Effect of Mineral, Organic and Bio- Fertilizer on Yield and Yield Components of Bread Wheat at Siwa Oasis

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Received on: 23/2/2016 *Accepted: 5/6/2016*

ABSTRACT

Two field experiments were conducted at El-Hag Ali region at west Siwa, Siwa Oasis, Matrouh governorate, during 2011/2012 and 2012/2013 growing seasons. The objective of this study was to investigate the effect of mineral, organic, and bio-fertilizer on yield and yield components of bread wheat to improve wheat productivity and minimizing pollution.

The study included three levels of organic fertilizer (10, 15, 20 m^3/fed of organic manure), two regimes of bio-fertilizer. (without bio-fertilizer and bio-fertilized with Microbein as Pseudomonas sp., Azotobacter sp., Azospiirillum sp., and B.megaterium), and two levels of mineral fertilizer(100% and 50% of recommended NPK fertilization levels) .Grain yield and its components i.e. plant height, number of tillers/m^2, number of spikes/m^2, number of spikelets /spike, number of grains/ spike, 1000 grain weight, straw and grain yields were significantly increased by adding bio- fertilizer compared to control in both seasons, respectively. The adding of mineral fertilizer at the rate 100 % of recommended dose of NPK mineral fertilizer and 20 m^3 /fed organic manure fertilizer resulted in significant increment in grain yield, plant height (cm), 1000 grain weight (g), number of spikes/m^2, number of tillers/m^2,number of spikelets/spike, and straw yield compared with rate 50% of recommended dose of NPK mineral fertilizer and the other two levels of organic fertilizer in both seasons.

The second order interaction between mineral, organic, and bio-fertilizer was significant for all characters under study in the first and second seasons, respectively.

The highest grain yield was obtained by using rate 100% NPK mineral fertilizer, 20 m^3/fed organic manure with adding bio-fertilizer in the first and second season, respectively.

Key words: wheat (*Triticum aestivum L.*), bio-fertilizer, organic manure, mineral fertilizer, grain yield.

INTRODUCTION

Wheat is the world most important and most widely grown cereal crop for its many properties and uses of its grain and straw. Increasing grain yield of wheat is an important goal to face the continuous increasing food needs of Egyptian population. Recently, a great attention of several investigations has been directed to increase the productivity of wheat to minimize the gap between the Egyptian production and consumption by increasing the cultivated area and wheat yield per unit area.

Maintaining soil fertility and use of plant nutrients in sufficient and balanced amounts is one of the key factors in increasing crop yield (Diacono *et al*., 2013). Nitrogen (N) is the most important nutrient supplied to most non– legume crops ,including wheat. The most important role of N in plant is its presence in the structure of protein and nucleic acids, which are the most important building and information substances of every cell. In addition, N is also found in chlorophyll that enable the plant to transfer energy from sunlight by photosynthesis. Thus, N supply to the plant will influence the amount of protein, amino acids, protoplasm and chlorophyll formed. Moreover, it influences the cell size, leaf area and photosynthetic activity (Daneshmand *et al.*, 2012, Diacono *et al.*, 2013 and Piccinin *et al.*, 2013). Therefore, adequate supply of N is necessary to achieve high yield potential in crops, N fertilizer is known to affect the number of tiller m^2 , number of grains /spike, spike length and weight, 1000 grain weight and grain yield of wheat (Kandil *et al.*, 2011 and Campuzano *et al.*, 2012).

Increasing and extruding the role of biofertilizer can reduce the need for chemical fertilizers and decrease adverse environmental effects. They can play significant role in fixing atmospheric N and production of plant growth promoting substances. Therefore, in development and implementation of sustainable agricultural techniques, bio-fertilizer has great importance in alleviating environmental pollution (Ibrahim *et al*., 2004, Suzan., 2007 and Namvar *et al.*, 2012) reported that the inoculation with bio-fertilization had significant effect on plant height, grain weight/spike, number of spikes/m^2, number of grains /spike, 1000 grain weight, grain and straw yields and crude protein percentage in wheat plants.

Organic fertilizers reduce pollution and sustain soil fertility through their effect on the physical,

chemical and biological properties of soil. Hossam El-Din (2007) indicated that the application of farmyard manure at different rates significantly increased yield and its components with increase of farmyard manure rate in all studied characters .He added that the use of organic fertilizer alone was not sufficient to meet the plant requirements of nutrients and application of bio-fertilizer would be necessary to enhance the role of organic fertilizer in reducing of applied chemical fertilizer, production costs and environmental pollution. The objective of this study was to investigate the effect of mineral, organic, and bio-fertilizer on yield and yield components of wheat, to improve wheat productivity and minimizing pollution under soil salinity conditions of Siwa Qasis

MATERIALS AND METHODS

Two field experiments were conducted at El-Hag Ali region at west Siwa, Siwa Oasis, Matrouh governorate, during 2011/2012 and 2012/2013 growing seasons. The objective of this study was to investigate the effect of mineral, organic, and bio-fertilizers application on yield and yield components of wheat, to improve wheat *(Triticum aestivum, L.)* productivity and minimizing pollution.

