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Effect of Specific Ions, Salinity and Alkalinity on Yield and Quality of Some Egyptian Cotton Genotypes

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TWO FIELD experiments were conducted at the Experimental Farm of/ Sakha Agricultural Research Station located at 31⁰, 05, 13.8 latitude and 30 °, 56, 10.6 longitude., during 2017 and 2018 growing seasons. Objective of this investigation was, to study the effect of soil soluble salts, and specific ion effect on seed cotton yield and fiber quality. Five Egyptian cotton genotypes, (*G. Barbadence L.*); Giza 85, Giza 89 and, new hybrid Giza 86 x 89 (long staple) and Giza 87 and new hybrid Giza 84 (Giza 74 x Giza 68) extra- long staple were planted. The obtained results can be summarized as follows: (1) seed cotton yield was highly significantly affected by soil salinity level. (2) Significant interaction was observed between different soluble ions, according to simple and partial correlation analysis. (3) Negative correlations were observed between seed cotton yield, and each of Na^+, Ca^{++} and Mg^{++}. The highest negative correlation was obtained with soluble and/or exchangeable Na^+ , because of its higher toxicity, in addition to restricting water movement and aeration. (4) Negative correlations were shown between seed cotton yield, and each of Cl^- and SO^{--}_4. It could be noticed that the effect of antagonism between SO^{--}_4 and Cl^- may depress the toxic effect of the latter. (5) Data revealed negative correlation between exchangeable sodium percentages, and seed cotton yield of some studied cotton genotypes. (6) Highly significantly negative correlations were recorded between ECe, cations (Na^+, Ca^{++} and Mg^{++}), anions (Cl^- & $SO^{=}_4$) and each of some studied cotton genotypes characteristics (boll weight, 2.5 Spin length, lint percentage and plant height).

Keywords: Salinity, Alkalinity, Specific ion effect and Egyptian cotton.

Introduction

Soil salinity is the most important environmental factor limiting the agricultural productivity, especially in arid and semi-arid regions, as in Egypt. A saline soil is widely found in the northern part of Egypt, especially at Kafr El-Sheikh Governorate. The management of salt affected soils requires a good understanding of crop salinity relations, particularly, under field conditions (Zein et al., 2002a). Cotton is still one of the most important economic crops in Egypt, so, it was chosen for the present study. Lacher (1995) stated that high saline water was difficult to be obtained by plant for growth. In addition, many plant species are sensitive to specific ion in soil solutions. The accumulation of Na salts in the protoplasm led to disturbance in the ionic balance (K^+ and Ca^{++} to Na^+). Zeina (2001) found that yield, yield components and fiber quality of eighteen Egyptian cotton varieties, and promising hybrids were highly significant affected with levels of soil salinity. Yadar (1977) in salinity hazards field trials, tested several field crops in micro-plots, using water with different salinity levels, on different types of soils, at different locations in India, with EC values 2, 4, 6, 8, 12 and 16 dS/m. He found that the percentage of reduction of wheat in sandy loam was 0, 0, 5, 5, 25 and 45, respectively. Zein et al. (2003) found that wheat grain and straw yields, as well as, plant height, spike length and 1000 grain weight, were significantly affected by increasing irrigation water salinity. They added that, Egyptian and Syrian wheat varieties differed in their tolerance to water salinity levels. Sharma, (1996) observed that there were increase in Na^+

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and Cl^- concentration at higher salinities, which considered to be a cause of reduction in growth of wheat plant. Also, the uptake of K decreased, particularly in the salt sensitive plants. Hussein (1978) reported that higher K translocation by salt sensitive barley varieties, may result in an increase of salt influx of K ions to the guard cells, which in turn, may affect the rapid change of osmotic potential in these cells; due to the maintenance of stomatal opening, and consequentially, increase in transpiration rate. The negative influence of NaCl stress on the growth, is not primarily due to an impaired protein synthesis, but may be due to determined effect of Na on the other metabolic processes (Helal et al., 1975). Egyptian cotton occupies the first rank among the other crops, because of its economic importance as export crop or local use in the Egyptian factories. So agricultural researches ought to direct its concern and interest to increase cotton productivity and impose its quality (Gazia and El-Basuny, 2004).

Simple relationship between two variables, (*e.g.* cotton yield and salinity) is measured by simple correlation coefficient (r). This simple relation means, in fact, that the media is closed on these two variables only, and there is no any other factor affecting this relation. But the relationship between the solved elements and compounds in the soil solution and cotton yield are complex. Some of these relations are antagonistic; that some of these solved elements antagonize the effect of other element on cotton yield. Other relations are associative; meaning also that some of these solved elements, associate and help the effect of other element on cotton yield. Other relations are independent. Determining and quantifying the kind of these relations, could be done by comparing the simple and specific relations between these elements, and cotton yield. Specific relation could be measured by eliminating the effect of some element X_2 (*e. g.* Ca^{++}, and SO_4^{--}), on both other elements X_1(*e. g.* Na^+ and Cl^-,) and cotton yield (Y), then calculate the relation between X1 and Y. Eliminating the effect of element could be done through many procedures. In the current study partial correlation coefficient will be followed to eliminate such effect (Pindyck and Rubinfeld, 1976).

Thus, objectives of the present investigation were, to evaluate yield and some yield components, of five Egyptian cotton genotypes, against four levels of soil salinity under field conditions, also to select the suitable genotype adapted for the level of soil salinity. The specific ion effects were concerned.

Materials And Methods

Two field experiments were conducted at the Experimental Farm of Sakha Agricultural Research Station located at 31^0 , 05, 13.8 latitude and 30^o, 56, 10.6 longitude., Kafr El-Sheikh, during two successive growing seasons 2017 and 2018, to study the effect of soil soluble salts and specific ions effect on cotton seed yield, some yield components and fiber quality. The examined cotton genotypes were, Giza 85, Giza 89, new hybrids Giza 86 x Giza 89 (long staple), Giza 87 and Giza 84 x (Giza 74 x Giza 68) extra-long staple.

Experiments were conducted in split plot design, with four replicates. Four ranges of soil salinity: S_1 (6-11 dS m^{-1}), S_2 (11-14 dS m^{-1}), S_3 (14-18 dS m^{-1}) and S_4 (>18 dS m^{-1}) under field conditions occupied the main plots, while the five cotton genotypes, occupied the subplots. The studied parameters were: yield, some yield components and lint characters.

The soil was prepared for planting, and was divided into 80 plots. Each plot consisted of 5 ridges, 4 m in length and 0.65 m in width. Chemical soil analysis of each plot was conducted before cultivation in both growing seasons, according to Richards (1954) was shown in Table 1.

Seeds were planted in hills, 25 cm a part and thinned to two plants per hill after six weeks. At planting, 22.5 kg P_2O_5/fed. as calcium super phosphate (15.5% P_2O_5) were added to the soil for each season. Plants were fertilized with 70 kg N/ fed. at two equal doses. The first dose was added after thinning, and the second was added 15 days later. Potassium fertilizer was added at the rate of 48 kg K_2O/fed. in the form of K_2SO_4, (48% K_2O) with the second dose of nitrogen.

