Effect of Potassium, Phosphorus and Bio- fertilization on Barley Productivity

Rahuma, M. A. A., F. I. Radwan, M. A. Goma and I. F. Rehab
Plant Production Dept. Faculty of Agriculture (Saba Basha) Alexandria University

ABSTRACT: This study was carried out at the Experimental Farm of Faculty of Agriculture (Saba-Basha), Alexandria University, Egypt ,at Abees region during 2013/2014 and 2014/2015 seasons to study the effect of phosphorus and potassium fertilizer rates and different biofertilization treatments on growth, yield, yield components and chemical grain contents of six rows barley (*Hordeum vulgare*, L.) variety Giza 123.The experimental design used was a split-split plot with three replicates, where the three phosphorus application rates (0, 37.2 and 74.4 kg P_2O_5 /ha) were randomly distributed on main plot, three potassium fertilizer levels (0, 57.6 and 115.2 kg K_2O/ha) were located in sub-plots, whereas the three biofertilization treatments i.e. uninoculation, inoculation with phosphorein and inoculation with potassmage were occupied the sub-sub plots. Application of 74.4 kg P_2O_5 /ha significantly gave the highest value of yield and its attributes i.e. plant height (cm), number of tillers/m^2, spike length (cm), number of spikes/m^2, number of grains /spike, spike weight/m^2, 1000-grain weight (g), grains yield (t/ha), biological yield (t/ha) and harvest index (%) and N, P, K and protein percentages in grains. Increasing potassium application of 115.2 kg K_2O/ha increased the yield and its components, as well as, all chemical composition in grains. Inoculation potassmage gave the highest yield and its components, also N, P, K and protein in grains. Also, the obtained results indicated that the favorable effect of the highest levels of the studied factors, i.e., 74.4 kg P_2O_5 /ha, 115.2 kg K_2O/ha and inoculation with potassmage on barley plant growth, yield and its attributes and grain chemical contents in grains.

Keywords: barley, phosphorus, potassium, biofertilizers, yield, Chemical composition.

INTRODUCTION

Barley (*Hordeum vulgare*, L.) is considered one of the most adapted cereals crops to adverse environmental conditions at Abees region, salinity and drought, so it is the main crop grown in a wide acreage in the North west Coast and newly reclaimed lands. According to MALR (2014), barley cultivated area reached (86800) feddan in 2013/2014 growing season.

Inadequate P and K applications leads to imbalance in agricultural ecosystems and stagnation of yields will become more pronounced with time (Regmi *et al.,* 2002).

Phosphorus is one of the most essential elements for barley growth and development after nitrogen (Tigre *et al.,* 2014). However, the availability of this nutrient for plants is limited by different chemical reactions especially in arid and semi-arid soils. Phosphorus plays a significant role in several functions such as photosynthesis, transformation of sugar to starch, protein and oil formation, nucleic acid production and nitrogen fixation. Also, the part of all biochemical cycles in plants (Mehrvarz and Chaichi, 2008).

Plants acquire phosphorus from soil solution as phosphate anion. It is lower mobile element in the plant and soil than other macronutrients. A large amount of P applied as a fertilizer becomes immobile through precipitation reaction with highly reactive Fe^{3+}, Al^{3+}, Ca^{2+} and Mg^{2+} in the acidic and calcareous or alkaline or normal soils (Awasthi *et al.* 2011).

Potassium (K) is an essential element for plant growth and development, and is required for a wide variety of processes within the plant. These processes can be broadly divided into biophysical processes such as stomatal opening and cell extension and biochemical processes such as protein synthesis and enzyme activation. It is, also, commonly considered as the "quality nutrient." It affects the plant shape, size, color, taste and other measurements attributed to healthy produce. Potassium is absorbed by the roots as a K^+ ion.

Environmental problems caused by irregular applications of chemical fertilizers, inappropriate energy production methods and excessive consumption costs all have had harmful effects on biological cycles, and destroyed farming stability systems; these factors all together encourage the use of bio-fertilizers. Now-a-days attention to bio-fertilizer has been increased due to the advancement in countries research development, high prices of chemical fertilizers and attention to sustainable agricultural systems (Yosefi *et al.,* 2011).

