Nat. Volatiles & Essent. Oils, 2021; 8(5): 13288-13302

Differential Responses Modeling Of Some Cotton (Gossypium Barbadense L.) Cultivars For Salinity Stress Condition Using Nano-Fertilizer

El- kadi, D. A[1] , H.M. Abdel – lattif [1] , Ayman E. Badran[2] ; Nermeen O. Mohamed [2]

[1]Department of Agronomy, Faculty of Aagriculture, Cairo university, Giza, Egypt.

[2] Department of Genetic Resources, Desert Research Center, Cairo, Egypt.

Abstract

It's no doubt that, the high costs of fertilization under Egyptian lands affected by salinity is considered one of the main challenges in agriculture sector. So, this investigation was carried out to assessment the performance of five Egyptian cotton cultivars using Nano-fertilizers (0.00, 0.25 ,0.50 and 0.75 g/l nano p/k) under two salinity levels (4557 and 8934 ppm) to improve seed cotton yield/plant during two growing seasons (2018 and 2019). Tolerance indices under low salinity level (4557 ppm) compared to high salinity level (8934 ppm) were used to evaluate the tested cultivars. Results indicated that, Giza 95 has the highest values of salt tolerance and relative performance indices (1.079 and 1.060, respectively) as tolerant cultivar while, Giza 94 recorded the lowest values (0.561 and 0.962, respectively) as sensitive cultivar. The results indicated that Nano-scale fertilizer is considered as a vital topic to be aware by its influence on cotton yield under stress conditions. Different molecular weights of protein bands were detected under the two salinity levels. Such specific bands could be used to distinguish tolerant or sensitive cotton cultivars to salinity using Nano- fertilizers depending on tolerance indices.

Keywords: Salinity tolerance index, cotton, Nano-scale, protein.

Introduction

More than 6% of the total land area in the world and about 30% of the irrigated lands are under salt stress (UNESCO 2005 and FAO 2008). It has been predicted that an increase in land salinization will lead to a loss of land up to 50% by 2050 (Wang et al., 2003). The productivity of agricultural land can be increased by developing and selecting salt-tolerant varieties to meet the demands of the world's increasing population (Pitman and Lauchli 2002 and Munns et al., 2006). In arid and semi-arid regions where water is limited, improvement of salt-tolerant crops will allow reusing of low-quality irrigation water (Pitman and Lauchli 2002 and Gorham et al., 2010).

Cotton is a crop that plays a fundamental role in economic development around the world as an important source of fiber, oils and animal feed (Dai and Dong, 2014). G. barbadense produces extra-long and extra-fine cotton fibers that make up about 3% of the total global cotton market (ICAC 2004). Cotton is the main fiber crop in Egypt as well as the world. Egyptian statistics indicate that the area planted with cotton has shrunk from 357538.86 (ha) in 1991 to about 90.7290.72 (ha) in 2017 (a decrease of 74.56%) and consequently a decrease in cotton production from 5,826,000 kantar in 1991 to about 1,357,000 kantar. In 2017, a decrease of 76.71% (Egyptian Cotton Gazette, 2017).

Using foliar application improves fertilizer use efficiency and reduces environmental pollution. The foliar application of micronutrient mixtures has been shown to play an important role in the growth efficiency and physiological characteristics of cotton during the flower and almond growth stages of the cotton plant, thus reducing almond shedding and increasing yield (Radhika et al., 2013).

Nano-particles have sizes of less than 100 Nano-meters, which are reliable in applications for agriculture, food technology, medicine, and environmental conservation. These Nano-particles are used for their low cost and non-toxicity and these are the basic requirements in the field of agriculture (Madbouly, 2018). Moreover, Nano-particles have unique physical and chemical properties, for example, large surface area, high reactivity, adjustable pore size and particle morphology (Siddiqui et al., 2015). Generally, this application is used in various fields, including agriculture, and Nano-technology has extraordinary potential to facilitate the next stage of precision farming methods. The agricultural sector will use more Nano-technology in the future to achieve higher returns in an environmentally friendly manner as well as in adverse environmental conditions (Ali et al., 2014 and Prasad, 2014). In this agricultural field, Nano--fertilizers improve the absorption of nutrients by the roots, as well as facilitate this through molecular transporters, through the formation of new pores, or through ion channels. (Dhal et al.,2011).

