URGING COTTON PLANTS TO OVERCOME THE SALT STRESS CONDITIONS IN THE RECLAIMED LAND USING A COMBINATION OF INNOVATIVE AGRICULTRAL FACTORS II-THE RELATIONSHIP BETWEEN YIELD AND SOME CHARACTERS IN EGYPTIAN COTTON

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ABSTRACT

The technique of stepwise multiple regression and correlation analysis was employed to determine the contribution of the various traits to the variation in cotton yield. Data were obtained from yield trials carried out in El-Tahrir Province, El-Behera Governorate, Egypt. during 2009 and 2010 seasons. The mean squares of regression analysis were high for nine acceptance variables (traits), *i.e*., the number of leaves per plant, leaf area per plant, dry weight of leaves per plant, chlorophyll b, total carotenoids, phosphorus, iron, manganese and lint percentage out of eighteen ones. The total contribution of the previously mentioned traits over all variation in seed cotton yield per plant was 99.46 %. However, the residual effect of other nine traits reduced 0.54 % of the total variation in cotton yield. Seed cotton yield was significantly positive and had the greatest values of correlation coefficients with the number of leaves per plant (0.980), leaf area per plant (0.974) and chlorophyll b (0.970). High increase in the range of performances was detected for nine mentioned traits due to the creation of variation *via* different treatments under study. Finally, as increased number of leaves per plant, leaf area per plant and chlorophyll b may induce positive impacts on cotton yield under salinity conditions.

Key words: cotton, regression and correlation analysis, salinity stress.

1. INTRODUCTION

Cotton is an important field crop in many developing countries especially in Egypt. The yield of the crop is dependent upon the environment in which it is grown and the management practices of the cropping system. Salinity is a major limiting factor in crop production in many regions of the world. Plant physiologists have found chlorophyll content to be a valuable tool for monitoring plant stress response. It has been widely applied to the assessment of chlorophyll index in crop plants such as corn, wheat, cotton, rice as well as other agricultural species (Patrick, 2007).

The chlorophyll content is useful for improving nitrogen and fertilizer management (Gitelson *et al.*, 2003). Determination of the relationship of the chlorophyll trait, yield and yield components facilitates selection of high yielding varieties (Singh, 2001).

Regression and correlation study is important to assistant cotton breeders. Therefore, it is necessary to determine the relationship between cotton yield and the various factors contributing to seed cotton yield per plant. Fonseca and Paterson (1968) found that the correlation coefficient analysis measures, the magnitude of relationship between various plant characters, the component character on which selection, can be based for improving seed cotton yield. The technique of stepwise multiple regression analysis has been extensively used by El-Shear *et al.* (1984), Seyam *et al.* (1984) and Ghaly *et al.* (1990). The present study used the regression and correlation analysis of cotton traits, for the information of interrelationship between cotton yield and other important traits, to determine the traits accounted for most of the variation in yield under salinity stress conditions.

2. MATERIALS AND METHODS

This study was conducted in the Experimental Field of El-Tahrir Province, El-Behera Governorate, Egypt during 2009 and 2010 seasons

to find out the regression and correlation of seed cotton yield with various physiological traits under salinity stress conditions. Before sowing, soil samples to 30 cm depth from the experimental site were collected and analyzed by the standard procedures of Jackson (1967). Analysis results of the soil samples are presented in (Table 1).

Table (1): Physical and chemical properties of the selected site in both seasons.

Property	2009	2010
Physical:		
Clay%	24.70	23.50
Silt%	22.10	23.90
Sand%	53.20	52.60
Soil texture	Loamy sand	Loamy sand
Chemical:		
pH (1:2.5)	7.900	7.750
ECe (dS m^{-1})	10.930	10.970
Organic matter%	1.080	1.100
CaCO$_3$%	6.050	6.090
Total N%	0.070	0.074
Available nutrients (mg kg^{-1} soil):		
K	70.15	72.10
P	19.05	18.80
Fe	6.52	6.10
Mn	5.45	5.00
Zn	1.15	1.05
Cu	1.60	1.75

The treatments were comprised of 4 ascorbic acid rates; 0 (control), 200, 400 and 600 mgl^{-1}. These treatments were applied alone or in combination with seed treatment with calcium paste.

