International Journal of Environment Volume : 04 | Issue : 02 | April-June | 2015
ISSN: 2077-4508 Pages: 151-157

Influence of Algal Extracts on Yield and Chemical Composition of Moringa and Alfalfa Grown Under Drought Condition

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ABSTRACT

Global climate change makes drought a serious threat to food security worldwide. Drought, as an abiotic stress, is multidimensional in nature, and it affects plants at various levels of their organization. Therefore, use of foliar application of Algae (seaweed extract) may has become a new trend to reduce the harmful effects of drought on some crops. Therefore, the research was carried out at the Agricultural Experimental Station of National Research Centre, Nubaria Sector, Beheira Governorate, Egypt during the summer season of 2013 was conducted to study the Influence of Algae (*seaweed extracts*) on growth, yield and chemical composition on of Moringa and alfalfa plants. Where have been identified meteorological data of the experimental sites recorded by Central Laboratory for Agricultural Climate during crop growth. Algae were applied as foliar application at rates of 0.0 and 1.5 g L^{-1} which equal zero and 300 g per 200 L fed^{-1}. The algae was sprayed two times, 30 and 45 days of planting respectively and after that 15 and 30 days after each cutting. Results obtained showed that the foliar application of Algae at a rate of 300 g fed^{-1} achieved the highest values of fresh and dry weight (g $plant^{-1}$) and a remarkable increase of fresh and dry weight ton per feddan, it was the first cut overtake to second cut. Also, data presented that macro and micronutrient and protein content highest significant values of Moringa and Alfalfa particularly with first cutting.

Key words: Alfalfa, Moringa, Algae, drought, yield

Introduction

Agriculture is facing the dual challenges of increasing crop production and climate change. Rising temperature, drought, salinity, floods, desertification and weather extreme are adversely affecting agriculture especially in developing world IPCC, (2007). Environmental factors are essential components which affect on quality and quantity of crop yield to a great extent. The introduction of resistance to salt, cold, and drought into crop plants has become a topic of major economic interest for agriculture. In the case of drought, scientists have been able now to uncover some of the extremely intricate mechanisms through which seed from orthodox plants acquires tolerance to desiccation during their final maturation period (Oliver *et al*., 2010). Drought triggers a wide variety of plant responses (Ajum *et al*., 2011). Osmoregulatory processes generally occur to protect membrane integrity and maintain the inflow of water to the cell as well as the accumulation of organic solutes as sugars, quaternary ammonium compounds (glycine betaine and alanine betaine) (Ashraf and Foolad, 2007). Water is the most important substance in the initial phase of plant development from germination and seedling formation to establishment in the field and a reduction in the water supply in this stage can lead to dehydration and even death (Jaleel *et al*., 2009).

Using algae either soil or foliar application lead to improve the physiological status of plants and their ability to drought tolerance (Dela *et al*., 1988). The application of algae (seaweed extract) as an organic biostimulant is becoming an accepted practice in horticulture industry, it is available as an extract, powder system, helps plant becoming more disease resistant and helps provide rapid root development. 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 (Subramanian and Uma 1996). Excretion of growth-promoting substances such as hormones (Auxin, Gibberellins), vitamins, amino acids (Rodriguez *et al*., 2006). Increase in soil biomass after their death and decomposition (Saadatnia and Riahi 2009). Preventing weeds growth, Increase in soil phosphate by excretion of organic acids (Wilson, 2006). Moringa is an alternative to imported food supplies to treat malnutrition in poor countries. Moringa can be cultivated in a wide range of soil types but grow best in well-drained loam to clay loam soil with slightly acidic to neutral pH however; it cannot withstand prolonged water logging(Fuglier, 1999).

