	19.09	20.97	21.14
	Zinc 100 mg / L	3.10	3.46	36.14	38.33	16.28	18.16	19.07	19.12
	Zinc 200 mg / L	3.99	4.14	40.24	42.04	17.19	19.12	20.04	20.98
	Boron 500 mg/L	3.22	3.80	36.99	38.11	18.24	19.87	19.58	20.17
	Boron 1000 mg/ L	3.98	4.15	41.56	43.09	18.86	20.14	20.77	20.84
Mean of cultivars (A)		3.99	4.36	39.71	41.56	17.85	19.07	19.70	20.38
Means of Nutrients solutions (B)	Control (tap water)	2.82	2.98	26.78	28.11	15.78	16.41	16.60	17.76
	Novatreen	6.30	6.49	51.51	52.53	21.03	21.68	22.80	23.46
	Citreen	5.34	6.01	47.79	49.63	19.33	19.71	21.56	21.96
	Zinc 100 mg / L	3.51	3.79	36.63	38.74	16.71	18.20	19.17	19.61
	Zinc 200 mg / L	3.99	4.30	41.17	43.16	17.87	19.29	20.05	20.91
	Boron 500 mg/L	3.66	4.02	37.57	40.19	18.14	19.98	20.57	20.56
	Boron 1000 mg/ L	3.99	4.41	42.34	43.15	19.15	20.63	20.78	21.41
Mean		4.23	4.57	40.54	42.22	18.26	19.41	20.22	20.81
L.S.D0.05	A	NS	0.52	1.32	1.28	0.36	0.52	0.64	NS
	B	0.88	0.97	1.45	1.19	0.47	0.33	0.84	0.79
	A×B	1.56	1.83	2.44	2.30	1.35.	1.50.	1.37	1.46

The foliar application of nutrient solutions significantly increased total phenolics, total carbohydrates, seed oil content and seed crude protein content in compared with control treatment in 2017 and 2018 seasons. The highest values of total phenolics (6.30 and 6.49%), total carbohydrates (51.51 and 52.53 µg/g D.W), seed oil contents (21.03 and 21.68%) as well as seed crude protein content (22.80 and 23.46%) observed by using novatreen meanwhile, the lowest values of total phenolics (2.82 and 2.98%), total carbohydrates (26.78 and 28.11 µg/g D.W), seed oil contents (15.78 and 16.41%) as well as seed crude protein content (16.60 and 17.76%) produced by using no nutrient solutions (Table 8). Generally there was a significant difference between novatreen and citreen regarding the above mentioned characters in both seasons. Except total phenolics, total carbohydrates, seed oil content and seed crude protein content significantly increased when the dose of Zn increased from 100 mg/L to 200 mg/L in 2017 and 2018 seasons meanwhile, nearly the same trend observed with increasing the dose of B from 500 mg/L to 1000 mg/L (Table 8). In this respect, Marschner, et al., (1987) observed that the roots of zinc-deficient cotton plants excreted 3.3 and 2.6 times more amino acids and more carbohydrates respectively, than zinc-sufficient control plants and the electrical conductivity of the root exudates solution also increased 3-fold. These results are in general agreement with those obtained by Sawan, *et al*., (2001); Abdallah and Mohamed, (2013); Ahmed, *et al*., (2013); Gebaly, (2013) as well as Emara, and Abd El-All, (2017).The interaction between the two cultivars and nutrient solutions had a significant effect on total phenolics, total carbohydrates, seed oil contents and seed crude protein content in both seasons (Table 8). The highest values of total phenolics (6.71 and 6.84%), total carbohydrates (52.80 and 53.98 µg\g D.W), seed oil contents (21.88 and 22.27%) and seed crude protein content (23.54 and 23.99%) were obtained by using Giza 96 cultivar and application of novatreen in 2017 and 2018 seasons (Table 8). On the other hand, The lowest values of total phenolics (2.73 and 2.94%), total carbohydrates (26.13 and 27.89 µg\g D.W), seed oil contents (15.45 and 16.04%) and seed crude protein content (16.18 and 17.47%) were achieved by using cultivar Giza 95 with untreated plants in both seasons. Similar results were obtained by Abdallah and Mohamed, (2013).

CONCLUSION

In a broad sense, on deficient soils this results could be used in making decisions concerning the use of micronutrient fertilizers. In a narrow sense, according to these results, it could be concluded that the use of either novatreen or boron as two foliar sprays given at the commence of the flowering and 15 days later of cotton plant along with the recommended NPK fertilizers could be recommended under the conditions of Giza locally.

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إستجابة صنفين من القطن المصرى للتسميد المتوازن للعناصر الكبرى والصغرى بالرش الورقى

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أجريت تجربتان حقليتان بمحطة البحوث والتجارب الزراعية ـ كلية الزراعة ـ جامعة القاهرة بالجيزة خلال موسمى 2017 و2018 لدراسة إستجابة وتقييم إنتاجية وجودة صنفى القطن المصرى الجديدين جيزة 95 و 96 للتسميد الورقى المتوازن بين العناصر الصغرى والكبرى. أشتملت التجربة على 14 معاملة وهى التوافيق بين صنفى القطن والرش الورقي لستة محاليل مغذية (زنك 100ملجم/لتر ، 200 ملجم/لتر ، بورون 500 ملجم/لتر ، بورون 1000 ملجم/لتر ، نوفاترين واحد لتر/فدان و سترين واحد لتر/فدان) بالأضافة الى معاملة الكنترول. نفذت التجربة فى تصميم القطاعات الكاملة العشوائية بتوزيع القطع المنشقة مرتين حيث وضعت الأصناف بالقطع الرئيسية وخصصت القطع المنشقة للرش بالمحاليل المغذية. أظهر الصنفان فروق معنوية لمعظم الصفات المدروسة فى كلا موسمى الدراسة. تخطى الصنف جيزة 96 الصنف جيزة 95 فى طول النبات ، عدد الأفرع الثمرية/نبات ، عدد اللوز الكلى/نبات ، وزن اللوزة ، دليل البذرة ، تصافى الحليج ومحصول القطن الزهر. فى نفس الوقت تفوق الصنف جيزة 96 على الصنف جيزة 95 لصفة طول الألياف ، متانة الألياف ، أستطالة الألياف ونعومة الألياف. مقارنة بمعاملة عدم الأضافة (الكنترول) أدت أضافة المحاليل المغذية الى زيادة معنوية لصفات النمو ، محصول القطن الزهر ومكوناته. علاوة على ذلك أدى الرش بالمحاليل المغذية الى تحسن معنويا فى الصفات التكنولوجية للألياف ، محتوى أوراق القطن من العناصر الكبرى والصغرى ، محتوى الأوراق من المركبات البيوكيميائية و محتوى بذرة القطن من الزيت والبروتين وذلك فى كلا الموسمين. وبصفة عامة سجل النوفاترين أعلى القيم لمعظم الصفات المدروسة. كان التفاعل بين أصناف القطن ومحاليل المغذيات الكيميائية معنوياً فيما يتعلق بمعظم الصفات المدروسة.