ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Response of Peanut and Maize crops to foliar application of Algae extracts Under sandy soil condition

Nofal[1] OA, Hellal[1] FA, El Sayed[1] SAA and Bakry A.B[2]*

[1]Plant Nutrition Dept., [2]Field Crop Research Dept., National Research Centre, 33 El Bohouth St., Dokki, Egypt – P.O.12622

ABSTRACT

Effect of Algae extracts foliar application on peanut and maize was investigated during the two successive cultivation seasons of 2013 and 2014. Peanut and maize were cultivated and sprayed twice after five and nine weeks from transplanting by extract of Algae extracts at concentrations of 1.5 g/l which is equal to 300 g/200 L/fed as foliar application. Data showed that differences were was superior in both peanut and maize with application of Algae extracts in yield parameters and nutrient contents as compared to the control treatment. Applying Algae extracts significantly increased pod weight, number of Pod per plant, number of seed per plant, pod and seed yield and oil percentage. Foliar application of 300 g Algae per feddan also improved nitrogen, and protein contents of the peanut seeds and maize grains. This treatment also, significantly improved the iron, zinc, manganese and copper content of both peanut and maize crops. The results of the study concluded a positive response of peanut and maize yield and nutrient content to the foliar application of Algae extract.

Keywords: Peanut, Maize, Algae extracts, protein, nutrient content

Corresponding author

ISSN: 0975-8585

INTRODUCTION

In view of increasing the population in Egypt, resort to increase the provision of food, it was necessary to increase the agricultural area of new land newly reclaimed facing many difficulties as regards the physical, chemical and biological properties. Where are these kinds of land down the nutritional content and Structural weakness and loss of fertilizer the imbalance between the elements. In addition, low in micronutrients, these circumstances is difficult to achieve these demands was the duty to follow the methods increase productivity in sandy soil **(1)**. Peanut (*Arachis hypogaea, L.*) as one of the leguminous crops, is due to the high nutritive value of its seeds which considered rich in protein and fats in addition to other vital components. Therefore, it is an important source of edible oil and protein **(2).** In addition, the crop has a good ability for growing in light soil, and thrives on improving the characteristics of the newly reclaimed sandy soils which commonly suffer from some constraints such as poor physical properties and nutrient deficiency. In Egypt, during the last two decades, land reclamation is necessary. Maize (Zea mays) is regarded as an ideal silage crop with a low buffering capacity and adequate water soluble carbohydrates which results in rapid preservation **(3)**. The biggest limitation of maize silage as animal feed is its relative low crude protein value of 7.7 % of DM **(4).**

The use of biofertilizer in such soil showed a good means in that concern. Numerous studies have shown a substantial increase in growth and yield of wheat plant in reclaimed sandy soils **(5)**. Algae is considered as an important group of microorganisms capable of fixing atmospheric nitrogen, However, extracts of algae naturally contain auxins, cytokinins and gibberellic acid **(6).** Blue green algae (BGA) are photosynthetic nitrogen fixers and are free living. Cyanobacteria are capable of abating various kinds of pollutants and have advantages as potential biodegrading organisms **(7)**. Excretion of growth-promoting substances such as hormones (Auxin, Gibberellins), vitamins, amino acids (**8). (9)** on palms and **(10)** on orange trees reported that foliar application of algae extract considerably improved the leaf area of palms and orange trees and increased content of N in leaves of palm trees. **(11)** showed that increasing grain and straw yield, plant height, number of capsule/ plant, number of branches/ plant, seed weight/ plant and 1000 seed weight of sesame plants when spirulina algae was used as bio-organic fertilizer. **(12)** Found that BGA and Azotobacter in different combinations with chemical fertilizers gave the highest values of chlorophyll. **(13)** stated that cynobacteria are used as biofertilizers, which enhanced the growth of higher plants like wheat, rice, maize, vegetables and certain medicinal plants. The main objective of this study is to evaluate the application of Algae extracts in enhancing the yield, quality and nutrient contents of peanut and maize grown in field experiments under sandy soil conditions.