In field experiments, tolerance indices of a biotic stress are based on yield production under stress conditions compared to non-stress conditions. Generally, tolerance indices are used to identify stress tolerant genotypes. The relative yield performance of genotypes under abiotic stress conditions and more appropriate environments seems to be a common beginning point in identification of traits related to abiotic stress and selection of cultivars for use in breeding programs for stress conditions (Badran and Moustafa 2014).

This investigation was carried out to evaluate the differential responses of the seed cotton yield of five Egyptian cotton cultivars under two salinity levels of irrigation water using four treatments of Nano--fertilizers.

Materials and Methods

The field experiments were carried out at Ras-Sudr research station, Desert Research Center (DRC)at Sinai Governorate, Egypt during 2018 and 2019growing seasons. The seeds of five commercial cultivars used in this study (Giza 90, Giza 92, Giza 94, Giza 95 and Giza 86) (Gossipium barbadense L.) were obtained from the Agriculture Research Center, Giza, Egypt (Table 1). The tested cultivars has been evaluated under two salinity levels of irrigation water (4557and8934 ppm) andusing foliar application of three rates from Nano-fertilizers (0.25 ,0.50 and 0.75 g/L Nano- p/k) compared with the control (without Nano-.fertilizer ,however, 45kg/ feddan potassium sulfate (48%K2O) and 22kg calcium super phosphate /feddan were applied). The rates of potassium sulfate and calcium super phosphate were as recommended practices from Agricultural Research Center). Furthermore,60 kg ammonium nitrate (33.5 %N)as a source of nitrogen was added to the all experimental units.

Table (1) . The name, pedigree and the type of the cotton cultivars.

No	Cultivar	Pedigree	Type
1	Giza 92	G84(G74 x G68	Extra- Long- staple
2	Giza 94	10229 x G.86	Long- staple
3	Giza 86	(G.77xG.45)	Long- staple
4	Giza 90	(Giza83× Dandara	Long- staple
5	Giza 95	G.83 × (G.75 × 5844) × G.80)]	Long- staple

Two water wells were used in this experiment as a source of water irrigation .The water analysis of the two irrigation wells and soil analysis are presented in Table (2).

Table (2): The Water analysis of the two irrigation wells and soil analysis .

Level	pH	EC Ppm	Cations (meq/L)				Anions (meq/L)			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
Water analysis										
Well 1	7.82	4557	10.8	7.15	53.6	0.35	-	5.30	39.1	26.8
Well 2	7.66	8934	19.3	13.8	105.1	0.90	-	7.50	93.1	38.7
Soil analysis										
Soil	7.76	6195	4.6	3.2	88.3	0.67	-	4.95	65.7	26.1

Experimental design:

The split- split plot design with the main plots in RCBD was carried out with five replications. Two salinity levels (the first factor) were assigned for the main plots . Five cultivars (The second factor) were applied in sub plots .Four Nano- treatments ,e.g, three rates and control (the third factor) were applied in sub- sub plots.

Experimental conditions

Based on the previous description , each replication include 40 experimental units (sub-sub plots), each experimental unit (plot) consists 5 ridges (3 internal ridges and two border ridges) , the distance between ridges was 60 cm and the length of line was 3.6 m. Each plot size was 10.8m^2 (3.0 m x 3.6 m) . The distance among hills was 25 cm with two plants in each hill.

During the cultivation ,for each of the treatments of Nano- fertilizer, seeds of each cultivar were soaked in fertilizer solution according to the tested rate .Also, for each cultivar , two foliar applications of Nano- fertilizer according to the tested rate were applied after 21 days and 42 days from date of cultivation .The drip irrigation system was carried out every three days.

Salinity tolerance indices

Four salinity tolerance indices including stress tolerance index (STI), yield injury% (YI), superiority measure (SM), and relative performance (RP) were calculated based on seed cotton yield/plant under high salinity level (Ys) and low salinity level (Yn). Salinity tolerance indices were calculated by using the equations cited in (Table 3).