Biofertilizers are low cost, renewable sources of plant nutrients. These are selected strains of beneficial soil microorganisms cultured in the laboratory and packed in suitable carrier. Bio-fertilizers are gaining momentum recently due to the increasing emphasis on maintenance of soil health by controlling soil borne diseases, minimize environmental pollution and cut down on the use of the chemicals in agriculture Muraleedharan *et al.* (2010). It is, also, increased of protein content and the improvement of amino acid composition in cereal grains was observed (Mikhailouskaya and Bogdevitch, 2009). Increased crop production largely relies on the type of fertilizers used to supplement essential nutrients for plants. For optimum plant growth, nutrients must be available in sufficient and balanced quantities. From the soil nutrients only a minor portion is released each year through biological activities or chemical processes. Therefore, biofertilizers are designed to supplement the nutrients already present in the soil (Chen, 2006). Very often microorganisms are not as efficient in natural surroundings as one would expect them to be and therefore artificially multiplied cultures of efficient selected microorganisms play a vital role in accelerating the microbial processes in soil.

The objective of the present investigation was to study the effect of mineral phosphorus and potassium fertilizer rates, besides biofertilizers inoculation on growth, yield and yield attributies and grain chemical composition in grains of barley crop.

MATERIALS AND METHODS

The present study was carried out at the Experimental Farm, Faculty of Agriculture (Saba- Basha), Alexandria University, Egypt, at abees region during two successive growing seasons of 2013/2014 and 2014/2015, to study the effect of P, K and biofertilization application on growth, yield and yield components of barley.

The experimental design was a split- split plot with three replicates. Phosphorus fertilizers levels (0, 37.2 and 74.4P_2O_5 kg/ha) were allocated in the main plots. Potassium fertilizer rates (0, 57.6 and 115.2K_2O kg /ha) were randomly distributed in the sub-plot and three biofertilizer inoculation treatments (Uninoculation, Phosphorein and Potassmage) were allocated in the sub-sub plots.

Barely grains were wetted with water, and then bio- fertilizers (Phosphorein or Potassmage) according to the treatments and (arbic gum 5%) was mixed carefully and spread on a plastic sheet far from the direct sun shine effect for a short time before sowing. The field was immediately irrigated after sowing.

Each sub- sub plot in both experiments was 3.5 meters long and 3 meters wide 10.5 m^2 i.e. (1/400 feddan).

Sowing date was on December 3rd in both seasons after corn as a preceding crop with seeding rate of 40 kg grain/fed., other cultural practices, were applied as recommended during the two growing seasons in the two experiments. Harvesting was carried out manually during May in both seasons.

Soil was clay loam texture, soil samples were taken from different sites of the experiment at 0- 30 cm depth from the soil surface. The samples were air-dried and then ground to pass-through a 2mm sieve and well mixed. The procedure or preparation and measurements of the soil were made according to Page *et al*. (1982). Result of the soil physical and chemical analysis for experimental sites in both seasons are shown in Table (1).

Table (1). Physical and chemical properties of soil at the experimental site in 2013/2014 and 2014/2015 seasons.

Soil properties	Seasons	
	2013/2014	**2014/2015**
A) Mechanical analysis		
Clay	14.70	14.20
Sand %	41.50	42.70
Silt %	43.80	43.10
Soil texture	**Clay loam soil**	
B) Chemical properties		
pH (1 : 1)	7.80	7.70
EC (dS/m)	3.20	3.30
1) Soluble cations (1 : 2) (cmol/kg soil)		
K^+	1.25	1.40
Ca^{++}	14.30	14.90
Mg^{++}	11.50	11.30
Na^{++}	12.70	13.20
2) Soluble anions (1 : 2) (cmol/kg soil)		
$CO_3^{--} + HCO_3^-$	2.70	2.70
Cl^-	18.90	19.10
SO_4^{--}	12.20	12.50
Calcium carbonate (%)	6.50	6.70
Total nitrogen %	0.90	0.85
Available phosphate (mg/kg)	3.70	3.65
Organic matter (%)	1.35	1.40

Data recorded

At harvest, one square meter was randamly taken from each sub-sub plot to determine the following traits:

1. Plant height (cm)
2. Number of tillers/m^2
3. Spike length (cm)
4. Number of spikes/m^2
5. Spike weight/m^2(g)
6. Number of grains/spike
7. 1000- grain weight (g)
8. grain yield (ton/ha)
9. Biological yield (ton/ha)
10. Harvest index

Grain quality

Protein percentage

Protein percentage in grains was determined by estimating the total nitrogen in the grains and multiplied by 6.25 to obtain the percentage of grain protein percentage according to AOAC (1990).

