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Response of four genotypes of corn (*Zea mays* L.) to foliar nutrition by seaweed extract

JASSIM J. JADER*, HAIDER T. HUSSEIN AND MAHDI A. HAMZA

Al-Musaib Tech. College
Al-Furat Al-Awsat Tech. University, Iraq
**(e-mail : alnuaimid92@gmail.com)*

ABSTRACT

A field experiment was conducted during spring seasons of 2017 and 2018 in Al-Hindiya Barrier Region, Babylon Province, Iraq to study the effect of foliar spraying of seaweed extracts on growth traits and grain yield of four genotypes of yellow corn. The experiment was conducted using the randomized complete block design (RCBD) for factorial experiments with three replications. The first factor included the genotypes (5015, 5016, 5017 and 5018). The second factor included foliar spraying of seaweed extract with three concentrations (3, 6 and 9 ml/l) in addition to the control treatment in which the plants were sprayed with distilled water only. The results showed that the corn genotypes differed significantly in respect to growth and yield traits. The corn genotype 5017 produced significantly higher growth and yield traits compared to other genotypes during both the years. The magnitude of production for plant height, leaf area, number of cobs per plant, cob length, number of grains/cob and grain yield per plant was 226.42 and 229.50 cm, 5291.8 and 5299.7 cm^2, 1.93 and 1.96 cobs/plant, 1.30 and 18.45 cm, 445.75 and 451.75 grains/cob and 163.17 and 167.50 g in 2017 and 2018, respectively. The spraying of corn plants with seaweed extract @ 6 ml/l produced significantly higher leaf area, length of cob, number of grains/cob and grain yield per plant to the tune of 5241.9 and 5250.8 cm^2, 17.97 and 18.14 cm, 443.42 and 448.58 grains/cob and 160.92 and 165.67 g in 2017 and 2018, respectively. On the basis of these results, it can be concluded that genotype 5017 sprayed with seaweed extract @ 6 ml/l excelled over other genotypes in respect of growth and yield.

Key words : Cob, concentration, correlation, foliar spraying, leaf area, plant yield

INTRODUCTION

The production capacity of any genotype of the corn (*Zea mays* L.) relies on adoption of modern methods and techniques for crop cultivation and management of soil (Kaur and Kaur, 2018; Shrestha *et al.,* 2018). The use of seaweed extract, which is rich in plant nutrients and used as organic fertilizer that promotes plant growth by adding in the soil or spraying on the plant as supplementary materials for fertilizers rather than as a substitute (Abdul-Jabar *et al.,* 2014).

The organic compound positively affects fresh weight and growth parameters in plants (Al-Sabary, 2011; Al-Taey *et al.,* 2018). The present trend in the cultivation of crops is to use natural alternatives including seaweed extracts, etc. by reducing the use of chemical fertilizers due to their health, environmental and economic hazards. The organic substances to be used as fertilizers are characterized as non-toxic, non-polluting and low-costing (Khan *et al.,* 2009; Al-Ubaidi, 2013; Babilie *et al.,* 2016; Sanchez-Barrios *et al.,* 2017). Moreover, chemical fertilizers are not only in short supply but also expensive, therefore, they can be supplemented with cheaper organic sources as fertilizers (Al-Taey and Majid, 2018). These are also considered as encouraging materials of plant growth when used in low concentrations which contribute to important physiological functions of any crop. The organic substances also contain more than one group of growth-promoting plant hormones such as auxins, cytokinines, etc. and a number of macronutrient elements (N, K, Mg) and micronutrients such as Co, Bo, Mo, Zn and Cu (Dell, 2003; Craigie, 2011; Abdul-Jabar *et al.,* 2014). It also contains some amino acids and vitamins such as B1, B2, C and E (Latique *et al.,* 2014; Anisimov and Chaikina, 2015; Kasim *et al.,* 2015) so they encourage the vegetative growth and root system of plants and improve root efficiency for water and mineral nutrients absorption. The organic sources when used as fertilizers also inhibit root senescence, increase chlorophyll content in leaves and respiration (Abu-Dahi and Shati, 2009; Al-Maleky, 2013). They also play an important role in regulating cell components and increasing plant tolerance for environmental stresses such as salt stress and drought stresses (Nelson and Van-Staden, 1996; Dell, 2003). They also act as an antioxidant through its role in increasing the activity of certain enzymes such as enzymatic peroxidase and catalase (Kasim *et al.,* 2015; Babilie *et al.,* 2016). Majid *et al.* (2015) reported that spraying the whole vegetative parts of corn plants with seaweed extracts has led to a significant increase in corn plant height, leaf area, number of grains/cob and grain yield compared to plant spraying with water only.

