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Mitigating the Effects of Abiotic Stresses on Barley Using Compost and Bio-Fertilization Under Rain-Fed Conditions

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ABSTRACT

Two field experiments were conducted at El-Qasr region in Matrouh Governorate, the North-Western Coast of Egypt, during two growing seasons of 2021/2022 and 2022/2023, to investigate the vital role of bio and organic fertilizers in facing abiotic stresses in barley fields. The treatments include compost levels (0, 5, 10, 15 t ha^{-1}) as soil addition and biofertilizers i.e. nitrogen fixers strains (*Azotobacter chroococcum* (AZ)), phosphate dissolving bacteria (*Bacillus megatherium* (N)), potassium solubilizing bacteria (*Bacillus circulans* (R)), and their combinations relative to control (distilled water). The results showed the positive effects of biofertilizers and organic fertilizers (compost) on barley plant growth, photosynthetic activity, yield and its components. Variance analysis results (ANOVA) showed extremely significant ($p<0.05$) variations among different treatments in all traits. The highest grain yields were recorded in both seasons once applied compost (15 t ha^{-1}) alongside a combination of (AZ+N+R) bacteria which recorded 2744.1 kg ha-1 and 873.2 kg ha-1 in the first and second seasons respectively. Also, it can be concluded that the combination of applying compost (15 t ha-1) with biofertilizer triple combination of (AZ+N+R) gave maximizing barley biomass, photosynthetic potential activity, and water use efficiency in both seasons.

Keywords: Barley, rain-fed, compost, nitrogen fixers, phosphate dissolving, potassium solubilizing, photosynthetic potential, WUE.

INTRODUCTION

Egypt's agricultural lands are characterized as an arid and semi-arid land. Additionally, Egypt is facing a substantial drop in arable soil, which makes up between 3 and 4% of the country's total land area, which means that crop production is confronted with a growing need for food despite the country's restricted agricultural output. In Egypt, achieving economic and social advancement depends critically on the relationship between increasing food security, environmentally sustainable agriculture, and poverty decline (El-Ramady, *et al.*, 2013). Hence the interest in expanding the cultivated areas in the marginal lands represented in the coasts of Egypt, whether eastern or western, which cover 995 Km of the Mediterranean coastal area with a deep 50 km to the south, which depends on their cultivation rainfall in the winter season, that average annual rainfall ranges from 120-180 mm (Gomaa, *et al.*, 2014).

The North Western Coast of Egypt (NWCE) has recently been affected by the prevailing climatic changes, as well as more vulnerable to land degradation and desertification processes which lead to deterioration fertility, and then will ultimately negatively affect both land covering and biodiversity, associated with decrease plant production (Mohamed, *et al.*, 2013; Said, *et al.*, 2020) .

Land degradation (LD) is one of the environmental processes evoked by climate change, water and wind injury, human activities, unsustainable agricultural practices, and poor land management, which negatively affects soil productivity as a result of soil erosion or changes in the hydrological, biological, physical and chemical properties of the soil, which could exacerbate finally losing their fertile topsoil (Ferreira, *et al.*, 2022; Haregeweyn, *et al.*, 2023; Abdullahi, *et al.*, 2023). Many negative effects of land degradation may appear through soil erosion, loss of soil organic matter content, salinization, and finally desertification (Turner, et al., 2016). These negative effects extend to affecting land productivity, biodiversity, and soil flora and fauna (AbdelRahman, 2023). Beillouin, *et al.* (2022), and Wang (2022) explained that about 90% of the world's topsoil is threatened by degradation, which may exacerbate negative consequences such as the negative impact on food security. Natural causes including drought, heat, a reduction in vegetation cover, and biological production exacerbate land degradation in dryland environments, according to the United Nations Convention to Combat Desertification (Stringer, 2008; Abdullahi, *et al.*, 2023).

One of the most important agricultural practices that have been applied recently to overcome such problems is the so-called ecological agriculture practices by expanding the application of bio- and organic-fertilizers reducing the use of agricultural chemicals to achieve sustainable agricultural development by increasing crop productivity and raising soil fertility, and production free from chemical residues. Bio-fertilizers are a type of low-cost eco-friendly fertilizers, so it leads to sustainable crop production (Naher *et al.*, 2016; Singh and Patel, 2016; Abd-Elghany, *et al.*, 2017). In addition,

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produces vitamins, hormones, and other essential growth factors for plants. It ultimately leads to the preservation of biodiversity, land cover, and the protection of lands from degradation, which leads us to desertification.

Compost application has been recognized to enhance and improve a wide range of soil physical and chemical properties. Where there has also been a widespread interest in using compost to amend degraded soils to improve function. Documented changes of compost on soil physical properties such as hydraulic conductivity, bulk density, infiltration rate, water content, and porosity, as well as increase the content of organic matter (Kranz, *et al.,* 2020).

