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EFFECT OF *Azolla* AND CYANOBACTERIA AS BIOFERTLIZER ON BARLEY CULTIVATED IN SALINE SOIL

Aref, Elham M. ; Azza A. M. Abd El-All ; Kh. A. H. Shaban and R. M. El-Shahat
Soils, Water and Environ. Res. Inst., Agric.Res. Center, Giza, Egypt

ABSTRACT

Both the nitrogen fixing, plant growth promoting *Azolla pinnata* and a mixture of two cyanobacteria strains *viz. Nostoc muscorum* and *Anabaena oryzae* commonly used in rice cultivation were applied in a field trial for barely. The experiment was conducted at South El- Hossinia Res. farm Station, El-Sharkia Governorate, Agric. Res. Center (ARC), Egypt, at the winter season of 2007/08. The trial was to study the effect of *Azolla* (fresh, dry and as extract as foliar spray) and cyanobacteria as suspension for seed soaking and filtrate for spray treatments as well as urea (46.5%N) as nitrogen fertilizer on growth, yield and yield components of barley (*Hordum vulgare*) cultivated in saline soil (EC: 23.5 dSm^{-1}). Also, to study their effect on some soil characteristics (chemical properties and biological activity). Results revealed that the highest organic matter per cent was due to the use of dry *Azolla* (1.35) (T_3). All tested biofertilizer treatments decreased both EC and pH compared to the control treatment. Foliar spray by both *Azolla* and cyanobacteria as foliar spray plus 100% N as urea (T_9) gave the highest soil available N, P and K values. The treatment (T9) of *A. pinnata* and cyanobacteria applied as foliar spray gave also the highest values of all soil biological activity parameters. Results also exhibited a favorite influence of foliar application for both *Azolla* and cyanobacteria (T_9), since it gave significantly higher barely yield, yield components and N,P and K contents of both grains and straw compared to the other biofertilizer treatments and control (100% N). However, based on the present study it may be of beneficial to use *Azolla* and cyanobacteria as foliar spray plus mineral N fertilizer for barley plants.

INRODUCTION

Barley (*Hordeum vulgare*) is the fourth important cereal crop after maize, wheat and rice. It is widely used as malt for manufacturing beverages or malt enriched food products in the world. It is used as fodder crop for animal and human food in the form of preached grain.

The main problem in South El – Hossinia (EL-Sharkia Governorate) soils is high content of both $CaCO_3$ and high salinity. Regarding the effect of halo tolerant N_2- fixing microbes on a possible amelioration for some physical properties, Rogers and Burns (1994) observed a significant increase in the values of soil aggregates stability due to an increase in polysaccharide content of soil when inoculated with N_2-fixing cyanobacteria.

The intensive use of expensive mineral fertilizers in recent years, which resulted in environmental pollution problems, has focused the attention of researchers on the possibility of using bio-fertilizers as an alternative or a complementary for mineral fertilization.

N_2-fixing *Azolla* and blue-green algae (cyanobacteria) serve as an excellent source for utilizing solar energy efficiency for providing the soil with organic matter (Venkatarman, 1981). Mandal *et al.* (1999) owed the positive effect of N_2-fixing cyanobacteria on plant growth and yield of crops to the production of growth- promoting substances, i.e., gibberellins, cytokinins, auxins, abscisic acids, vitamins, antibiotics and amino acids. *Azolla* is an important biological source to improve the N balance of many crops. Choudhury and Kennedy (2004) reported that aquatic biota cyanobacteria and *Azolla* can supplement the nitrogen requirement of plants, replacing 30-50% of plant required urea-N. Azolla symbiont is able to release nutrient into soil availing them for plant uptake (Wagner, 1997). Azolla when decaying releases nutrients better as fresh matter than desiccated matter in water (Marwaha et al., (1992).

The main target of this study is to a certain the impact of using *Azolla* (fresh, dry and extract foliar spray) and /or cyanobacteria suspension and extract on barely yield and its components when cultivated in saline soil .As well as to study this impact on N, P and K contents of both barley grains and straw, some soil chemical, and biological properties.

MATERIALS AND METHODS

Materials:

1-Barley seeds:

Barley seed cultivar Giza 123 (*Hardeum vulgare*) were kindly obtained from crop Res. Institute, Agric. Res. Center (ARC), Giza,Egypt.

