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Enhancement of Barley (*Hordeum vulgare* L.) Productivity by EM Foliar and Soil Amendments Under the Rain Fed Conditions of the North Western Coast of Egypt

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ABSTRACT

Two filed experiments were conducted at Sidi-Barrani, Marsa Matrouh Governorate in the North Western Coast of Egypt during the two successive growing seasons of 2014/2015 and 2015/2016 to study the effect of different EM foliar application {Tap water (control), EM_1 and (EM_1+ micronutrients i.e balanced Cu – Fe – Mn – Zn - Mo)}and different soil amendments {without amendments (Control), Plants residues alone, (Plants residues + EM-Bokashi), Bio-Polymer (Polyacrylamide), and Bio-Polymer (Polyacrylamide) + EM-Bokashi) } in addition to their interactions on yield and its attributes of barley cv, Giza 126 under the rainfed conditions of the North-Western Coast of Egypt. The results illustrated that all the studied characters, i.e. plant height (cm), number of spikes/m^2, spike length (cm), 1000 grains weight (g), grain yield (kg/fed), straw yield (kg/fed), biological yield (kg/fed) as well as harvest index (%) was significantly promoted by each of the EM_1 foliar applications, Soil amendment incorporation and their interaction as compared with the control treatments. The highest significant observations for the all studied characters of barley cv. Giza 126 under rain-fed conditions were obtained from the interaction between {EM_1 foliar application+ micronutrients}×{Bio-Polymer (Polyacrylamide) + EM-Bokashi}.We advise that; under the rain-fed condition, such existed in the North-Western Coast of Egypt, Matrouh Governorate, foliar application of (EM_1+ micronutrients) with (Bokashi + polymer) as soil amendments seemed to be necessary in order to have an appreciated yield of barley.
Keywords: Barley, Soil amendment, EM_1, Yield and its attributes, North Western Coast of Egypt.

INTRODUCTION

The rain-fed agricultural region in the Northern coast of Egypt is one of the promising extension areas for agriculture. This region extended from Salloum in the west beside the Libyan borders to Rafah in the east beside the Palestinian borders to cover 995 Km of the Mediterranean coastal area and 50 km to the south, with low annual precipitation rate average (120 – 130 mm) during winter season. These features make the agricultural extension in these areas is one of the promising keys to overcome the gap between production and consumption of the agricultural products in Egypt. Yet, this region is totally exposed to most of the desertification factors, i.e. sea water intrusion, soil fertility depletion, water and wind erosion, overgrazing and loss of land cover. It also exposed to the climate change factors, particularly sea level raises and drought. In another word, the area is one of the harshest environments in the Egyptian biodiversity (Abd El-Ati, 2014).

Barley (*Hordeum vulgare* L.) is a fast growing, winter annual grain crop that could be used as forage as well as a cover crop to improve soil fertility (Ghanbari *et al*., 2012). It is the major cereal crop in many dry areas of the world as a human food and animal feed. In Egypt, barley tolerate both salt and drought stresses to be qualified to be grown in a wide range of stresses, especially in the North Coast region as well as in the new cultivated area where salinity and drought are mostly dominant. It also can grow in varied range of environments ranging from the desert of the Middle East to the high elevation of the Himalayas (Hayes *et al*., 2003).

The efficacy of EM_1 application on crop production and growth was noticed after EM_1 was used as foliar application or incorporated with organic manure added to soil (Jilani *et al*., 2010). EM-Bokashi can be prepared using any kind of animal dung and EM_1 fermented compost and induced significance promotion to crop production (Lee *et al*., 2008). EM-Bokashi application provided a significant amount of residual nutrients for cultivation of a short duration succeeding crop and the residual benefits depend on the initial nutrient content of manure. There was a significant difference in radish tuber diameter, fresh and dry weights of leaves and tuber and total dry matter content between manures (Suthamathy and Seran, 2013).

Foliar application of microelements is more beneficial than soil application. Since application rates are lesser as compared to soil application, the same application could be given easily and crop reacts to nutrient application immediately (Zayed *et al*., 2011). The use of micronutrients in soil nutrition is the pillars of agriculture in developing countries. Proper plant nutrition is one of the most important factors in improving the quality and quantity of plant product (Mousavi *et al.,* 2011 and Yosefi *et al.,* 2011).