Barley (*Hordeum vulgare* L.) is considered the most important cereal crop, especially in arid and semi-arid regions (such as the northwestern coast of Egypt). Economically, barley ranks fourth among the most important cereal crops after wheat, rice, and corn in the world (Abd-El-Hamid, and Bugaev, 2020; Kumar, *et al.,* 2022). It is characterized by its rapid growth within normal or stressful conditions notably, drought and salinity. It is grown for animal and human feed, it is also used as a cover crop to improve soil fertility and protect the soil, as well as cultivated in many countries for industrial usage (Abd-El-Hamid, and Bugaev, 2020; Kumar, *et al.,* 2022).

The objective of this study was to investigate the effect of compost amendment and biofertilizers on barley growth, yield and its components, and water use efficiency under the rain-fed conditions of the North-Western Coast of Egypt.

MATERIALS AND METHODS

Location site:

The field experiment was conducted at El-Qasr region in Matrouh Governorate, the North-Western Coast of Egypt, during the successive growing seasons of 2021/2022 and 2022/2023, to study the effect of compost as a soil amendments treatments, and different bio fertilization in addition to their interactions on barley cv. Giza 126 productivity under rain-fed conditions of the North-Western Coast Zone (NWCZ) of Egypt.

Experimental Design:

A month pre-sowing date, the plowing process was completed and the proposed compost fertilization rates were added by 3 levels (5, 10, and 15 t ha^{-1}) compared to control (without compost). Bio fertilization treatments were applied as a pre-sowing seed treatments for 2-3 hours including nitrogen fixers *Azotobacter chroococcum* (AZ), phosphate dissolving bacteria *Bacillus megatherium* (N), and potassium solubilizing bacteria *Bacillus circulans* (R), compared with control (Distilled water).

The experimental design used in this experiment was the split-plot design with four replicates, where compost fertilization occupied the main plots and the bio fertilization treatments were arranged in the sub ones. The plot area was 21 m^2 (7 meters long and 3 meters wide).

Studied characteristics:

Growth and growth attributes

Three random samples (1 m^2) from each subplot in four replicates were taken during all growth stages from tillering stage to milky ripeness stage to determine the following growth traits:

1- Dynamics of barley leaf surface formation, (thousand m^2/h): was calculated for all leaves/ plant samples and then converted to thousand m2/ha.
2- Photosynthesis potential (thousand m^2/h*day): was calculated as follows:

$$\left[\frac{\textbf{The average increase in leaf area per stage}}{\textbf{The number of days of the same stage}}\right]$$

Yield and its components

Grain yield (Kg/h): Estimated by harvesting and threshing all sub-sub plot area, and then converted to kg/ha.

Biological yield (Kg/h): estimated as the weight of all harvested plants in each sub-sub plot before threshing, and then converted to ton/ha.

Water Use Efficiency (WUE; kg grain/m^3 water): was calculated as follows:

$$WUE = \left[\frac{Grain\ yield\ (Kg)}{rainfall\ volume\ (m^3)}\right]$$

Statistical analysis

The statistical analysis of data was conducted according to Gomez and Gomez 1984, by variance analysis (ANOVA), using the SPSS software program. L.S.D at 5% was used for comparing mean treatments.

Soil analysis

The physical and chemical analysis and soil characteristics of the 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. chemical and physical properties of the soil in seasons 2021/2022 and 2022/2023

Physical analysis					
Seasons	**Clay (%)**	**Silt (%)**	**Sand (%)**	**Organic matter (%)**	**Texture class**
2021/2022	20.40	21.15	58.45	0.48	Sandy clay loam
2022/2023	20.50	21.96	57.54	0.57	

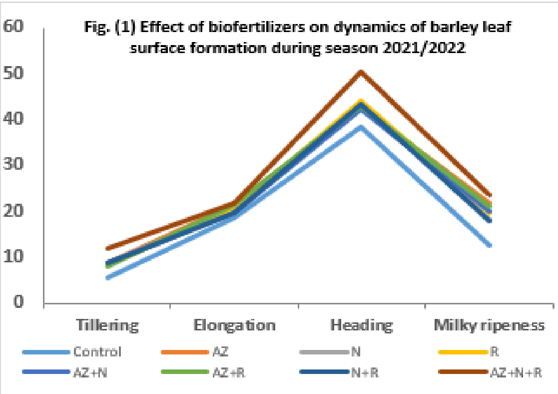
Chemical analysis										
Seasons	pH	ECe (ds m^{-1})	HCO_3 (%)	$CaCO_3$ (%)	Cations and anions (meq/L)					
					Ca	Mg	K	Na	Cl	Zn
2021/2022	8.10	3.6	5.55	15.10	2.2	1.22	0.50	4.3	0.78	0.65
2022/2023	8.00	3.1	5.48	15.02	2.7	1.28	0.63	4.1	0.71	0.86

RESULTS AND DISCUSSION

One of the most important determinants of crop productivity is the extent to which plants can carry out photosynthesis, which occurs mainly in the leaves of plants, (Krylova, 2015). Therefore to increase crop productivity, it is necessary to improve photosynthesis processes and create favorable conditions for the growth and development of the crop.