Other agricultural practices were carried out, as the common recommendations. The studied characters were as follows: I) Seed cotton yield in (kentar = 157.5 kg)was estimated as the weight of seed cotton yield per feddans, II) Boll weight (B.W): the average weight in grams of twenty five bolls picked at random from each treatment, III) Lint percentage (L.P): the percentage weight of lint = (weight of lint /weight of seeds) x 100, IV) plant height in (cm)and V) fiber quality traits = 2.5% span length was measured by means of the digital fibrograph 530, according to the standard method of (A.S.T.M.D. 144783).

Experimental land preparation

At starting the experiment, soil was ploughed and prepared for planting, it was divided into plots, and irrigated to redistribute salinity vertically and horizontally in each plot. Soil was left for ten days, then three samples were taken from each plot, at depths of (0-30),(30-60) and (60-90) cm. The cotton plants were irrigated at 75 depletion of available soil moisture, to control soil salinity levels in the root zone. Composite soil samples were taken for chemical analysis from each plot, representing the root zone depth (0-90 cm). Electrical conductivity (ECe) and soluble cations and anions (meq/l) were determined in soil paste extract. Alkalinity has been characterized through calculation of SAR according to Jurinak and Sauvez (1990), and ESP according to Gazia (2001) ESP= -0.8843+1.4107(SAR)^2, R^2=0.9998. ECe was ranged from 10 to 28 dS/m, ESP was ranged from 17 to 31. Experimental soil was clayey soil.

To explore the specific ion effects on the studied characters, partial correlation coefficients were calculated, to determine the relative importance of one independent variable, after getting out the effect of any other independent variables. Simple correlations were also calculated, as well as, comparison between simple and partial correlation (*i. e.* If partial correlation exceeds the simple correlation, that means that, the relation is antagonistic. On the other hand, if simple correlation exceeds the partial correlation, that means that, the relation is associative. Finally, if simple and partial correlations are equal, then the relation is independent (Pindyck and Rubinfeld (1976). Data were statistically analyzed using computer soft were referring to the statistical textbooks Cochran and Cox (1960).

Results And Discussion

Chemical analysis of the studied soils

The data of chemical composition, of soil paste extract of the studied soil, ECe, soluble cations; Na^+, Ca^{++}, Mg^{++} and K^+, soluble anions, $CO_3^=$, HCO_3^-, Cl^- and $SO_4^=$ and ESP values, are presented in Table 1. It could be concluded that the dominant soluble salts are in the form of chlorides and sulfates. These findings correspond to those reported by Ayres and Westcot (1985), Saied(2017) and Zein et al. (2002b).

Statistical analysis of ECe and ESP values were done for both seasons using complete randomized block design, as shown in Table 2. Data revealed highly significant difference between ECe, values where there is no significant difference between ESP values. Data also, show that ECe values were highly significantly decreased after the 1st season, while they were insignificantly affected after the 2nd season. This means that salinity and alkalinity were stable throughout the studying period. This result may be due to the ineffective drainage system, and the controlled irrigation practices in experimental field.

Effect of soil characters on seed cotton yield

Effect of soil salinity

Results in Table 3(a and b) show the effect of salinity, genotypes and their interaction, on seed cotton yield for 1st and 2nd seasons. Data revealed that seed cotton yield was highly significantly affected by salinity level. The highest seed cotton yield was obtained under the lowest salinity level S_1 (8.647 and 10.024 kentar/fed for 1st and 2nd seasons, while the lowest values were obtained under the highest salinity level S_4 (4.350 and 4.856 kentar/fed for 1st and 2nd seasons).

Data also showed that seed cotton yield was highly significantly affected by cotton genotypes. Giza 85 was the superior cotton genotypes, since it yielded the highest values of seed cotton yield (7.06 and 7.92 kentar/fed for 1st and 2nd seasons), while the least seed yield was given with genotypes H74 x 68 (5.81 kentar/fed) in the 1st season and Giza 89 (6.78 kentar/fed) in the 2nd season. Moreover, data showed insignificant interaction effect, between salinity and cotton genotypes. The highest values of seed cotton yield, were obtained by the interaction between the lowest salinity level with G87 in the 1st season (9.12 kentar/fed), or with H(86 x 89) for 2nd seasons (10.47 kentar/fed).

The relation between ECe and seed cotton yield, represented by equations (1-10) of second order, which is adequate explicitly decreasing of seed cotton yield with increasing soil salinity (ECe), more than the linear, which assumed equal decrements in seed cotton yield (y), with increasing one unit of ECe value units, that is unreasonable. The equation has very high determination coefficients, which indicate that they are fit to predict yield at given ECe.

The results herein showed the effect of salinity, which can be interpreted by FAO, (1985), which concluded that salinity may affect different metabolic processes, such as CO_2 assimilation, protein synthesis, respiration or phytormone turn over and toxicity, begins with an imbalance of ions in the plant tissue, often with a large excess

TABLE 1. Soil chemical analysis of the experimental field before planting and after the two growing seasons (mean values of four replicates)