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Alfalfa (*Medicago sativa* L.) has been called the queen of forge crops (Fabaceae), it is an important crop used as forage legume with over 32 million hectares in the world (Mohamed *et al.,* 2009). It is high yield perennial nutritious forage legume that grows in different climates all over the world (Lancefield *et al.,* 2009). Alfalfa grows well in both tropical and temperate climates and it survives in frosty winters (McDonald *et al*., 2003). Annicchiarico *et al.* (2010) that stated Alfalfa is a forage crop of huge importance because of its contribution to sustainable agriculture and its higher productivity of feed proteins per unit area compared to other forages or grain legumes. It is a drought resistant perennial forage legume that can yield high quality forage in times of little rainfall (McDonald *et al*., 2003). This is because Alfalfa has a deep root system with a straight taproot that can cover a depth of more than 15 m (Jasjeet *et al.*, 2011). In cold winters, Alfalfa becomes dormant and when summer approaches it re-grows by using the nutrients reserved in the roots. In areas like California and Egypt 8-10 harvests are annually realized through irrigation. When Alfalfa is harvested by cutting, the plant regrows using the root nutrient reserves (Zanin, 1998). Alfalfa pellets are used as animal feed, and they also increase organic matter in the soil. Alfalfa pellets, may contain weed seeds, which can sprout in fields and will have to be removed. Liquid fertilizers derived from natural sources like seaweeds are found to be viable alternatives to fertilizing input for agricultural crops due to its high level of organic matter, micro and macro elements, vitamins, fatty acids and also rich in growth regulators (Crouch and Van Standen 1993). The objectives of this research work are to improve the yield and nutrient contents of Moringa and Alfaalfa grown under drought condition by application of algal extracts.

Material and Methods

This research was carried out at the Agricultural Experimental Station of National Research Centre, Nubaria Sector, Behira Governorate, Egypt, during the summer season of 2013. The meteorological data of National Research Centre, production and experimental farm was illustrated in Table (1 a,b).

Table 1 a: Meteorological data of the experimental location from (Oct 2012 to April 2013).

Elemental.		Oct	Nov	Dec	Jan	Feb	Mar	April
Dew Point C^o	aver	16.85	14.81	8.06	7.65	7.70	8.72	9.64
	min	7.00	4.00	0.50	-5.10	-6.60	-5.60	-10.00
Air Temp. C^o	min	22.60	17.20	11.50	10.10	10.90	13.80	18.40
	max	31.10	26.40	20.70	16.70	18.30	23.20	29.30
Soil Temp. C^o	min	9.06	5.93	1.50	-1.31	-0.06	0.68	4.06
	max	38.31	33.31	32.43	26.43	29.56	41.50	44.56
HC Air temp. C^o	min	12.00	8.04	4.41	1.76	2.33	4.15	6.57
	max	33.35	30.47	27.87	25.36	27.36	35.42	36.76
HC Relativ %	min	21.00	24.00	19.00	18.00	12.00	7.00	5.00
	max	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Wind speed (m/sec)	aver	1.49	1.40	1.55	1.55	1.38	1.76	1.90
	max	7.80	7.90	9.40	10.70	9.00	8.00	7.40
ETo (mm)	aver	2.10	2.00	1.90	1.80	2.50	4.00	4.90
Leaf Wetne (min)	time	18205	23375	18750	20990	20600	17935	19745
Precipitate (mm)	sum	3.60	8.20	12.80	28.80	19.80	577	115.20
Wind direc. (deg)	aver	194	132	123	137	183	233	262
Solar radl. [W/m^2]	aver	178	182	219	213	198	174	204

Table 1 b: Meteorological data of the experimental location from (May 2012 to Oct 2013).