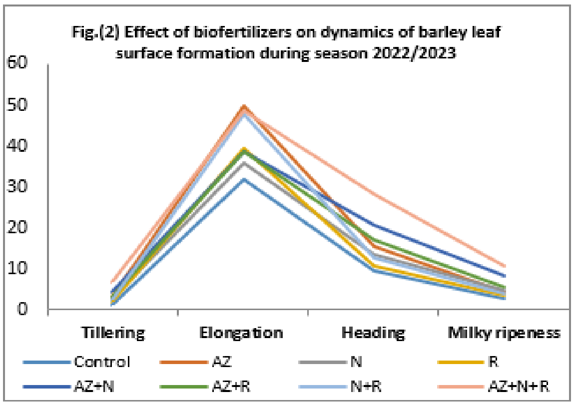
Dynamics of barley leaf surface formation:

Data in Figures 1 and 2 illustrate the impact of biofertilizers on the dynamics of barley leaf surface formation during 2021/2022 and 2022/2023, (thousand m^2/h). The result shows the positive effect of biofertilizer treatments on barley leaf area during the two growing seasons at all growth phases. The maximum leaf area of barley was recorded within the triple mixtures of biofertilizers (AZ+N+R) over control plants or inoculation with each biofertilizer alone, during both seasons. In the first season leaves area reached 50.43, an increase of 31.71% compared to untreated grains during the heading phase. On the other hand, the maximum leaf area of barley was reached in the second season during the elongation phase; it reached 48.53, an increase of 51.5% compared to the control.



(AZ) *Azotobacter chroococcum*, (N) *Bacillus megatherium*, (R) *Bacillus circulans*

Figure 1. Effect of biofertilizers on dynamics of barley leaf surface formation during season 2021/2022



(AZ) Azotobacter chroococcum, (N) Bacillus megatherium, (R) Bacillus circulans

Figure 2.Effect of biofertilizers on dynamics of barley leaf surface formation during season 2022/2023

Figures 3 and 4 show the effect of compost on the dynamics of barley leaf surface formation during 2021/2022 and 2022/2023, (thousand m^2/h).

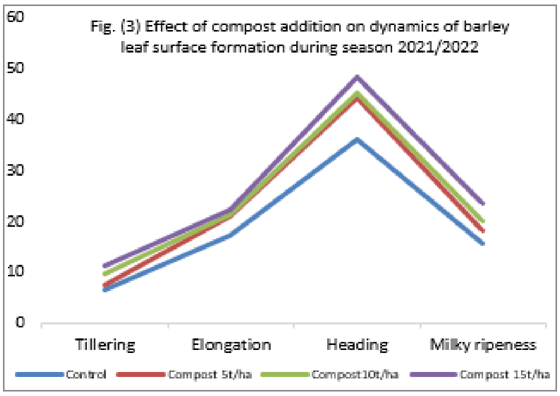


Figure 3. Effect of compost addition on dynamics of barley leaf surface formation during season 2021/2022

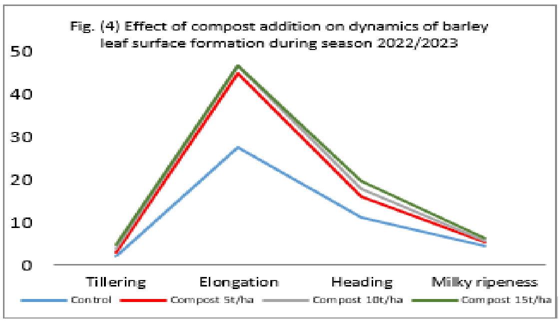
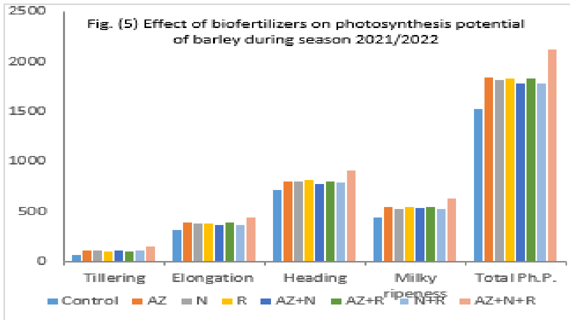