Hence, the present study was conducted to determine the effect of foliar spraying of seaweed extract on growth traits and yield of four genotypes of yellow corn.

MATERIALS AND METHODS

A field experiment was conducted during spring seasons of 2017 and 2018 in Al-Hindiya Barrier region, Babylon Province in silty loam soil. The chemical and physical properties of experimental soil are shown in Table 1. The objective of the study was to determine the effect of foliar spraying of seaweed extract (Bulitem short cycle) on some growth traits in four genotypes of yellow corn. The experiment was conducted using the randomized complete block design (RCBD) for factorial experiments with three replications. The first factor included the genotypes 5015, 5016, 5017 and 5018. The second factor included foliar spraying of the seaweed extract with three concentrations (3, 6 and 9 ml/l) in addition to the control treatment in which the plants were sprayed with distilled water only. The seaweed extract (Bulitem short cycle) used in this study was extract of a group of seaweed with amino acids produced by QUIMICAS MERISTEM SL. It contains *Ascophyllum nodosum* extract 57%, free amino acids 6.5%, total nitrogen 6.1%, organic nitrogen 1.3%, ammonical nitrogen 1.1%, urea nitrogen 3.7%, P_2O_5 4.0%, K_2O 5.0%, 0.5% chelated Fe, 0.5% chelated Mn, 0.5% chelated Zn, 0.3% IAA, 0.3% GA_3 and 0.8% cytokinins, respectively. This extract was obtained from College of Agriculture, Al-Qasim Green University, Iraq.

The experimental field was prepared by ploughing, smoothing and settling before planting. The experimental field was divided into three replications. The area of experimental unit was kept as 3 × 4 m^2, leaving some distance between experimental units as well as between replications. In each experimental unit, the maize crop was sown in 5 lines keeping 4 m length of each line. The distance between the lines was kept as 75 cm in each experimental unit. The seed of experimental crop was obtained from the Field Crops Department, College of Agriculture, University of Baghdad, Iraq during both the years. The whole amount of phosphorus (100 kg/ha P_2O_5) was applied as basal through superphosphate (46% P_2O_5) after ploughing but before smoothing. The nitrogen was applied @ 200 kg/ha through urea (46% N) in two equal instalments first at sowing and second instalment after one month of sowing of experimental crop. The growing plants were sprayed with water two times with

Table 1. Some chemical and physical traits of the soil of the experimental field

Traits	Spring season 2017	Spring season 2018
pH of soil	7.8	7.7
Electrical conductivity of soil EC (dS/m)	4.5	4.4
Texture	Silty loam	Silty loam
Soil separates (g/kg)		
Sand	320	314
Silt	435	438
Clay	245	248
Phosphorus availability (mg/kg)	4.54	4.43
Total nitrogen availability (%)	0.448	0.45
Potassium availability (mg/kg)	2.6	2.8
Organic matter (g/kg)	23.68	22.47
pH of irrigation water	7.4	7.5
Electrical conductivity of irrigation water EC (dS/m)	1.86	1.88

a 20L Backpack Sprayer under pressure of 2.8 kg/cm^2. The water was sprayed first at six leaves emerging stage and second time at nine leaves emerging stage until the complete wetness of vegetative parts of the plant. The experimental crop was harvested on 16th and 19th July during 2017 and 2018, respectively. The following growth and yield traits of corn were studied :

Plant Height

It was measured from the surface of the soil until the last node of the stem down the flower inflorescence and for five plants, then extracted the average.

Leaf Area of Plant

It was calculated from the average of five plants using the following formula :

Leaf area = The square length of the leaf under the cob leaf × 0.75 (EL-Sahookie, 1985).

Number of Cobs/Plant

It was calculated from the average of five plants taken randomly from the intermediate lines and extracted the average.

Length of the Cob

It was measured from its base until its apical, by taking 10 cobs and counting the average.