Elemental.		May	Jun	Jul	Aug	Sep	Oct
Dew Point C^o	aver	14.41	16.67	19.43	20.38	17.87	13.96
	min	-4.80	-6.10	8.30	8.80	3.30	3.30
Air Temp. C^o	min	23.70	27.10	27.90	27.70	26.00	24.10
	max	33.20	34.90	36.20	36.60	34.40	30.50
Soil Temp. C^o	min	9.31	11.18	14.37	14.50	11.75	9.43
	max	55.75	58.12	52.68	50.68	46.00	41.06
HC Air temp. C^o	min	12.14	14.25	16.77	16.48	13.86	12.58
	max	49.00	43.65	35.61	36.48	41.29	32.93
HC Relativ %	min	6.00	5.00	20.00	21.00	10.00	16.00
	max	100.0	100.0	100.0	100.0	100.0	100.0
Wind speed (m/sec)	aver	2.23	2.26	1.98	1.28	1.59	2.00
	max	8.80	10.40	6.50	5.70	7.00	7.60
ETo (mm)	aver	6.10	6.40	5.80	5.20	4.80	4.20
Leaf Wetne (min)	time	14970	16700	19030	19995	18330	3400
Precipitate (mm)	sum	0.00	0.00	0.00	0.00	0.00	0.00
Wind direc. (deg)	aver	279	300	291	267	247	217
Solar radl. [W/m^2]	aver	215	262	284	262	228	251

A randomized complete Block design with three replications was used. All recommended cultural practices for the Moringa (*Moringa oleifae* L.) plants were applied. Sowing procedure was done on the 15th June 2013 in pots with peat moos for 15 days in greenhouse before transferring to field (half feddan area). The seedlings were planted in hills spaced 60 cm between. The purpose of this study was to find out the influence of drought conditions on plant growth of Moringa and the response of yield to algae (seaweed) foliar application. Also, alfalfa planted on area 0.5 feddan. Plot area was 10-5m^2 (3 x 3.5 m) which, seeding rate was 20 Kg seeds/fed. Representative 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 Cottenie *et al*, (1982) and data showed in (Table 2).

Table 2: Physical and chemical properties of soil for experimental location before sowing

Particle size distribution (%)			Texture class	pH (1: 2.5)	EC (dS m^{-1}) Soil paste	Organic Matter (%)	$CaCO_3$ (%)
Sand	Silt	Clay					
76.5	4.82	19.22	Sandy loam	8.10	4.79	0.93	4.46
Soluble cations (mg 100 g soil^{-1})				Soluble anions (mg 100 g soil^{-1})			
Na^+	K^+	Ca^{++}	Mg^{++}	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}
5.46	3.55	1.34	5.31	0.00	17.93	2.64	25.63
Available Macronutrients (mg 100 g soil^{-1})				Available Micronutrients (ppm)			
N	P		K	Fe^{++}	Zn^{++}	Mn^{++}	Cu^{++}
16.10	9.38		16.31	4.92	0.21	7.92	0.08

It was fertilized with 100 Kg fed^{-1} Calcium super phosphate (15.5% P_2O_5) during the tillage N fertilizer was applied in form Ammonium nitrate (33% N) divided into 3 equal parts started after one week of planting in the field and after one week after every cutting respectively. Algae (seaweed) were applied as foliar application at rates of (0.0 and 1.5 g L^{-1}) which equal zero and 300 g /200 L fed^{-1}. The extract of algae was sprayed twice at 30 and 45 days of planting respectively and after that 15 and 30 days after each cutting. Chemical composition and mineral concentration of feeds and feces were determined according to the standard methods of AOAC (2000) as shown in (Table 3).

Table 3: Chemical composition and mineral concentration of algal 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)	2.60 ± 0.21
Total lipids	7.13 ± 0.18	Calcium	(ppm)	63.70 ± 0.73	Cupper	(ppm)	5.10 ± 0.66
crude fiber	4.11 ± 0.18	Sodium	(ppm)	216.7 ± 4.41	Lycine	(mg/g)	19.10 ± 1.01
carbohydrates	20.42 ± 0.27	Magnesium	(ppm)	6.20 ± 0.06	Methionine	(mg/g)	5.31 ± 0.81