Figure 4. Effect of compost addition on dynamics of barley leaf surface formation during season 2022/2023

Adding compost enhanced the surface leaves area of barley during the two growing seasons, with clear significant differences between the compost addition rates, where adding compost at a rate of 15 t/h recorded the best dynamics of barley leaf surface formation. The maximum leaf area in the first season reached (48.27 thousand m^2/h) during the heading phase. On the other hand, in the second season during the elongation phase reached (46.6 thousand m^2/h). While the maximum barley leaves area in the control (without adding compost) reached 35.96 thousand m^2/h in the heading phase, and (27.5 thousand m^2/h) in the elongation phase during the first and second seasons, respectively.

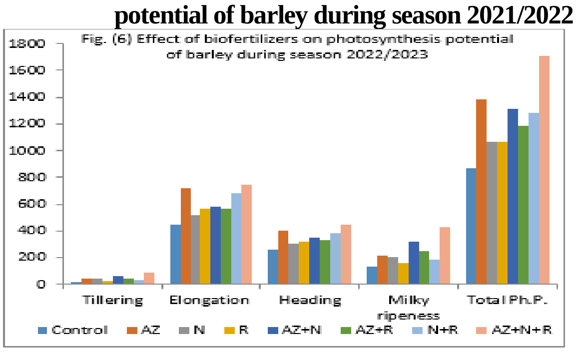
Photosynthesis potential (thousand m^2/h*day)

Figures 5,6 presents the impact of biofertilizers and adding compost on the photosynthesis potential during the 2021-2022 and 2022-2023 growing seasons.



(AZ) *Azotobacter chroococcum*, (N) *Bacillus megatherium*, (R) *Bacillus circulans*

Figure 5. Effect of biofertilizers on photosynthesis potential of barley during season 2021/2022



(AZ) Azotobacter chroococcum, (N) Bacillus megatherium, (R) Bacillus circulans

Figure 6. Effect of biofertilizers on photosynthesis potential of barley during season 2022/2023

In terms of biofertilizer, the most significant increase of photosynthesis potential in the first season was observed with the mixture application of the three strains of bacteria (AZ+N+R) during the heading stage, resulting in the highest photosynthesis potential of 903.44 (thousand m^2/h*day). During the second season, the application of the three bacteria mixture produced statistically similar results but in the elongation stage, with a photosynthesis potential of about 746.05 (thousand m^2/h*day).

On the other hand, the results in Figures 7 and 8 show the effect of adding compost on the photosynthesis potential during the 2021-2022 and 2022-2023 growing seasons.

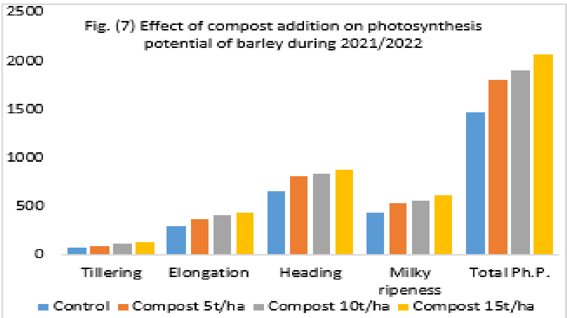


Figure 7. Effect of compost addition on photosynthesis potential of barley during season 2021/2022

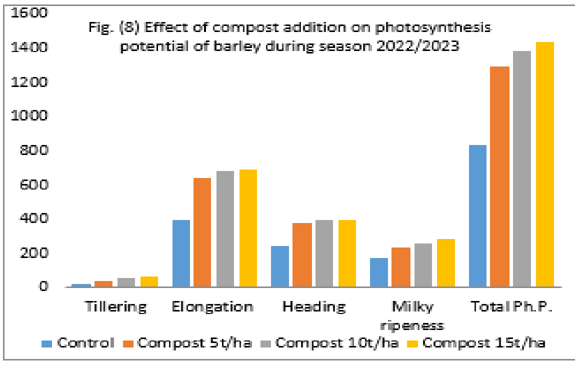


Figure 8. Effect of compost addition on photosynthesis potential of barley during season 2022/2023

The highest photosynthesis potential in both growing seasons was achieved by applying either 15 t.ha^{-1}, specifically, the photosynthesis potential in these treatments was 883.22 (thousand m^2/h*day), in the heading phase, and 691.39 (thousand m^2/h*day), in the elongation stage, in both growing seasons, respectively.