Number of Grains/Cob

It was calculated by taking 10 cobs and grain abandonment and counted and then extracted the average number of grains in the cob divided by the number of cobs.

Weight of 1000 Grains

It was calculated by taking a random sample and weighing the grain with a sensitive balance.

Plant Yield

It was measured by dividing the yield of the 10 plants on the number of plants.

Statistical data were statistically analyzed using the statistical program Genestat and the average was compared using the least significant difference at a significant level of 0.05 (Steel and Torrie, 1980). The genetic, environmental and phenotypic correlations of the studied and calculated traits were calculated after calculating the genetic, environmental, and phenotypic variations of the traits according to Robinson *et al.* (1951).

RESULTS AND DISCUSSION

Plant Growth Traits

The results indicated that there were significant differences in the effect of spraying treatments with seaweed extract, genotypes and their interaction, and for both the seasons as shown in Table 2. Corn plants that sprayed with seaweed extract at a concentration of 6 ml/l achieved the highest two averages of plant height amounted (214.17 and 216.58 cm). The control treatment recorded the lowest two averages of plant height (201.17 and 202.58 cm) for both the seasons, respectively. This was due to rise in the content of the extract from auxins, cytokinines and gibberellins. Therefore, the addition of these extracts to plants, especially on the vegetative parts, contributed to the promotion of apical sovereignty in the plant and reduced the growth of lateral buds, which were primers of plant branches. These results agree with those of Kumar and Sahoo (2013) who found that most seaweed extract contained in their composition high levels of natural auxins and cytokinines that promoted apical sovereignty.

The genotypes differed significantly in the plant height where the plants of the genotype 5017 achieved the highest averages of 226.42 and 229.50 cm, while the plants of genotype 5016 recorded the lowest average of 192.83 and 193.08 cm for both the seasons, respectively. The variation in genotypes was due to differences in the physiological and biological processes necessary to stimulate the growth of side buds that represent the branches primates of enzymatic activity, growth regulators, etc. according to the genetic mechanism controlling this trait and for each genotype. (Khan *et al.*, 2009). As for the interaction between the genotypes and the spraying treatments of the seaweed extract, the results (Table 2) showed

Table 2. Effect of spraying with seaweed extract in the plant height (cm) for four corn genotypes

Genotype	Concentrations of seaweed extract				Average
	0 ml/1	3 ml/1	6 ml/1	9 ml/1	
			Season 2017		
5015	184.67	193.67	197.67	197.00	193.25
5016	185.00	193.67	199.33	193.33	192.83
5017	214.33	229.00	235.33	227.00	226.42
5018	220.67	228.67	224.33	226.33	225.00
LSD (P=0.05)	7.64				
Average	201.17	211.25	214.17	210.92	3.82
LSD (P=0.05)	3.82				
			Season 2018		
5015	185.33	198.67	192.00	196.33	193.08
5016	187.67	202.33	202.33	193.33	196.42
5017	218.00	231.00	239.00	230.00	229.50
5018	219.33	234.33	226.67	223.00	225.83
LSD (P=0.05)	8.91				
Average	202.58	216.58	215.00	210.67	4.45
LSD (P=0.05)	4.45				

that the genotype 5017, which was sprayed with a concentration of 6 ml/l excelled by giving it the highest averages of 235.33 and 239.00 cm. The plants of genotype 5015 that sprayed with distilled water only recorded the lowest averages of 184.67 and 185.33 cm, respectively.

The results indicated significant differences in the effect of spraying treatments with seaweed extract, genotypes and their interaction, and for both the seasons as shown in Table 3. Corn plants that sprayed with seaweed extract at a concentration of 6 ml/l achieved the highest average of the leaf area amounted (5241.9 and 5250.8 cm^2). While the control treatment recorded the lowest two averages of this trait amounted (5163.8 and 5176.2 cm^2) for both the seasons, respectively. The result was due to high concentrations of auxins, cytokinines, amino acids and a number of macro and micro-mineral elements that stimulate cell division and expansion. As well as to balance the physiological and biological processes affecting root growth and increase its ability to absorb water and soluble elements, which was positively reflected on the growth of the total vegetative, especially the leaves. This result agrees with that of Gollan and Wright (2006), who confirmed that the leaf area of corn plants was increased when sprayed with seaweed extract. The genotypes differed significantly in the leaf area. Plants of the genotype 5017 achieved the highest averages of 5291.8 and 5299.7 cm^2, while the genetically modified plants of 5015 recorded the lowest