Chemical analysis

The NPK percentages were determined in grains dried in a drying chamber to a constant weight at 75^{o}C for 72 hour according to Tandon (1995). After dryness, the plant samples were milled and stored for analysis as reported. However, 0.5g of the grain powder was wet-digested with H_2SO_4 – H_2O_2 mixture according (Lowther, 1980) and the following determinations were carried out in the digested solution to determine the following:

- Nitrogen content (N %) in grains

Total nitrogen was determined in digested grains colorimetrically by Nessler`s method (Chapman and Pratt, 1978). Nessler solution (35 KI/100 ml d.w.) + 20g $HgCl_2$ / 500 ml d.w.) +120 g NaOH / 250 ml d.w. Reading was achieved at wave length of 420 nm and N was determined as percentage as follows:

$$\% N = NH_4 \% \times 0.776485$$

- Phosphorus content (P %) in grains

Phosphorus was determined by the Vanadomolyate yellow method as given by Jackson (1973) and the intensity of colour developed was read in spectrophotometer at 460nm.

- Potassium content (K %) in grains

Potassium was determined according to the method described by Jackson (1973) using Beckman Flame photometer.

Statistical Analysis

Obtained data were statistically analyzed to Gomez and Gomez (1984). The treatment means were compared using the least significant differences (L.S.D.) test at 5% level of probability.

RESULTS AND DISCUSSION

A. Yield and yield attributes

Results recorded in Tables (2 and 3) revealed that plant height (cm), number of tillers/m^2, spike length (cm), number of spikes/m^2,Spike weight /m^2, number of grains /spike, 1000-grain weight (g), grain yield (t/ha), biological yield (t/ha) and harvest index (%) in both seasons were significantly affected by phosphorus and potassium fertilizer rates and biofertilizer inoculation, besides all possible interactions in the two growing seasons.

Phosphorus application at 74.4kg P_2O_5/ha significantly gave the highest values of yield and its attributes (plant height (cm), number of tillers/m^2, spike length (cm), number of spikes/m^2,Spike weight /m^2, number of grains /spike, , 1000-grain weight (g), grain yield (t/ha), biological yield (t/ha) and harvest index (%) in the two successive seasons. The positive of phosphorus fertilization on yield and its components of barley might be attributed to the soil of the experimental site, which was very poor in the phosphorus contents. Also, P plays important role in enhancing translocation of metabolites which might be the reason for the increase observed of yield component. Ahmed (2009) and Tigre *et al.* (2014).

Increasing potassium application rate up to 115,2 kg K_2O/ha significantly increased the yield and its components compared to unfertilized treatment. Aown *et al.* (2012) and Zareian and Tabatabaei (2014).

On the other hand, inoculated barley grains with biofertilizer significantly increased yield and its attributes **(**plant height (cm), number of tillers/m^2, spike length (cm), number of spikes/m^2, spike weight/m^2,number of grains /spike, 1000-grain weight (g), grain yield (t/ha), biological yield (t/ha) and harvest index (%)**)**. It could be concluded that a Potassmage inoculation treatment promoted the production of grain yield because of biofertilization increase the synthesis of the endogenous phytohormons i.e. IAA, GAs and CKs which could play an important role formation of a big active root system (Chen, 2006). These findings are confirmed with Naseri *et al.* (2013), Azimi *et al.* (2013) and Heidaryan and Feilinezhad (2015).

With respect to phosphorus x potassium fertilizer levels interaction effect in both season, results in Tables (2 and 3) showed that the maximum values of yield and its components resulted from 74.4kg P_2O_5/ha and 115.2 kg K_2O/ha application.

Similar trend observed in Tables (2 and 3), where applied 74.4kg P_2O_5/ha to inoculated grains with potassmage biofertilizer recorded the highest yield and its components in 2013/2014 and 2014/2015 seasons, respectively. Eftekhari *et al.* (2012) and Sharma *et al.* (2012).