Regarding Alfalfa, it cultivated at March 20 2012/2013 and at harvest the early flowering stage three cuts were taken during this year at 60, 106 and 150 days after sowing. The first cut was taken after 60 days and other cuts were taken after 45 days intervals between cuts. Representative, leaf samples were taken from 4th to 7th leaf from each replicate after two weeks from each foliar application. Two cuts of Moringa plants were taken during this year at 75 and 120 days of sowing. The first cut was taken after 75 days from sowing. Second cuts were taken after 45 days from 1st cut. Representative leaf samples were taken from 4th to 7th leaf from each replicate after two weeds from each foliar application soil and leaf samples were analyzed of the nutrients content in Moringa (N, P, K, Na, Ca, Mg, Fe, Zu, Cu and Mn) were determined according to Cottenie *et al*., (1982).

Statistical analysis: All data were statistically analyzed according to the technique of analysis of variance (ANOVA) as published by (Gomez and Gomez 1984), using "MSTAT-C" Computer software package. Least Significant Differences (LSD) was used to test the differences between treatment means.

Results and Discussion

Vegetative growth of Moringa

Climatic changes which prevailed Nubaria station during the period of Oct 2012 to Oct 2013. (Table 1) showed that the Air temperature values from 31.10 ºC to 30.50 ºC an average 28.58 ºC during that period, mean maximum of soil temperature ranged of 38.31 ºC to 41.60 ºC an average 42.34 ºC, values of relative humidity % have been of 21.0 % to 16.0 % an average 14.15 % and wind speed were About 7.8 (m/sec) to 7.6(m/sec) an average 8.17(m/sec) throughout the year. These environmental conditions play an important role and have an impact on physiological case of plant. Data in Table (4) clear that the foliar application of Algae at a rate of 300 g fed^{-1} achieved the highest values of fresh weight (g plant^{-1}) whether first or second cut. The results shown that first cut have been about 265.0 – 364.0 (g plant^{-1}) an average 286.0 (g plant^{-1}). While, second cut were 164.0 – 232.0 (g plant^{-1}) an average 199.0 (g plant^{-1}). At a time when the control given an average 74.01, 118.7 (g plant^{-1}) first cut and second cut respectively. Experimental results show a remarkable increase of fresh weight ton per feddan where it was an average 4.82, 3.35 ton fed^{-1} at first and second cutting, respectively. Also, treatment caused a significant increase of dry weight of mean 49.94 (g plant^{-1}) for first cut and 33.72 (g plant^{-1}) second cut, increased of dry weight ton per feddan mean of approximately 0.84 and 0.57 (ton fed^{-1}) at first and second cutting respectively. The table shows the evidence that the increase in the number of leaves per plant as affected by a foliar application of algae at a rate of 300 g fed^{-1}. It has been 16, 24 average of first cut and second cut. It explained that the increased of plant height by application mentioned treatment it was 88 (cm) at 1st cut and 69 (cm) at 2nd cut. It could be argued that the foliar application has been used as a means of supplying supplemental doses of minor and major nutrients, plant hormones, stimulants, and other beneficial substances. Observed effects of foliar fertilization have included yield increases, improved drought tolerance, and enhanced crop quality.

Plant response is dependent on species, fertilizer form, concentration and frequency of application, as well as the stage of plant growth (Anonymous, 1985). (Bassal and Zahran, 2002) revealed that the blue green algae addition significantly increased flag leaf area, plant height, number of panicles/m2 panicle length (cm) number of filed grain/panicle, grain weight panicle, 1000-grain weight, grain yield and straw yield.