Table 3. Effect of spraying with seaweed extract on the leaf area (cm^2) for four corn genotypes

Genotype	Concentrations of seaweed extract				Average
	0 ml/1	3 ml/1	6 ml/1	9 ml/1	
			Season 2017		
5015	5089.3	5127.0	5139.0	5137.0	5123.1
5016	5139.7	5146.0	5168.7	5162.7	5154.2
5017	5212.3	5273.3	5345.3	5336.3	5291.8
5018	5214.0	5239.0	5314.7	5315.0	5270.7
LSD (P=0.05)	26.57	13.29			
Average	5163.8	5196.3	5241.9	5237.8	13.29
LSD (P=0.05)	13.29				
			Season 2018		
5015	5099.0	5134.7	5141.7	5143.3	5129.7
5016	5146.0	5152.7	5176.0	5163.3	5159.5
5017	5223.3	5272.3	5357.3	5345.7	5299.7
5018	5236.3	5249.3	5328.0	5325.3	5284.8
LSD (P=0.05)	30.06	15.03			
Average	5176.2	5202.2	5250.8	5244.4	15.03
LSD (P=0.05)	15.03				

average of 5123.1 and 5129.7 cm^2 for both the seasons, respectively. The reason for the variation of the genotypes in the leaf area was due to the difference in the genetic mechanism controlling this important function for the grain crops (Al-Ubaidi, 2013). As for the interaction between the genotypes and the spraying treatments with the seaweed extract, the results (Table 3) showed that the plants of the 5017 genotype, which were sprayed with a concentration of 6 ml/l, achieved the highest averages of 5345.3 and 5357.3 cm^2. While the plants of 5015 genotype that sprayed with distilled water only recorded the lowest averages of this trait amounted (5089.3 and 5099.0 cm^2) for both the seasons, respectively. This was due to the fact that the genotype 5017 had a genetic structure that had contributed to giving the plants the highest average of leaf area, especially when sprayed with seaweed extract. This was a useful indicator of the genotype 5017 relative to the leaf area compared to the other genotypes under study. These results are also evidence of the difference in the response of the genotypes for corn to the seaweed extract of this trait.

Yield Traits

The results indicated a significant difference in the effect of genotypes and for both the seasons as shown in Table 4. The genotypes differed significantly in the number of cobs/plant. The plants of the genotype 5017 achieved the highest two averages of 1.93 and 1.96 plants/cob, while the plants of the genotype 5016 recorded the lowest two averages of 1.62 and 1.67 plants/cob for both the seasons, respectively. The genetic variation was due to its different genotypes, and this result agrees with that of Dell (2003. The data (Table 4) indicated that there were no significant differences in the spraying treatments with the seaweed extract, and the absence of any interaction between the extract and the genotypes.

The results showed significant differences in the effect of spraying treatments with seaweed extract, genotypes and their interaction, and for both the seasons as shown in Table 5. Plants of corn that sprayed with seaweed extract at 6 ml/l gave the highest two averages of length of the cob amounted (17.97 and 18.14 cm), respectively. While the control treatment recorded the lowest two averages of this trait (17.04 and 17.16 cm) for both the seasons, respectively. The increase in the length of the cob due to the spraying of corn plants with seaweed extract was due to the positive effects of plant hormones and the macro and micronutrient elements involved in the formation of seaweed extract, which play an important role in the cells expansion as well as their importance in encouraging the root growth, which reflected positively along the length of the cob. These results agree with those of Craigie (2011). The genotypes differed significantly in the length of the cob. The plants of the genotype 5017 achieved the highest two averages of 18.30 and 18.45 cm, while the plants of the genotype 5015 recorded the lowest two averages of 16.89 and 17.11 cm for both

Table 4. Effect of spraying with seaweed extract on the number of cobs for plant (plants/cob) for four corn genotypes