Calcium nitrate, humic acid and wheat bran (a by-product of wheat grain) at the ratio of 1:1:3 (by weight), respectively were mixed and kneaded together by using Arabic Gum solution (8%) as a sticking agent to obtain paste of calcium able to remaining around seeds to a longer time. Before sowing, cotton seeds were covered with calcium paste through the better mixing between them. Treated seeds were allowed to dry.

Chemical analysis of the most important components of humic acid and wheat bran was

determined (Table 2) as outlined by A.O.A.C. (1995).

The experimental design used was a split-plot with three replicates. The main plots were calcium paste treated-seeds or untreated seeds. Ascorbic acid treatments occupied the sub-main plots. The experimental unit was 21 m^2 (3 x 7m). Seeds of cotton (cultivar Giza 90) obtained from the Agricultural Research Center, Giza, Egypt were sown (20 cm between hills) on March 21st in both seasons. The cultural practices were applied as recommended for cotton production except for the variables under study. Three months after sowing, plants of four hills were randomly chosen from each experimental unit for determining the number of leaves plant^{-1}, leaf area plant^{-1} and dry weight of leaves plant^{-1}.

Leaves of plants submitted to vegetative growth trait were also subjected to chemical determinations. Chlorophyll a, chlorophyll b and total carotenoids were extracted by acetone (80%) then, their concentrations were determined using colorimetric method as described by Arnon (1949). Ascorbic acid (mg g^{-1} fresh leaves) was determined using the dye 2,6-dichlorophenol indophenols method as outlined by A.O.A.C. (1995). Total soluble sugars (mg g^{-1} dry matter) were colorimetrically determined using phosphomolybdic acid reagent according to Dubois *et al.* (1956). Free proline was extracted by 5-sulphosalicylic acid (3%) then, determined (mg g^{-1} dry matter) colorimetrically using acid ninhydrin reagent as outlined by Bates *et al.* (1973). Nitrogen (mg g^{-1} dry matter) was colorimetrically determined by using the Orange G dye according to the method of Hafez and Mikkelsen (1981). For P, K, Ca, Na, Fe, Mn and Zn determinations; the wet digestion of 0.1 g of fine dry material of leaves of each treatment was done with sulphuric and perchloric acid mixture as mentioned by Piper (1947). Phosphorus (%) was colorimetrically estimated using chlorostannus molybdo-phosphoric blue color method in sulphuric acid system as described by Jackson (1967). Potassium and sodium (%) were

Table (2): The most important constituents of humic acid and wheat bran used in the experiment of both seasons.

Humic acid analysis %			Wheat bran analysis		
Main constituent	2009	2010	Main constituent	2009	2010
Humic acid	18.5	18.5	Moisture%	4.50	4.30
Total Fe	0.5	0.5	Ash%	5.20	5.15
Total Mn	0.5	0.5	Total fibers%	35.45	36.25
Total Zn	0.5	0.5	Water holding capacity (g g^{-1})	3.35	3.40
Total Cu	0.5	0.5			

determined using a Perkin-Elmer, Flame Photometer (Page *et al.*, 1982). Calcium (%), iron, manganese and zinc (ppm) were determined using a Perkin-Elmer, Model 3300, Atomic absorption Spectrophotometer (Chapman and Pratt, 1961). At harvest, the plants of four hills were randomly marked in each experimental unit to determine seed cotton yield and lint percentage. Designation and full details of experimentation are listed elsewhere (Dewdar and Rady, 2011).

The stepwise multiple regression and correlation analyses were carried out according to the procedures outlined by Draper and Smith (1966) to determine the variable which would account for the most variation in crop yield.

3. RESULTS AND DISCUSSION
3.1. Analysis of variance

The analysis of variance presented in Table (3) showed that the mean squares of regression analysis were highly significant for the nine acceptance variables out of eighteen ones (traits) *i.e.* number of leaves per plant, leaves area per plant, dry weight of leaves per plant, chlorophyll b, total carotenoids, phosphorus, iron, manganese and lint percentage, indicating that dependent variable (seed cotton yield) was affected by the nine acceptance variables (independent variables).