Increasing the soil, water holding capacity by hydrophilic polymers or highly water absorbing organic amendments is necessary under drought conditions (Ellefson, 1992 and Weinstein, 1999). The organic matter content of soil is one of the most important soil features that plays an important role in increasing soil water holding capacity thus productivity. (Mann *et al.,* 2002).

Incorporation amendment into the soil postponed the time of permanent and temporary wilting up to 50 - 70 % and 150 - 200 %, respectively. Application of Igita super absorbent caused increment in pre-plant stage was between 10 - 40 % in clay soils, 5 - 32 % for loamy and 9 to 37% in sandy soil. Use Igita, super absorbent, nutrient (NPK) uptake increase and the most uptake of this element in clay, loam and sandy soil was in application of Igita in the amount of 0.05, 0.1 and 0.3 %, respectively. Utilization the Igita absorbent in soil-increased water holding capacity and available water in soil and thereafter, the water intervals increased. Increasing in water intervals in clay soils was about 30 to 130%, loamy soil 60 to 120%, sandy soil up to 150 to 300%. The saved water quantity was 30, 40 and 70% in clay, loam and sandy soils, respectively (Karimi*et al*., 2008). Lawrence *et al*. (2009) revealed that under drought stress in the green house, amending soil with super absorbent (0.2 and 0.4 % in weight) caused an increment in biomass of 9 ornamental tress species. Adding this material to the soils their moisture was at the field capacity range, caused an increase in water consumption efficiency and using it in photosynthesis of plants. The remaining water in sandy soil was equal to 23 and 95% with application of polymer 0.03 and 0.07 % of its weight, respectively (Sivapalan, 2006).

Effective microorganism (EM_1) was used as a means of improving soil conditions, suppressing the disease and improving the efficiency of organic matter utilization by crops (Anon, 1995).

Super absorbent polymer application promoted shoots and root growth of *Pinus halepensis* Mill under the drought stress (Huttermann *et al.*, 1999). Super absorbent polymer in soil help roots in three ways:(1) the water-fulfilled hydrophilic polymer granules enhanced the water availability to plants and; (2) the exchangeable K+ that contained in the two polymers was favorable for plants to retain a K+/Na+ homeostasis, and (3) polymer fragments held salt ions in the drying soil (Shi *et al.,* 2010). Artificial polymers used more than natural ones, because having more stability against environmental breakdown (Peterson, 2002). Application of K400 Stockosorb polymer, in 0.4-0.6 % of weight caused that water potential of Buttonwood (*Conocarpus erectus* L.) seedlings increased significantly in dry regions. These seedlings survived three times more than that of control under drought stress. They also expressed that root and shoot growth was increased significantly by using of hydrogels (Al-Humaid and Moftah, 2007). Shim *et. al.* (2008) detected that easiness in magnesium and calcium uptake by plant in two kinds of polymer was a result of better plant growth.

This work aimed to study the effect of different EM_1 foliar applications, different soil amendments and their interactions on the yield and its attributes of barely cv. Giza 126 as proper agricultural practices to mitigate the environmental stress that existed under the rain-fed condition of Sidi-Barrani, Matrouh Governorate in the North-Western Coast of Egypt.

MATERIALS AND METHODS

Two filed experiments were conducted at Sidi-Barrani, Marsa Matrouh Governorate, the North-Western Coast of Egypt, in Latitude (31° 34′ 19.4″), longitude (25° 59′ 16.0″) and altitude (33) during the successive growing seasons of 2014/2015 and 2015/2016 respectively, to study the effect of different EM_1 foliar treatments {tap water (control), EM_1, (EM_1+ micronutrients)} and different soil amendments treatments {without amendments (Control), Plant residues alone, (Plant residues + EM-Bokashi), Bio-Polymer (Polyacrylamide), and Bio-Polymer (Polyacrylamide) + EM-Bokashi)} in addition to their interactions on barley cv. Giza 126 yield and yield characteristics, i.e. plant height (cm), number of spikes/m^2, spike length (cm), 1000 grains weight (g), grain yield (kg/fed), straw yield (kg/fed) and biological yield (kg/fed) as well as harvest index (%).