Concerning potassium fertilizer levels x biofertilizer inoculation interaction effect on yield and its components, resulted in Tables (2 and 3) demonstrated that the maximum yield and its components in the first and second seasons, respectively, resulted from application of 115.2 kg K_2O/ha to inoculated grains with Potassmage. Conversely growing uninoculated barley grains with biofertilizer under without potassium fertilizer application produced the minimum yield and its components in the two successive seasons.

B. Chemical composition

Results presented in Table (4) revealed that nitrogen, phosphorus, potassium and protein percentages in barley grains was significantly affected by the three studied factors, i.e. phosphorus levels, potassium fertilizers and biofertilizers application, besides, the two and three factors interactions in the two growing seasons.

Increasing phosphorus fertilizer levels up to 74.4kg P_2O_5/ha obtained the highest nitrogen, phosphorus, potassium and protein percentage in barley grains in the first and second seasons, respectively, as shown in Table (4). Sharma *et al.* (2012) and Kostadinova (2014).

The same trend was found in the Table (4), where increasing potassium fertilizers levels up to 115.2 kg K_2O/ha recorded the highest nitrogen, phosphorus, potassium and protein percentages in barley grains in the two respective seasons. Ashok *et al.* (2009) and Wilczewski *et al.* (2014).

Results presented in that Table, also, revealed that treated barley grains with potassmage biofertilizer produced the highest nitrogen, phosphorus, potassium and protein percentages in barley grains in the two successive seasons. Radwan and Wafaa (2009), Ewais *et al.* (2010) and El-Gizawy (2010)

Concerning the first order interaction effects, on traits of nitrogen, phosphorus, potassium and protein percentages, results presented in Table **(**4) indicated that barley crop fertilized with 74.4kg P_2O_5/ha and 115.2 kg K_2O/ha combination showed the highest nitrogen, phosphorus, potassium and protein percentages in barley grains in the first and second seasons, respectively.

On the other hand, application of 74.4kg P_2O_5/ha to inoculated barley grains gave the highest nitrogen, phosphorus, potassium and protein percentages in barley grains in the two successive seasons.

In addition, the highest nitrogen , phosphorus, potassium and protein percentages in barley grains as shown in Table (4) in the first and second seasons, respectively, resulted from application of 115.2 kg K_2O/ha to inoculated barely grains with potassmage biofertilizer. As for interaction effect of the three studied traits on nitrogen, phosphorus, potassium and protein % in barley grains, results presented in Table (4) stated that growing inoculated grains with potassmage biofertilizer under application of 74.4kg P_2O_5/ha and115.2 kg K_2O/ha recorded the maximum grain nitrogen , phosphorus, potassium and protein content in the first and second seasons, respectively. However, sowing uninoculated barely grains with biofertilizers without phosphorus and potassium fertilization gave the lowest grain nitrogen, phosphorus, potassium and protein contents in the two respective seasons.

Table (2). Effect of phosphorus, potassium and biofertilizer rates on yield and its components of barley cv.G123 during 2013/2014 and 2014/2015 seasons.

Treatments	Plant height (cm)		Number of tillers/m^2		Spike length (cm)		Number of spikes/m^2		Spike weight/m^2 (g)	
	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
A) Phosphorus levels										
Untreated	120.95c	121.69c	317.11c	318.40c	22.07c	22.04c	306.22c	305.74c	340.81c	351.88c
37.2kg P_2O_5/ha	129.35b	130.43b	346.18b	350.22b	23.76b	23.12b	335.18b	337.29b	424.29b	481.14b
74.4kg P_2O_5/ha	140.96a	140.31a	374.29a	377.48a	24.37a	24.15a	361.11a	363.70a	607.44a	613.37a
L.S.D.(0.05)	**0.38**	**0.92**	**3.45**	**2.07**	**0.15**	**0.34**	**2.52**	**7.83**	**2.86**	**3.04**
B) Potassium levels										
Untreated	126.98c	126.87c	333.81c	337.96c	22.94c	22.54c	322.92c	325.48c	416.07c	439.59c
57.6 K_2O/ha	130.45b	131.37b	347.85b	348.37b	23.48b	23.03b	335.40b	333.70b	464.55b	487.29b
115.2 K_2O/ha	133.83a	134.18a	355.92a	359.77a	23.79a	23.74a	344.18a	347.55a	491.92a	519.51a
L.S.D.(0.05)	**0.52**	**0.51**	**1.05**	**1.28**	**0.23**	**0.17**	**0.91**	**6.62**	**1.66**	**1.83**
C) Biofertilization										
Uninoculated	125.15c	124.98c	330.18c	334.03c	22.04c	21.88c	318.81c	321.62c	376.55c	390.25c
Phosphorein	129.39b	130.73b	348.22b	352.40b	23.65b	23.17b	337.48b	336.66b	456.62b	496.14b
Potassmage	136.72a	136.71a	359.18a	359.66a	24.51a	24.26a	346.22a	348.44a	539.37a	560.00a
L.S.D.(0.05)	**0.72**	**0.70**	**1.86**	**1.16**	**0.14**	**0.17**	**1.94**	**6.33**	**1.50**	**1.31**
Interactions										
Ax B	**ns**	**	**	**	**ns**	**	**	**ns**	**	**
AxC	**	**	**ns**	**	**	**	**	**ns**	**	**
BxC	**	**	**ns**	**	*	**	**	**ns**	**	**
AxBx C	**ns**	**ns**	**ns**	**	**ns**	*	**	**ns**	**	**