Salinity ranges dS/m	EC dS/m	Cations (meq/L) K^+	Na^+	Mg^+	Ca^{++}	Anions (meq/L) CO^-_3	HCO^-_3	Cl^-	SO^{--}_4	SAR	ESP %
Initial (before planting)											
Giza 84											
S_1 (6-11)	10.23	2.43	69.16	11.35	19.50	0.33	2.83	65.98	33.30	17.60	19.82
S_2 (11-14)	12.70	0.37	92.33	13.94	20.17	-	3.16	93.13	30.52	22.36	24.01
S_3 (14-18)	16.40	1.83	120.20	15.26	28.55	0.66	4.33	119.66	41.19	25.68	26.57
S_4 > 18	28.50	3.46	205.33	28.14	51.16	-	3.83	205.66	78.60	33.01	31.19
Giza 85											
S_1 (6-11)	10.90	2.85	76.53	9.72	19.50	0.33	3.50	73.11	31.66	20.03	22.04
S_2 (11-14)	13.76	2.18	90.43	14.87	31.30	0.33	3.00	92.63	42.82	18.84	20.97
S_3 (14-18)	16.39	3.15	134.20	7.58	19.50	0.50	2.33	133.06	28.54	36.46	32.87
S_4 > 18	22.80	2.70	148.00	43.50	68.12	-	7.00	147.26	108.06	16.91	19.17
Giza 87											
S1 (6-11)	10.63	3.14	65.33	12.84	24.83	-	3.33	62.13	40.68	15.05	17.33
S2 (11-14)	13.80	3.70	111.00	5.96	17.43	0.50	4.00	108.39	25.20	32.46	30.89
S3 (14-18)	16.10	3.28	96.43	24.89	34.30	0.33	3.16	94.36	61.05	17.73	19.95
S4 > 18	22.86	1.73	184.96	37.79	43.16	-	5.66	189.65	72.33	29.45	29.13
Giza 89											
S1 (6-11)	9.62	0.70	70.00	9.12	16.50	-	2.50	68.65	25.17	19.55	21.61
S2 (11-14)	13.20	1.93	94.83	12.43	24.57	0.16	3.16	92.73	37.71	22.05	23.76
S3 (14-18)	17.90	4.12	123.60	20.89	32.29	-	3.50	113.00	64.40	23.95	25.27
S4 > 18	23.16	4.16	197.33	22.77	46.17	-	4.50	200.26	65.67	33.39	31.39
Giza 86 x 89											
S1 (6-11)	10.90	3.17	85.73	6.64	14.80	0.33	3.33	86.38	20.30	26.22	26.96
S2 (11-14)	13.86	2.18	99.83	11.11	25.33	-	3.83	100.86	33.76	23.38	24.83
S3 (14-18)	17.70	3.62	119.26	21.09	36.29	-	3.50	120.53	56.23	22.25	23.92
S4 > 18	20.50	2.26	138.13	16.28	43.50	-	5.16	133.13	61.88	25.25	26.26
2017											
Giza 84											
S1 (6-11)	8.50	2.04	57.85	8.05	16.76	-	3.00	55.43	26.27	16.45	18.60
S2 (11-14)	12.25	2.35	90.79	10.49	19.67	-	2.94	92.75	27.54	23.49	24.90
S3 (14-18)	15.64	3.47	106.23	19.42	28.02	-	3.50	108.20	45.44	22.01	23.58
S4 > 18	23.1	3.30	156.36	29.71	44.25	-	3.55	158.0	72.07	25.52	24.08
Giza 85											
S1 (6-11)	9.09	2.15	67.28	7.88	14.45	-	3.33	64.77	23.66	20.86	22.27
S2 (11-14)	12.83	2.31	67.05	13.28	23.77	-	3.05	93.23	10.13	16.13	17.69
S3 (14-18)	15.93	3.28	123.15	11.04	22.49	-	3.44	122.10	34.42	30.54	29.36
S4 > 18	22.87	3.26	155.98	27.96	44.19	-	4.66	151.33	75.40	27.93	27.30
Giza 87											
S1 (6-11)	9.55	2.43	60.82	11.03	20.98	-	3.55	58.09	33.61	15.27	17.51
S2 (11-14)	12.57	3.02	97.92	7.95	16.47	-	3.58	96.93	24.85	28.09	28.08
S3 (14-18)	15.61	3.50	96.35	20.96	34.82	-	3.05	97.24	55.34	18.28	20.43
S4 > 18	22.58	2.46	153.85	28.70	41.18	-	3.89	154.63	67.67	26.70	27.11
Giza 89											
S1 (6-11)	8.19	1.14	60.95	6.44	12.94	-	3.11	59.07	19.23	19.54	21.57
S2 (11-14)	12.16	2.78	90.92	15.72	19.13	-	3.16	89.03	36.36	24.84	25.67
S3 (14-18)	17.02	3.93	122.63	14.90	29.13	-	3.39	123.67	43.53	26.54	27.08
S4 > 18	22.40	3.11	152.54	25.94	44.83	-	3.71	155.00	67.71	25.60	26.10
Giza 86 x 89											
S1 (6-11)	9.82	2.46	70.64	8.67	17.91	-	3.61	69.23	26.84	19.77	21.49
S2 (11-14)	13.73	2.47	96.10	12.50	25.94	-	3.39	93.57	40.05	21.94	23.68
S3 (14-18)	17.13	3.32	120.70	18.40	28.65	-	3.16	121.00	46.91	25.22	26.13
S4 > 18	20.47	3.38	141.39	20.77	40.01	-	4.05	125.67	75.83	27.68	26.58
2018											
Giza 84											
S1 (6-11)	10.67	2.42	74.91	11.17	18.67	-	3.35	74.4	29.42	19.15	21.51
S2 (11-14)	11.98	2.98	90.23	7.60	19.12	-	3.17	88.80	27.96	24.70	25.84
S3 (14-18)	15.72	2.90	104.70	17.47	33.32	-	2.83	104.00	51.56	20.78	22.69
S4 > 18	18.35	2.40	111.48	24.40	45.07	-	3.59	113.00	66.76	18.92	21.04
Giza 85											
S1 (6-11)	9.13	1.88	71.30	4.53	14.18	-	3.79	69.52	18.58	23.33	24.79
S2 (11-14)	11.65	1.78	90.77	7.89	17.70	-	2.69	89.08	26.37	25.42	26.38
S3 (14-18)	16.80	2.46	111.34	17.87	37.83	-	2.57	108.70	58.23	21.01	22.95
S4 > 18	21.22	3.72	141.81	28.77	41.08	-	2.47	137.40	75.81	24.00	25.32
Giza 87											
S1 (6-11)	8.35	1.34	50.66	12.17	18.73	-	4.36	48.03	30.51	12.90	15.11
S2 (11-14)	13.00	2.98	99.46	9.45	17.45	-	3.61	98.30	27.53	27.28	27.51
S3 (14-18)	15.50	4.41	101.04	18.70	31.84	-	3.35	107.00	45.64	20.14	22.13
S4 > 18	23.88	3.47	165.08	26.00	45.59	-	3.75	159.00	76.39	27.65	27.93
Giza 89											
S1 (6-11)	9.13	1.10	67.03	8.23	14.05	-	3.88	65.30	21.23	19.93	21.85
S2 (11-14)	12.78	2.61	94.05	10.46	20.02	-	3.12	108.00	16.02	25.25	25.99
S3 (14-18)	17.43	4.29	122.36	17.21	33.25	-	3.37	124.00	49.74	24.40	25.62
S4 > 18	23.66	2.79	172.35	21.12	43.23	-	3.16	175.00	61.33	31.47	29.93
Giza 86 x 89											
S1 (6-11)	9.58	1.70	70.37	6.48	14.99	-	3.33	71.30	18.91	21.48	23.27
S2 (11-14)	13.67	2.21	102.11	10.80	24.08	-	3.45	52.70	83.05	24.45	25.65
S3 (14-18)	16.60	3.20	120.60	18.30	28.45	-	3.00	120.70	46.85	25.28	26.17
S4 > 18	21.06	2.30	147.95	25.33	38.27	-	2.96	147.13	63.76	26.71	26.78

TABLE 2. The mean values of ECe and ESP before planting and after the 1st and 2nd seasons

Season	ECe dS m^{-1}	ESP
Initial (before planting)	15.899 a	24.897 a
After 1st season	15.072 a	23.961 a
After 2nd season	15.000 b	24.425 a
F-test	**	NS
LSD 0.05	0.568	1.625
LSD 0.01	0.760	2.177

TABLE 3a. Mean values of seed yield of different genotypes of cotton, under ascending salinity levels in kentar/fed for the two growing seasons

Factor	2017	2018
Salinity (S)		
S_1	8.647	10.024
S_2	7.043	8.737
S_3	5.853	6.336
S_4	4.350	4.858
F-test	**	**
LSD 0.05	0.859	0.628
0.01	1.302	0.951
Genotype		
H74x68	5.809	7.903
G 85	7.063	7.911
G 87	6.820	7.406
G 89	6.248	6.779
H 86 x 89	6.424	7.385
F-test	**	**
LSD 0.05	0.450	0.656
0.01	0.606	0.874
S x V	NS	NS

TABLE 3b.Mean values of seed cotton yield, as affected by interaction between soil salinity and cotton genotypes, for the two growing seasons

Season	Salinity	Genotypes					LSD interaction at 0.05 and 0.01
		H 74x68	G85	G 87	G89	H 86x89	
2017	S_1	7.75	8.90	9.12	8.50	8.96	Genotype
	S_2	6.62	8.08	6.65	6.83	7.04	LSD 0.05 = 0.901
	S_3	5.28	6.61	6.16	5.77	5.45	LSD 0.05 = 1.211
	S_4	3.59	4.67	5.35	3.89	4.25	
		Salinity LSD 0.05 = 1.173, LSD 0.01 = 1.674					
2018	S_1	10.18	9.99	10.17	9.31	10.47	Genotype
	S_2	9.71	10.13	8.29	7.28	8.29	LSD 0.05 = 1.300
	S_3	6.42	6.98	6.26	5.91	6.10	LSD 0.05 = 1.747
	S_4	5.54	4.54	4.90	4.62	4.68	
		Salinity LSD 0.05 = 1.318, LSD 0.01 = 1.816					

of Na^+ by excluding its uptake or secreting into vacuoles. These regularity processes require an additional amount of energy, and for this reason, plants subjected to salinity condition show higher respiration rate and deplete storage carbohydrates to a great extent than plants grown under non saline conditions. The same trend was found by Yadar (1977) and Zein et al. (2003) and Amer and hashem (2018).