Table (3): Salinity tolerance Indices based on seed cotton /plant

Index name	**Outcomes**	**Formula**	**Reference**
Stress Tolerance Index (STI)	The cultivars with high STI values will be tolerant to stress	$\mathbf{STI} = \frac{Y_n x Y_s}{(\bar{Y}_n)^2}$	Fernández, 1992.
Yield injury % (YI)	The cultivars with low YI values will be tolerant to stress	$\mathbf{YI} = \left[\frac{Y_n - Y_s}{Y_n}\right] X100$	Blum et al., 1983.
Superiority measure (SM)	The cultivars with high SM values can be regarded as stable cultivars under stress and non-stress conditions.	$\mathbf{SM} = \frac{Y_s}{Y_n}$	Lin and Binns, 1988.
Relative performance (RP)	The cultivars with high STI values will be tolerant to the stress condition.	$\mathbf{RP} = \frac{Y_s / Y_n}{R}$ where $\mathbf{R} = \frac{\bar{\bar{Y}}_s}{\bar{\bar{Y}}_n}$	Abo-Elwafa and Bakheit, 1999.

Where; Yn= seed cotton yield under low salinity level; Ys= seed cotton yield under high salinity level; $\bar{Y}_s$ = the means of all cultivars under high salinity level; $\bar{Y}_n$ = the means of all cultivars under low salinity level.

SDS- PAGE technique

SDS-polyacrylamide gel electrophoresis (SDS- PAGE) technique- was carried out in The Central Lab ,Desert Research Center Cairo, Egypt.

SDS-PAGE was carried out according Laemmli (1970), Young leaves were collected from 10 plants and one gram of the 10 leaves plant sample was treated with liquid nitrogen and ground with 2 ml Lan's buffer - (2X) using mortar and pestle. Protein fractions were analyzed using gel photography and documentation system (BIO RAD Model Gel Doc2000).

- **Statistical analysis of seed cotton yield / plant :**

The analyses of variance and tests of significance for the differences among treatment means were carried out according to the procedures described by Gomez and Gomez (1984). Data were statistically analyzed using the MSTAT-C Statistical Software Package (Freed, 1991).

Results and Discussion

Analysis of variance

The significance of mean squares (M.S.) were studied for each of the salinity levels (S), the tested cultivars (C) and the Nano- treatments (T), in addition to the two- and three-way interactions for the seed cotton yield and these results are in agreement with those of Anon (2015) and Hussain and Abu Bakr (2018) . The data showed that, there are highly significant effects of the three studied factors and the interactions among them as shown in Table (4).

Table (4): Mean squares of seed cotton yield / plant for two growing seasons 2018 and 2019.

S.V	**d.f.**	**M.S**	
		2018	**2019**
Rep.	4	49.87	6.47
Salinity (S)	1	1670.42**	1568.00**
Error (a)	4	14.72	8.60
Cultivars (C)	4	375.66**	468.05**
S x C	4	21.53**	13.60**
Error (b)	32	4.83	9.71
Nano - Treatment (T)	3	163.87**	131.13**
S x T	3	33.13**	5.64**
C x T	12	9.18**	10.38**
S x C x T	12	20.61**	8.27**
Error (c)	120	4.56	5.35

** Significant at 1% level of probability.

Mean performance

Effect of the three studied factors

The results of seed cotton yield presented in Table (5) showed significant differences between the two salinity levels. In both seasons, the high level of salinity caused decreasing in seed yield/plant compared to low level. Meanwhile, cultivars had a significant effect for seed cotton yield/plant where, Giza 95 cultivar gives the highest mean of seed cotton yield during two growing seasons (26.30 and 25.81g respectively), followed by Giza 90, Giza92 and Giza 86, while Giza 94 recorded the lowest values (18.84 and 18.43 g for 1st and 2nd season, respectively) under the same conditions. Concerning the effect of Nano-fertilizers in both seasons, the mean performance indicated that, increasing Nano-fertilizer dose caused increasing in seed cotton yield/plant gradually compared with control (without Nano- fertilizer) under the two salinity levels. The results of this investigation agree with Yehia (2020) who stated that, abiotic stress represented by drought affected the cotton genotypes in terms of the studied traits, while others were drought tolerant, indicating genetic variation among 24 cotton genotypes. Also he confirmed that the drought tolerance indices (i.e. mean productivity index, geometric mean productivity, stress tolerance index, yield index and harmonic mean) under normal conditions (no stress) and drought stress conditions can correctly distinguish the tested drought-resistant genotypes with high yield performance. Furthermore, his results also showed examining drought-resistant genotypes using the average performance and drought tolerance indices showed that Giza 94, Giza 86, Giza 96 and Giza 89 were the most tolerant for drought under normal conditions compared to drought conditions.

Table (5): Means of Nano-treatments and tested cultivars under two salinity levels during two seasons for seed cotton yield, g /plant.