2- *Azolla* and cyanobacteria strains:

Both *Azolla* (*Azolla pinnata*) and cyanobacteria (*Nostoc muscorum* and *Anabaena* oryzae) strains were kindly provided Agric. Res. Microbiol. Dept. Soils, water and Environ. Res. Inst., ARC Giza, Egypt. Azolla was grown in the greenhouse up to log .phase on Yoshida medium (Yoshida et al., 1976), while cyanobacteria strains were grown in the Lab. on BG11 medium (Allen and Stanier, 1968)) under continuous illumination (5000 Lux) up to the log. Phase.

Methods:

1-Greenhouse and laboratory works:

1-1. Fresh and dry *Azolla* inocula preparation:

1-1.1. Fresh *Azolla*

Wet *Azolla* was collected from the growth trays in the greenhouse at the log. Phase growth, plotted between to layer of tissue paper to get rid from excess water and then it is ready to be used as biofertilizer. However, a considerable amount from this *Azolla* was oven dried (60°C) for 24 hours to determine its nitrogen contents (Black, 1965)

1-1.2. Dry *Azolla*:

Wet *Azolla* was collected from the growth trays in the green house at the log .phase growth and allowed to be air dried in the shade. *Azolla* was also subjected to determine its nitrogen content as previously mentioned.

1-2. Azolla extract:

Wet *Azolla* was hardly crushed and blended in a mixture till obtaining a suspension. The obtained suspension was filtrated through a sheet of cotton cloth. The obtained filtrate will then represent the *Azolla* extract to be used in *Azolla* foliar spray treatments.

1-3. Cyanobacteria suspension and cyanobacteria filtrate:

Cyanobacteria strains were grown up to log phase growth in the Lab. and then mixed together using a mixture to obtain a suspension .The obtained suspension was then filtered through Wathman paper No.1. The obtained filtrate will then represent cyanobacteria extract to be used in foliar spray cyanobacteria treatments.

However, the obtained suspensions for both *Azolla* and cyanobacteria were also mixed together in a plastic bag to be used for carrying out the soaking treatments.

1-4. Initial soil analysis:

The experimental field soil was sampled initially before conducting the experiment to determine its physical and chemical analyses according to Jackson (1976) .The results of these analyses are shown in Table (1).

2- Field experiment:

A field experiment was carried out at South El- Hossinia Res. farm Station, El-Sharkia Governorate, Agric. Res. Center (ARC), Egypt, during the winter season of 2007/2008 to study the effect of *Azolla* (fresh, dry and as extract) and cyanobacteria as suspension for seed soaking and extract for spray treatments as well as urea (46.5%N) as nitrogen fertilizer on growth and yield of barley (*Hordum vulgare*) cultivated in saline soil (EC: 23.5 dSm^{-1}).

Fresh and dry *Azolla* were incorporated into the upper fifth cm layer of the soil, while cyanobacteria suspension was surface applied to the soil. Both *Azolla* and cyanobacteria treatments were basically added to soil 15 days before barely seeds sowing .Before sowing of barely seeds, they were soaked in both *Azolla* and cyanobacteria suspensions for 2 hours, this was carried out for the treatments devoted for soaking process. After thirty and sixty days from sowing ,barley plants were exposed to foliar spraying by both *Azolla* and cyanobacteria extracts at the rate of 125 L fed^{-1} (Reddy et al.,1986) only on plots nominated for foliar spraying exposure. Urea (46.5%N) was applied at the recommended dose (75kg $urea/fed^{-1}$) individually or in combination with some tested biofertilizer treatments .phosphorus was added in the form of superphosphate (15.5% P_2O_5) at the rate of 100kg fed^{-1}, while potassium was added in the form of potassium sulphate (48%K_2O) at the rate of 50kg K_2O fed^{-1} Both phosphorus and potassium were applied during soil preparation. The amount of added *Azolla* (fresh or dry) was calculated due to that *Azolla* contains 4%N on the dry weight bases.

The experiment was arranged in complete randomized design with three replicates and contains the following treatments:

Treatments:

T1: 100% recommended Nitrogen dose as Urea (46.5 % N) (control).