Genotype	Concentrations of seaweed extract				Average
	0 ml/l	3 ml/l	6 ml/l	9 ml/l	
			Season 2017		
5015	1.92	1.60	1.68	1.69	1.79
5016	1.51	1.62	1.68	1.69	1.62
5017	1.90	1.99	1.90	1.91	1.93
5018	1.91	1.80	1.74	1.69	1.79
LSD (P=0.05)	0.54	0.27			
Average	1.81	1.75	1.75	1.81	0.27
LSD (P=0.05)	0.27				
			Season 2018		
5015	1.97	1.64	1.75	2.02	1.85
5016	1.52	1.68	1.75	1.74	1.67
5017	1.95	2.03	1.94	1.90	1.96
5018	1.95	1.77	1.78	1.83	1.83
LSD (P=0.05)	0.51	0.25			
Average	1.85	1.78	1.81	1.87	0.25
LSD (P=0.05)	0.25				

Table 5. Effect of spraying with seaweed extract on the length of the cob (cm) for four corn genotypes

Genotype	Concentrations of seaweed extract				Average
	0 ml/l	3 ml/l	6 ml/l	9 ml/l	
			Season 2017		
5015	16.64	16.80	17.17	16.94	16.89
5016	16.82	17.31	17.50	17.16	17.20
5017	17.43	18.26	18.99	18.51	18.30
5018	17.26	17.85	18.22	18.12	17.86
LSD (P=0.05)	0.34	0.17			
Average	17.04	17.55	17.97	17.68	0.17
LSD (P=0.05)	0.17				
			Season 2018		
5015	16.71	17.17	17.36	17.21	17.11
5016	16.92	17.58	17.70	17.36	17.39
5017	17.66	18.46	19.08	18.61	18.45
5018	17.35	17.91	18.42	18.25	17.98
LSD (P=0.05)	0.41	0.20			
Average	17.16	17.78	18.14	17.86	0.20
LSD (P=0.05)	0.20				

the seasons, respectively. The difference between genotypes was due to their variation in their genetic structure, and these results agree with those of Nelson and Van-Staden (1996). The interaction between the genotypes and the spraying treatments with the seaweed extract is shown in Table 5. The plants of genotype 5017 that sprayed with a concentration of 6 ml/l achieved the highest two averages of 18.99 and 19.08 cm, while the plants of genotype 5015 that sprayed with distilled water gave the lowest two averages for this trait amounted (16.64 and 16.71 cm) for both the seasons, respectively.

The results indicated significant differences in the effect of spraying treatments on seaweed extract, genotypes and their interaction, and for both the seasons as shown in Table 6. The corn plants that sprayed with seaweed extract at a concentration of 6 ml/l achieved the highest two averages for the number of grains amounted (443.42 and 448.8 grains/cob), while the control treatment recorded the lowest two averages of this trait (428.42 and 431.92 grains/cob) for both the seasons, respectively. This was due to the important role of the plant hormones involved in the composition of seaweed extract in regulating the distribution of materials manufactured between the source and the sink, especially when starting the formation and emergence of grain sites as well as the important role of these hormones and some mineral elements present in seaweed extract as elements B, Mg, Mn and k to encourage the growth of roots and increase their efficiency in

Table 6. Effect of spraying with seaweed extract on the number of grains in cob (grains/cob) for four genotypes of yellow corn

Genotype	Concentrations of seaweed extract				Average
	0 ml/l	3 ml/l	6 ml/l	9 ml/l	
			Season 2017		
5015	419.67	428.33	435.00	432.67	428.92
5016	427.67	435.33	442.67	440.33	436.50
5017	433.00	446.67	453.00	450.33	445.75
5018	433.33	438.33	443.00	440.00	438.67
LSD (P=0.05)	4.83	2.41			
Average	428.42	437.17	443.42	440.83	2.41
LSD (P=0.05)	2.41				
			Season 2018		
5015	421.00	431.33	438.33	437.00	431.92
5016	431.67	439.33	448.67	448.00	441.92
5017	437.67	454.33	458.00	457.00	451.75
5018	437.33	442.67	449.33	445.00	443.58
LSD (P=0.05)	5.21	2.61			
Average	431.92	441.92	448.58	446.75	2.61
LSD (P=0.05)	2.61				