Factor	1st season	2nd season
Low salinity level	25.39	24.25
High salinity level	19.95	20.35
LSD $_{(0.05)}$	1.66	1.63
Giza 90	24.26	22.83
Giza 92	22.81	21.87
Giza 86	21.14	22.56
Giza 94	18.84	18.43
Giza 95	26.30	25.81
LSD $_{(0.05)}$	1.38	1.48
0,00 (control)	20.54	20.19
0.25 g/L Nano- p/k	21.57	21.85
0.50 g/L Nano- p/k	23.34	23.22
(0.75 g/L Nano- p/k	25.23	23.94
LSD $_{(0.05)}$	1.14	1.32

Effect of the interactions among the studied factors

Performance means of the interactions between Nano- treatments and the tested cultivars under salinity stress are presented in Table 6 . Generally, Nano-fertilizer affects the most characters under different salinity levels. Application of Nano-P, K improve the nutrients uptake under salinity stress. The interaction effect of Nano-fertilizer and salinity through some growth stages of cotton plants indicated that application of Nano-$_{P,K}$ at rate 0.5 and 0.75 g/1 promoted the nutrients uptake under low salinity level during the two growing seasons for seed cotton yield per plant. Also, the three doses improved yield under high salinity level.

The same trend of results was obtained by Emara et al., 2018 who stated that levels of Nano--fertilizer had significant effect on growth traits (plant height and number of sympodials / plant), number of bolls/plant, boll weight and seed cotton yield / feddan, however, levels of Nano – fertilizer did not exhibit any significant effect on seed index, lint percentage and fiber parameters in both seasons.

The results of the present study showed that seed cotton yield per plant significantly increased with increasing the doses of Nano- fertilizers (Table 6). The high response may be due to the effect of Nano- foliar application which led to the production of more sympodial branches, which led to increase in number of boll per plant to increase seed cotton yield. This trend is in harmony with Taiz and Zeiger, 2010; Tarafdar et al., 2012a and Tarafdar et al., 2012. The obtained results indicate that increased trend of seed cotton yield per plant with increasing rates of Nano-fertilizer application (Table 6). Significant differences were achieved among the treatments of Nano--fertilizers. This may be due to differences in number of fruiting branches, productive bolls and seed cotton weight per boll. Nano- fertilizers increase availability of nutrient to the growing plant which increase chlorophyll formation, photosynthesis rate, dry matter production and improve overall growth of the plant (Hediat and Salama, 2012).

Table (6): Performance means of seed cotton yield (g./ plant) as affected by the interactions between Nano- treatments and the tested cultivars under salinity stress condition , in 2018 and 2019 seasons.

Salinity	**Cultivar**	**Treatments (**g/L nano- $_{p,k}$)	**1st season**	**2nd season**
	Giza 90	0.0 (Control)	24.16	21.52
		0.25	25.68	23.60
		0.50	27.58	26.54
		0.75	29.22	27.70
	Giza 92	0.0 (Control)	24.74	22.56
		0.25	23.42	24.54
		0.50	26.52	25.70
		0.75	27.68	27.58
	Giza 86	0.0 (Control)	21.30	20.66
		0.25	23.58	22.64
		0.50	24.60	23.60
		0.75	26.78	23.32
		0.0 (Control)	20.10	19.64
		0.25	19.68	21.70

Low level	Giza 94	0.50	22.46	20.70
		0.75	23.74	22.68
	Giza 95	0.0 (Control)	26.54	25.52
		0.25	27.76	26.78
		0.50	29.70	28.60
		0.75	32.60	29.38
High level	Giza 90	0.0 (Control)	19.48	18.68
		0.25	20.78	20.70
		0.50	21.76	20.40
		0.75	25.40	23.52
	Giza 92	0.0 (Control)	17.36	16.60
		0.25	19.74	17.60
		0.50	20.50	19.70
		0.75	22.52	20.70
	Giza 86	0.0 (Control)	15.56	20.66
		0.25	16.80	22.64
		0.50	19.78	23.60
		0.75	20.74	23.32
	Giza 94	0.0 (Control)	14.64	13.68
		0.25	15.60	14.66
		0.50	16.76	17.64
		0.75	17.76	16.70
	Giza 95	0.0 (Control)	21.50	22.40
		0.25	22.70	23.64
		0.50	23.78	25.68
		0.75	25.82	24.50
LSD $_{(0.05)}$			3.68	4.19