T2: 100% recommended Nitrogen dose as fresh *Azolla*

T3: 100% recommended Nitrogen dose as dry *Azolla*

T4: 100% recommended Nitrogen dose +Soaking in *Azolla* extract

T5: 100% recommended Nitrogen dose + Soaking in cyanobacteria suspention of (*Anabaena oryzae* + *Nostoc muscorum*)

T6: 100% recommended Nitrogen dose + spraying *Azolla* extract
T7: 100% recommended Nitrogen dose + spraying cyanobacteria filtrate
T8: 100% recommended Nitrogen dose +Soaking in *Azolla* and cyanobacteria suspensions.
T9: 100% recommended Nitrogen dose + *spraying Azolla* extract and cyanobacteria filtrate.

At harvest, random plant samples from each plot were collected by using one square meter wooden frame to determine barley yield and its components. plant samples were then oven dried at 70°C for 24 hours up to a constant dry weight, pulverized and exposed for the determination of N, P and K contents of both grains and straw through the digestion with a mixture of concentrated sulpheric acid and perchloric acid at the ratio of 1:1 ratio (v/v) (Black,1965). After barely harvesting, the experimental soil was sampled, air dried and pulverized, and then passed through 2ml sieve and subjected to determine particle size distribution (piper, 1950), organic matter (OM) (Walkley and Black,1934), $CaCO_3$ (Black, 1965), soil reaction (pH) (1:2.5 suspension) and electric conductivity (EC)in soil paste (Jackson,1976). As well as, soil available N,P and K were also determined (Jackson,1976). On the other hand, the humid collected soil samples before drying was used for the determination of soil biological activity in terms of soil total bacterial count(Allen, 1959), total cyanobacteria count (Allen and Stainer, 1968), carbon dioxide evolution (Gaur et al., 1971), dehydrogenase activity (DHA) (Casida et al., 1964) and nitrogenase activity (Dart et al.,1972). All obtained data were statistically analyzed for least significant difference between obtained means as described by Gomez and Gomez (1984).

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

$CaCO_3$ %	O.M%	Clay%	Silt%	Fine sand %	Coarse sand %	Texture
1.15	0.32	19.25	52.50	20.10	8.15	Sand clay loam

Anions (meq L^{-1})			Cations (meq L^{-1})				EC(dS m^{-1})	pH 1:2.5
SO_4^{--}	Cl^-	HCO_3^-	K^+	Na^+	Mg^{++}	Ca^{++}		
37.58	188	9.93	1.41	196	20.16	17.94	23.5	8.23

Available nutrients (mg kg^{-1} soil)						
Cu	Zn	Mn	Fe	K	P	N
0.082	0.62	3.88	2.67	201	4.96	38

RESULTS

Data in Table (2) show some chemical properties of the saline soil after barley harvesting as affected by different applied treatment of Azolla and cyanobacteria and /or urea.

Soil chemical properties:

1-Soil organic matter (OM):

Soil organic mater after barley harvesting as affect by the tested biofertilizer treatments and/or urea is shown in Table (2). Results revealed that only the incorporation either dry or fresh increased the soil organic matter over all other biofertilizer treatments and control (100%N). However, the highest organic matter per cent was due to the use of dry *Azolla* (1.35%) (T_3) followed fresh *Azolla* (1.17%) (T_2).

2-Soil electric conductivity (EC) and soil reaction (pH):

All tested biofertilizer treatments decreased both EC and pH compared to the control treatment. However, the treatment received dry *Azolla* T_3 the least EC (15.42 dSm^{-1}), while the least pH degree (7.65) was due to the treatment received fresh *Azolla* (T_2).

3. Soil Available N, P and K:

Soil available N, P & K, exhibited higher values due all the biofertilizer treatments over the control treatment (100% N). Nevertheless, the highest soil available N, P and K values were recorded by the treatments received 100%N + foliar spray by both *Azolla* and cyanobacteria as foliar spray (T_9). The corresponding values were 97.5 mg N kg^{-1} soil, 11.69 mg P kg^{-1} soil and 223 mg K kg^{-1} soil.