Table 4: Effect of fresh green algae foliar application on some characters of Moringa

Treatment	Fresh weight yield		Dry weight yield		No. of leaves	Plant length (cm)
	(g plant^{-1})	(ton fed^{-1})	(g plant^{-1})	(ton fed^{-1})		
1st Cut						
0.0 g/fed	74.01	1.24	17.74	0.30	13.00	69.00
300 g/fed.	286.80	4.82	49.94	0.84	16.00	88.00
LSD 0.05 %	141.10	2.38	22.68	0.34	1.94	16.00
2nd Cut						
0.0 g/fed	118.70	2.00	19.61	0.31	21.00	60.00
300 g/fed.	199.00	3.35	33.72	0.57	24.00	69.00
L.S.D 0.05 %	83.10	1.40	8.13	0.13	4.00	9.40

Vegetative growth of Alfalfa

The results obtained from Fig 1(A and B) illustrated that the fresh and dry weight (ton fed^{-1}) markedly increase affected by foliar application of Algae (seaweed extract) at a rate of 300 g fed^{-1} as compared to control particularly with second cut. Whereas the remarkable decreased of fresh and dry weight at third cut.

Also, Data in Fig 1 (C) presented that highly increase of protein as affected by spraying of Algae (seaweed extract) at a rate of 300 g fed^{-1} comparison with not spraying particularly at first cut however gradually decrease of second and third cutting.

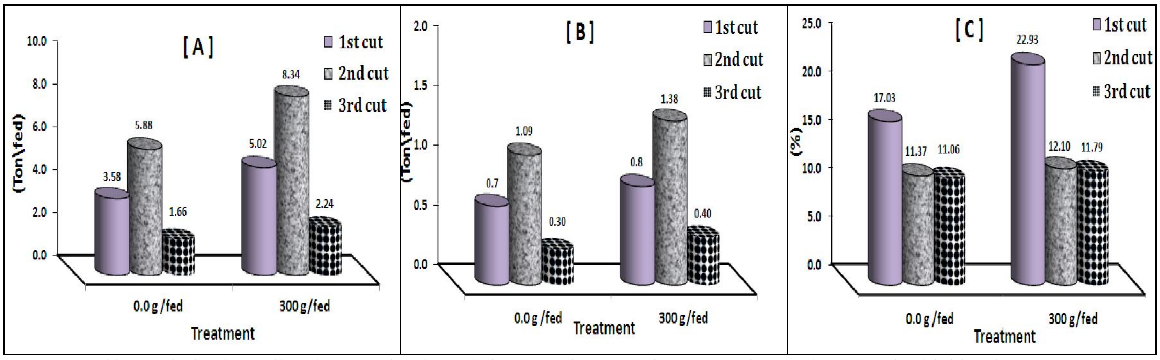

Fig 1: Effect of algal application on fresh weight (A), dry weight (B) and protein (C) of Alfalfa plant.

It could be argued that Algae are considered as an important group of microorganisms capable of fixing atmospheric nitrogen, However extracts of algae naturally contain auxins, cytokinins and gibberellic acid (Crouch and Standen 1991). Auxins and cytokinins are known to stimulate establishment and elongation rate of root hairs and increase their number and gibberellins promote lateral growth. Abd-El Maguid *et al*., (2004) stated that application algae increased vegetative growth of coratina olive transplants. Gobara (2004) on palms and Hegab *et al*., (2005) 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.

Nutrient content of Moringa

Application of seaweed extracted from marine 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 Zhang *et al*., (2003).

Macro and micro nutrient content, Data presented in Table (5) show that the influence of Algae a foliar application on total macronutrient and micronutrient content in Moringa plants. Table (5) revealed that the foliar application of Algae (seaweed extracted) at a rate of 300 g fed^{-1} markedly increase of nitrogen, phosphorus and potassium content by 32.63%, 22.22% and 60.89%, respectively at first cutting as compared with control. While, the second cutting slightly increased of NPK by 7.32%, 6.45% and 34.60%, respectively, as compared with not foliar application. Also, Data in Table (5) presented that the micronutrient (ppm) affected by spray of Algae at a rate of 300 g fed^{-1}. Results observed revealed that a remarkable increase of Fe, Mn, Zn and Cu by 69.21%, 68.72%, 66.77% and 62.86%, respectively at the first cut.