Following the common agricultural practices of the region, the experimental soil was plowed two overlapping times without any chemical fertilization application. The experimental design used in this experiment was the split plot design with four replicates, where the EM_1 foliar treatments occupied the main plots and the soil amendments treatments were arranged in the sub ones. The plot area was 12 m^2 (6 meters long and 2 meters wide).

The physical and chemical analysis, soil characters of surface layer (0 - 30 cm) depth of the experimental sites were determined before the sowing date in the two growing seasons, according to Chapman and Pratt (1978) and illustrated in Table.1.

Table 1. Some physical and chemical properties of the soil in 2014/2015 and 2015/2016 growing seasons.

Mechanical analysis					
Seasons	**Clay (%)**	**Silt (%)**	**Sand (%)**	**Organic matter (%)**	**Texture class**
2014/2015	20.40	21.15	58.45	0.48	Sandy clay loam
2015/2016	20.50	21.96	57.54	0.41	

Chemical analysis										
Seasons	**pH**	**ECe (ds m^{-1})**	**HCO_3^- (%)**	**Ca CO_3 (%)**	**Available element (meq/L)**					
					Ca	**Mg**	**K**	**Na**	**Cl**	**Zn**
2014/2015	8.10	3.6	5.55	15.10	2.2	1.22	0.50	4.3	0.78	0.65
2015/2016	8.00	3.1	5.48	15.02	2.7	1.18	0.63	4.1	0.71	0.86

EM-Bokashi was prepared following the method that described by Higa (2000), while the structure of the other materials used in this study was shown in Table 2. While EM_1 (Effective Microorganisms) was kindly obtained from EEAA- Ministry of Environmental Affairs. The foliar treatments that used in this study, i.e. Tap water (control), EM_1 (Effective microorganisms) at the rate of 10 cm/L and {EM_1 (10 cm/L) + micronutrients at rate 1 kg/fed}. Both EM_1 and (EM_1+ micronutrients) were applied as a foliar application on 17 March and 13 March in the first and second seasons, respectively. Knapsack sprayer 20 L with total water volume of 300 L/fed was used. The soil amendments that were added one week prior to sowing date in both seasons (without plant residues (Control), plant residues alone (1 ton/fed), {plant residues (1 ton/fed) + EM_1 (40%)}, Bokashi (1 ton/fed), Bio-Polymer (Polyacrylamide a rate of 20 kg/fed) and {Bio-Polymer (Polyacrylamide) at the rate of 20 kg/fed + Bokashi (1 ton/fed)} respectively.

Table 2. The structure of the materials that were used in the study.

	EM_1	**Micronutrients**	**Plant Residues**	**EM- Bokashi**
Structure	Photosynthetic Bacteria- Lactic Bacteria- Yeasts- Fermentative Fungi- Actinomycetes	Cu-Fe – Mn–Zn – Mo (Balanced)	Fine chopped Barley and Rice straw	Mixed with rice and barley straw+ EM_1 20% solution +sheep dung + water (total humidity 40%)

Barley (*Hordeum vulgare* L.) cultivar Giza 126 grains, which were kindly obtained from Field Crop Research Institute- Agricultural Research Center- Giza – Egypt, were sown using the broadcasting sowing method with seeding rate of 30 kg grain/fed at 22th November in the first season and 26th November in the second season, respectively. The sowing dates vary in the two seasons, according to the time of the accurate rainfall in each season; where the total precipitation rate was 91.9 mm and 138.9 mm during the first and second seasons, respectively as it will be described later in details in Table 3.