The experimental design was split –split plot design with three replications. The mineral fertilizers treatments were allocated in the main plots, organic fertilizers treatments were allocated to the sub plots, while the bio-fertilizer treatments were allocated to the sub –sub plots. The size of each sub-sub plot was $25m^2$, 5m long and 5m wide .Each experiment included 12 treatments which were three levels of organic fertilizer, two bio-fertilizer treatments and two mineral fertilizer treatments. The levels applied for each factor were as follows:

A-Mineral fertilizer:

1-M_1-Recommended dose(100%) of NPK fertilizers

2-M_2-(50%)of recommended dose of NPK fertilizers

B-Organic fertilizer:

Three levels of organic fertilizer (10 (O_1), 15(O_2), and 20 (O_3) m^3/fed.

C-Bio –fertilizer:

1- (B_1) Microbein bio-fertilizer (*Pseudomonas sp., Azotobacter sp., Azospiirillum sp., and B.megaterium*).

2- (B_0) Without bio- fertilizer

Physical and chemical characteristics of experimental site are presented in the following table:

Grains of Sakha- 93 wheat cultivar were used in both seasons, supplied by the Wheat Research Division, Agriculture Research Center. Ministry of Agriculture. Grain preparation by soaking in tap water for 24 hours followed by air drying. The grains were divided into two parts, the first one was without bio-fertilizer (control (B_0)), and the second was coated by microbein (B_1).

During land preparation, mineral fertilizers were added as follows: Super phosphate (15.5%P_2O_5) was applied before sowing at the rate of 150 kg/fed. (The recommended dose). Potassium fertilizer was applied before sowing (during seedbed preparation) at the rate of 50 kg/fed in the form of potassium sulphate (48%K_2O) (the recommended doses).Nitrogen fertilizer was added in three dose at a rate of 100 kg N/fed. (the recommended dose) where 20 kg N/fed were added at sowing time ,40 kg N/fed added at tillering stage (45 days after sowing)and the third dose (40 kg N/ fed) was applied 70 days after sowing. In the form of ammonium nitrate (33.5 % N).Organic fertilizer was applied at rates of 10, 15 and $20m^3$ /fed and mixed well with the soil two weeks before sowing. Sowing dates were November 30 and November 28 in both seasons, respectively, while seeding rate was 60 kg/fed .At harvest, the following characters were determined:

1-Numberof tillers/m^2

2-Number of spikes /m^2

3-Number of spikelets/spike as an average of 10 random spikes

4- Number of grains/ spike as an average of 10 random spikes

5- 1000 grain weight (g) average of two 1000- grain samples taken at random from each sub-sub plot

6- Grain yield (kg/fed) weight of grain harvested from $10m^2$ and converted to kg/ feddan

7- Straw yield (kg/fed) weight of straw harvested from $10m^2$ and converted to kg/feddan

8- Biological yield (kg/fed) total weight of plants harvested from $10m^2$ and converted to kg/feddan

Physical analysis		**Chemical analysis (meq L^{-1})**				**pH**	**E.C. ds/m**	**O.M%**	**SAR**
Coarse sand	94.28	Anions		cations		7.78	6.22	0.86	8.1
Silt and clay	5.72	CO_3^{--}	0.0	Ca^{++}	29.0				
Soil texture	Sandy	HCO_3^-	6.0	Mg^{++}	20.0				
		CL^-	40.0	Na^{++}	40.0				
		SO_4^{--}	44.7	K^+	1.7				

9- Plant height (cm) from soil surface to tip of plant, excluding awns, as an average of three readings from each sub-sub plot .
10- Spike length (cm) as an average of 10 random spikes
11-Crop index (%): Grain yield / Straw yield x 100
12- Harvest index (%): Grain yield/ Biological yield x100

Data obtained were exposed to the proper method of statistical analysis of variance to differentiate among means of different treatments as described by Gomez and Gomez (1984). The treatments means were compared using the least significant differences (L.S.D.) test at 5% level of probability.