Means in the same column followed by the same letter are statistically equalled according to LSD 0.05 probability level.
ns: not significant
, *: Significant at 0.05 and 0.01 level of probability, respectively.

Table (3). Effect of phosphorus, potassium and biofertilizer rates on yield and its components of barley cv.G123 during 2013/2014 and 2014/2015 seasons.

Treatments	Number of grains/spike		1000-grain weight (g)		Grain yield (t/ha)		Biological yield (t/ha)		Harvest index (%)	
	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
A) Phosphorus levels										
Untreated	44.00c	44.62c	44.14c	45.67c	5.30b	5.10c	14.33c	13.73c	36.98b	37.14b
37.2 kg P_2O_5/ha	46.33b	47.22b	46.75b	46.93b	5.31b	5.21b	14.92b	14.50b	35.58c	35.93c
74.4kg P_2O_5/ha	52.88a	54.29a	51.22a	49.72a	6.10a	5.90a	16.39a	15.50a	37.21a	38.06a
L.S.D.(0.05)	**1.19**	**0.64**	**0.83**	**0.39**	**0.01**	**0.01**	**0.07**	**0.09**	**0.05**	**0.27**
B) Potassium levels										
Untreated	45.14c	46.03c	45.09c	45.48c	5.30c	5.10c	14.74c	14.03c	35.95c	36.34c
57.6 K_2O/ha	47.59b	48.48b	46.99b	47.47b	5.58b	5.38b	15.22b	14.49b	36.66b	37.11b
115.2 K_2O/ha	50.48a	51.62a	50.03a	49.38a	5.82a	5.62a	15.69a	14.93a	37.09a	37.64a
L.S.D.(0.05)	**0.31**	**0.44**	**0.59**	**0.31**	**0.012**	**0.01**	**0.05**	**0.05**	**0.04**	**0.19**
C) Biofertilization										
Uninoculated	43.92c	45.00c	44.19c	42.72c	5.24c	5.04c	14.15c	13.54c	37.03a	37.21a
Phosphorein	47.55b	48.59b	47.61b	48.55b	5.47b	5.27b	15.20b	14.44b	35.98c	36.49b
Potassmage	51.74a	52.55a	50.31a	51.05a	6.00a	5.80a	16.29a	15.51a	36.83b	37.39a
L.S.D.(0.05)	**0.30**	**0.35**	**0.42**	**0.32**	**0.01**	**0.01**	**0.04**	**0.03**	**0.04**	**0.18**
Interactions										
Ax B	**	**	**	*	**	**	**	**	**	**
AxC	**	**	**	**	**	**	**	**	**	**
BxC	**	*	**ns**	**	**	**	**	**	**	**
AxBx C	**	**	**ns**	**ns**	**	**	**	**	**	**

Means in the same column followed by the same letter are statistically equalled according to LSD 0.05 probability level.
ns: not significant
, *: Significant at 0.05 and 0.01 level of probability, respectively.

Table (4). Effect of phosphorus, potassium and biofertilizer rates on grains chemical composition of barley cv.G123 during 2013/2014 and 2014/2015 seasons.