MATERIAL AND METHODS

Two summer field experiments were carried out at the Station in National Research Centre, Nubaria Sector, Beheira Governorate, Egypt, during the summer season of 2013, to investigate the response of peanut and maize to a foliar application of algae under sandy soil condition. Soil sample was taken from 0-30 for analysis before applying the fertilizers and during preparing soil. Some physical and chemical properties of a representative soil sample used in the experimental soil site were determined according to **(14)** and data showed in (Table 1).

Table (1): Soil physical and chemical soil properties of the experimental soil site

Soil characteristics	Maize	Peanut	Soil characteristics	Maize	Peanut
Particle size distribution (%)			Available Macronutrients (mg 100 g soil^{-1})		
Sand	77.52	76.5	N (K- Chloride Ex.)	3.19	16.10
Silt	10.00	4.82	P (Na Bicarbonate Ex.)	0.97	9.38
Clay	12.48	19.22	K (Ammo. Acetate. Ex.)	12.3	16.31
Texture class	Sandy loam	Sandy clay loam	Available Micronutrients (ppm)		
pH (1:2.5)	8.30	8.30	Fe++ (DTPA Extract)	3.2	13.5
EC (dS m^{-1}) (1:5)	0.684	4.275	Zn++ (DTPA Extract)	2.9	0.12
Organic matter (%)	0.92	0.91	Mn++ (DTPA Extract)	0.12	8.44
$CaCO_3$ (%)	4.76	4.82	Cu++ (DTPA Extract)	0.004	0.02
Soluble Cation (mg 100 g soil^{-1})			Soluble Anion (mg 100 g soil^{-1})		
Na^+	4.66	4.37	CO_3^{--}	0.00	0.00
K^+	4.66	4.35	HCO_3^-	19.03	25.38
Ca^{++}	4.73	1.87	Cl^-	9.08	3.52
Mg^{++}	1.14	4.35	SO_4^{--}	13.92	15.43

A randomized complete design with three replications was used. Maize seeds (hybrid 3) and peanut grains variety (Giza 6) planted on 13th May, 2013 and 2014. With insulted before sowing with the specific Rhizobium bacteria inoculants. It was fertilized with 100 Kg/fed. Calcium super phosphate (15.5 % P_2O_5) during the tillage and N fertilizer was applied as Ammonium nitrate (33 % N) divided into 3 equal doses started after one week of planting in the field and after one week after every cutting, respectively. Algae (seaweed) extracts were applied as a foliar application on the plants. The rates used were 0.0 and 1.5 g/L which equal zero and 300 g/ 200 L/fed. The algae was sprayed two times, 30 and 45 days of planting and after that 15 and 30 days after each cutting. Chemical composition and mineral concentration of Algae extracts were determined according to the standard methods of **(15)** and presented in (Table 2). At harvest, representative leaf and Seeds samples were analyzed for the nutrient content in peanut and maize (N, P, K Fe, Zu, Cu and Mn) and determined according to **(14)**.

Table (2): Chemical composition and mineral concentration of algae extracts

Chemical composition (%)		Mineral concentration							
Moisture	6.12 ± 0.02	**Nitrogen**	(%)	8.00		**Iron**	(ppm)	12.4 ±	0.16
crude protein	50.67 ± 1.79	**Phosphorus**	(ppm)	123.1 ±	1.46	**Zinc**	(ppm)	0.72 ±	0.04
Ash	10.55 ± 0.32	**Potassium**	(ppm)	170.0 ±	2.86	**Manganese**	(ppm)	2.6 0 ±	0.21
Total lipids	7.13 ± 0.18	**Calcium**	(ppm)	63.7 ±	0.73	**Cupper**	(ppm)	5.1 0 ±	0.66
crude fiber	4.11 ± 0.18	**Sodium**	(ppm)	216.7 ±	4.41	**Lycine**	(ppm)	19.10 ±	1.01
carbohydrates	20.42 ± 0.27	**Magnesium**	(ppm)	6.20 ±	0.06	**Methionine**	(mg/g)	5.31 ±	0.81