Table 5: Effect of Algal application on macro and micronutrients contents of Moringa Leaves

Treatments	Macronutrients (%)			Micronutrients (ppm)				Crude protein (%)
	N	P	K	Fe	Mn	Zn	Cu	
1st cut								
0.0 g/fed	3.20	0.28	1.76	482.3	47.0	133.1	26.67	19.9
300 g/fed	4.75	0.36	4.50	1566.3	150.3	400.5	71.80	29.7
LSD 0.05 %	1.52	0.06	1.12	351.7	56.9	170.0	46.48	9.50
2nd Cut								
0.0 g/fed	1.52	0.29	2.40	374.1	47.9	35.6	115.5	9.52
300 g/fed	1.64	0.31	3.67	416.9	53.9	39.5	129.47	10.2
LSD 0.05 %	0.16	0.03	1.33	31.38	4.34	2.33	15.92	0.98

While, the second cutting down the concentration of micronutrients by 10.27%, 11.03%, 9.80% and 10.81% for Fe, Mn, Zn and Cu. respectively, comparison to the control. The results also showed that spraying of algae at a rate of 300 g fed^{-1} had a positive effect on the protein content, increased in the first cutting by 32.66%, but in the second cutting down the crude protein it has been 6.94% as compared with not spraying treatment. These results may be attributed to the seaweed extract have the ability to develop tolerance to environment stress (Zhang and Schmidt, 2000); Zhang *et al*., (2003), increase nutrient uptake from soil (Turan and Köse, 2004). The beneficial effect of seaweed extract application is as a result of many components that may work synergistically at different concentrations, Fornes *et al.*, (2002).

Nutrient content of Alfalfa

The results obtained from the analysis of alfalfa leaves, different chemical elements present were shown in Table (6) it turned out, including a marked increase in macronutrient (NPK) influenced by using spray of algae at a rate of 300 g fed^{-1} by about 25.89%, 33.33% and 23.96%, respectively as compared with control at first cut. Whilst, slightly increase of NPK by 6.37%, 43.62% & 26.50% and 6.35%, 3.57% & 23.57% comparison to not spray of algae at the 2nd and 3rd cutting, respectively. Regarding of micronutrient data in Table (6) revealed that the foliar application of algae (seaweed extract) at the rate of mention previously significantly increase of micronutrient (ppm) such as Fe, Mn, Zn and Cu by 54.90%, 28.87%, 45.04% and 34.67%, respectively. as compared with control at 1st cut. While in the 2nd and 3rd cut slightly increase of micronutrient it was 51.62%, 36.11%, 20.17% & 18.34% and 21.02%, 18.42%, 16.52% & 18.64% as compared with control, respectively. The results also observed that the foliar application of algae at a rate of 300 g fed^{-1} had a positive effect of protein content, increased in the first cutting by 25.73%, but in the second and third cutting down the crude protein it has been 2.40% and 6.18% as compared with not spraying treatment, respectively.

Similar observation were enhanced by (Dixit and Gupta, 2000) reported that the application blue green algae (BGA) inoculation for rice in paddy filed increased the economic yield and the average increase in grain yield due to blue green algae (BGA) was 0.24 ton ha^{-1} and uptake of N, P and K showed increasing trends due to blue green algae (BGA) inoculation furthermore, quality parameters like hulling %, milling %, protein content increased due to use of BGA inoculation for rice paddy filed. Singh *et al*. (1990) and (Singh and Shrivastava, 1990) come to confirm the fact 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 Tarakhovskaya *et al*., (2007). Changes in the level of exogenous cytokinins alter the regulation of physiological plant processes (Stirk and van Staden, 2010). Acadian claims that phytohormones in their products elicit natural cytokin and auxin production in plants resulting in better growth with more buds, healthier, greener leaves, and increased tolerance to environmental stresses.