Impact of compost application

Data in Table 2 revealed that compost treatments (5, 10, and 15 t ha^{-1}) caused a significant increase in barley productivity during the two tested seasons compared to untreated (control). Data in the first season indicate that the application of 15 t ha^{-1} compost recorded the highest yield, reaching 40.82 % compared with control, also raised about 8.5 % and 19.68 % when addition compost by (5, and 10 t ha^{-1}), respectively compared with control. While the maximum amount of biomass reached 4535.03 kg ha^{-1} when adding compost at a rate of 15 t ha^{-1} an increase of 58.31% over the control, which recorded a biomass amount of 2864.75 kg ha^{-1}. There were significant differences between the compost rates and the control, as the increase in biomass yield reached between 12.3% and 22.31 % when applying compost at rates of 5 and 10 t ha^{-1} compared to the control, respectively. Adding compost also had a positive effect on the efficiency of rainwater use, as the maximum water use efficiency of 3.54 kg of grains m^{-3} rainwater was achieved when adding compost at a rate of 15 t ha^{-1} while the lowest water use efficiency was recorded in the case of not adding compost (control), which was 2.24 kg m^{-3} rain water.

This indicates that adding compost as an organic fertilizer and soil conditioner has led to an increase in the efficiency of both unit area and unit water. This may be because adding compost improves the physical and chemical soil properties such as bulk density, porosity, hydraulic conductivity, infiltration rate, water content, and aggregate stability as well as nutrient dynamics increasing its fertility as a result of its high content of organic matter. It also increases the soil's capacity to retain rainwater in the root area (Kranz, *et al.*, 2020).

Table 2. Effect of compost application rate on barley productivity (kg ha^{-1}, biomass kg ha^{-1}, and water use efficiency kg m^{-3} ha^{-1})

Compost rates	Grain yield kg ha^{-1}		Bio mass kg ha^{-1}		WUE kg m^{-3} ha^{-1}	
	First season	Second season	First season	Second season	First season	Second season
Control	1804.80	511.68	2864.75	1804.80	2.24	0.57
Compost 5 t ha^{-1}	2026.99	635.18	3217.46	2027.00	2.51	0.71
Compost 10 t ha^{-1}	2207.48	691.24	3503.90	2207.46	2.74	0.77
Compost 15 t ha^{-1}	2857.06	727.85	4535.04	2857.07	3.54	0.81
LSD $_{0.05}$	8.699	6.195	9.188	9.829	0.063	0.025

Impact of biofertilizer

Data in Table 3 showed that all bio-fertilization treatments *Azotobacter chroococcum* (AZ), *Bacillus megatherium* (N), *Bacillus circulans* (R), and their combination significantly increased the above-mentioned parameters compared with the control treatment. The treatment of (AZ+N+R) was superior in this respect and gave a significant increase in barley yield which amounts to 2162.5 kg. ha^{-1} and 1872.2 kg. ha^{-1} in the first and second seasons, respectively. While barley productivity was 853.3 kg. ha^{-1} and 1041 kg. ha^{-1} in the first and second growing seasons, respectively relative to untreated barley grains pre-sowing by bio fertilizers. The biomass production of barley grains that were treated pre-sowing with the mixture (AZ+N+R) was the best, where gave a significant increase of 2667 kg. ha^{-1} and 1680.6 kg. ha^{-1} in the first and second seasons, respectively, compared to untreated barley grains pre sowing with bio fertilizers. Treating barley grains pre sowing using bio fertilizers also led to an increase in the rainwater use efficiency, which led to an increase from 1.83 to 3.91 kg. m^{-3} ha^{-1} in the first season, and 0.48 to 0.87 kg. m^{-3} ha^{-1} in the second season when treated barley grains pre sowing using a mixture of bacteria (AZ+N+R).

The positive effects might be due to the main role bio-fertilizers in improving crop growth to increase in synthesis of growth-promoting substances by phosphate solubilizing by *Bacillus megatherium* (N) and N fixing bacteria by *Azotobacter chroococcum* (AZ). Phosphorus solubilizing bacteria (N) plays a strong role in phosphorus nutrition by enhancing its availability to plants through release from inorganic and organic soil by solubilization and mineralization processes (Abd-Elghany, *et al.*, 2017; Silva, *et al.*, 2023; Sarmah and Sarma, 2023; and Yadav, *et al.*, 2023). It is the reason bio-fertilizers led to increased barley productivity, biomass, and other characteristics of plant growth.

Mishra and Dash (2014), also reported that biofertilizers encourage growth by increasing the availability of the main nutrients, and growth stimulants to crops, whether when applied to seeds pre-sowing, as a foliar application of plant, or soil additions. Gopalakrishnan *et al.* (2015) also explained that rhizobacterial species are bacteria that promote plant growth by fixing nitrogen, dissolving phosphate, chelating iron, and producing phytohormones as well as improving and increasing the resistance of plants against plant pathogens and abiotic stresses.