Amino acid concentrations (mg/g)					
Essential amino acids			**Non essential amino acids**		
Isoleucine	14.16 ±	0.98	**Cystine**	3.30 ±	0.41
Leucine	29.42 ±	1.27	**Alanine**	33.81 ±	1.21
Lycine	19.10 ±	1.01	**Aspartic**	36.69 ±	1.09
Methionine	5.31 ±	0.81	**Serine**	18.43 ±	1.14
Phenylalanine	23.78 ±	1.21	**Glycine**	15.06 ±	1.04
Threonine	13.59 ±	0.87	**Tyrosine**	19.74 ±	1.03
Valine	18.40 ±	1.41	**Proline**	14.88 ±	0.34
Histidine	13.46 ±	1.19	**Ammonia**	54.91 ±	1.12

Statistical analysis:

All data were statistically analyzed according to the technique of analysis of variance (ANOVA) according to **(16)**, using "MSTAT-C" Computer software package. Newly Least Significant Differences (NLSD) according to the producer outlined by **(17)** were used to test the differences between treatment means.

RESULTS AND DISCUSSION

Peanut Yield

Data in Table (3) cleared that the foliar application of Algae extract at a rate of 300 g fed^{-1} achieved the highest values of fresh weight (g $plant^{-1}$), pods and seeds weight and number of pods. The results shown that a remarkable increase in fresh weight (g $plant^{-1}$) such as plant all, shoot and root. Pods and seeds weight increased by about 20% and 35% as compared with control. As well, number of pod and seed per plant increased by application of Algae at a rate of 300 g fed^{-1}. **(18)** reported that vegetative parameters that is, plant length, number of leaves, leaf area, and number of branches and fresh weight of shoot, responded positively and significantly to the application of seaweed extract with a gradual effect relative to the applied concentration.

Also, Data in table (3) showed that the foliar application of Algae extracts at a rate of 300 g fed^{-1} enhanced pods, seeds and oil by about 20%, 35% and 38 % respectively as compared with control. Furthermore, oil extraction percentage increased by about 36.07 % due to addition of Algae at rate 300 g fed^{-1} compared to control (35.30 %). Table shows the increase productivity of peanut, was 27.67 (ton fed^{-1}) as affected by foliar application of Algae at a rate 300 g fed^{-1}. These results may be due to the Algae extracts have the ability to develop tolerance to environment stress **(19).** Microalgae have a higher photosynthetic efficiency, biomass productivity, and growth rate than oilseed crops (**20** and **21).**

Table (3): Yield parameters of peanut plant as affected by foliar application of Algae

Treatment	Fresh weight (g $plant^{-1}$)			Pods weight g $plant^{-1}$	Seeds weight g $plant^{-1}$	Pod number $plant^{-1}$
	plant all	Shoot	Root			
0.0 g/fed.	157.36	128.83	2.63	25.9	9.53	22.67
300 g/fed.	446.11	403.84	9.87	32.4	14.74	49.00
LSD 0.05 %	**72.13**	**69.28**	**3.237**	**4.80**	**4.349**	**11.92**
Treatment	**Productivity (Ton fed^{-1})**			**Oil Extraction (%)**	**Seed number $plant^{-1}$**	
	Pods	**Seeds**	**Oil**			
0.0 g/fed.	2.18	0.8	0.28	35.30	45.3	
300 g/fed.	2.72	1.24	0.45	36.07	114.0	
LSD 0.05 %	**0.404**	**0.366**	**0.113**	**2.61**	**23.85**	

Nutrient contents of Peanut

Application of algae in agricultural crops and many beneficial effects may be achieved in terms of enhancement of yield and quality. Liquid extracts from seaweeds have recently gained importance as foliar sprays for many crops including various cereals, pulses and different vegetable species. Seaweed extracts contain major and minor nutrients, amino acids, reported to stimulate the growth and yield of plants, develop tolerance to environmental stress (**22**).