the absorption of water and nutrients in addition to the role of these elements, especially the element of boron in the composition of the cells of the tubes of the vaccine and this affected significantly the success rate of fertilization and the formation of grain. This result agrees with that of Nelson and Van-Staden (1996). The genotypes differed significantly in the length of the cob. The genotype 5017 achieved the highest two averages of 445.75 and 451.75 grains/cob, while the 5015 genotype gave the lowest two averages of 428.92 and 431.92 grains/cob for both the seasons, respectively. This was because the 5017 genotype had the ability to fertilize and form the seeds compared to other genotypes. This result agrees with that of Kumar and Sahoo (2013). The interaction between the genotypes and the spraying treatments with the seaweed extract is shown in Table 6. The plants of the genotype 5017 that sprayed with a concentration of 6 ml/l excelled by giving it the highest two averages of 453.0 and 458.0 grains/cob, while the plants of the genotype 5015 that sprayed with distilled water only recorded the lowest two averages of this trait amounted (419.67 and 421.0 grains/cob) for both the seasons, respectively.

The results indicated that there were no significant differences in the effect of spraying treatments with the seaweed extract and the genotypes and their interaction between them and for both the seasons as shown in Table 7.

The results showed significant differences in the effect of spraying treatments with the seaweed extract, the genotypes and their interaction, and for both the seasons as shown in Table 8. The corn plants, which were sprayed with seaweed extract at a concentration of 6 ml/l achieved the highest two averages for the plant yield amounted (160.92 and 165.67 g/plant), while the control treatment recorded the lowest two averages for this trait amounted (142.75 and 146.58 g/plant) for both the seasons, respectively. It was a logical result. This was due to the corn plants that sprayed with seaweed extract at a concentration of 6 ml/l was already excelled in both traits of the length of the cob as shown in Table 5 and the number of grains in the cob as shown in Table 6, which reflected positively on the grain yield of the plant. The genotypes differed significantly in the length of the cob. The plants of genotype 5017 achieved the highest two averages amounted (163.17 and 167.5 g/plant), whereas the plants of genotype 5015 gave the lowest two averages of 144.42 and 148.92 g/plant for both the seasons, respectively. The reason for the superiority of genotype 5017 in this trait was due to its superiority in giving the highest leaf area as shown in Table 3, the number of cobs as shown in Table 4 and the length of the cob as shown in Table 5. This was an indication that the genotype 5017 had the genetic capacity that made its plants more efficient than other genotypes in achieving the optimal balance between the source and the sink. As well as the characterization of its plants in rising the averages of physiological and biological processes affecting the traits of growth and yield, which reflected positively on the grain of

Table 7. Effect of spraying with seaweed extract on the weight of 1000 grains (g) for four genotypes of yellow corn

Genotype	Concentrations of seaweed extract				Average
	0 ml/l	3 ml/l	6 ml/l	9 ml/l	
			Season 2017		
5015	323.0	325.0	321.3	325.7	323.8
5016	323.3	322.7	320.3	311.0	319.3
5017	326.0	327.0	313.3	320.0	321.6
5018	314.3	315.0	321.0	320.3	317.7
LSD (P=0.05)	13.89	6.64			
Average	321.7	322.4	319.0	319.2	6.94
LSD (P=0.05)	6.94				
			Season 2018		
5015	328.0	329.0	324.3	329.0	327.6
5016	326.0	327.0	324.7	317.0	323.7
5017	332.0	331.0	319.7	324.7	326.8
5018	319.3	318.7	326.3	324.0	322.1
LSD (P=0.05)	14.12	7.06			
Average	326.3	326.4	323.8	323.7	7.06
LSD (P=0.05)	7.06				

Table 8. Effect of spraying with seaweed extract in the plant yield (g) for four corn genotypes

Genotype	Concentrations of seaweed extract				Average
	0 ml/l	3 ml/l	6 ml/l	9 ml/l	
			Season 2017		
5015	135.33	145.00	150.00	147.33	144.42
5016	143.67	150.00	158.67	154.00	151.58
5017	146.33	166.67	172.00	167.67	163.17
5018	145.67	155.67	163.00	161.33	156.42
LSD (P=0.05)	6.12	3.06			
Average	142.75	154.33	160.92	157.58	3.06
LSD (P=0.05)	3.06				
			Season 2018		
5015	138.33	148.67	155.67	153.00	148.92
5016	147.33	154.67	163.00	157.67	155.67
5017	150.67	172.00	176.67	170.67	167.50
5018	150.00	158.67	167.33	164.00	160.00
LSD (P=0.05)	5.83	2.91			
Average	146.58	158.50	165.67	161.33	2.91
LSD (P=0.05)	2.91				