Barley plants were harvested on 6 May 2015 and 21 April 2016 in the first and the second seasons, respectively. At harvest, ten guarded plants were taken randomly from each plot to measure plant height (cm), spike length (cm) and number of grains/spike. While number of spikes/m^2, 1000 grains weight (g), grain yield (kg/fed), straw yield (kg/fed), biological yield (kg/fed)were measured from 1 m^2 in both growing seasons. Moreover,harvest index (%) was calculatedfollowing the equation (harvest index= grain yield/biological yield x 100)

Table 3. Meteorological data of the study location during the two growing seasons:-

	Season 2014/2015						Season 2015/2016					
	S.R. (MJ/m^2/day)	Max. T. (C)	Min. T. (C)	RAIN (mm)	Wind (m/s)	RH (%)	S.R. (MJ/m^2/day)	Max. T. (C)	Min. T. (C)	RAIN (mm)	Wind (m/s)	RH (%)
Nov.	13.14	22.27	15.27	0.30	4.05	63.21	13.49	22.05	15.7	0	4.23	66.7
Dec.	11.38	19.47	11.86	20.6	4.87	62.69	10.5	18.01	12.85	68.7	4.58	70.58
Jan.	12.24	16.37	8.71	29.2	6.46	60.43	12.23	16.59	9.69	65.6	5.66	65.59
Feb.	13.89	16.88	9.16	14.1	6.11	59.68	15.70	19.54	10.90	2.6	5.59	65.29
Mar	14.8	19.79	10.82	12.5	4.67	62.32	18.98	21.08	11.3	0.2	5.47	61.51
Apr.	23.81	22.76	12.27	15.2	5.28	56.14	23.92	26.16	14.19	1.8	4.46	51.26
May	26.98	27.28	16.00	0	4.31	54.55	25.94	27.87	16.77	0	5.11	54.21

Pooled data were subjected to statistical analysis of variance as described by Gomez and Gomez (1984), while the L.S.D. test at 0.05 level was used to verify the significant differences between treatments.

RESULTS AND DISCUSSIONS

Data in Table 4 revealed that the effect of different foliar application and different soil amendment treatments on plant height (cm), spike length (cm), number of spikes/m^2 of barley cv. Giza 126 during the growing seasons 2014/2015 and 2015/2016. Foliar application of EM_1 + micronutrients recorded the highest mean values for plant attributes, namely; plant height, spikes number/m^2 as well as spike length in the second season, only. On the other hand the lowest ones these traits were obtained by control treatment (without EM_1 foliar), whereas, in the first growing season no significant effect were obtained for these traits. These results are confirmed with Higa (2000) and Hussain *et al*. (2002) they indicated that effective micro- organisms (EM_1) improved crop growth and yield by increasing photosynthesis, producing bioactive substances, such as hormones and enzymes, controlling soil diseases, and accelerating decomposition of lignin materials in the soil. It may be due to EM_1 culture consists of co-existing beneficial microorganisms, mainly species of photosynthetic bacteria (*Rhodopseudomonas plastris and Rhodobacter sphacrodes*), lactobacilli (*Lactobacillus plantarum, L. casei, and Streptococcus lactis*), yeast (*Saccharomyces* spp.), and actinomycetes (*Streptomyces* spp.).

Table 4. Average of plant attributes of barley (*Hordeum vulgare*) cv. Giza 126as affected by different foliar application with EM_1 and different soil amendments application and their interaction during 2014/2015 and 2015/2016 seasons.