Table (3): Mean squares of regression analysis of stepwise technique in Egyptian cotton under saline conditions.

S.V.	D.F.	M.S.
Regression	9	606.416**
Residual	14	1.294

** Significant at p< 0.01 percent level of probability.

3.2. Stepwise multiple regression analysis

The results in Table (4) clarify that those nine traits *i.e.* number of leaves per plant, leaf area per plant, dry weight of leaves per plant, chlorophyll b, total carotenoids, phosphorus, iron, manganese and lint percentage were significantly contributing to the variation in seed cotton yield per plant. The total contribution of the above mentioned characters over all variation in seed cotton yield per plant was 99.46 %. While, the residual effect of the other nine traits in seed cotton yield per plant was very small. It was reduced only 0.54 % of the total variance. It is clear that the residual effect has slight importance contribution in cotton yield. The residual effect, which determines how best the causal variables account for the variability of the independent

ariable was estimated by Singh and Chaudhary (1985). These results agree with those of El- Shear *et al.* (1984), Seyam *et al.* (1984) and Ghaly *et al.* (1990) who used the technique of stepwise multiple regression in Egyptian cotton.

3.3. Correlation coefficients analysis

The simple correlation coefficients between seed cotton yield per plant and the different variables are shown in Table (4). Cotton yield was positively correlated (highly significant) with the number of leaves per plant, leaf area per plant , dry weight of leaves per plant, chlorophyll b, total carotenoids, phosphorus, iron, manganese and lint percentage traits. Where their obtained values were 0.980, 0.974, 0.968, 0.970, 0.937, 0.953, 0.950, 0.940 and 0.923, respectively. It seems therefore that the number of leaves per plant granted the highest value followed by leaf area per plant then chlorophyll b, while the lowest value was obtained from lint percentage. On the contrary, the other six traits ranked as the second in their values of correlation coefficients.These results agree with those obtained by Singh (2001), Reddy and Kuman (2004) and Gitelson *et al.* (2003), who reported significant and positive association between cotton yield and chlorophyll traits. Also, similar correlations were found between cotton yield and lint percentage by Karademir *et al.* (2009). Also, they added that the results of correlation coefficients analysis revealed that seed cotton yield per plant was positively and significantly correlated with chlorophyll content and lint percentage, as the increase in the two previously traits which may induced positive impacts on seed cotton yield under salinity stress conditions. Finally, the true picture of the correlation between seed cotton yield per plant and the acceptance traits under study is positively reflected from direct effect of these traits which will help for identifying the trait that contributes directly to improve cotton yield trait.

3.4. Range and mean performances

The results presented in Table (5) show the range and mean performances of the studied acceptance variables under salinity stress conditions. The results showed that the high increase in range might be attributed to the creation of variation *via* different treatments under study, whereas the number of treatments were eight (four rates of ascorbic acid; 0, 200,400 and 600 mgL^{-1} and two calcium paste treatments) provided a total of 8 treatments.

The obtained mean values were 38.30, 49.24, 22.03, 0.65, 0.41, 0.35, 474.70, 283.13 and 34.86 for the following traits: number of leaves per

Table (4): Correlation coefficient, standard error and multiple coefficient of determination of nine various traits with seed cotton yield in Egyptian cotton.

Parameter	Correlation (r) with seed cotton yield per plant	Std. Error	Remarks
Number of leaves per plant	0.980	0.416	H.S
Leaves area per plant	0.974	0.615	H.S
Dry weight of leaves per plant	0.968	0.013	H.S
Chlorophyll b	0.970	26.175	H.S
Total carotenoids	0.937	23.881	H.S
Phosphorus	0.953	24.153	H.S
Iron	0.950	0.062	H.S
Manganese	0.940	0.110	H.S
Lint percentage	0.923	0.718	H.S
Multiple coefficient of determination = 99.46 Residual = 0.54			

H.S. denotes highly significant for (r) values at (n-2) degree of freedom (df) against the table.
values of correlation at 5 % and 1 % level of significance.