The following equations identify the relations between seed cotton yield and soil salinity ECe:

For 1st season (2017)

Yield (Giza 84) = 0.0098 $(ECe)^2$ -0.5901 (ECe) +12.088 $R^2 = 0.9116$ (1)

Yield (Giza 85) = 0.0015 $(ECe)^2$ -0.2305 (ECe) + 10.953 $R^2 = 0.7717$ (2)

Yield (Giza 87) = 0.0232 $(ECe)^2$ -1.0157 (ECe) + 16.244 $R^2 = 0.7813$ (3)

Yield (Giza 89) = 0.0181 $(ECe)^2$ - 0.8494 (ECe) + 14.323 $R^2 = 0.7842$ (4)

Yield (Giza 86 x 89) = 0.0068 $(ECe)^2$ - 0.6439 (ECe) + 14.578 $R^2 = 0.929$ (5)

For 2nd season (2018)

Yield (Giza 84) = 0.02963 $(ECe)^2$ -1.5029 (ECe) +23.116 $R^2 = 0.8636$ (6)

Yield (Giza 85) = -0.0178 $(ECe)^2$ +0.0602 (ECe) + 11.254 $R^2 = 0.9214$ (7)

Yield (Giza 87) = 0.0178 $(ECe)^2$ -0.9226 (ECe) + 16.729 $R^2 = 0.9257$ (8)

Yield (Giza 89) = 0.0151 $(ECe)^2$ - 0.7949 (ECe) + 14.992 $R^2 = 0.7647$ (9)

Yield (Giza 86 x 89) = 0.019 $(ECe)^2$ - 0.9492 (ECe) + 16.873 $R^2 = 0.9134$ (10)

As an example to illustrate the relationship between seed cotton yield and ECe, to obtain the marginal seed cotton yield by differentiating equations(1-10) with respect to ECe when ECe = 6 dSm-1, the decrease in (y) were 0.4725, 0.2125, 0.7373, 0.6322, and 0.5623 kentar/fed in 1st season, and 1.147311, 0.1534, 0.709, 0.6137 and 0.7212 kentar/fed in 2nd season, for Giza 84, 85, 87, 89 and 86 x 89 respectively. While the decrease, when ECe = 18 dSm-1 were 0.2373, 0.1765, 0.1805, 0.1978, 0.3991 kentar/fed in 2nd season and 0.43622, 0.5806, 0.2818, 0.2513 and 0.2652, kentar/fed in 2nd season, for the same genotypes, respectively.

Partial effect of cations

Results in Table 4 showed negative simple correlation, between seed cotton yield, of the studied genotype, Giza 84, 85, 87, 89 and (86 x 89) and sodium concentration, $r_{y.Na}$ = -0.85, -0.81, -0.80, -0.71 and -0.91 for 1st season, respectively, while they were -0.90, -0.94, -0.90, -0.84 and -0.89, for 2nd season, respectively. These results indicated that seed cotton yield of all studied cotton genotypes, decreased by increasing soil salinity levels, but they differ in its extend. This may be due to the difference in salinity tolerance of these genotypes. These results are in agreement with those obtained by Bohn *et al.* (1985) who reported that sodium is toxic to some plants at high concentration, but for most plants, this is a relatively minor problem compared with the restricted water movement, and aeration that normally precede sodium toxicity. The adverse effect of Na^+ on yield may attributed, to its toxicity for plants (Bohn et al., 1985), decrease the up-take of K^+ due to ion antagonism (Sharma, 1996), increase the respiration rate, due to translocation of K^+ to the guard cell, which in turn change rapidly the osmotic pressure in these cells (Hussain, 1978) and/or due to impairing of protein synthesis (Helal et al., 1975) and (Baio et al., 2019).

Partial correlation is often used, to determine the relative importance of one independent variable, after getting out the effect of any other independent variables. The data of partial correlations of the studied cations with seed cotton yield, are listed in Table 4. Data revealed that in 1st season, $r_{y.Na}$ (-0.85) > $r_{y.Na\cdot CaMg}$ (-0.22), $r_{y.Ca}$ (-0.92) > r_{yCaNa}, Mg (-0.24) and r_{yMg} (-0.96) > $r_{yMg.NaCa}$ (-0.71) for Giza 84. The same results obtained for Giza 85, 87, 89 and (86 x 89) in 1st and 2nd seasons. It is clear that all simple correlations, are higher than the corresponding ones of partial correlations. This may be due to: 1) various interactions between ions during their uptake and, therefore, high sodium levels could conceivably lead to calcium and magnesium deficiencies levels, 2) Ca^{++} compete quite effectively with Mg^{++}, and strongly depress its uptake rate (Marschner, 1997), so, the presence of Ca^{++} shift K/Na uptake ratio in favor of K^+ at the expense of Na^+ (Jeschke and Jambor, 1981). 3) Alkali metal ions such as Na^+ and K^+ form ion pairs only in highly saline soils. Mg^{++} and Ca^{++} also form sulphate and carbonate (Bohn et al., 1985), consequently, cations balance affected their activities in soil solution and in turn their effects on plant growth.

TABLE 4. Simple and partial correlation between cations and each of yield, boll weight, 2.5% span length, lint percentage and plant height.