Treatments	Protein content (%)		N (%)		P (%)		K (%)	
	2013/2014	**2014/2015**	**2013/2014**	**2014/2015**	**2013/2014**	**2014/2015**	**2013/2014**	**2014/2015**
A) Phosphorus levels								
Untreated	9.15c	8.85c	1.441c	1.417c	0.363c	0.351c	1.41c	1.38c
37.2 kg P_2O_5/ha	10.15b	9.93b	1.625b	1.590b	0.409b	0.402b	1.59b	1.58b
74.4 kg P_2O_5/ha	11.40a	11.05a	1.824a	1.768a	0.634a	0.630a	2.33a	2.47a
L.S.D.(0.05)	**0.20**	**0.08**	**0.012**	**0.011**	**0.001**	**0.002**	**0.07**	**0.01**
B) Potassium levels								
Untreated	9.55c	9.41c	1.529c	1.506c	0.421c	0.413c	1.50c	1.55c
57.6 K_2O/ha	10.43b	9.99b	1.645b	1.598b	0.467b	0.461b	1.87b	1.84b
115.2 K_2O/ha	10.73a	10.43a	1.717a	1.671a	0.518a	0.513a	1.97a	2.05a
L.S.D.(0.05)	**0.14**	**0.05**	**0.008**	**0.007**	**0.002**	**0.001**	**0.06**	**0.01**
C) Biofertilization								
Uninoculated	8.52c	8.20c	1.341c	1.312c	0.395c	0.387c	1.55c	1.51c
Phosphorein	10.58b	10.33b	1.693b	1.654b	0.481b	0.472b	1.85b	1.83b
Potassmage	11.60a	11.30a	1.857a	1.809a	0.530a	0.527a	1.94a	2.10a
L.S.D.(0.05)	**0.13**	**0.04**	**0.006**	**0.007**	**0.002**	**0.001**	**0.06**	**0.01**
Interactions								
Ax B	**	**	**	**	**	**	**	**
AxC	**	**	**	**	**	**	**	**
BxC	**	**	**	**	**	**	**	**
AxBx C	**	**	**	**	**	**	**	**

Means in the same column followed by the same letter are statistically equalled according to LSD 0.05 probability level.
ns: not significant
, *: Significant at 0.05 and 0.01 level of probability, respectively.

REFERENCES

Ahmed, S. M. M. (2009). Response of wheat in fertilization under sandy soil condition. Ph. D. Thesis, Fac. Agric. Zagazig Univ. Egypt.

AOAC (1990). Official Methods of Analysis Association of Official Analytical Chemists, 12th edition. Washington, D.C

Aown, M., S. Raza, M. F. Saleem, S. A. Anjum, T. Khaliq and M. A. Wahid (2012). Foliar application of potassium under water deficit conditions improved the growth and yield of wheat (*Triticum aestivum* L.). J. Animal & Plant Sci., 22(2): 431-437.

Ashok, J., P. Singh. N. Kumar. M. Chauhan and G.R. Singh (2009). effect of the levels of potassium and manganese on the uptake of N, P, and K and yield of wheat. J. Agric. Physics., (9):28-32.

Awasthi, R., R. Tewari and H. Nayyar (2011). Synergy between plants and P-solubilizing microbes in soils: Effects on growth and physiology of crops. International Res. J. Microbiol., 2(12): 484-503.

Azimi, S. M., A. Farnia. M. Shaban and M. Lak (2013). Effect of different biofertilizers on seed yield of barley (*Hurdeom vulgar* L.) Bahman cultivar. Int. J. Adv. Biol.& Biomedical Res. 1(5): 538-546.

Chapman, H. D. and P.F. Pratt (1978). Method of analysis for Soil and water. 2nd Ed., Chapter, 17:150-161. Uni. Calif. Div. Agric. Sci. USA.

Chen, J. (2006). The combined use of chemical and organic fertilizers and/or biofertilizer for crop growth and soil fertility, International Workshop on Sustained Management of the Soil-Rhizosphere System for Efficient Crop Production and Fertilizer Use", Land Development Department, Bangkok, Thailand.

Eftekhari, S. A., M. R. Ardakani, F. Rejali, F. Paknejad and T. Hasanabadi (2012). Phosphorus absorption in barley (*Hordeum vulgare* L.) under different phosphorus application rates and co-inoculation of *Pseudomonas fluorescence* and *Azospirillum lipoferum***.** Ann. Biol. Res., 3(6): 2694-2702.