Attribute	A). Foliar application	B) Soil amendment application: Control	Plant residues	Plant residues + EM_1	Bokashi	Polyacril amide	Bokashi + Polyacrilamide	Average (A)	L.S.D. at 0.05: A	B	A x B
		The First Season 2014/2015									
Plant height (cm)	Control	19.5	22.5	24.1	26.1	28.2	27.5	24.7			
	EM_1	20.1	21.7	20.4	22.7	22.6	24.5	22.0	NS	2.3	NS
	EM_1 +Micronutrient	18.1	21.5	23.2	24.7	24.1	25.0	22.8			
	Average (B)	19.2 d	21.9 c	22.6 bc	24.5ab	25.0 a	25.7 a				
		The second season 2015/2016									
	Control	16.50	34.45	21.25	26.85	21.05	25.28	24.2 b			
	EM_1	19.40	28.10	24.78	29.55	29.05	33.15	27.3b	3.41	2.34	4.07
	EM_1 +Micronutrient	26.50	32.65	30.35	32.60	34.85	43.78	33.5a			
Average (B)		20.8 e	31.7 ab	25.5 d	29.7 bc	28.3 c	34.1 a				
		The First Season 2014/2015									
Spikes number/m^2	Control	66.0	73.0	69.0	83.0	89.0	109.8	81.6			
	EM_1	36.3	42.3	62.5	66.3	75.0	83.5	61.0	NS	15.7	NS
	EM_1 +Micronutrient	44.5	61.3	60.3	61.5	64.5	78.3	61.7			
	Average (B)	48.9d	58.9cd	63.9bcd	70.3bc	76.2ab	90.5a				
		The second season 2015/2016									
	Control	55.3	58.3	59.5	62.0	63.3	65.5	60.7 c			
	EM_1	66.3	59.5	69.8	65.0	65.3	76.0	67.0 b	4.8	5.0	8.7
	EM_1 +Micronutrient	72.5	62.3	69.5	86.3	81.8	78.3	75.1 a			
Average (B)		64.7cd	60.0d	66.3bc	71.1ab	70.1ab	73.3 a				
		The First Season 2014/2015									
Spike length (cm)	Control	3.0	3.6	3.9	4.0	4.4	4.0	3.8			
	EM_1	3.6	3.7	3.1	3.7	3.7	4.1	3.7	NS	0.49	NS
	EM_1 +Micronutrient	2.9	3.5	3.8	4.2	4.1	4.5	3.8			
	Average (B)	3.2 c	3.6bc	3.6bc	4.0 ab	4.1ab	4.2 a				
		The second season 2015/2016									
	Control	2.2	2.4	3.8	3.9	2.7	3.5	3.1 b			
	EM_1	2.8	3.0	4.1	3.7	3.1	4.1	3.5 a	0.33	0.46	0.79
	EM_1 +Micronutrient	3.4	3.6	4.0	3.6	4.0	4.2	3.8 a			
Average (B)		2.8 c	3.0bc	4.0 a	3.7 a	3.3 b	3.9 a				

- Mean values in the same column/row marked with the same letters are not significantly different at 0.05 level of probability.
- NS: not significant difference at 0.05 level of probability according to L.S.D.

Concerning of the effects of application of soil amendment on plant height (cm), spike length (cm), number of spikes/m^{2}in both cropping seasons, data as shown in Table 4 showed that Bokashi and Polyacrylamide + Bokashi recorded the highest mean values ofthese characters as compared with other treatments during 2014/2015 and 2015/2016 seasons. Meanwhile, the lowest mean value of these traits was detected with a control treatment. These results, clearly show the importance of Bokashi and Polyacrylamide which cleared by Liu and Guo (2001), they indicated that Superabsorbent polymers improve the water holding capacity of soils to promote seed germination and plant growth.

In this respect, data of Table 4 also, demonstrated that the interaction between foliar application and soil amendment materials, which had significant differences in plant height (cm), spikes number/m^2 and spike length (cm), only during the second season. Where, foliar application of EM + micronutrients with Bokashi and polymer (Polyacrylamide) application in soil as soil amendments recorded the highest values for these traits. Meanwhile, control (untreated) treatment with water spray as foliar (control) recorded the lowest ones in the second season. These findings, results are in agreement with those obtained by Javaid (2011) who concluded that the beneficial effects of EM_1 and Bio power can be exploited by using them combined with a suitable soil amendment. Both of these biofertilizers markedly enhanced rice shoot biomass and grain yield in the green manure amendment.

Data tabulated in Table 5 reportedthat foliar application of EM1 and EM1+micronutrient showed significantly effect of grains number/spike,1000 grains weight and grain yield (kg/fed) of barley cv. Giza 126 during 2014/2015 and 2015/2016 seasons. Whereas, foliar application of EM_1 + micronutrients recorded the highest mean values of grains number/spike, 1000 grains weight, grain yield (kg/fed) during both seasons. On the other hand, the lowest observations of these traits were recorded with control treatment in the first and second seasons. These findings are in agreement with these results obtained by Javaid and Mahmood (2010) they showed that an increase in plant growth and yield by applying EM_1.