Table (2): Some chemical properties of the experimental soil after barley harvesting as affected by *Azolla* and cyanobacteria bio - fertilizers

Treatment	OM%	E.C ($dS\ m^{-1}$)	pH	Available N, P and K mg kg^{-1} soil		
				N	P	K
T1 (control)	0.54	18.39	8.17	32	5.01	107
T2	1.17	16.59	7.65	75	8.32	120
T3	1.35	15.42	8.1	86	9.73	213
T4	0.75	16.79	8.05	93.5	7.30	208
T5	0.60	16.70	8.0	69.8	7.63	203
T6	0.80	16.85	7.95	69.0	7.85	205
T7	0.73	17.05	8.11	81.5	8.50	211
T8	0.83	16.75	8.06	95.3	11.50	217
T9	0.95	16.83	8.05	97.5	11.69	223

Soil biological activity:

Results revealed that all tested soil biological activity parameters (Table 3) under different treatments of cyanobacteria and *A. Pinnata* and high salinity (EC) were higher than those of control (T1) treatment. However the treatment (T9) of *A. pinnata* and cyanobacteria applied as foliar spray gave the highest values of all soil biological activity parameters. i.e., total bacteria count 17.90 x 10^5 cfu g^{-1} dry soil, total cyanobacteria count 6.2 x 10^3 cfu g^{-1} dry soil, 158.21 mg CO_2 100g dry soil day^{-1} (CO_2 evolution) 80.15 µg TPF g^{-1} dry soil (DHA) and 390.19 mmole C_2H_4 g^{-1} dry soil h^{-1} (nitrogenase), followed by (T_8) the so called soaking in both *Azolla* and cyanobacteria suspensions, which recorded 16.08 x 10^5 cfu g^{-1} dry soil (total bacteria count), 5.75 x 10^3 cfu g^{-1} dry soil, 142.2mg CO_2 100 g^{-1} dry soil day^{-1} (CO_2 evolution), 62.7 µg TPF g^{-1} dry soil (DHA) and 368.2 mmole C_2H_4 g^{-1} dry soil h^{-1} (nitrogenase).

Table (3): Effect of *Azolla*, Cyanobacteria and or/urea on soil biological characters after barley harvesting

Treatments	Total Bact. counts (10^5cfu g^{-1} soil)	Total Cyano. counts (10^3 cfu g^{-1} soil)	CO_2 evolution (mg100g $soil^{-1}$)	Dehydrogenase activity (µg $TPFg^{-1}$ dry soil Day^{-1})	Nitrogenase activity (µ mole C_2H_4 g $soil^{-1}hr.^{-1}$)
T_1	4.35	1.66	60.90	10.92	85.00
T_2	8.90	3,55	89.60	12.18	140.11
T_3	10.17	3.60	105.80	35.20	163.15
T_4	12.15	3.90	115.10	42.35	205.70
T_5	14.35	4.35	120.80	47.13	235.15
T_6	15.40	4.70	125.15	52.18	311.55
T_7	16.05	4.98	135.75	58.85	300.75
T_8	16.80	5.75	142.20	62.70	368.20
T_9	17.90	6.20	158.21	80.15	390.19

Barely Yield Components:

1. Grain Yield:

Results in Table (4) exhibit the favorite influence of 100%N + foliar application for both *Azolla* and cyanobacteria extract (T_9), since it gave significantly higher barely grain yield (3 tons fed^{-1}) compared to the other biofertilizer treatments and control. This trend was true for all tested biofertilizer treatments except for T_8 that gave grain yield of 2.52 tons fed^{-1} and was significantly higher than those givin by the other biofertilizer treatments.

2. Straw yield:

Data in Table (4) prove the priority of T_7, T_8 and T_9 in recording the highest significant barley straw yield of 3.90, 3.90 and 4.05 tons fed^{-1} compared to all the other tested biofertilizer treatments and control. However, these treatments recorded no significant differences between each other due to barely straw yield. Obviously, T_9 the treatment received 100% N of the recommended dose as urea + both *Azolla* and cyanobacteria extract as foliar spray was superior in giving the highest significant and improved grain yield only (Table 4).