Table 3. Effect of biofertilizers on barley productivity (kg ha^{-1}, biomass kg ha^{-1}, and water use efficiency kg m^{-3} ha^{-1})

Bio fertilizers	Grain yield kg ha^{-1}		Bio mass kg ha^{-1}		WUE kg m^{-3} ha^{-1}	
	First season	Second season	First season	Second season	First season	Second season
Control	853.26	433.75	2336.57	1472.04	1.83	0.48
AZ	1143.64	525.74	2956.52	1862.61	2.31	0.59
N	1295.88	757.52	3319.47	2091.27	2.59	0.84
R	1182.63	576.44	3056.38	1925.52	2.39	0.64
AZ+N	1825.97	716.41	4294.08	2705.27	3.35	0.80
AZ+R	1295.48	723.28	3523.69	2219.93	2.75	0.81
N+R	1224.61	618.70	3751.30	2363.32	2.93	0.69
AZ+N+R	2162.54	780.07	5004.30	3152.71	3.91	0.87
LSD 0.05	12.302	8.761	12.994	13.900	0.089	0.036

(AZ) ***Azotobacter chroococcum*****, (N)** ***Bacillus megatherium*****, (R)** ***Bacillus circulans***

Impact of Interaction between biofertilizer, and compost application

Table 4 shows the effect of the interaction influence between biofertilizer, and compost application rate on barley productivity, biomass, and water use efficiency. In terms of productivity, the most significant grain yield was observed in both seasons when within the treatment of compost (at 15 t ha^{-1}) alongside triple biofertilizer strains mixture (AZ+N+R). In the first season, the grain yield reached 2744.1 kg ha^{-1} and 873.2 kg ha^{-1} in the second season.

Table 4. Influence of interaction between biofertilizer, and compost application rate on barley productivity, biomass, and water use efficiency

Organic Fertilizer (A)	Bio fertilizer (B)	Productivity (kg h^{-1})		Biomass (kg h^{-1})		Water use efficiency (kg m^{-3} h^{-1})	
		2021/22	2022/23	2021/22	2022/23	2021/22	2022/23
Control	Control	603.8	242.6	1539.0	969.6	1.20	0.27
	AZ	967.2	449.9	2458.6	1548.9	1.92	0.50
	N	1219.9	592.0	3003.6	1892.3	2.35	0.66
	R	993.2	513.7	2474.6	1559.0	1.93	0.57
	AZ+N	1442.2	608.0	3461.8	2180.9	2.70	0.68
	AZ+R	1189.5	567.5	2887.2	1819.0	2.26	0.63
	N+R	1057.2	491.0	2574.6	1622.0	2.01	0.55
	AZ+N+R	1895.2	628.9	4518.6	2846.7	3.53	0.70
Compost 5 t.h^{-1}	Control	884.8	393.9	2472.2	1557.5	1.93	0.44
	AZ	1051.6	497.9	2896.0	1824.5	2.26	0.55
	N	1169.5	785.9	3138.7	1977.4	2.45	0.88
	R	1032.0	535.3	2754.5	1735.3	2.15	0.60
	AZ+N	1844.1	728.0	4157.9	2619.5	3.25	0.81
	AZ+R	1139.9	751.9	3122.8	1967.3	2.44	0.84
	N+R	1120.8	614.3	3008.4	1895.3	2.35	0.68
	AZ+N+R	1920.4	774.3	4189.1	2639.1	3.27	0.86
Compost 10 t.h^{-1}	Control	938.8	529.8	2475.8	1559.8	1.93	0.59
	AZ	1048.8	571.9	2689.3	1694.3	2.10	0.64
	N	1084.0	805.1	2876.8	1812.4	2.25	0.90
	R	1213.5	601.1	2979.6	1877.2	2.33	0.67
	AZ+N	1938.0	743.2	4349.5	2740.2	3.40	0.83
	AZ+R	1366.7	759.9	3845.7	2422.8	3.00	0.85
	N+R	1532.2	675.2	3902.8	2458.8	3.05	0.75
	AZ+N+R	2090.4	843.8	4911.6	3094.3	3.84	0.94
Compost 15 t h^{-1}	Control	985.6	568.8	2859.3	1801.3	2.23	0.63
	AZ	1507.0	583.4	3782.1	2382.7	2.95	0.65
	N	1710.1	847.1	4258.7	2683.0	3.33	0.94
	R	1491.8	655.7	4016.8	2530.6	3.14	0.73
	AZ+N	2079.6	786.4	5207.1	3280.5	4.07	0.88
	AZ+R	1485.8	813.9	4239.1	2670.6	3.31	0.91
	N+R	1188.3	694.4	5519.4	3477.2	4.31	0.77
	AZ+N+R	2744.1	873.2	6397.8	4030.6	5.00	0.97
LSD 0.05	A	8.699	6.195	9.188	9.829	0.063	0.025
	B	12.302	8.761	12.994	13.900	0.089	0.036
	A*B	17.398	12.39	18.376	19.658	0.126	0.051