RESULTS AND DISCUSSION

1-Effect of mineral fertilizers

Data presented in Table (1) revealed that plant height(cm),number of tillers/m^2, number of spikes/m^2, spike length, number of grains per spike ,number of spikelets / spike, 1000 grain weight ,grain yield, biological and straw yields, harvest index(%) and crop index(%),during the two growing seasons, were affected by adding mineral fertilizer. The adding of mineral fertilizer at the rate of 100% recommended dose NPK mineral fertilizers resulted in significant increment in yield and its components, compared with the rate of 50% of recommended dose in both seasons, except the harvest index which was not significantly affected in the second season. Increase in plant height may be due to stimulation of cell division and internodes elongation resulting from nitrogen application. Similar findings were reported by El-Ganbeehy *et al.* (2001), Abd El Hammed (2005),Tabl *et al.* (2005) and Abo-El-Ela (2006) who reported that increasing mineral N fertilizer significantly increased grain, straw, biological yields and harvest index. This increase in grain yield could be attributed to significant increase in number of spikes/m^2, spike length, number of spikelets/spike, number of grains /spike, and 1000 grains weight in both seasons. These finding are in agreement with those obtained by Ottoman e*t al.*,(2000) Sharshar *et al*. (2000), El-Ganbeehy *et al.* (2001) Moussa (2001); Tabl et *al.* (2005), Abo-El - Ela (2006) and Zeidan *et al.(*2009). In addition, the increase in grain yield and other studied traits could be due to the increase in dry weight of vegetative organs which may be considered as a criterion for photosynthetic efficiency of the plant. Similar results were obtained by Abo-EL-Ela (2001). In general, application of mineral fertilizer at the rate of 100% of recommended dose of NPK gave the highest values for grain yield and its components compared to the other level of application.

2-Effect of organic fertilizer:

With regard to the effect of organic fertilizer on yield and its components, the results given in Table (2), generally, showed that all characters under study were significantly affected by adding organic fertilizer. Results presented in Table(2) showed that the highest values of number of spikes/m^2, number of tillers/m^2, 1000 grain weight, straw, biological and grain yields (feddan) were obtained by treatment (O_3 organic fertilizer 20m^3/fed), in both seasons. Organic fertilizer (20m^3/fed) had marked effect on all mentioned characters, compared to other rates of organic fertilizer (10 and15 m^3/fed).The increment in yield and its components may be due to the increase in vegetative growth of plants and effects of organic fertilizer on enhancing root growth and dry matter accumulation. These results were in harmony with previous findings of Hosam EL-Din (2007) who reported that the application of farmyard manure at different rates significantly increased yield and its components. He added that organic fertilization reduce soil pollution and sustain soil fertility through their effect on physical, chemical and biological properties of soil. Sarwar (2005) found that grain yield and yield components of wheat were significantly increased with the application of different organic materials in the form of compost. Tayebeh *et al*. (2007) reported a positive effect of organic fertilizer on soil structure that lead to better root development and more nutrients uptake. They also concluded that compost not only slowly releases nutrients but also prevent the loss of chemical fertilizers through desertification, volatilization and leaching by binding to nutrients and releasing with the passage of time (Zeidan and El-Karmany 2001). Thus, it is very likely that when we apply enriched compost along with chemical fertilizers, compost prevent nutrient losses.

3-Effect of bio-fertilizer on wheat yield and its components

The results in Table (3) generally, showed that all characters under study were significantly affected by inoculation of wheat grains with Microbein when compared with the control treatment (without inoculation). Plant height at harvest, number of tillers /m^2, spike length, number of spikes/m^2, number of tillers/m^2, number of grains per spike,1000 grain weight, biological, straw and grain yields (feddan) of wheat plants were significantly increased with application of microbein bio- fertilizer compared to control (without bio-fertilizer). That may be attributed to better development of inoculated plants compared to non inoculated ones, creating a more favorable environment, in terms of nature and concentration of root exudates, for cell growth and metabolic activities of rhizospheric microorganisms or due to production of growth promoting substances such as indole acetic and gibberellic acids which positively affect plant growth.

Many investigators reported the positive effect of biofertilizer on those characters (Bashan, 2004, Ibrahim *et al.*, 2004; Tawfik and Gomaa, 2005, El-Esh, 2007 and Hosam El-Din,2007).

4-The effect of interaction between mineral, organic, and bio-fertilizer.

Since the three factor interaction was significant for all studied characters, it would be appropriate to discuss the effect of that second order interaction and disregarding the first order interactions even if they were significant.