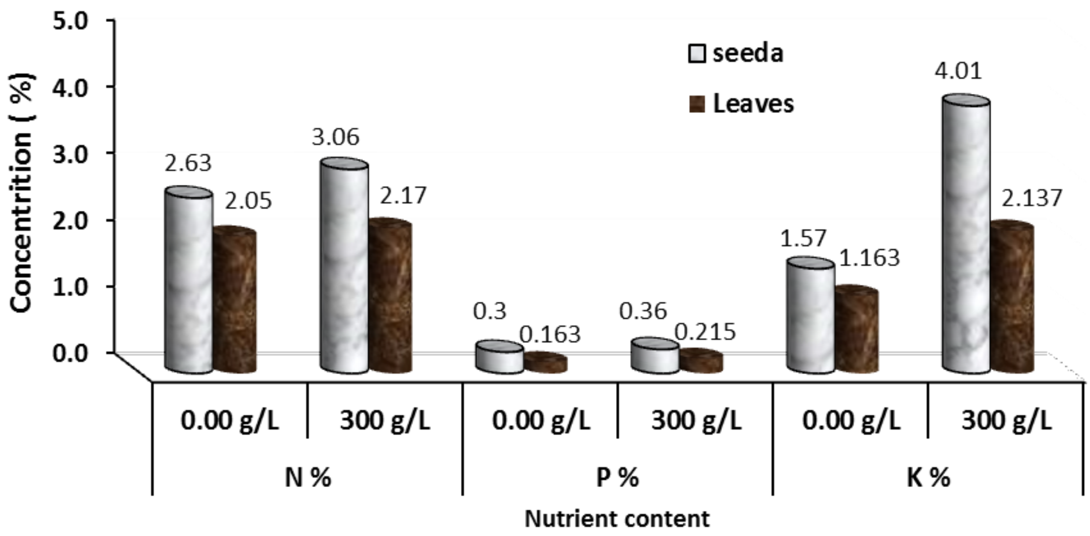

Fig (1): Nutrient contents of peanut as affected by foliar application of Algae

Fig (1) presented that the foliar application of Algae at a rate of 300 g fed^{-1} markedly increase of macronutrient content in seeds and leaves such as NPK this results were (3.06%, 0.36% and 4.01%) as compare to control treatment (2.17% , 0.215% and 2.137%), respectively. Algae extracts fertilizers have often been more beneficial to the crop plants than the conventional chemical fertilizer. Seaweed meals provide nitrogen (N), phosphorous (P), potassium (K) and beside some readily available microelement to the plants **(23).**

Table (4) illustrated that the application of Algae extracts at a rate of 300 g fed^{-1} led to a remarkable increase of Fe, Zn, Mn and Cu content in leaves of peanut by about 38.0%, 38.0%, 8.0% and 39.0% respectively. As will as, significantly increased content in seeds of peanut by about 62.0%, 9.0%, 7.0% and 20.0% respectively as compared with no fertilizer. Data also, revealed increased of Crude protein percentage in leaves and seeds, these results were 6.0% and 14.0%, approximately. Algae extract (Spirulina) contains unusually high amounts of protein, between 55 and 70 percent by dry weight, depending upon the source **(24).**

Table (4): Micronutrients and protein of peanut as affected by foliar application of Algae

Treatment	Micronutrients (ppm)				Crude protein (%)
	Fe	Mn	Zn	Cu	
peanut leaves					
0.0 g/fed	415.33	21.34	30.00	2.60	12.83
300 g/fed	665.31	34.67	32.67	4.27	13.58
LSD 0.05 %	**116.06**	**9.967**	**12.55**	**1.93**	**1.12**
peanut seeds					
0.0 g/fed	1653.3	26.63	132.17	32.13	16.42
300 g/fed	4317.7	29.20	141.87	40.27	19.12
LSD 0.05 %	**778.2**	**6.75**	**16.13**	**7.20**	**9.58**

Yield and Nutrient contents of Maize

Application of Algae extracts have been known for many years as soil fertilizers and plant growth supplements in agriculture giving beneficial effect, including, increase in crop yield, fruit fresh weight, improved fruit yield, high chlorophyll levels in the plant leaves, improved nutrient uptake by the crops, enhancement of seed germination, plant resistance against stress conditions, reduced incidence of fungal disease and insect attack, and the reduction of the effect of water and salinity stress on the plant (**25 and 26).** Data represented in Table (5) demonstrated that adding of Algae extracts at a rate of 300 g fed^{-1} led to significant increase nitrogen, phosphorus, potassium and protein content in maize plant by about 25.0%, 26.0%, 44.0% and 25.0%, respectively as compared with control.