the plant, this result agrees with that of Kumar and Sahoo (2013). The interaction between the genotypes and the spraying treatments with the seaweed extract is shown in Table 8. The plants of the genotype 5017, which were sprayed with a concentration of 6 ml/l, achieved the highest two averages of 172.0 and 176.67 g/plant), while the plants of the genotype 5015 that sprayed with distilled water only recorded the lowest two averages of this trait amounted (135.33 and 138.33 g/plant) for both the seasons, respectively.

Genetic and Phenotypic Correlations

Genetic, phenotypic and environmental correlations showed that all genetic correlation values were higher than the phenotypic correlation values (Tables 9 and 10). Genotype determined the external appearance, but if the phenotypic correlation values were higher, this indicated that it was affected by environmental conditions. This result agrees with that of Robinson *et al.* (1951), Hafeez (1991), Banziger and Laffitte (1997) and Wahib (2001). Tables 9 and 10 show that most traits had a high positive genetic correlation. The plant height and the leaf area were highly, positively, genetically and phenotypically correlated with yield. These two traits worked to increase the utilization of the sources of growth available within the environment in which the plant lived to employ them to build a strong sink. The contribution of this source in the construction of the sink, it began by providing these nutrient elements to the sink and accumulating them to increase its capacity and increase the efficiency of the capacity of the fixed system. The required level of the components of any trait in the system was determined by the sources of the environment available which worked on it through genetics and through the stresses that determined the work of the gene, and here in this study we observed increased response to the selection using different criteria by increasing the foliar spraying with seaweed, and the lack of exposure of the system to stresses that hindered the functioning of the gene.

The availability of growth sources led to the formation of a good source and then a good strong sink represented by the length of the cob, the number of its rows, the number of grains in row, the number of grains in cob, the number of cobs in plant and the grain weight with high, positive correlation with yield, which can be relied upon by the selection to increase the yield, to be criteria to be adopted in the selection and use of electoral evidence to increase. From this, we note that the study of the correlation between different plant traits has provided and can provide in future to plant breeders with great opportunities to develop cultured cultivars and hybrids by understanding the correlation between different traits. It also enables it to distinguish the best criterion for measuring the yield. The genetic and phenotypic correlation tables showed that plant traits were interrelated between them, which showed that the traits of the plant complemented each other in achieving plant productivity with different role of each trait from the other.

Table 9. Values of genetic correlations between studied traits for 2017 and 2018 seasons

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_1	1.000	0.812	0.819	0.904	0.481	0.545	0.823
	1.00	0.785	0.837	0798	0.521	0.538	0.784
X_2		1.000	0.846	0.866	0.594	0.468	0.821
		1.000	0.853	0.734	0.566	0.562	0.765
X_3			1.000	0.850	0.415	0.481	0.762
			1.000	0.900	0.478	0.321	0.654
X_4				1.000	0.428	0.556	0.853
				1.000	0,512	0.585	
X_5					1.000	0.287	0.788
					1.000	0.300	
X_6						1.000	0.635
						1.000	0.621
X_7							1.000
							1.000

X_1–Plant yield, X_2–Leaf area, X_3–Length of cob, X_4–Number of grains/cob, X_5–Number of cobs/plant, X_6–Average weight of grain, X_7–Plant yield.

Table 10. Values of phenotypic correlations between studied traits for 2017 and 2018 seasons

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_1	1.000	0.786	0.622	0.879	0.465	0.535	0.805
	1.000	0.776	0,623	0.872	0,470	0.498	0.778
X_2		1.000	0.575	0.639	0.403	0.491	0.639
		1.000	0.587	0.644	0.456	0.5.02	0,587
X_3		0.662	1.000	0.886	0.618	0.565	0.869
		0.634	1.000	0.873	0.547	0.555	0,855
X_4				1.000	0.418	0.549	0.844
				1.000	0.421	0.527	0.799
X_5					1.000	0.385	0.780
					1.000	0.376	0,688
X_6						1.000	0.628
						1.000	0.611
X_7							1.000
							1.000

Trait details are given in Table 9.

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