Table (4): Barley yield components as affected by *Azolla*, Cyanobacteria and/ or urea fertilization in saline soil

Treatment	Yield (Ton/Fed)		Plant height(cm)	1000-grain weight (g)	No of spikes (m^{-2})
	Grain	Straw			
T1	1.73	2.02	63.94	29.57	165
T2	1.93	2.90	70.11	42.02	184
T3	2.07	2.92	72.24	46.01.	196
T4	2.10	3.05	70.71	48.93	213
T5	1.98	3.11	70.33	43.26	215
T6	2.31	3.65	77.90	49.62	249
T7	2.15	3.90	80.73	47.48	270
T8	2.52	3.90	80.97	52.64	290
T9	3.00	4.05	80.91	52.06	304
LSD 5%	0.23	0.36	5.58	5.49	14.01

3. Plant height:

Barley plant height exhibits in Table (4) pointed out that any of T_6, T_7, T_8, and T_9 had significantly recorded higher values than those recorded by the other biofertilizer treatments and control (100% N only). The corresponding plant height values were 77.90, 80.73, 80.97 and 80.91 cm against 63.94, 70.11, 72.24, 70.71 and 70.33 cm for T_1, T_2, T_3, T_4 and T_5, respectively. However, the highest barley plant height of 80.97 cm was due the treatment received 100%N + *Azolla* and cyanobacteria as soaking (T8).
. Also, it is of worth to note that no significant difference was detected between the biofertilizer treatments from T_6 to T_9 which were significantly higher than those of the biofertilizer treatments from T_2 to T_5 (Table 4).

4. 1000-grain weight:

Due to 1000-grain weight, results confirmed that all biofertilizer plus 100% N treatment gave significantly higher values over the control treatment. However, the highest 1000-grain weight values were due to T_9 (52.o6 g) and T_8 (52.64 g) without significant difference between both of them. Both of these high values were significantly higher than those recorded by the other biofertilizer treatments (from T_2 to T_7) as shown in Table (4).

5. Number of spikes m^{-2}:

Again as in plant height, T_8 and T_9 recorded the highest significant No. of spikes m^{-2} (304) compared to the other biofertilizer treatments and control. However, no significant difference was detected between T_8 and T_9 due the number of spikes m^{-2}. Then the priority was also noticed for T_9 that received the foliar spray for both *Azolla* and cyanobacteria extract rather than the other biofertilizer treatments and control (100% N treatment) (Table 4).

Nitrogen, phosphorus and potassium contents in both barley grains and straw:

Data in Table (5) reveal that all the biofertilizer treatments increase N, P and K contents in both barley grains and straw over the control treatments (T_1). Due to nitrogen percentages in grains, no significant trend was observed compared to control treatment despite the slight increases recorded due to all tested biofertilizer treatments (T_2 to T_9). While for straw, a significant trend was achieved by all the tested treatments. The highest significant percentage of nitrogen of 2.7 was due to T_9 followed by those of T_8, (2.56) and T_3 (2.45). On the other hand, T_2, T_4, T_5, T_6 and T_7 have not achieved any significant difference compared to the control treatments (Table 5). In case of phosphorus percentage content in both barley grains and straw, results indicated that all biofertilizer treatments recorded higher significant P percentages increases compared to the control treatment except for T_2 in grains. The highest P percentage of 0.67 was due to T_9 followed by 0.65 and 0.62 for both T_8 and T_6, respectively (Table 5). Owing to P percentage in straw, same trend of grains was observed in straw, since the highest P percentage was recorded by T_9 (0.45) followed by those of T_7 and T_8, which recorded the same percentage of 0.41 compared to the control treatment (T_1). On the other respect, also both T_3 and T_4 recorded P percentages contents of straw of 0.32 % and 0.38% which were significantly higher than the control treatment. It is of worth to note that P percentage of T_9 (0.45) was significant by higher also than those recorded by T_3 and T_4 rather than control. With regard to potassium barley grains content, results revealed that both T_8 and T_6 gave K percentages, significantly higher than all the other biofertilizer treatments rather than control the corresponding higher K percentages for grains were 2.45 (T_9) and 2.40 % (T_8). However, K percentages recorded by, T_3, T_4, T_5, T_6 and T_7 were significantly higher than control without any significant difference between each other (Table 5). Due to K percentages of straw, also both T_8 and T_9 gave significantly higher percentages compared to the other biofertilizer treatments and control treatment. The corresponding percentages of T_8 and T_9 were 2.69 and 2.72 % without any significant difference between both of them.