Character	Ions					
	Na^+		Ca^{++}		Mg^{++}	
	Simple correlation	Controlling for Ca & Mg	Simple correlation	Controlling for Na & Mg	Simple correlation	Controlling for Na Ca
2017						
H (74 x 68)						
	ry Na	ryNa.CaMg	ry Ca	ryCa.NaMg	ry Mg	ryMg.NaCa
Yield (y)	-0.85**	-0.22	-0.92**	-0.24	-0.96**	-0.71
Boll weight (B.W)	-0.78**	-0.67	-0.60*	0.48	-0.66*	-0.40
2.5% span length (SL)	-0.80**	-0.09	-0.87**	-0.43	-0.82**	-0.10
Lint percentage (L.P)	-054n.s	-0.16	-0.53n.s	-0.39	-0.53n.s	-0.10
Plant height (P.H)	-0.77**	-0.22	-0.80**	-0.02	-0.84**	-0.45
Giza 85						
	ry Na	ryNa.CaMg	ry Ca	ryCa.NaMg	ry Mg	ryMg.NaCa
Yield (y)	-0.81**	-0.76	-0.71**	-0.14	-0.67*	-0.12
Boll weight (B.W)	-0.80**	-0.75	-0.69*	0.04	-0.68*	-0.28
2.5% span length (SL)	-0.81**	-0.75	-0.43n.s	-0.05	-0.37n.s	0.03
Lint percentage (L.P)	-0.59*	-0.47	-0.59*	0.10	-0.60*	-0.26
Plant height (P.H)	-0.80**	-0.82	-0.73**	0.23	-0.75**	-0.52
Giza 87						
	ry Na	ryNa.CaMg	ry Ca	ryCa.NaMg	ry Mg	ryMg.NaCa
Yield (y)	-0.80**	-0.76	-0.49n.s	-0.29	-0.49n.s	0.36
Boll weight (B.W)	-0.72**	-0.40	-0.66*	0.01	-0.75**	-0.30
2.5% span length (SL)	-0.94**	-0.92	-0.80**	-0.68	-0.82**	0.19
Lint percentage (L.P)	-0.01n.s	-0.27	0.19n.s	-0.07	0.24n.s	0.27
Plant height (P.H)	-0.85**	-0.76	-0.81**	-0.61	-0.78**	-0.24
Giza 89						
	ry Na	ryNa.CaMg	ry Ca	ryCa.NaMg	ry Mg	ryMg.NaCa
Yield (y)	-0.71**	0.21	-0.90**	-0.39	-0.89**	-0.13
Boll weight (B.W)	-0.77**	-0.05	-0.90**	-0.30	-0.88**	-0.14
2.5% span length (SL)	-0.88**	-0.54	-0.94**	-0.15	-0.92**	-0.35
Lint percentage (L.P)	-0.59*	0.29	-0.83**	-0.16	-0.86**	-0.37
Plant height (P.H)	-0.81**	-0.30	-0.86**	-0.19	-0.83**	-0.09
H 68 x 89						
	ry Na	ryNa.CaMg	ry Ca	ryCa.NaMg	ry Mg	ryMg.NaCa
Yield (y)	-0.91**	-0.79	-0.86**	-0.43	-0.71*	-0.32
Boll weight (B.W)	-0.86**	-0.72	-0.80**	-0.59	-0.91**	-0.65
2.5% span length (SL)	-0.78**	-0.31	-0.94**	-0.78	-0.80**	-0.45
Lint percentage (L.P)	-0.82**	-0.52	-0.80**	-0.45	-0.50n.s	0.10
Plant height (P.H)	-0.88**	-0.79	-0.77**	0.09	-0.71*	-0.58
2018						
H (74 x 68)						
	ry Na	ryNa.CaMg	ry Ca	ryCa.NaMg	ry Mg	ryMg.NaCa
Yield (y)	-0.90**	-0.63	-0.87**	-0.10	-0.8**	-0.35
Boll weight (B.W)	-0.87**	-0.58	-0.83**	-0.54	-0.60*	0.48
2.5% span length (SL)	-0.89**	-0.54	-0.94**	-0.83	-0.70**	0.61
Lint percentage (L.P)	-0.96**	-0.87	-0.82**	-0.11	-0.70**	0.26
Plant height (P.H)	-0.92**	-0.70	-0.88**	-0.51	-0.70**	0.34
Giza 85						
	ry Na	ryNa.CaMg	ry Ca	ryCa.NaMg	ry Mg	ryMg.NaCa
Yield (y)	-0.94**	0.18	-0.93**	-0.20	-1.00**	-0.50
Boll weight (B.W)	-0.96**	-0.71	-0.83**	0.53	-0.93**	0.03
2.5% span length (SL)	-0.96**	-0.62	-0.92**	-0.38	-0.94**	0.31
Lint percentage (L.P)	-0.85**	-0.48	-0.73**	0.21	-0.81**	0.15
Plant height (P.H)	-0.84**	-0.34	-0.85**	-0.44	-0.82**	0.27
Giza 87						
	ry Na	ryNa.CaMg	ry Ca	ryCa.NaMg	ry Mg	ryMg.NaCa
Yield (y)	-0.90**	-0.68	-0.87**	-0.07	-0.83**	-0.26
Boll weight (B.W)	-0.96**	-0.95	0-0.83**	0.69	-0.83**	-0.80
2.5% span length (SL)	-0.85**	-0.39	-0.92**	-0.44	-0.87**	-0.09
Lint percentage (L.P)	-0.52n.s	-0.39	-0.39n.s	0.15	-0.38n.s	-0.12
Plant height (P.H)	-0.92**	0.76	-0.87**	0.15	-0.85**	0.48
Giza 89						
	ry Na	ryNa.CaMg	ry Ca	ryCa.NaMg	ry Mg	ryMg.NaCa
Yield (y)	-0.84**	-0.79	-0.66*	-0.56	-0.42n.s	0.75
Boll weight (B.W)	-0.86**	-0.31	-0.88**	-0.66	-0.71**	0.50
2.5% span length (SL)	-0.80**	-0.47	-0.72**	-0.56	-0.50n.s	0.60
Lint percentage (L.P)	-0.81**	-0.46	-0.74**	-0.29	-0.59*	0.28
Plant height (P.H)	-0.88**	-0.85	-0.66*	-0.06	-0.48n.s	-0.49
H 68 x 89						
	ry Na	ryNa.CaMg	ry Ca	ryCa.NaMg	ry Mg	ryMg.NaCa
Yield (y)	-0.89**	-0.76	-0.88**	0.05	-0.83**	-0.53
Boll weight (B.W)	-0.87**	-0.66	-0.91**	-0.15	-0.87**	-0.50
2.5% span length (SL)	-0.85**	-0.49	-0.93**	-0.46	-0.84**	-0.17
Lint percentage (L.P)	-0.81**	-0.65	-0.81**	0.30	-0.82**	-0.60
Plant height (P.H)	-0.90**	-0.67	-0.90**	-0.34	-0.79**	-0.14

ryNa = simple correlation between y and Na

ryNa.CaMg = partial correlation of y and Na (controlling for Ca and Mg).

**, * and ns means highly significant, significant and not significant, respectively

Specific effect of anions

Soils with high levels of ions (Cl^-, HCO^-_3 and SO_4) within the root zone, affecting crop growth. Toxicity of chlorine is much more world wide in arid and semi arid regions.

The data in Table 5 show negative correlation between seed cotton yield and CL^- and SO^{--}_4, where r_{yCl} were -0.86, -0.82, -0.80, -0.70 and 0.94 for Giza 84, 85, 87, 89 and (86 x 89) in 1st season, respectively, while r_{yCl} were -0.89, -0.93, -0.90, -0.83 and -0.79, in the 2nd season for the same genotypes respectively, r_{ySO4} were -0.94, -0.75, -0.48, 0.88 and -0.77 in the 1st season and -0.89, -0.97, -0.84, -0.54 and -0.47 in the 2nd season, for the five genotypes, respectively.

From the results in Table 5 it can be observed that, $r_{yCl} < r_{yCl^{\cdot}HCO3SO4}$ for all genotypes in 1st and 2nd seasons. This may be attributed to an inhibitory effect of HCO^-_3 and SO^{-}_4 on Cl^-, and it could be noted that the effect of antagonism between SO^{-}_4 and Cl^- may depress the toxic effect of the latter. These findings are in agreement with that of Selim *et al.* (1978). The partial correlation of y and SO^{-}_4 eliminating the effect of Cl^-, HCO^{-}_3 were -0.77, -0.53, -0.35, -0.77 and -0.64, while the simple correlation ry_{SO4} were -0.94, -0.75, -0.48, -0.88 and -0.77 for cotton genotypes 84, 85, 87, 89 and ((86 x 89) for 1st season, respectively, while the corresponding values were -0.49, -0.75, -0.36, -0.39 and -0.91for partial correlation and were -0.89, -0.47, -0.84, -0.54 and -0.47 for simple correlation for cotton genotypes 84, 85, 87, 89 and (86 x 89) for 2nd season, respectively, this leads to synergistic of Cl^- and HCO^-_3 for the toxic effect of SO^{-}_4. Similar conclusions were reported by numerous studies such as: 1) Cram (1973) who reported that competition, between nitrate and chloride during uptake, is of great importance for crop production. The net influx of nitrate is decreased by chloride. 2) Luttge and Laties (1966) reported that at high external concentration, anion which is taken up relatively slowly, can depress the uptake of an oppositely charged more mobile ion. For example SO^{-}_4 depresses K^+ uptake and Ca^{++} depresses Cl^- uptake.