El- Gizawy, N. Kh. B. (2010). Effect of nitrogen biogas sludge manure and biofertilizer on grain, nitrogen up take and yield of wheat (*Triticum aestivum*, L.). Int. Conf. Agron., 1- 13.

Ewais, A. Magda, Awataf, A. Mohmoud and S. A. El-Sheikh (2010). Influence of organic, N-mineral and bio-fertilization on growth, yield and chemical composition of wheat plants. Minufya J. Agric. Res. 35(3): 1125-1146.

Gomez, A.K. and A.A. Gomez (1984). Statistical procedures for agricultural research. (2nd edition). John Wiley and Sons., New York.

Heidaryan, J. and A. Feilinezhad (2015). On the effect of biofertilizers on the yield and yield components of wheat (*Triticum aestivum*) under Eyvan climate condition biological Forum – An International J., 7(1): 581-585.

Jackson, M. L. (1973). Soil chemical analysis, Prentice Hall of India private limited, New Delhi, P. 498.

Kostadinova, S. (2014). Grain yield and protein of barley in dependence of phosphorus and potassium nutrition. Scientific Papers. Series A. Agronomy, Vol. LVII: 232-235

Lowther, G.R. (1980). Using of a single H_2So_4 - H_2O_2 digest for the analysis of Pinus radiate needles. Commun. Soil Sci. Pl. Analysis, 11: 175-188.

MARL (2014). Annual report of the central Administration of Agricultural Economics, Ministry of Agriculture and land Reclation Egypt.

Mehrvarz, S. and M.R. Chaichi (2008). Effect of phosphate solubilizing microorganisms and phosphorus chemical fertilizer on forage and grain quality of barely (*Hordeum vulgare*, L.). Am-Euras. J. Agric. &Environ. Sci., 3 (6): 855-860.

Mikhailouskaya, N. and I. Bogdevitch (2009). Effect of biofertilizers on yield and quality of long-fibred flax and cereal grains. Agrono. Res. **7**(Special issue I), 412–418.

Muraleedharan, H., S. Seshadri and K. Perumal (2010). "Biofertilizer (Phosphobactaria)", Shri Aam Murugappa chettiar research center taramani chennai.

Naseri, R., S. Azadi; M. J. Rahimi; A. Maleki and A. Mirzaei (2013). Effects of loculation with *Azotobacter Chroococcum* and *Pseudomonas Putid* on yield and some of the important agronomic traits in barley (*Hordeum vulgar,* L). Int. Journal Agron. & Pl. Prod. 4 (7): 1602-1610.

Page, A.L., R.H. Miller and D.R. Keeny (1982). Methods of soil analysis part 2 chemical and microbiological properties. 2^{nd} Ed. ASS. A-Midison Wise, U.S.A.

Radwan, F. I. and Wafaa H. M. Arifa (2009). Response of barley (*Hardeum vulgare*, L.) to organic nitrogen and biofertilization treatments. Alex. Sci., Exchange J. 30 (4): 471-479.

Regmi A.,J. Ladha, E. Pasuquin and M. Pathak (2002). The role of potassium in sustaining yields in a long-term rice wheat experiment in the Indo-Gangetic Plains of Nepal. Biol. Fert. Soils, 36:240–247.

Sharma, A., U. S. Rawat and B. K. Yadav (2012). Influence of phosphorus levels and phosphorus solubilizing fungi on yield and nutrient uptake by wheat under sub-humid region of rajasthan, India. Int. Scholarly Res. Network, Article ID 234656, 9 pages doi:10.5402/2012/234656

Tandon, H., (1995). Methods of analysis of soil, plants, waters and fertilizer, p: 144. Fertilizers Development and Consultation Organization, New Delhi, India.

Tigre, W., W. Worku and W. Haile (2014). Effects of nitrogen and phosphorus fertilizer levels on growth and development of barley (*Hordeum vulgare* L.) at Bore District, Southern Oromia, Ethiopia. Am. J. Life Sci.; 2(5): 260-266

Wilczewski, E., M. Szczepanek, T. Knapowski and E. Rosa (2014). The effect of dressing seed material with a humus preparation and foliar potassium fertilization on the yield and chemical composition of spring barley grain. Acta. Sci. Pol. Agric., 13(4):153-162.