Data in table(4) showed that, all studied characters, in the two growing seasons, were significantly affected by the interaction between the three studied factors, i.e., mineral fertilization level, amount of applied organic fertilizer and the application of bio-fertilizer. That implies the necessity for determining the best combined application level, from the three types of fertilizers, to obtain the highest value of the studied characters. However, the magnitude of interaction between the three factors was varied. For example, grain yield increased with increasing NPK application from 50 to100%of recommended dose and increasing organic fertilizer application up to $20m^3$ / fed in addition to application of bio-fertilizer. The effect of organic and bio-fertilizer application was pronounced under 50% compared to100%NPK applications, in both seasons, where the application of organic and bio-fertilizer gave an average increase of 28.9 and 39.3 kg/fed under 100% NPK, compared to 41.6 and 47.7kg/fed under 50% NPK, in the two growing seasons, respectively. The same trend could be observed in the other studied characters. That variation in response may be explained by the differential response of the plant to the type and availability of applied fertilizer. The increment in yield and its components may be due to the increase in vegetative growth of plants and these results may be due to response of wheat to environmental conditions and effects of fertilization package on enhancing root growth and dry matter accumulation. The previous finding were in harmony with those reported by several investigators who studied the interaction effect of mineral, organic and bio-fertilizer, in first order or second order, on wheat growth, development and productivity (El-Kholy and 2000, Kabesh and El-Karmany, 2008, Zaki *et al*.,2012 and Namvar and Khandan, 2013).

In conclusion, the present study indicated that application 100% NPK with 20 m^3 organic manure and application of the bio-fertilizer (microbein) gave the highest values for grain yield and other studied characters. However, application of the organic and bio-fertilizer gave values at 50% NPK comparable to that under 100% NPK fertilization. That may imply the possibility of replacing mineral fertilization with organic and bio-fertilization to improve soil fertility, reduce environmental pollution and mediate soil and water salinity in Siwa Oasis.

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الملخص العربى

تاثيرالتسميد المعدنى والعضوى والحيوى على محصول القمح ومكوناتة بواحة سيوة

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اقيمت تجربتان حقليتان بمنطقة الحاج/ على غرب سيوة– مركز سيوة– محافظة مطروح خلال الموسمين ٢٠١١/٢٠١٢ و٢٠١٢/٢٠١٣ لدراسة مدى تاثير كلا من التسميد المعدنى والعضوى والحيوى على انتاجية محصول القمح.

واشتملت معاملات الدراسة الاتى: (١)مستويين من التسميد المعدنى –١٠٠% من الكمية الموصى بها من NPK والمستوى الثانى ٥٠% من الكمية الموصى بها لتسميد القمح من NPK، (٢)ثلاث مستويات من التسميد العضوى ١٠، ١٥، ٢٠ م^{٣}/ فدان، (٣) معاملة البذور بالمخصب الحيوى(الميكروبين) وبدون معاملتها.

وكانت اهم النتائج كالاتى:

١- اظهرت النتائج ان هناك تاثير معنوى بين التسميد بالمعدل الموصى بة وهو ١٠٠% من التسميد المعدنى NPK وكل الصفات تحت الدراسة ومحصول القمح ومكوناتة كما ادى التسميد بالمعدل١٠٠% زيادة معنوية فى انتاجية الحبوب والقش والمحصول البيولوجى وبقية مكونات المحصول وكان أعلى قيمة لمحصول الحبوب ٦٢٨ كجم/فدان مع معدل التسميد الموصى بة ١٠٠%من التسميد المعدنى.

٢- واوضحت النتائج ان هناك زيادة معنوية لمحصول القمح ومكوناتة عند اضافة المستوى الثالث٢٠م^{٣}/ فدان من التسميد العضوى وكانت اعلى قيمة لمحصول الحبوب (٦٨٦ كجم /فدان) فى الموسم الاول مع المستوى الثالث ٢٠ م^{٣}/ فدان.

٣- واثبتت النتائج ان هناك زيادة معنوية فى محصول القمح ومكوناتة بمعاملة القمح بالمخصب الحيوى (الميكروبين) عنة بدون المعاملة.

٤- واظهرت النتائج ان التفاعل بين المعاملات الثلاثة وهى التسمد المعدنى والتسميد العضوى، والمعاملة بالمخصب الحيوى لة تأثير معنوى على كل صفات المحصول ومكوناتة تحت الدراسة اى هناك فرق معنوى بين كل الصفات تحت الدراسة فى كلا الموسمين.

٥- واثبتت النتائج ان افضل المعاملات كانت المستوى ١٠٠% من التسميد المعدنى الموصى به لتسميد القمح + ٢٠م^{٣} من التسميد العضوى + المعاملة بالمخصب الحيوى فى كلا الموسمين على التوالى.

٦- واوضحت النتائج ان الموسم الاول٢٠١١/ ٢٠١٢ كان افضل من الموسم الثانى ٢٠١٢/٢٠١٣ فى كافة نتائج المحصول ومكوناتة.