(AZ) Azotobacter chroococcum, (N) Bacillus megatherium, (R) Bacillus circulans

Also, the application of 15 t ha^{-1} compost with (AZ+N+R) bacteria had a positive effect on biomass, and the results had a significant effect compared to other treatments. The highest biomass recorded was 6397.9 and 4030.6 kg ha^{-1} in the first and second seasons, respectively under the same treatments.

Similarly, these treatments also led to the highest significant values improvements in rainwater use efficiency. Where reached in the first season, 5 kg m^{-3} rainwater, while in the second season, they measured 0.97 kg m^{-3} rainwater.

The study results revealed that there was a significant effect of bio fertilizers triple mixtures on barley photosynthetic activity barley yield, and its component under rain-fed conditions in North western coast of Egypt. Generally, the best dynamics of barley leaf surface formation, photosynthesis potential, yield, and its components were obtained when the combination of (AZ+N+R) bacteria, and compost application of 15 t/ha. Where there was a significant difference among compost levels i.e., 5, 10, and 15 t/ha, also among several bacteria strains used, and interaction between compost levels with bacteria strains. From these findings, it could be concluded that there was a response of barley to the biofertilizers applied and compost as a soil amendment to mitigate against the effects of abiotic stresses, especially drought, and soil degradation under the study region conditions.

REFERENCES

Abd-Elghany, G. G., El-Shazly, M. M., and Hashem, H. A. (2017). Water management for the fenugreek plant and its response to biofertilization in North Sinai. Egypt. J. Appl. Sci, 32(12), 494-515.

Abd-El-Hamid, S. E. A., and Bugaev, P. D. (2020). Impact of seed treatments pre-sowing and organo-mineral fertilizer on spring Barley production. Indian Journal of Agricultural Research, 54(5), 611-616.

AbdelRahman, M. A. (2023). An overview of land degradation, desertification and sustainable land management using GIS and remote sensing applications. Rendiconti Lincei. Scienze Fisiche e Naturali, 1-42. Ferreira CSS, Seifollahi-Aghmiuni S, Destouni G, Ghajarnia N, Kalantari Z (2022). Soil degradation in the European Mediterranean region: Processes, status and consequences. Science of the Total Environment 805, 150106.

Abdullahi, M. B., Elnaggar, A. A., Omar, M. M., Murtala, A., Lawal, M., and Mosa, A. A. (2023). Land degradation, causes, implications and sustainable management in arid and semi-arid regions: a case study of Egypt. Egyptian Journal of Soil Science, 63(4).

Beillouin, D., Demenois, J., Cardinael, R., Berre, D., Corbeels, M., Fallot, A., ... & Feder, F. (2022). A global database of land management, land-use change and climate change effects on soil organic carbon. Scientific Data, 9(1), 228.

El-Ramady, H. R., El-Marsafawy, S. M., and Lewis, L. N. (2013). Sustainable agriculture and climate changes in Egypt. Sustainable Agriculture Reviews: Volume 12, 41-95.

Gomaa, M., Radwan, F., Moselhy, N., El-Sadek, A., and Abdelkader, S. (2014). Participatory plant breeding approach for identifying the superior rainfed barley genotypes in Egypt. International Journal of Agronomy and Agricultural Research, 5(3), 52-61.

Gopalakrishnan, S. ; A. Sathya ; R. Vijayabharathi ; R.K. Varshney ; C.L.L. Gowda and L. Krishnamurthy (2015). Plant growth promoting rhizobia: challenges and opportunities. Biotech., 5: 355-377

Haregeweyn N, Tsunekawa A, Tsubo M, Fenta AA, Ebabu K, Vanmaercke M, Borrelli P, Panagos P, Berihun ML, Langendoen EJ (2023). Progress and challenges in sustainable land management initiatives: A global review. Science of the Total Environment 858, 160027.

Kranz, C. N., McLaughlin, R. A., Johnson, A., Miller, G., and Heitman, J. L. (2020). The effects of compost incorporation on soil physical properties in urban soils–A concise review. Journal of Environmental Management, 261, 110209.

Kumar, A., Verma, R. P. S., Singh, A., Sharma, H. K., and Devi, G. (2020). Barley landraces: Ecological heritage for edaphic stress adaptations and sustainable production. Environmental and Sustainability Indicators, 6, 100035.