Data of Table 5 also, revealed that Bokashi and (Bokashi + Polyacrylamide) recorded the highest mean values for grains number/spike,1000 grains weight and grain yield (kg/fed) during 2014/2015 and 2015/2016 seasons. Meanwhile, the lowest mean value for these characteristics were recorded with control. This effect could be due to the combined use of organic manures and inorganic fertilizers influences the physical, chemical and biological properties of the soil and plays an important role in energy flow and nutrient cycling. It does not only sustain higher levels of productivity, but also improves soil health and enhances nutrient use efficiency. In addition, organic manure can be improved soil physicochemical, hydrological and biological characteristics, which facilitate nutrient uptake, and increases grain yield for barley (Palm *et al.,* 2001).

Table 5. Average of plant attributes of barley (*Hordeum vulgare*) cv. Giza 126 as affected by different foliar application with EM_1 and different soil amendments application and their interaction during 2014/2015 and 2015/2016 seasons.

Attribute	A). Foliar application	B) Soil amendment application: Control	Plant extracts	Plant extracts + EM_1	Bokashi	Polyacril -amide	Bokashi + Polyacrila mide	Average (A)	L.S.D. at 0.05: A	B	A x B
				The first Season 2014/2015							
	Control	12.3	15.3	18.8	20.5	22.0	24.5	18.9b			
	EM_1	15.5	19.0	17.3	20.0	23.0	20.8	19.3b			
	EM1 +Micronutrient	15.8	19.1	25.5	24.5	29.5	28.5	23.8a	4.6	4.4	NS
Grains number/spike	Average (B)	14.5c	17.8bc	20.5ab	21.7	24.8a	24.6a				
				The second Season 2015/2016							
	Control	11.50	15.00	20.25	20.25	14.25	19.50	16.79b			
	EM_1	17.25	19.50	19.00	19.50	18.25	19.25	18.79b	2.13	3.18	5.55
	EM1 +Micronutrient	19.75	28.25	18.25	22.50	23.00	26.50	23.04 a			
	Average (B)	16.17c	20.92ab	19.17abc	20.75ab	18.50bc	21.75a				
				The First Season 2014/2015							
	Control	23.0	29.4	26.7	23.0	27.9	29.5	25.9b			
	EM_1	20.7	21.7	23.5	25.2	25.9	35.9	25.5b	7.6	4.6	NS
	EM1 +Micronutrient	22.2	25.9	31.2	31.8	34.8	32.3	30.4a			
1000- grain weight	Average (B)	22.0c	25.7bc	27.1b	26.7bc	29.5ab	32.6a				
				The second Season 2015/2016							
	Control	18.7	23.3	28.9	29.0	23.4	29.3	25.4 b			
	EM_1	18.1	29.3	28.2	35.8	23.8	32.7	28.0 b	4.80	3.97	NS
	EM1 +Micronutrient	26.9	38.9	28.3	33.7	33.8	40.5	33.7a			
	Average (B)	21.3 d	30.5 ab	28.5 b	32.8 a	27.0 b	34.2 a				
				The First Season 2014/2015							
	Control	36.5	40.8	55.8	62.0	76.1	102.7	62.3b			
	EM_1	48.3	61.3	67.6	73.9	66.1	99.1	69.4b	31.3	41.6	76.3
	EM1 +Micronutrient	46.1	66.5	87.8	105.8	156.3	186.7	108.2a			
Grain yield (kg/fed)	Average (B)	43.6d	56.2cd	70.4bcd	80.6bc	99.5ab	129.5a				
				The second Season 2015/2016							
	Control	47.5	49.1	64.9	61.9	60.0	63.4	57.8 b			
	EM_1	67.5	58.5	57.9	55.7	60.6	72.8	62.2 b	9.8	9.2	15.9
	EM1 +Micronutrient	81.1	120.3	77.3	110.2	158.9	137.5	114.2 a			
	Average (B)	65.4c	76.0c	66.7c	75.9b	93.2a	91.2a				

- Mean values in the same column/row marked with the same letters are not significantly different at 0.05 level of probability.