Table 6: Effect of Algal application on macro and micronutrients contents of Alfalfa Leaves

Treatment	Macronutrients (%)			Micronutrients (ppm)				Crude protein (%)
	N	P	K	Fe	Mn	Zn	Cu	
1st cut								
0.0 g/fed	2.72	0.24	1.65	417	46.0	22.7	8.9	17.0
300 g/fed	3.67	0.36	2.17	925	64.7	41.3	13.7	22.9
LSD 0.05 %	0.94	0.041	0.51	283.9	17.41	3.123	5.52	5.86
2nd cut								
0.0 g/fed	1.81	0.18	3.42	782.3	57.8	125.1	42.73	11.37
300 g/fed	1.94	0.31	4.65	1617.0	90.5	156.7	52.33	12.10
LSD 0.05 %	0.39	0.13	1.16	446.4	28.97	24.69	13.72	2.40
3rd cut								
0.0 g/fed	1.77	0.27	3.21	298.8	37.2	125.0	40.6	1.77
300 g/fed	1.89	0.28	4.20	378.3	45.6	149.7	49.9	1.89
LSD 0.05 %	0.18	0.06	0.52	99.77	14.4	12.5	7.50	1.12

Conclusion

Foliar application of Algae (seaweed extract) can be reduce the harmful effects of drought and improve plant growth and increase Moringa and Alfalfa yield and macro-micronutrient . Seaweed liquid fertilizer can be applied to various crop plants in order to increase their resistance to climate changes in arid and semi arid soil.

References

A.O.A.C., 2000. Official Methods of Analysis of the Association of Official Agricultural Chemist 20th Ed. Washigton DC. USA.

Abd-El-Maguid, A.A., El-Sayed A.B. and H.S.A. Hassan, 2004. Growth enhancement of olive seedlings by broken cells of fresh green algae as soil application. Minofiya. J. Agric. Res. 29(3): 723-737.

Ajum, S.A., X.Y. Xie, L.C. Wang, M.F. Saleem, C. Man and W. Lei. 2011. Morphological, physiological and biochemical responses of plants to drought stress. African Journal of Agricultural Research. 6(9):2026-32.

Annichiarico, P., C. Scotti, M. Carelli, and L. Pecetti, 2010. Questions and avenues for lucerne improvement. Czech. Journal of Genetic Plant Breeding, 46 (1): 1-13.

Anonymous., 1985. TNA Principles of Foliar Feeding. Trans National Agronomy, Grand Rapids, MI. 2 p.

Ashraf M. and M. R. Foolad, 2007. Roles to glycine betaine and proline in improving plant abiotic stress resistance. Environmental and Experimental Botany 2007; 59: 206-216.

Bassal, S.A.A. and F.A. Zahran, 2002. Effect of farmyard manure, bio and mineral nitrogen fertilizer and hill spaces on rice crop productivity. J. Agric. Sci. Mansoura Univ. 27: 1975-1988.

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.

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.

Crouch, J.J. and J. Van standen, 1993. Evidence for the presence of plant growth regulators in commercial seaweed products. Plant Growth Reg. 13: 21-29.

Dela, C. R. E., M. Q. Manalo, N. S Agangan and J.D. Tambalo, 1988. Growth of three legume trees inoculated with VA mycorrhiza fungi and Rhizobium. Plant and Soil, 108: 111-115.

Dixit, K. G. and B.R. Gupta, 2000. Effect of farmyard manure and biofertilizers on yield and quality of rice (Oryza sativa) and soil properties. J. Indian Society of Soil Sci. 48 (4): 773-780.

Fornes, F.; Sánchez-Perales, M. and J. L. Guadiola, 2002. Effect of a seaweed extract on the productivity of 'de Nules' Clementine mandarin and navelina orange. Botanica Marina. 45:486–489.

Fuglier. L. J., 1999. The Miracle Tree: Moringa oleifera, Natural Nutrition for the Tropics, Church World Service, Dakar, Senegal, 1999.