Data in Table 5 showed week correlation between seed cotton yield and bicarbonate ion, where r_{yHCO3} and $r_{yHCO3.ClSO4}$ were found in small amount than r_{yCl} and r_{ySO4}. This may be due to the specificity in tolerance of bicarbonate ion or it has low concentration. This trend was observed by Mostafa *et al.* (1992), who found that increasing salinity level of irrigation water up to 4000 ppm, gradually and significantly increased EC, Cl^- and SO^{--}_4 concentration and slightly decreased soil pH and HCO^{--}_3 content.

Evaluation of sodicity and its effect

The sodium status in soils is generally described by exchangeable sodium percentage (ESP), which derived from sodium adsorption ratio (SAR) according to Gazia (2001). The mean values of ECe ranged between 8.19 and 23.88 dSm^{-1} for all plots, while ESP mean values were ranged from 15.11 to 29.93. Table (1). It could be observed that as ESP increased, seed cotton yield decreased. Such relationship is represented by equation of second order, which is adequate explicitly decreasing of seed cotton yield, with increasing ESP more than the linear equation which assumed equal decrements in seed cotton yield (y), with increasing ESP one unit, which is unreasonable. The equations were as follows:

For 1st season (2017)

Yield (Giza 84) $y = 0.00569\,(ESP)^2 - 0.0301\,(ESP) + 8.2415$ $R^2 = 0.3258$ (1)

Yield (Giza 85) $y = -0.0005\,(ESP)^2 - 0.0631(ESP) + 8.9362$ $R^2 = 0.1294$ (2)

Yield (Giza 87) $y = 0.0261(ESP)^2 - 1.4205\,(ESP) + 25.08$ $R^2 = 0.585$ (3)

Yield (Giza 89) $y = 0.0188\,(ESP)^2 - 1.0219\,(ESP) + 19.804$ $R^2 = 0.0402$ (4)

Yield (Giza 68 x 89) $y = 0.0116\,(ESP)^2 - 0.8523\,(ESP) + 20.172$ $R^2 = 0.3512$ (5)

For 2nd season (2018)

Giza 84 $y = 0.2234\,(ESP)^2 - 10.003\,(ESP) + 118.94$ $R^2 = 0.2801$ (6)

Giza 85 $y = 0.03561\,(ESP)^2 - 16.995\,(ESP) + 209.75$ $R^2 = 0.1416$ (7)

Giza 87 $y = 0.0353\,(ESP)^2 - 1.8203\,(ESP) + 29.586$ $R^2 = 0.6172$ (8)

Giza 89 $y = 0.0094\,(ESP)^2 - 0.8884\,(ESP) + 23.33$ $R^2 = 0.658$ (9)

Giza 86 x 89 $y = 0.0403\,(ESP)^2 - 2.5867\,(ESP) + 47.052$ $R^2 = 0.2751$ (10)

From these equations, the marginal seed cotton yield at any specific level of salinity could be obtained for the studied cotton genotypes. For example to obtain the marginal seed cotton yield by differential equation (1), and assuming that ESP = 5, the decrement in y = 0.0268 kentar/fed. and when ESP = 10 the decrement becomes 0.0837 kentar/fed. for Giza 84 genotype in the first season. Similar negative correlation were also found between ESP and seed cotton yield. The data in Table 6 revealed that as ESP increased, seed cotton yield decreased, and negative correlations were as follows: r_{yESP} = -0.58, -0.36, -0.64, -0.13 and -0.58 for the 1st season for Giza 84, 85, 87, 89 and (86 x 89), respectively, while for the 2nd season, were -0.34, -0.27, -0.63, -0.78 and -0.48, for the same genotypes, respectively.

TABLE 5. Simple and partial correlation between anions and each of yield, boll weight, 2.5% span length, lint percentage and plant height