Tolerance indices of salinity stress

The results in Table 7 show salinity stress tolerance indices in evaluating the performance of five cotton cultivars based on seed cotton yield/plant under low salinity level (Yn) and high salinity level (Ys). According to the values of salinity tolerance index (STI) during the two growing seasons, the cultivars were divided into three groups, The first group has higher value than 1 and represents the most tolerant cultivar (Giza 95), while the second group (Giza 90 followed by Giza 92) has higher value than the general mean (0.814) .However ,both Giza 86 followed by Giza 94 ordered in the third group as sensitive cultivars (0.680 and 0.538, respectively) compared with the general mean of the index. In the same manner, yield injury (YI) of seed cotton yield / plant during the two growing seasons, Giza 94 cultivar recorded the highest deficiency in seed cotton yield (24.66 and 23.56 %, respectively) followed by Giza 86 cultivar (24.46 and 19.23 %, respectively) . However, Giza 95 cultivar recorded the lowest deficiency in seed cotton yield (19.55 and 14.94 %) followed by Giza 92 (21.880

and 20.167 %) during the two growing seasons. With regard to, superiority measure (SM) and relative performance (RP) during the two growing seasons 2018 and 2019 respectively, each of Giza 92 and Giza 95 cultivars have scored the highest mean compared to other cultivars while Giza 94 cultivar has scored the lowest mean values of SM (0.56 and 0.59) and Rp (0.76 and 0.76) as shown in Table (7).

This study divided the tested cultivars to tolerant and sensitive under low and high salinity levels based on seed cotton yield/plant. The evaluation based on salinity tolerance index (STI) is a reliable predictor to select high-yielding cultivar under high stress compared to the normal condition according to Pour dad 2008, and Badran and Moustafa 2014 However , Ramirez et al., 1998 and Guterre et al., 2001 depended on the stress sensitivity index (SSI) to select high yield cultivar to improve tolerance to salinity or drought stresses in crop. So, we believe that it is better to depend on more than factor of the environmental stress tolerance for classifying tested cultivars under salinity stress compared to optimal condition or low stress. These previous finding are in harmony with Fernandez 1992 and Badran 2015 who reported that, cultivars are classified into 4 groups according to their performance mean under stress conditions compared with non- stress condition .

Table (7): Tolerance indices of tested cultivars across treatments for both seasons.

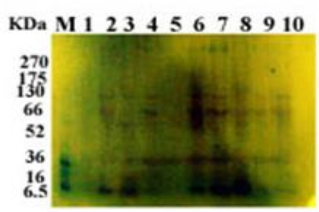
Cultivar	**Stress tolerance index (STI)**			**Yield injury YI (%)**			**Superiority measure SM)**			**Relative performance (RP)**		
	2018	**2019**	**Mean**	**2018**	**2019**	**Mean**	**2018**	**2019**	**Mean**	**2018**	**2019**	**Mean**
Giza 90	0.903	0.922	0.912	18.195	11.824	15.010	0.922	0.882	0.902	1.042	1.055	1.049
Giza 92	0.795	0.856	0.825	21.880	20.167	21.024	0.906	0.798	0.852	0.997	0.934	0.965
Giza 86	0.680	0.700	0.690	24.461	19.238	21.849	0.909	0.808	0.858	0.962	0.963	0.962
Giza 94	0.538	0.584	0.561	24.663	23.560	24.111	0.885	0.764	0.825	0.96	0.929	0.945
Giza 95	1.058	1.101	1.079	19.554	14.944	17.249	0.934	0.851	0.892	1.025	1.096	1.060
Mean	0.795	0.832	0.814	21.751	17.947	19.849	0.911	0.821	0.866	0.997	0.995	0.996

Biochemical analysis of salt tolerance using Nano- fertilizer:

SDS-PAGE:

The leaves protein was extracted from fresh leaves after completing the Nano treatment for five commercial cotton cultivars and the results of SDS-PAGE are illustrated in Figs. (1 and 2)and Tables(9 and 10). Protein bands with different molecular weights were detected under two salinity levels and ranged from 7 band in Giza 95 cultivar under the first low salinity level and 8 bands in Giza 92 under the high salinity level. Unique bands were recorded in Giza 92 and Giza 95 under high salinity level with using 0.075 g/liter Nano- $_{p,k}$ compared to the control (without nano- fertilizer) . These results are in harmony with the tolerance indices of the these cultivars . Such specific bands could be used to distinguish the salt tolerant and /or sensitive cotton cultivars when using Nano-fertilizers compared to the other cultivars. On the other hand, Giza 86 cultivar showed high response to Nano- fertilizer under the high salinity level (Table 10) with molecular weights 204 and 316 kDa positively differentiate . Similar results were obtained by Kumar et al., (2013) utilizing SDS-PAGE technique for the identification and genetic diversity estimation of two diploid and six tetraploid cotton cultivars . Nano- particle interacts with all plants at cellular and subcellular levels, promoting changes in morphological, biochemical ,physiological, and molecular states (Khan et al., 2019). Thus , this application was used in the current study to examine its effects on some cotton cultivars under salinity stress special proteins . these data agree with Paramo et al., 2020 , who studied the effect of Nano- fertilizers application to improve the products in various crops .

Four polypeptides with disulphide-linkages were also reported for the first time. The analysis revealed more electrophoretic pattern variations between the lines of two species in Albumins followed by globulins (Singh and Kaur, 2019) .This is in agreement with the current our investigation . where some cultivars recorded differential responses based on molecular weight 14 kDa under the high salinity.



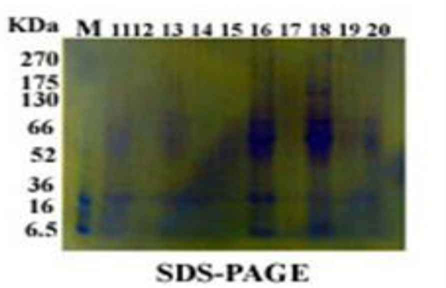
M= marker, 1=Giza90 (without nano), 2=Giza 90 (the high nano dose),3=Giza92 (without nano), 4=Giza 92 (the high nano dose),5=Giza86 (without nano), 6=Giza 86 (the high nano dose),7=Giza94 (without nano), 8=Giza 94(the high nano dose),9=Giza95 (without nano), 10=Giza 95(the high nano dose).

Fig. (1): SDS- protein banding pattern in leaves of five tested cotton cultivars treated (high nano fertilizer) and untreated (without nano) under low salinity levels.

Table (9): The presence (1) and absence (0) of leaves protein of five Egyptian cotton cultivars using high nano fertilizer dose (N-L) compare to control (without nano (C-L)) under low salinity level

Band	M.W	Giza 90		Giza 92		Giza 86		Giza 94		Giza 95	
No	KDa	C-L	N-L	C-L	N-L	C-L	N-L	C-L	N-L	C-L	N-L
1	318	1	1	1	1	0	1	1	0	0	0
2	204	1	1	1	1	1	1	1	1	0	0

3	156	1	1	1	1	1	1	1	1	0	0
4	106	1	1	1	1	1	1	1	1	1	1
5	89	1	1	1	1	1	1	1	1	1	1
6	55	1	1	1	1	1	1	1	1	1	1
7	46	1	1	1	1	1	1	1	1	1	1
8	40	1	1	1	1	1	1	1	1	1	1
9	20	1	1	1	1	1	1	1	1	1	1
10	14	1	0	1	1	0	1	1	0	0	0
11	10	1	1	1	1	1	1	1	1	1	1
Total		11	10	11	11	9	11	11	9	8	7



M= marker, 11=Giza90 (without nano), 12=Giza 90 (the high nano dose), 13=Giza92 (without nano), 14=Giza 92 (the high nano dose), 15=Giza86 (without nano), 16=Giza 86 (the high nano dose), 17=Giza94 (without nano), 18=Giza 94(the high nano dose), 19=Giza95 (without nano), 20=Giza 95(the high nano dose).

Fig. (2): SDS- protein banding pattern in leaves of five Egyptian cotton cultivars under high salinity levels.