- NS.: not significant difference at 0.05 level of probability.

Data in Table 5, revealed that the interaction between the foliar application and soil amendments induced significant differences in the grains number/spike and the grain yield (kg/fed) during the second season only. Whereas, in the first season it increased significantly the grain yield (kg/fed) only. Meanwhile, without soil amendments (control) ×foliar application with water (control) gave the lowest values for all traits in the first and second season.

Data in Table 6 illustrated that the effect of different foliar treatments on straw yield (kg/fed), biological yield (kg/fed) and harvest index (%). Results indicated that in the first season there were no significant differences between all treatments for the three studied traits. In the second season, the highest significant values were obtained from the foliar application with (EM_1 + micronutrients) for the three studied traits compared to the control treatment. This may be because of the precipitation inadequacy in the first year in contrary with the second year.

Regarding the effect of the soil amendments, the high observations were obtained from (Bokashi + polyacrylamide) in both seasons. This may be due to the vital role of organic manure, which contains microorganisms that make nutrients more available in the soil. In addition, it may play an important role in increasing nutrient availability through the processes of chelating, biochemical processes and production of several organic acids during decomposition, Hammad and Abdel Ati, (1998). This also could be due to the importance of Bokashi and Polyacrylamide in improving the water holding capacity of soils that enhance the soil plant water relations thus promote seed germination and plant growth and thus productivity as reported by Liu and Guo (2001).

Regarding the interaction between foliar application treatments and soil amendments on straw yield (kg/fed), biological yield (kg/fed) and harvest index (%), the highest observation was obtained from the interaction between {foliar application of (EM_1+micronutrients) × (Bokashi + polyacrylamide)} for the three studied traits in the second season only. These findings agree with what obtained by Javaid and Mahmood (2010).

Table 6. Average of plant attributes of barley (*Hordeum vulgare*) cv. Giza 126as affected by different foliar application with EM_1 and different soil amendments application and their interaction during 2014/2015 and 2015/2016 seasons.

Attribute	A). Foliar application	B) Soil amendment application							L.S.D. at 0.05		
		Control	Plant extracts	Plant extracts + EM_1	Bokashi	Polyacrilamide	Bokashi + Polyacrilamide	Average (A)	A	B	A x B
	The First Season 2014/2015										
Straw yield (kg/fed)	Control	217.6	229.4	229.7	248.2	346.2	383.5	275.8			
	EM_1	154.8	172.5	197.9	231.9	260.9	312.6	221.8	NS	70.7	NS
	EM_1+Micronutrient	146.3	175.7	200.5	190.9	205.7	222.0	190.2			
	Average (B)	172.9 c	192.5 c	209.4bc	223.7 bc	270.9 ab	306.0 a				
	The second Season 2015/2016										
	Control	115.3	122.9	129.0	136.4	130.8	139.5	129.0 b			
	EM_1	123.5	114.4	122.3	141.9	131.1	155.5	131.5 b	13.9	14.8	25.5
	EM_1+Micronutrient	151.3	171.0	128.0	188.7	219.1	249.4	184.6 a			
	Average (B)	130.0 c	136.1 c	126.4 c	155.7 b	160.3 b	181.5 a				
	The First Season 2014/2015										
Biological yield (kg/fed)	Control	254.1	270.2	285.5	310.2	422.3	486.2	338.1 a			
	EM_1	203.1	233.8	265.5	305.8	327.0	411.7	291.2 a	NS	86.2	NS
	EM_1 +Micronutrient	192.4	242.2	288.3	296.7	362.0	408.7	298.4 a			
	Average (B)	216.5 d	248.7 cd	279.8 cd	304.2bc	370.4 ab	435.5 a				
	The second Season 2015/2016										
	Control	162.8	172.0	193.9	198.3	190.8	202.9	186.8 b			
	EM_1	191.0	172.9	180.2	197.6	191.7	228.3	193.6 b	20.4	19.3	33.5
	EM_1 +Micronutrient	232.4	291.3	205.3	298.9	378.0	386.9	298.8 a			
	Average (B)	195.4 c	212.1 c	193.1 c	231.6 b	253.5 a	272.7 a				
	The First Season 2014/2015										
Harvest index (%)	Control	14.4	15.1	19.5	20.0	18.0	21.1	18.0			
	EM_1	23.8	26.2	25.5	24.2	20.2	24.1	24.0	NS	8.3	NS
	EM_1 +Micronutrient	24.0	27.5	30.5	35.7	43.2	45.7	34.4			
	Average (B)	20.7 c	22.9 c	25.2bc	26.6abc	27.1 ab	30.3 a				
	The second Season 2015/2016										
	Control	29.2	28.5	33.5	31.2	31.4	31.2	30.9 b			
	EM_1	35.3	33.8	32.1	28.2	31.6	31.9	32.2 b	2.1	2.9	5.1
	EM_1 +Micronutrient	34.9	41.3	37.7	36.9	42.0	35.5	38.0 a			
	Average (B)	33.1 ab	34.6 ab	34.4 ab	32.1 b	35.0 a	32.9 ab				