Character	Ions: Cl^- Simple correlation	Cl^- Controlling for HCO_3^- & SO_4	HCO_3^- Simple correlation	HCO_3^- Controlling for Cl^- & $SO_4^=$	$SO_4^=$ Simple correlation	$SO_4^=$ Controlling for Cl^- & HCO_3^-
2017						
Giza 84						
	ryCl	ryCl.HCO$_3$.SO$_4$	ryHCO$_3$	ryHCO$_3$.ClSO$_4$	ry SO$_4$	rySO$_4$.Cl HCO$_3$-0.77
Yield (y)	-0.86**	-0.23	-0.46n.s	-0.25	-0.94**	
Boll weight (B.W)	-0.79**	-0.65	-0.49n.s	-0.28	-0.61*	0.26
2.5% span length (SL)	-0.81**	-0.25	0.52n.s	-0.33	-0.84**	-0.47
Lint percentage (L.P)	-0.55n.s	-0.20	-0.59*	-0.46	-0.50n.s	-0.04
Plant height (P.H)	-0.80**	0.99	-0.32n.s	-0.01	-0.79**	-0.34
Giza 85						
	ry Cl	ryCl.HCO$_3$.SO$_4$	ryHCO$_3$	ryHCO$_3$.ClSO$_4$-	rySO$_4$	rySO$_4$.Cl HCO$_3$
Yield (y)	-0.82**	-0.70	-0.50n.s	--0.02	-0.75**	-0.53
Boll weight (B.W)	-0.85**	-0.78	-0.44n.s	0.44	-0.75**	-0.67
2.5% span length (SL)	-0.83**	-0.77	-0.18n.s	0.41	-0.48n.s	-0.13
Lint percentage (L.P)	-0.53n.s	-0..19	-0.36n.s	0.32	-0.65*	-0.54
Plant height (P.H)	-0.85**	-0.78	-0.60*	-0.09	-0.78**	-0.45
Giza 87						
	ryCl	ryCl.HCO$_3$.SO$_4$	ry Ca	ryHCO$_3$.ClSO$_4$	ry SO$_4$	rySO$_4$.Cl HCO$_3$-0.35
Yield (y)	-0.80**	-0.84	-0.03n.s	0.60	-0.48n.s	
Boll weight (B.W)	-0.73**	-0.41	-0.26n.s	-0.12	-0.70**	-0.45
2.5% span length (SL)	-0.95**	-0.45	-0.19n.s	0.58	-0.79**	-0.69
Lint percentage (L.P)	0.02n.s	-0.43	0.36n.s	0.53	0.19n.s	0.45
Plant height (P.H)	-0.85**	-0.87	0.02n.s	0.70	-0.82**	-0.64
Giza 89						
	ry Cl	ryCl.HCO$_3$.SO$_4$	ryHCO$_3$	ryHCO$_3$.ClSO$_4$	ry SO$_4$	rySO$_4$.Cl HCO$_3$
Yield (y)	-0.70**	-0.06	-0.28n.s	0.33	-0.88**	-0.77
Boll weight (B.W)	-0.80**	-0.32	-0.22n.s	0.52	-0.88**	-0.77
2.5% span length (SL)	-0.90**	-0.58	-0.49n.s	-0.11	-0.94**	-0.81
Lint percentage (L.P)	-0.60*	0.21	-0.40n.s	-0.03	-0.81**	-0.72
Plant height (P.H)	-0.80**	-0.43	-0.51n.s	-0.23	-0.84**	-0.50
Giza 68 x 89						
	ry Cl	ryCl.HCO$_3$.SO$_4$	ryHCO$_3$	ryHCO$_3$.ClSO$_4$-	rySO$_4$	rySO$_4$.Cl HCO$_3$-0.64
Yield (y)	-0.94**	-0.91	-0.14n.s	0.09	-0.77**	
Boll weight (B.W)	-0.89**	-0.82	-0.18n.s	-0.01	-0.80**	-0.67
2.5% span length (SL)	-0.80**	-0.67	-0.37n.s	-0.44	-0.80**	-0.64
Lint percentage (L.P)	-0.74**	-0.46	-0.43n.s	-0.51	-0.83**	-0.71
Plant height (P.H)	-0.85**	-0.75	-0.09n.s	0.22	-0.82**	-0.71
2018						
Giza 84						
	ryCl	ryCl.HCO$_3$.SO$_4$	ryHCO$_3$	ryHCO$_3$.ClSO$_4$	rySO$_4$	rySO$_4$.Cl HCO$_3$
Yield (y)	-0.89**-	-0.67	-0.19 n.s	0.45	-0.89**	-0.49
Boll weight (B.W)	-0.88**	-0.66	-0.33 n.s	-0.59	-0.74**	-0.27
2.5% span length (SL)	-0.91**	-0.65	-0.26 n.s	-0.71	-0.85**	-0.67
Lint percentage (L.P)	-0.93**	-0.84	0.12 n.s	0.49	-0.81**	0.08
Plant height (P.H)	-0.89**	-0.62	0.11 n.s	0.24	-0.87**	-0.39
Giza 85						
	ryCl	ryCl.HCO$_3$.SO$_4$	ryHCO$_3$	ryHCO$_3$.ClSO$_4$	rySO$_4$	rySO$_4$.Cl HCO$_3$
Yield (y)	-0.93**	0.04	0.57n.s	-0.36	-0.97**	-0.75
Boll weight (B.W)	-0.96**	-0.89	0.65*	0.06	-0.88**	0.65
2.5% span length (SL)	-0.95**	-0.38	0.75**	0.46	-0.95**	-0.41
Lint percentage (L.P)	-0.85**	-0.50	0.72**	0.39	-0.79**	0.24
Plant height (P.H)	-0.84**	-0.02	0.72**	0.37	-0.86**	-0.32
Giza 87						
	ryCl	ryCl.HCO$_3$.SO$_4$	ryHCO$_3$	ryHCO$_3$.ClSO$_4$	rySO$_4$	rySO$_4$.Cl HCO$_3$
Yield (y)	-0.9**	-0.75	0.41n.s	0.32	-0.84**	-0.36
Boll weight (B.W)	-1.0**	-0.86	0.41n.s	0.37	-0.86**	-0.40
2.5% span length (SL)	-0.90**	-0.55	0.40n.s	0.31	-0.87**	-0.53
Lint percentage (L.P)	-0.60*	-0.54	0.52n.s	0.42	-0.33n.s	0.33
Plant height (P.H)	-0.90**	-0.74	0.36n.s	0.18	-0.86**	-0.44
Giza 89						
	ryCl	ryCl.HCO$_3$.SO$_4$	ryHCO$_3$	ryHCO$_3$.ClSO$_4$	rySO$_4$	rySO$_4$.Cl HCO$_3$
Yield (y)	-0.83**	-0.78	0.57n.s	0.38	-0.54n.s	-0.39
Boll weight (B.W)	-0.84**	-0.57	0.66*	0.45	-0.80**	-0.40
2.5% span length (SL)	-0.78**	-0.55	0.58*	0.31	-0.64*	-0.04
Lint percentage (L.P)	-0.78**	-0.51	0.60*	0.33	-0.69*	-0.15
Plant height (P.H)	-0.85**	-0.78	0.35n.s	-0.14	-0.54n.s	0.20
Giza 68 x 89						
	ryCl	ryCl.HCO$_3$.SO$_4$	ryHCO$_3$	ryHCO$_3$.ClSO$_4$	rySO$_4$	rySO$_4$.Cl HCO$_3$
Yield (y)	-0.79**	-0.91	0.47n.s	0.37	-0.47n.s	-0.91
Boll weight (B.W)	-0.82**	-0.89	0.49n.s	0.31	-0.39n.s	-0.81
2.5% span length (SL)	-0.75**	-0.86	0.51n.s	0.52	-0.49n.s	-0.87
Lint percentage (L.P)	-0.77**	-0.80	0.49n.s	0.30	-0.37n.s	-0.70
Plant height (P.H)	-0.66*	-0.95	0.40n.s	0.67	-0.67*	-0.98

ryCl = simple correlation between y and Cl

ryCl HCO3, SO4 =partial correlation of y and Cl (controlling for HCO3, SO4).

**, * and ns means highly significant, significant and not significant, respectively

TABLE 6. Simple and partial correlation between ECe and ESP, and each of Y, B.W., S.I, L.P and P.H. for 2017 and 2018 growing seasons.