Mishra, P., & Dash, D. (2014). Rejuvenation of biofertilizer for sustainable agriculture and economic development. Consilience, (11), 41-61.

Mohamed, E. S., Schütt, B., and Belal, A. (2013). Assessment of environmental hazards in the north western coast-Egypt using RS and GIS. The Egyptian Journal of Remote Sensing and Space Science, 16(2), 219-229.

Naher, U.A. ; Q.A. Panhwar ; R. Othman ; M.R. Ismail and Z. Berahim (2016). Fertilizer as a supplement of chemical fertilizer for yield maximization of rice. J. of Agric. Food and Development., 2: 16-22.

Said, M. E. S., Ali, A. M., Borin, M., Abd-Elmabod, S. K., Aldosari, A. A., Khalil, M. M., and Abdel-Fattah, M. K. (2020). On the use of multivariate analysis and land evaluation for potential agricultural development of the northwestern coast of Egypt. Agronomy, 10(9), 1318.

Sarmah, R., & Sarma, A. K. (2023). Phosphate solubilizing microorganisms: A review. Communications in Soil Science and Plant Analysis, 54(10), 1306-1315.

Silva, L. I. D., Pereira, M. C., Carvalho, A. M. X. D., Buttrós, V. H., Pasqual, M., and Dória, J. (2023). Phosphorus-solubilizing microorganisms: a key to sustainable agriculture. *Agriculture*, *13*(2), 462.

Singh, N.K. and D.B. Patel (2016). Performance of fenugreek bioinoculated with Rhizobium meliloti strains under semiarid condition. J. of Environ. Biology., 37: 31-35.

Turner, K. G., Anderson, S., Gonzales-Chang, M., Costanza, R., Courville, S., Dalgaard, T., ... & Wratten, S. (2016). A review of methods, data, and models to assess changes in the value of ecosystem services from land degradation and restoration. Ecological Modelling, 319, 190-207.

Wang, X. (2022) Managing land carrying capacity: Key to achieving sustainable production systems for food security. Land, 11(4), 484

Yadav, R. S., Kumar, M., Santra, P., Meena, H. M., and Meena, H. N. (2023). Plant growth-promoting microbes: the potential phosphorus solubilizers in soils of arid agro-ecosystem. In *Plant Growth Promoting Microorganisms of Arid Region* (pp. 71-92). Singapore: Springer Nature Singapore.

التخفيف من آثار الضغوط اللاأحيائية على الشعير باستخدام الكومبوست والأسمدة الحيوية تحت الظروف المطرية

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الملخص

أجريت تجربتان حقليتان بمنطقة القصر بمحافظة مطروح بالساحل الشمالي الغربي لمصر، خلال موسمي زراعة 2022/2021 و2023/2022، لدراسة دور الأسمدة الحيوية والعضوية في مواجهة الإجهادات اللاحيوية في حقول الشعير . تتكون المعاملات من إضافة ثلاثة مستويات من الكمبوست (5، 10، 15 طن/ هكتار) مقارنة بالكنترول وثلاث سلالات بكتيرية: بكتيريا مثبتة للنيتروجين (AZ) *Azotobacter chroococcum* والبكتيريا المذيبة للفوسفات (N) *Bacillus megatherium*، والبكتيريا المذيبة للبوتاسيوم (R) *Bacillus circulans* مقارنة بالكنترول (الماء المقطر). أظهرت النتائج التأثير الإيجابي لإستخدام الكمبوست على صفات التمثيل الضوئي للشعير وكذلك المحصول ومكوناته. أظهرت نتائج تحليل التباين (ANOVA) وجود اختلافات معنوية بين المعاملات المختلفة في جميع الصفات. لوحظت أعلى قيم معنوية لإنتاج الحبوب في كلا الموسمين عند إضافة الكمبوست بمقدار 15 طن/ هكتار بالتزامن مع إستخدام مزيج من الثلاث أنواع من البكتيريا (AZ+N+R) والتي سجلت 2744.1 كجم/ هكتار، و873.2 كجم/ هكتار في الموسم الأول، والثاني على التوالي. كما يمكن الاستنتاج أن الجمع بين إضافة السماد بمقدار 15 طن للهكتار مع مزيج من بكتيريا (AZ+N+R) أدي إلي تعظيم الكتلة الحيوية للشعير، ونشاط التمثيل الضوئي (PP)، وكفاءة استخدام المياه (WUE) في كلا الموسمين.

الكلمات المفتاحية: الشعير، الزراعة المطرية، الكمبوست، إمكانية التمثيل الضوئي، WUE.