Table (5): Concentration of N, P and K in barely grain and straw as affected by *Azolla*, cyanobacteria and mineral N fertilization in saline soil

Treatments	N%		P%		K%	
	grain	straw	grain	straw	grain	Straw
T1	1.27	2.15	0.26	0.23	1.92	1.88
T2	1.79	2.30	0.35	0.30	1.95	2.01
T3	2.07	2.45	0.50	0.32	2.03	2.09
T4	2.01	2.30	0.52	0.38	2.08	2.11
T5	2.00	2.28	0.57	0.40	2.20	2.56
T6	2.04	1.88	0.62	0.40	2.36	2.66
T7	1.95	1.68	0.58	0.41	2.29	2.50
T8	2.30	2.56	0.65	0.41	2.40	2.69
T9	2.32	2.70	0.67	0.45	2.45	2.72
LSD 5%	0.17	0.14	0.11	0.09	0.16	0.11

DISCUSSION

In the area of agriculture, cyanobacteria are of importance in view of being used as nitrogen fixing biofertilizer either in free living or as symbiosis with the water fern azolla (El-Zeky et al., 2005). In the present study, the use of both cyanobacteria and *Azolla* applied by different methods plus 100% N as urea improved the soil chemical characters through decreasing both pH and EC compared to the use of urea alone. In this concern, Simpson *et al.* (1994) explained that in case of using *Azolla* for rice cultivation, incorporation of dry or fresh *Azolla* into soil, generally decreased Soil pH with priority to fresh *Azolla*, while urea raise the pH values. They attributed this trend to that the fertilization with urea stimulates *Azolla* growth and increases their photosynthetic activity. Therefore, the dissolved CO_2 in the soil is reduced, leading to reduce the soil pH. Also both cyanobacteria and *Azolla* have the ability to excrete extracellularly a number of compounds, like polysaccharides, peptides, lipids, organic acids leading to decrease the soil pH (EL-Ayouty et al., 2004). They also added that, the presence of these materials in their extracts adsorb both sodium and magnesium ions upon they get in touch with soil and thus prevent the harm effect of salinity against the cultivated plants. The experimental soil is generally characterized by high salinity; the character prevailed in such semi-arid regions. In this concern, all the applied biofertilizer treatments reduced EC, according to Molnar and Ordog (2005) who noted that some plant growth promoting regulators (PGPRs) are found to be released by cyanobacteria either in free living form and/or in symbioses as in *Azolla*, these PGPRs represent the defense systems that encounters the salt stress leading to decrease the soil EC degree. Salt affected soils are highly deficient in organic matter and nitrogen. The efficiency of nitrogen fertilizers is very poor due to extensive losses through volatilization in salt affected soils (Rao and Batra, 1983). Soil available N, P and K were also increased due to biofertilizer treatments over the use of 100% N treatment (control). These findings were observed by Strik and Staden (2003) who explained that incorporation of fresh or dry *Azolla* into soil increased significantly the soil organic matter, which in turn upon its decomposition by the soil microorganisms had released the macro and micronutrients into soil, leading to increase the soil available N, P and K. Also, under salt stress condition, cyanobacteria added to the soil either as free living and/or as *Azolla* symbiont lead to add to the soil organic matter, which is consequently increased the soil biological activity in terms of increasing the soil total bacterial count, CO_2 evolution, dehydrogenase activity and nitrogenase activity (Singh et al., 2008). This increase of the soil biological activity increased the soil fertility that in turn is reflected positively on the barely yield productivity.

Using cyanobacteria filtrate plus *Azolla* extract as foliar spraying (T9) leads to increase significantly barley yield and its components under salt stress condition. This trend was previously confirmed by Abd EL-Baky *et al.* (2008) who found that spraying wheat cultivated under salt stress condition with micro-algae extracts obtained from *chlorella ellipsoida* and *Spirulina* maxima led to keep good growth and yield of wheat compared to those received 100% N without algae extract spraying. In addition, the application of algal extracts significantly increased the contents of the total chlorophyll and antioxidant phenomenon. As well as algal extracts exhibited strong positive correlation with the increase of wheat fresh weight, grain weight and yield and yield components. They explained that algal spray application significantly increased the plant nutrients content and had a positive effect on plant growth, oxidation behavior and activity of antioxidant enzymes in plants affected by salt stress. Furthermore, both cyanobacteria and Azolla extracts are characterized by their cytocinins, gibberellins and auxins content that enhance the plant growth and furthermore these materials is proved to overcome the adverse effect of salinity in saline soil (Strik and Staden, 2003). The presence of such phytohormones in both cyanobacteria and *Azolla* encourages the agriculturists to use them as biofertilizer that influence the crop yield especially in reclaimed and salt stressed soils (Mussa, 2005).