Gobara, A.A., 2004. Performance of grandnaine banana plants to biofertilization. J. Agric. Sci. Mansoura Univ. 29(9): 522 1-5229.

Gomez, K.A. and A.A. Gomez, 1984. Statistical procedures for agricultural research. 2nd Edition, john Willy and sons Inc. New York. pp: 680.

Hegab, M.Y., A.M.A. Sharkawy and S.A.G. El-Saida, 2005. Effect of algae xtract and mono potassium phosphate on growth and fruiting of Balady orange trees. Bull. Fac. Agric. Cairo Univ. 56(1): 107-120.

IPCC., 2007. Climate change 2007: The physical science basis—Contribution of working group I to the fourth assessment report of the Intergovernmental Panel on climate change. http:// www. ipcc. ch/ publications_ and_ data/ar4/ wg1/en/contents.html.

Jaleel C.A., P. Manivannan, A. Wahid, M. Farooq, H.J. Al-Juburi, R. Somasundaram and R. Panneerselvam ,2009. Drought Stress in Plants: A Review on Morphological Characteristics and Pigments Composition. International Journal of Agriculture and Biology 11: 100-105.

Jasjeet, D., K. Pankaj, B. N. Tiwari, P. Rakesh, 2011. Chemo- pharmacological aspects of alfalfa: A Review. Journal of Advanced Scientific Research 2 (1): 50-53.

Lancefield, G. D., D. M. Ball, D. Hannock, J. Andrae, and R. Smith, 2009. Growing Alfalfa in the South. National Alfalfa and Forage Alliance 2009. On line at http://www.alfalfa.org/pdf/alfalfainthesouth.pdf

McDonald, W., A. Nikandrow, A. Bishop, M. Lattimore, P. Gardner, R. Williams, L. Hysons, 2003. Lucerne for pasture and fodder. Agfact.2.2.2.25, 3rd edition, NSW, Agriculture, Orange, NSW pp.1-39

Mohamed Ali Benabderrahim, Haddad Mansour and Ferchichi Ali, 2009. Diversity of lucerne (*Medicago sativa* L.) populations in south tunisia. Pak. J. Bot., 41(6): 2851-2861.

Oliver H.F, R.H. Orsi, M. Wiedmann and K.J. Boor, 2010. Listeria monocytogenes has a small core regulon and a conserved role in virulence but makes differential contributions to stress tolerance across a diverse collection of strains. Appl Environ Microb.76:42 16–32.

Rodriguez A.A., A.A. Stella, M.M. Storni, G. Zulpa, M.C. Zaccaro, 2006. Effects of cyanobacterial extracellular products and gibberellic acid on salinity tolerance in *Oryza sativa* L. Saline System. *2*:7.

Saadatnia, H. and H. Riahi, 2009. Cyanobacteria from paddy-fields in Iran as a biofertilizer in rice plants. Plant Soil Environment 55(5): 207–212.

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 .

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 .

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

Subramanian, G. and L. Uma, 1996. Cyanobacteria in pollution control. Journal of *Science* & Industrial Research. 55: 685-692.

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

Turan, M. and C. Köse, 2004. Seaweed extracts improve copper uptake of grapevine. Acta Agriculturae Scandinavica. Section B, Soil and Plant Science. 54:213–220.

Wilson L.T., 2006. Cyanobacteria: A Potential Nitrogen Source in Rice Fields Texas Rice. 6: 9–10.

Zanin V., 1998. A new nutritional idea for man: lucerne leaf concentrate. Association for the promotion of leaf concentrates in nutrition. On line at http://www.nutrition-luzerne.org/anglais/pdf/EtudeZaninenglish.pdf

Zhang X., E.H. Ervin, E.R Schmidt, 2003. Plant growth regulators can enhance the recovery of Kentucky bluegrass sod from heat injury. Crop Sci. 43:952-956.

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.