Table (10): The presence (1) and absence (0) of leaves protein of five Egyptian cotton cultivars using high Nano-fertilizer dose (N-H) compare to control (without nano (C-H)) under high salinity level

Band	M.W	Giza 90	Giza 92	Giza 86	Giza 94	Giza 95

No	KDa	C-H	N-H	C-H	N-H	C-H	N-H	C-H	N-H	C-H	N-H
1	318	1	1	1	0	0	1	1	1	1	1
2	204	1	1	1	0	0	1	1	1	0	0
3	156	1	1	1	1	1	1	1	1	1	1
4	106	1	1	1	1	1	1	1	1	1	1
5	89	1	1	1	1	1	1	1	1	1	1
6	55	1	1	1	1	1	1	1	1	1	0
7	46	1	1	1	0	1	1	1	1	1	1
8	40	1	1	1	1	1	1	1	1	1	1
9	20	1	1	1	1	1	1	1	1	1	1
10	14	1	0	1	1	1	1	0	1	1	1
11	10	1	1	1	1	1	1	1	1	1	1
Total		11	10	11	8	9	11	10	11	10	9

Conclusion

Salinity is considered one of the main abiotic stresses in Egyptian lands. Mean performance of tested cotton cultivars had a significant effect for seed cotton yield/plant where, Giza 95 cultivar gives the highest mean of seed cotton yield during two growing seasons, followed by Giza 90, Giza92 and Giza 86, while Giza 94 recorded the lowest values under the same conditions. . Based on the estimates of tolerance indices, Giza 95 was the highest tolerant cultivar for salinity stress. Unique bands were recorded in Giza 92 and Giza 95 under high salinity level with using 0.075 g/liter Nano- $_{p,k}$ compared to the control (without nano- fertilizer) . These results are in harmony with the tolerance indices of the these cultivars. So, different molecular weights of protein bands could be used to distinguish the salt tolerant or sensitive cotton cultivars using nano fertilizer application and which in harmony with tolerance indices estimates.

References

Abo-Elwafa A. and Bakheit B.R. (1999). Performance, correlation and path coefficient analysis in faba bean. Assiut J. Agric. Sci, 30:77-91.

Ali MA, Rehman I, Iqbal A, Din S, Rao AQ, et al. (2014) Nano-technology, a new frontier in agriculture. Adv Life Sci 1: 129-38.

Anonymous, 2015, Annual Report .(2015). ICAR-CICR, Nagapur, Maharashtra, India, 34 p

Badran A. E. (2015). Comparative analysis of some garlic varieties under drought stress conditions. Journal of Agricultural Science; Vol. 7, No.10**,** 271-280.

Badran, A.E. and E.S.A.Moustafa (2014). Drought resistance indices and path analysis in some wheat genotypes. World Applied Sciences Journal 30 (12): 1870-1876.

Blum, A., H. Poyarkova, G. Golan and J. Mayer (1983). Chemical desiccation of wheat plants as a simulator of postanthesis stress. I. Effects on translocation and kernel growth. Field Crops Research 6: 51–58.

Dai J, Dong H (2014) Intensive cotton farming technologies in China: achievements, challenges and countermeasures. Field Crop Res 155: 99-110.

Dhale, D.A., Chatte, S.N. and Jadhav, V. T. (2011). Response of bioinoculents on growth, yield and fiber quality of cotton under irrigation.Agric. and Biology J. of North America. Sci., 1(8), 145–152 Egyptian Cotton Gazette (2017). Alcotexa.149: 51.

Emara.M.A.A., S.A.F. Hamoda and Maha M.A. Hamada ,2018 Effect of Nano--Fertilizer and N-Fertilization Levels on Productivity of Egyptian Cotton under Different Sowing Dates .Egypt. J. Agron. The 15th Int. Conf. Crop Science, pp. 125 - 137 .

FAO (2008). FAO: Land and plant nutrition management service. http://www.fao.org/ag/agl/agll/spush. Accessed 24 April 2013

Fernandez, G. C. J. (1992). Effective selection criteria for assessing plant stress tolerance, pp. 257-270. In: Proceedings of the International Symposium on Adaptation of Vegetables and other Food Crops in Temperature and Water Stress, Chapter 25, Taiwan.

Gomez, K. A., & Gomez , A.A. (1984). Statistical procedures for agricultural research. John Willey and Sons. New York, Second Ed. PP.680.

Gorham J, La¨uchli A, Leidi EO (2010). Plant responses to salinity. In: Stewart JM, Oosterhuis DM, Heitholt JJ, Mauney JR (eds) Physiology of cotton. Springer, Netherlands, pp 129–141.

Hediat M. Salama.H (2012) Effects of silver Nano-particles in some crop plants, Common bean (Phaseolus vulgaris L.) and corn (Zea mays L.) International Research Journal of Biotechnology) 3: 190-7.

Hussein M M and Abou-Baker N H .(2018) .The contribution of nanozinc to alleviate salinity stress on cotton plants. Royal Society Open Science, 5(8): 171809.