Table (5): Nutrients, protein and yield of maize as affected by foliar application of Algae

Treatment	Macronutrients (%)				Crude protein (%)
	N		P	K	
0.0 g/fed.	1.14		0.157	1.02	7.146
300 g/fed.	1.52		0.212	1.83	9.521
LSD 0.05 %	0.26		0.055	0.62	2.11
Treatment	Micronutrients (ppm)				Grain yield (ton $fed.^{-1}$)
	Fe	Mn	Zn	Cu	
0.0 g/fed.	438.7	38.7	27.3	5.6	18.07
300 g/fed.	481.3	59.3	28.7	14.8	27.67
LSD 0.05 %	158.6	19.3	10.5	3.14	3.58

It is clear also from Table (5), enhancement of macronutrient content value by a foliar application of Algae at a rate of 300 g fed^{-1}. This treatment also significantly increased iron, zinc, manganese and copper by about 9.0%, 35.0%, 5.0% and 62 %, respectively as compared with no fertilizers applied. Application of the same rate of algae extract increased yield production of maize by about 35.0% compared with control. Similar observation were obtained by **(27)** and **(28)** they confirmed that using BGA or *Aspirllum spp* contributor in rice production and succeeded to enhance yield and yield components of rice crop and improved grain N, p, K, Cu, Zn, Fe, and Mn contents as compared with untreated grain. Algae are known to produce essentially all of the known phytohormones of higher plants and they carry out similar physiological functions in algae as they do in plants **(29).** Changes in the level of exogenous cytokinins alter the regulation of physiological plant processes **(30).**

CONCLUSION

The results showed the mode of action of Algae extracts beneficially influenced growth and yield of peanut and maize which may be due to the presence of some growth promoting substances present in the Algae extracts. This was mediated by an increase in the concentration of bioactive molecules including antioxidants in the treated plants.