CONCLUSION

Based on the present study, it may be advisable and be beneficial to use *Azolla* and cyanobacteria as foliar spray plus 100% N for barley plants cultivated under saline soil condition. Since, they improved soil available N, P and K, soil biological activity, barley yield, yield components and N, P and K contents of both grains and straw. However, this study needs to be repeated for another season at same and other locations using same cereal crop and/or other crops thus to have the confidence due to recommendation.

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تأثير الأزولا والسيانوبكتريا كسماد حيوى للشعير النامى فى تربة ملحية

الهام محمد عارف ، عزة احمد محمد عبد العال ، خالد عبده حسن شعبان و رضا محمد الشحات
معهد بحوث الأراضي والمياه والبيئة- مركز البحوث الزراعية- الجيزة – مصر

أجريت تجربة حقلية في مزرعة سهل الحسينية بمحافظة الشرقية . التابعة لمركز البحوث الزراعية بمصر خلال الموسم الشتوي ٢٠٠٧-٢٠٠٨ لدراسة تأثير كلا من الأزولا (رطبة – جافة – مستخلص) و السيانوبكتيريا كمعلق أو راشح بلاضافة الى السماد النيتروجينى المعدنى فى صورة يوريا علي محصول الشعير النامى فى تربة ملحية ومكوناته ومحتوى كل من الحبوب والقش من أى من النيتروجين والفوسفور والبوتاسيوم مقارنة بالتسميد ١٠٠% نيتروجين (الكنترول). وكذلك دراسة أثر هذه المعاملات على بعض خواص التربة الكيميائية والبيولوجية.
ويمكن تلخيص أهم النتائج المتحصل عليها باضافة السماد النيتروجينى المعدنى بمعدل ١٠٠% من الموصى به فى صورة يوريا مع الأسمدة الحيوية فيما يلى:

١- أدى التسميد بالأزولا الجافة الى تحقيق أعلى محتوى للمادة العضوية بالتربة بالمقارنة مع باقى المعاملات تحت الدراسة.
٢- جميع معاملات الأزولا والسيانوبكتريا أدت الى انخفاض درجتى الـ pHو EC للتربة بالمقارنة مع معاملة الكنترول (١٠٠% نيتروجين).
٣- أدت معاملة الرش بمخلوط من مستخلص الأزولا وراشح السيانوبكتريا الى زيادة عناصر النيتروجين والفوسفور والبوتاسيوم الميسرة بالتربة بالمقارنة مع باقى معاملات الأزولا والسيانوبكتريا وكذا معاملة الكنترول.
٤- أدت معاملة الرش بمخلوط من مستخلص الأزولا وراشح السيانوبكتريا الى زيادة النشاط البيولوجى بالتربة بالمقارنة مع باقى معاملات الأزولا والسيانوبكتريا وكذا معاملة الكنترول.
٥- أدت معاملة الرش بمخلوط من مستخلص الأزولا وراشح السيانوبكتريا الى زيادة معنوية فى كل محصول الشعير ومكوناته ومحتوى الحبوب والقش من كل من النيتروجين والفوسفور والبوتاسيوم بالمقارنة مع باقى معاملات الأزولا والسيانوبكتريا وكذا معاملة الكنترول(١٠٠% نيتروجين).

وعموما فانه من هذه الدراسة يمكن استخلاص أن استخدام معاملة الرش بمخلوط من مستخلص الأزولا وراشح السيانوبكتريا مع اضافة السماد النيتروجينى المعدنى كان مفيدا لمحصول الشعير ومكوناته ومحتواه من عناصر النيتروجين والفوسفور والبوتاسيوم وكذلك على خواص التربة الكيميائية والبيولوجية.

قام بتحكيم البحث

أ. د/ زكريا مسعد الصيرفى	**كلية الزراعة – جامعة المنصورة**
أ. د/ فكرى محمد عبد العال غزال	**مركز البحوث الزراعية**