ICAC (2004) . Cotton: Review of the World Situation. Vol 58 (2), November-December 2004 International Cotton Advisory Committee www.icac.org/cotton_info/publications/samples/reviews/ erev_november_04.pdf Cited 8 Oct 2006.

Khan, M.R, Vojtech Adam, Tanveer Fatima Rizvi, Baohong Zhang, Faheem Ahamad, Izabela Jos´ko, Ye Zhu, Mingying Yang, and Chuanbin Mao,2019 Nanoparticle–Plant Interactions: Two-Way Traffic. small, 1901794

Kumari,M.,Mukherjee,A., Chandrasekaran, N.,(2009) Genotoxicity of silver nanoparticles in Allium cepa Science of The Total Environment 407, 5243-5246.

KumarVineet,PraveenGuleria,VinayKumar,Sudesh,KumarYadav(2013) Gold nanoparticle exposure induces growth and yield enhancement in Arabidopsis thaliana Science of The Total Environment 461–462, 462-468

Laemmli, U.K. (1970). Cleavage of structural proteins during the assembly of the head of bacteriophage T4. Nature, 227: 680-685.

Lin, C. S. and M. R. Binns (1988). A superiority measure of cultivar performance for cultivar x location data. Can. J. Plant Sci, 68: 193-198.

Madbouly, A. K. (2018). Nano-particles as novel plant growth promoters. Novel Res. Microbiology J., 2 (4): 61-64.

Munns R, James RA, Lauchli A (2006). Approaches to increasing the salt tolerance of wheat and other cereals. J Exp Bot 57:1025–1043.

Paramo, L.A, Feregrino-Pérez ,A.A, Mendoza,S., Esquivel,K., (2020) Nanoparticles in Agroindustry Applications, Toxicity, Challenges, and Trends .Nanomaterials , 10, 1654.

Pitman MG, Lauchli A (2002). Global impact of salinity and agricultural ecosystyems. In: La¨uchli A, Lu¨ttge U (eds) Salinity: environment-plants-molecules. Kluwer Academic Publishers, Netherlands, pp 3–20.

Pourdad, S.S. (2008). Study of drought resistance indices in spring safflower. Acta Agron. Hung., 56: 203–212.

Prasad R, Kumar V, Prasad KS. , **(2014)**Nano-technology in sustainable agriculture: Present concerns and future aspects. African Journal of Biotechnology; 13(6): 705-713.

Radhika, K.; S. Hemalatha; S. P. Katharine; S. Maragatham and A. Kanimozhi (2013). Foliar application of micronutrinets in cotton - a review. Res. Rev. J. Agric. Allied Sci., 2 (3): 23-29.

Ramirez, P., and J.D. Kelly (1998). Traits related to drought resistance in common bean. Euphytica, 99: 127-136.

Siddiqui, M. H.; M. H. Al – Whaibi; M. Firoz and M. Y. Al – Khaishany (2015): Role of Nano-particles in plants. Nano-technology and plant Sci., chapter 2: 19 – 35.

Singh and Kaur (2019). Comparative studies on seed protein characteristics in eight lines of two Gossypium species. Journal of Cotton Research 2(6) 2-12.

Tarafdar, J. C.; Agrawal, A.; Raliya, R.; Kumar, Praveen; Burman, U.; Kaul, R. K.(2010) Zn O Nano-particles Induced Synthesis of Polysaccharides and Phosphatases by Aspergillus Fungi Advanced sci Eng medicine 4: 324-8

Tarafdar, J. C.; Raliya, Ramesh; Rathore, Indira (2012) Microbial Synthesis of Phosphorous Nano-particle from Tri-Calcium Phosphate Using Aspergillus tubingensis TFR-5 J Bio Nano- science 6:84-9

UNESCO (2005). Did you know…? Facts and figures about water and salinization/desalination, UNESCO water e-newsletter no. 117: water and salinization/desalination. http://www.unesco.org/water/news/newsletter/117.shtml.

Wang WX, Vinocur B, Altman A (2003). Plant responses to drought, salinity and extreme temperatures: towards genetic engineering for stress tolerance. Planta 218:1–14

Yehia, W.M.B. (2020). Evaluation of some Egyptian cotton (Gossypium Barbadense L.) genotypes to water stress by using drought tolerance indices. Elixir Agriculture 143, 54133-54141.