REFERENCES

[1] Balba, A., 1989. Management of Problem Soils in Arid Ecosystems. Dar El-Matbouat Al-Gadedah, Alex, Egypt.
[2] Migawer, Ekram A. and Mona A.M. Soliman (2001). Performance of two peanut cultivars and their response to npk fertilization in newly reclaimed loamy sand soil. j. agric sci. mansoura univ., 26 (11): 6653 – 6667.
[3] Meeske, R. & Basson H.M., (1998). The effect of a lactic acid bacterial inoculant on maize silage. Anim. Feed Sci. Technol. 70, 239-247.
[4] Aufrère, J., Graviou, D., Demarquilly, C., Andrieu, J., Emile, J.C., Giovanni, R. & Maupetit, P., (1992). Estimation of organic matter digestibility of whole maize plants by laboratory methods. Anim. Feed Sci. Technol. 36, 187-204.
[5] Hu J. Cui X. Dai J. Wang J. Chen R. Yin R. Lin X., (2014) Interactive Effects of Arbuscular Mycorrhizae and Maize (Zea mays L.) Straws on Wheat (Triticum aestivum L.) Growth and Organic Carbon Storage in a Sandy Loam Soil .Soil and Water Res., 9, 3: 119–126.
[6] Crouch, J.J. and J. Van standen, (1991). Evidence for rooting factors in a seaweed prepared from Ecklonia maxima. J. Plant Physiol., 137: 319-322.
[7] Subramanian, G. & Uma, L.1996. Cyanobacteria in pollution control. J.of Sci. and Ind. Res. 55: 685 - 692.
[8] Rodriguez A.A., Stella A.A., Storni M.M., Zulpa G., Zaccaro M.C. (2006): Effects of cyanobacterial extracelular products and gibberellic acid on salinity tolerance in Oryza sativa L. Saline System, 2: 7.
[9] Gobara, A.A., (2004). Performance of grandnaine banana plants to biofertilization. J. Agric. SCI Mansoura Univ., 29 (9): 522 1-5229.
[10] Hegab, M.Y., A.M.A. Sharkawy and S.A.G. El-Saida, (2005). Effect of algae extract and mono potassium phosphate on growth and fruiting of Balady orange trees. Bull. Fac. Agric. Cairo Univ., 56 (1): 107-120.
[11] Ali, K. M. and S. M. Mostafa (2009). Evaluation of potassium humate and Spirulina platensis as bio-organic fertilizer for sesame plants grown under salinity stress. Egypt. J. Agric. Res., 87: 369-388.
[12] Prasanna, R.; Jaiswal, P.; Singh, Y.V.; Singh, P.K. (2008). Influence of biofertilizers and organic amendments on nitrogenase activity and phototrophic biomass of soil under wheat. Acta Agronomica Hungarica. 56(2): 149-159.
[13] Aziz MA, Hashem MA (2004) Role of cyanobacteria on yield of rice in saline soil. Pakistan Journal of Biological Sciences 7: 309-311.
[14] Cottenie A., Verloo M., L. Kiekens, Velghe G. and R. Camerlynck (1982). Chemical analysis of plant and soil. In: Laboratory of Analytical and Agro Chemistry State Univ. Ghent Press, Ghent, Belguim.
[15] A.O.A.C. (2000). Official Methods of Analysis of the Association of Official Agricultural Chemist 20th Ed. Washigton DC. USA.
[16] Gomez, K.A. and Gomez, A.A. (1984). Statistical procedures for agriculture research. 2nd Edition, John Wiley and Sons Inc., New York.
[17] Waller, R.A. & D.B., Duncan, (1969). A bays rule for the symmetric multiple comparison problems. J. Amer. Assoc. 64: 1484-1503.
[18] Abdel-Mawgoud AMR, Tantaway AS, Hafez MM, Habib HAM (2010). Seaweed extract improves growth, yield and quality of different Watermelon hybrids. Res. J. Agric. Biol. Sci. 6(2):161-168.
[19] Zhang, X., and R.E. Schmidt. (2000). Hormone containing products' impact on antioxidant status of tall fescue and creeping bentgrass subjected to drought. Crop Science. 40:1344-1348.
[20] Milne, T.A.; Evans, R.J.; Nagle, N. (1990). Catalytic conversion of microalgae and vegetable oils to premium gasoline, with shape-selective zeolites. Biomass 1990, 21, 219–232.
[21] Mata, T.M.; Martins, A.A.; Caetano, N.S. (2010). Microalgae for biodiesel production and other applications: A review. Renew. Sustain. Energy Rev. 14, 217–232.
[22] Zhang X, Ervin EH, Schmidt ER (2003). Plant growth regulators can enhance the recovery of Kentucky bluegrass sod from heat injury. Crop Sci. 43:952-956.
[23] Elumalai LK, Rengasamy R (2012). Synergistic effect of seaweed manure and Bacillus sp. On growth and biochemical constituents of Vigna radiate L. J. Biofertil. Biopestici. 3:121.
[24] Phang, S.M., Miah, M.S., Chu, W.L. & Hashim, M. (2000). Spirulina culture in digested sago starch factory waste water. J. Appl. Phycol., 12: 395–400.
[25] El-Bakry, A. A.; Salah El Din, R. A.; Ghazi, S. M. and Abdel Hamid, O. M. (2006). Effect of some seaweed extracts on the growth and yield of Wheat (Triticum vulgare L.). *Egypt. J. Biotech*., 24: 195-209.

[26] Salah El Din, R. A; Elbakry, A. A.; Ghazi, S. M. and Abdel Hamid. O. M. (2008). Effect of seaweed extract on the growth and yield of Faba bean (Vicia faba L.). Egypt. J. of Phycology, 9: 25-38.

[27] Singh, S.; R. Prasad; B.V. Singh; S.K. Goyal and S.N. Sharma (1990). Effect of green manuring blue green algae and neem-cake-coated urea on wetland rice (*Oryza sativa* L.) Biology and Fertility of Soils. 9: 3, 235-238 .

[28] Singh, R. and S.K. Shrivastava (1990). Blue green algae (BGA) as a partial N substitute for rainfed lowland rice. International Rice Research Newsletter 15: 2, 20-25 .

[29] Tarakhovskaya E.R., Maslov Y.I. and M.F. Shishova. (2007). Phytohormones in algae. Russian Journal of Plant Physiology. 54:163-170.

[30] Stirk, W.A. and J. van Staden. (2010). Flow of cytokinins through the environment. Plant Growth Regulation. 62:101-116.