Table (5): Range and mean values of nine acceptance variables in Egyptian cotton under saline conditions.

Parameter	Range		Mean
	Minimum	Maximum	
Number of leaves per plant	26.30	47.00	38.30
Leaves area per plant	33.30	63.40	49.24
Dry weight of leaves per plant	16.10	27.60	22.03
Chlorophyll b	0.46	0.82	0.65
Total carotenoids	0.29	0.53	0.41
Phosphorus	0.23	0.48	0.35
Iron	411.00	538.00	474.70
Manganese	242.00	318.00	383.13
Lint percentage	32.00	37.60	34.86

plant, leaf area per plant, dry weight of leaves per plant, chlorophyll b, total carotenoids, phosphorus, iron, manganese and lint percentage, respectively. The standard error was the highest (26.175) for the chlorophyll b trait, whereas the lowest (0.013) for the dry weight of leaves per plant trait (Table 4).

In conclusion, this study was carried out under salinity stress condition, and showed significance for cotton yield and the three traits; number of leaves per plant, leaf area per plant and chlorophyll b. There is limited information between cotton yield and physiological parameters of cotton in the literature. Therefore, further investigation is required on cotton yield and physiological study.

The present regression and correlation analysis revealed that the number of leaves per plant, leaf area per plant and chlorophyll b may be an indication of seed cotton yield under salinity stress.

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دفع نباتات القطن للتغلب على ظروف الإجهاد الملحى فى الأراضي المستصلحة بإستخدام توليفة مستحدثة من العوامل الزراعية

2- العلاقة بين المحصول وبعض الصفات فى القطن المصرى

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ملخص

أجريت تجربتان حقليتان بمنطقة مديرية التحرير- محافظة البحيرة-مصر، خلال الموسمي 2009 و 2010 لدراسة مدى تحديد مساهمة الصفات المختلفة فى تباين محصول النبات فى القطن المصرى، وذلك بإستخدام تكنيك تحليل الإنحدار والإرتباط لصفة المحصول وثمانية عشرة صفة تحت ظروف التربة المستصلحة المتأثرة بالأملاح (حوالى 7000 جزء فى المليون).

أوضح تحليل الإنحدار المتعدد المرحلي أن هناك إنحدار لتسعة صفات (تسعة عوامل) من بين ثمانية عشرة صفة (ثمانية عشرةعامل)، وذلك على صفة المحصول من خلال تحليل الإنحدار عالى المعنوية، وهذه الصفات التسعة هى: عدد الأوراق على النبات، مساحة سطح الورقة، الوزن الجاف للأوراق، كلوروفيل ب، الكاروتنويدات الكلية، الفوسفور، الحديد، الماغنسيوم ونسبة الشعر.

كان إجمالى الإسهامات لهذه الصفات التسعة السابقة فى تباين المحصول 99.46 %، بينما كان إسهام باقى الصفات الأخرى صغير جداً ويقدر بحوالى 0.54%.

كانت قيم معاملات الإرتباط عالية المعنوية وموجبة بين كل من الصفات التسعة ومتوسط محصول النبات الفردى، وكانت أعلى القيم لمعاملات الإرتباط بين صفة المحصول وثلاثة صفات هى عدد الأوراق، مساحة سطح الورقة وصفة كلوروفيل ب، وكانت القيم المتحصل عليها هى: 0.980، 0.974 و0.970 على التوالى.

أشارت النتائج إلى أن الزيادة الواضحة والملحوظة فى مدى متوسطات الصفات يرجع إلى تأثر هذه الصفات بالمعاملات المختلفة تحت الدراسة.

يمكن من خلال النتائج المتحصل عليها إستنتاج أن الزيادة فى صفات عدد الأوراق للنبات، مساحة سطح الورقة و كلوروفيل ب، ربما يحدث تأثيرات موجبة على المحصول تحت ظروف الإجهاد الملحى فى الأراضي المستصلحة حديثاً.

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