- Mean values in the same column/row marked with the same letters are not significantly different at 0.05 level of probability.
- NS: not significant difference at 0.05 level of probability.

CONCLUSION

According to the obtained results, it can be concluded that using a foliar application of {EM_1 + (balanced micronutrients i.e Cu – Fe – Mn – Zn - Mo)} × {Bokashi+ polymer} result in high barley cv. Giza 126 yield and its components under rain-fed conditions of the North-Western Coast of Egypt, Matrouh Governorate.

We advise to integrate EM_1 and soil amendments for the clean agriculture under rain-fed conditions to enhance environmental sustainability and crop productivity in addition to minimize land degradation in these areas.

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زيادة إنتاجية الشعير بإستخدام الرش ب EM و محسنات التربة تحت الظروف المطرية للساحل الشمالي الغربي لمصر

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أجريت تجربتان حقليتان بمنطقة سيدى براني بمحافظة مطروح بالساحل الشمالي الغربي لمصر خلال الموسمين الزراعيين ٢٠١٥/٢٠١٤، ٢٠١٦/٢٠١٥ على التوالي لدراسة تأثير كلا من معاملات الرش الورقى بـEM [ماء فقط (كنترول) - EM_1 – EM_1+ العناصر الصغرى] ومعاملات محسنات التربة [بدون إضافة محسنات التربة (كنترول) - مخلفات نباتية فقط- مخلفات نباتية + EM-Bokashi- بوليمر (البولي أكريلاميد) - البوليمر+EM-Bokashi]بالإضافة للتفاعل بينهما على محصول الشعير و مكوناته صنف جيزة ١٢٦ تحت ظروف الزراعة المطرية بالساحل الشمالي الغرب لمصر. أظهرت النتائج أن كل الصفات التى تم دراستها مثل : ارتفاع النبات -عدد السنابل/م^2 – طول السنبلة – وزن ١٠٠٠ حبة - محصول الحبوب (كجم/فدان) – محصول القش (كجم/فدان) – محصول البيولوجي(كجم/فدان) بالإضافة إلي صفة دليل الحصاد (%) كانت تزداد معنويا بواسطة كلا من: معاملات الرش الورقى بـEM_1 و معاملات محسنات التربة والتفاعل بين عاملى الدراسة مقارنة بمعاملات الكنترول. - سجل التفاعل بين معاملة (الرش الورقى بـ EM_1 + العناصرالصغرى) ومعاملة (البوليمر+EM-Bokashi) أعلى القيم المعنوية لكل الصفات المدروسة لمحصول الشعير صنف جيزة ١٢٦ تحت ظروف الزراعة المطرية. وتوصي الدراسة بأنه تحت ظروف الزراعة المطرية مثل تلك السائدة في الساحل الشمالي الغربي لمصر – محافظة مطروح بإستخدام الرش بالمركب (EM_1 + العناصر الدقيقة) علي نبات الشعير مصحوباً باستخدام (البوكاشي + البوليمر) كمحسن للتربة من أجل الحصول علي محصول اقتصادي تحت هذه الظروف.