Character	ECe dSm^{-1}		ESP	
	Simple correlation	Controlling for ESP	Simple correlation	Controlling for EC
2017				
Giza 84				
	ryEC	ryEC.ESP	ryESP	ryESP.EC
Yield (y)	-0.93**	-0.92	-0.58n.s	0.54
Boll weight (B.W)	-0.75*	-0.48	-0.69*	-0.26
2.5% span length (SL)	-0.85*	-0.77	-0.59*	0.19
Lint percentage (L.P)	-0.56*	-0.33	-0.49n.s	-0.11
Plant height (P.H)	-0.82**	-0.71	-0.60*	0.10
Giza 85				
	ryEC	ryEC.ESP	ryESP	ryESP.EC
Yield (y)	-0.90**	-0.86	-0.36n.s	-0.14
Boll weight (B.W)	-0.90**	-0.89	-0.30n.s	0.01
2.5% span length (SL)	-0.70**	-0.72	-0.57n.s	-0.51
Lint percentage (L.P)	-0.60*	-0.61	-0.26n.s	-0.07
Plant height (P.H)	-0.90**	-0.90	-0.38n.s	-0.18
Giza 87				
	ryEC	ryEC.ESP	ryESP	ryESP.EC
Yield (y)	-0.75**	-0.67	-0.64n.s	0.50
Boll weight (B.W)	-0.79**	-0.78	-0.24n.s	0.22
2.5% span length (SL)	-0.97**	-0.97	-0.48n.s	-0.17
Lint percentage (L.P)	0.08n.s	0.26	-0.30n.s	-0.38
Plant height (P.H)	-0.91**	-0.89	-0.39n.s	0.07
Giza 89				
	ryEC	ryEC.ESP	ryESP	ryESP.EC
Yield (y)	-0.81**	-0.88	-0.13n.s	0.60
Boll weight (B.W)	-0.85**	-0.87	-0.88**	0.46
2.5% span length (SL)	0.94**	-0.94	-0.38n.s	0.43
Lint percentage (L.P)	-0.70*	-0.77	-0.06n.s	0.47
Plant height (P.H)	-0.86**	-0.84	-0.40n.s	0.14
Giza 68 x 89				
	ryEC	ryEC.ESP	ryESP	ryESP.EC
Yield (y)	-1.00**	-0.94	-0.58n.s	0.11
Boll weight (B.W)	-0.90**	-0.96	-0.43n.s	0.66
2.5% span length (SL)	-0.90**	-0.96	-0.29n.s	0.79
Lint percentage (L.P)	-0.80**	-0.83	-0.42n.s	0.28
Plant height (P.H)	-0.90**	-0.86	-0.61*	-0.10
2018				
Giza 84				
	ryEC	ryEC.ESP	ryESP	ryESP.EC
Yield (y)	-0.93**	-0.92	-0.34n.s	-0.05
Boll weight (B.W)	-0.85**	-0.89	0.07n.s	-0.53
2.5% span length (SL)	-0.92**	-0.92	0.27n.s	-0.25
Lint percentage (L.P)	-0.90**	-0.95	0.06n.s	-0.71
Plant height (P.H)	-0.91**	-0.93	0.20n.s	-0.40
Giza 85				
	ryEC	ryEC.ESP	ryESP	ryESP.EC
Yield (y)	-0.95**	-0.95	-0.27n.s	0.20
Boll weight (B.W)	-0.93**	-0.97	0.07n.s	-0.78
2.5% span length (SL)	-0.96**	-0.96	0.13n.s	-0.29
Lint percentage (L.P)	-0.82**	-0.85	-0.05n.s	-0.41
Plant height (P.H)	-0.85**	-0.84	0.29n.s	0.20
Giza 87				
	ryEC	ryEC.ESP	ryESP	ryESP.ECe
Yield (y)	-0.93**	-0.88	-0.63*	0.09
Boll weight (B.W)	-0.96**	-0.92	-0.72**	-0.24
2.5% span length (SL)	-0.91**	-0.91	-0.50n.s	0.47
Lint percentage (L.P)	-0.51n.s	-0.24	-0.51n.s	-0.25
Plant height (P.H)	-0.94**	-0.90	-0.62*	0.16
Giza 89				
	ryEC	ryEC.ESP	ryESP	ryESP.EC
Yield (y)	-0.79**	-0.64	-0.78**	0.62
Boll weight (B.W)	-0.89**	-0.85	-0.49n.s	0.13
2.5% span length (SL)	-0.79**	-0.67	-0.60*	-0.24
Lint percentage (L.P)	-0.81**	-0.71	-0.60*	-0.22
Plant height (P.H)	-0.83**	-0.71	-0.81**	-0.69
Giza 68 x 89				
	ryEC	ryEC.ESP	ryESP	ryESP.EC
Yield (y)	-0.94**	-0.94	-0.48n.s	0.29
Boll weight (B.W)	-0.94**	-0.95	-0.43n.s	0.51
2.5% span length (SL)	-0.92**	-0.94	-0.39n.s	0.53
Lint percentage (L.P)	-0.89**	-0.87	-0.42n.s	0.28
Plant height (P.H)	-0.94**	-0.92	-0.50n.s	0.21

**, * and ns means highly significant, significant and not significant, respectively
ryECe= simple correlation between y and ECe
ryESP = partial correlation of y and ECe (controlling for ESP).

Specific effect of salinity and sodicity

The specific effect of salinity and sodicity were studied, using the comparison between simple and partial correlations. As shown in Table 6, with controlling the effect of sodicity, the negative correlation $r_{yEC.ESP}$ was decreased, *i.e.* ($r_{yEC.ESP} < r_{yEC}$ and vice versa, with controlling the effect of EC, correlation $r_{yESP.EC}$ was increased *i.e.,* ($r_{yESP.EC} > r_{yESP}$). The interpretation of mutual effects of sodicity and salinity are rather difficult, but it could be shown that, sodium hazard can also be inhibited by salinity. This is clearly observed from increasing the effect of ESP, when controlling EC, where r_{yESP} for Giza 84, 85, 87, 89 and 86 x 89 were -0.58, -0.36, -0.64, -0.13 and -0.58 for 1st season, respectively, and -0.34, -0.27, -0.63,0.78 and -0.48 for 2nd season, for the same genotypes, respectively. The corresponding partial correlations r_{yESP}. EC_e, were as follows 0.54, -0.14, -0.50, 0.60 and 0.11 for 1st season, and -0.05, 0.20, 0.09, -0.62 and 0.29 for 2nd season, for the same genotypes respectively.

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التأثير النوعى للايونات والملوحة والقلوية على محصول القطن وجودته

فاروق إبراهيم زين ، السيد عامر السيد جازيه ، حميده محمد أنور الصنفاوى و ناصر ابراهيم طلحه
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أجريت تجربتان حقليتان بمحطة البحوث الزراعية بسخا - كفرالشيخ خلال موسمى الزراعة ٢٠١٧ ، ٢٠١٨م لدراسة تأثير الأملاح الأرضية الذائبة والتأثير النوعى للايونات على محصول القطن الزهر وجودة الألياف.

اختبرت خمسة تراكيب وراثية من القطن المصرى هى: جيزة ٨٥ ، جيزة ٨٩ والهجن المبشرة (جيزة ٨٦ × جيزة ٨٩) من طبقة طويل التيلة وجيزه ٨٧ والهجين المبشر جيزة ٨٤ (جيزة ٧٤ × جيزة ٦٨) من طبقة فائق طول التيلة تحت تأثير أربعة مستويات مختلفة من ملوحة التربة هى من ٦- ١١ ، ١١-١٤ ، ١٤-١٨ ، >١٨ ديسيمنز/م وكانت الصفات التى تمت دراستها هى محصول القطن الزهر ، ووزن اللوزه ، طول النبات ، وطول التيلة عند نسبه توزيع ٢,٥٪ ومعدل الحلج.

واوضحت النتائج ما يلى:

١- تأثر محصول القطن الزهر معنويا بمستويات الملوحة.

٢- من دراسة تأثير الأيونات النوعى بحساب معامل الارتباط البسيط والجزئى من الصفات المدروسة أوضحت النتائج وجود العديد من التفاعلات بين الأيونات خلال امتصاص النبات لها.

٣- وجود علاقة ارتباط سالبة بين محصول القطن الزهر وكل من ص$^{+}$ ، كا$^{++}$ ، مغ$^{++}$ ولكن قيمة ص$^{+}$ السالبه كانت مرتفعة بسبب السمية وإعاقة حركة الهواء والماء فى التربة.

٤- وجود علاقة سالبة بين محصول القطن الزهر وكل من كل ، كب أ$_{٤}^{=}$ ولوحظ تأثير التضاد بين كل من كل$^{-}$ و كب أ$_{٤}^{=}$ فقلل من سمية الـ كل$^{-}$.

٥- وجود علاقة ارتباط سالبة بين محصول الزهر ونسبة الصوديوم المتبادل (ESP).

٦- وجود علاقة سالبة عالية المعنوية بين كل من ملوحة التربة وكلا من الكاتيونات والانيونات لكل من الصفات المدروسة للأصناف المختلفة.