Yosefi, K., M. Galavi, M. Ramrodi and S.R. Mousavi (2011). Effect of bio-phosphate and chemical phosphorus fertilizer accompanied with micronutrient foliar application on growth, yield and yield components of maize (Single Cross 704). Australian J. Crop Sci.*,* 5(2): 175-180.

Zareian, A. and S. A. Tabatabaei (2014). Field performance of three wheat cultivars under drought stress and potassium foliar application treatments. Electronic Journal of Biology, 10(3): 52-58.

الملخص العربي

تأثير التسميد البوتاسي والفوسفوري والحيوي علي إنتاجية الشعير

محمود أبوعجيلة علي رحومه , فتحي رضوان, محمود جمعة , إبراهيم فتح الله رحاب

قسم الإنتاج النباتي- كلية الزراعة (سابا باشا)- جامعة الأسكندرية

أجريت تجربتان حقليتان بالمزرعة البحثية بكلية الزارعة سابا باشا جامعة الإسكندرية خلال الموسمين ٢٠١٣/٢٠١٤،٢٠١٤/٢٠١٥ بهدف دراسة تأثير معدلات السماد الفوسفاتي والبوتاسي والمعاملة بالأسمدة الحيوية علي نمو وإنتاجية والتركيب الكيماوي لحبوب الشعير ذو الستة صفوف (*Hordeum vulgare*, L.) صنف جيزة ١٢٣وكانت المعاملات.

معاملات القطع الرئيسية

- عدم إضافة السماد الفوسفاتي (مقارنة).
- إضافة السماد الفوسفاتي بمعدل ٣٧.٢ كجم فو٢أ٥/هكتار.
- إضافة السماد الفوسفاتي بمعدل ٧٤.٤ كجم فو٢أ٥/هكتار.

معاملات القطع الشقية الأولي

- عدم إضافة السماد البوتاسي (مقارنة).
- إضافة السماد البوتاسي بمعدل ٥٧.٦ كجم بو٢أ/هكتار.
- إضافة السماد البوتاسي بمعدل ١١٥.٢ كجم بو٢أ/هكتار.

معاملات القطع الشقية الثانية

- عدم معاملة الحبوب بالسماد الحيوي (مقارنة).
- تلقيح الحبوب بالفوسفورين.
- تلقيح الحبوب بالبوتاس ماج .

أوضحت النتائج مايلي:

إضافة ٧٤.٢ كجم فو٢أ٥/هكتار أعطي أعلي معنوية لقيم المحصول ومكوناته (طول النبات، عدد الأشطاء/م٢، طول السنبلة ، عدد السنابل/م٢،وزن السنابل/م٢، عدد الحبوب بالسنبلة , وزن ١٠٠٠ حبة، محصول الحبوب (طن/هكتار)، المحصول البيولوجي(طن/هكتار)، دليل الحصاد وأيضاً النسبة المئوية للنيتروجين والفوسفور والبوتاسيوم والبروتين) في الحبوب , كما ادي اضافة ١١٥.٢كجم بو٢أ /هكتار الي زيادة في المحصول ومكوناته وكذلك في التركيب الكيميائي للحبوب , وادي معاملة الحبوب بالسماد الحيوي البوتاس ماج للحصول علي اعلي قيم للمحصول ومكوناته واعلي نسبة من البروتين والنتروجين والفوسفور والبوتاسيوم في الحبوب في كلا الموسمين. وتم الحصول علي أعلي محصول للحبوب ومكوناته وأفضل جودة ومحتوي من البروتين والنيتروجين والفوسفور والبوتاسيوم لحبوب الشعير ذو الستة صفوف صنف جيزة ١٢٣ وذلك عند معاملة الحبوب بالسماد الحيوي البوتاس ماج مع التسميد الفوسفاتي بمعدل ٧٤.٤ كجم فو٢أ٥/هكتار والبوتاسي بمعدل ١١٥.٢ كجم بو٢أ/هكتار في كلا الموسمين ٢٠١٣/٢٠١٤ , ٢٠١٤/٢٠١٥ وذلك تحت الظروف البيئية لمحافظة الأسكندرية.