Impact of Sulfur, Nitrogen Application Methods and Biofertilization on Productivity and Quality of Wheat Crop

Radwan, F. I., I. E. Rehab*, G. Abdel Nasser ** and M. M. Ibrahim
*Plant Production of Department. Faculty of Agriculture Saba Basha, Alexandria University.
*Soil and Agricultural Chemistry Dept. Faculty of Agriculture Saba Basha Alexandria University.

ABSTRACT: Two field experiments were conducted at the Experimental Station Farm Facility of Agriculture (Saba-Basha) AlexandriaUniversity, Egypt during 2014/2015 and 2015/2016 seasons. The objective of this study was to investigation the effect of sulfur, nitrogen application methods and biofertilization on yield, components and chemical compositions of the Gemmeiza 9 wheat cultivar to improve wheat productivity and minimizing of pollution. The results could be summarized as follows. Applying sulfur at 400 kg/fed gave higher spike length, number of spikes/m2, weight of spike g/m2 , number of spikelets/spike, 1000- grain weight, grain, straw and biological yields (ton/fed) than 200kg/fed and untreated treatment in both seasons. Also, applying 400 kg/S/fed significantly surpassed untreated treatment for crude protein percentage, N, P and K percentages in both seasons. The addition of mixture nitrogen (soil + foliar) resulted in a significant increment in yield components and chemical composition of wheat grain in both seasons. Significant variation were recorded between the tested biofertilization on yield, yield components and chemical composition of wheat grain in both seasons A- mycorrhizal significantly surpassed uninoculation (control) for yield, yield components and chemical compositions in both seasons. Thus, it is possible to obtain maximum yield, yield components and chemical compositions of grain wheat through applying 400 kg S/fed, mixture nitrogen methods (Soil + foliar) and A- mycorrhizal inoculation (biofertilizer).
Key words: Nitrogen application method, sulfur levels, biofertilizer, yield, wheat quality.

INTRODUCTION

Wheat (Triticumaestivum, L.) is one of the most important crops used in human food and animal feed in Egypt. 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. Therefore, the local production of wheat grain (about 9.4 million tons) covers only 60% of the local consumption demand which reflect the need to import about 40% of wheat grains from abroad (FAO, 2013).

The role of sulphur and the importance of sulfur fertilization in the production of the major cereal crops, wheat and corn and in the high sulphur demanding oil crops have been examining work wide. Sulfur deficiency causes decreased N utilization and yield loss and decreased the baking value of the flour of cereal crops (Mars et al., 2006).

Nitrogen is important for plant growth however, plants have limited ability to extract them from the environment and these need microbes involved in "nutrient recycling" to help a plant uptake and absorb this nutrient of optimal concentration (Zakiet al., 2012).Foliar fertilization in a widely used practice to correct nutritional deficiencies in plant caused by improper supply of nutrient to roots (Ling and Silberbush, 2002).Increases were recorded in spike length, number of spikes/m2, number of grains/spike,1000- grain weight, grain and biological yields (ton)/fed with soil application (Gomaaet al., 2015).

Bio-fertilizers play vital role for increasing the number of microorganisms and accelerate certain microbial process in the rizosphere of inoculation soil plant which can change the available forms of nutrients into plants (Radwanet al., 2015).Arbuscularmycorrhizal (AM) fungi, forming symbiotic association with most economically important crop plant, can improve plant growth under low fertility condition and have affected a considered research to their agricultural potential use (Gomaaet al., 2011 and Radwanet al., 2014).

The aim of this investigation was designed to study the effect of sulfur, nitrogen application methods and biofertilization (A-mycorrhizal + Cerealin) on growth, productivity and quality of wheat crop.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm, Faculty of Agriculture (Saba Basha), Alexandria University, Egypt, during 2014/2015 and 2015/2016 seasons. The experiments were carried out to study the combined effect of sulfur, nitrogen application methods and biofertilization (A-mycorrhizal + Cerealin) on growth, productivity and quality of Gemmeiza 9 wheat cultivar (Triticumaestivum, L.).

The experimental design was split–split plot design with three replications. Sulfur levels were allocated in the main plot methods of nitrogen fertilizer application were allocated in the sub-plots and biofertilizer treatments were allocated in the sub-sub- plots. The size of each plot was 10.5 m2 (1/400 feddan) 3.5 m long and 3.0 m wide. Each experiment included 27 treatments which were the combination among three sulfur levels, three methods of nitrogen application and three biofertilizer treatments. The experimental treatments can be described as follows:

Sulfur levels
Untreated
200 kg Sulphur /fed
400 kg Sulphur/fed

Nitrogen application methods
Soil application
Foliar spraying
Mixture (Soil + foliar)

Biofertilizers
Uninoculation
A- Mycorrhizalbiofertilizer
Cerealinebiofertilizer

Nitrogen fertilizer was added at a rate of 100 kg N/fed (the recommended dose, for soil N application half dose of N was applied at sowing time while the remaining in three split dose. In case of soil were foliar application of 100 kg N/fed at two different stage i.e. half at sowing and half at second irrigation to the soil and foliar as well as mixture (Soil + Foliar) were used. In the two experiments N fertilizer added in the form of ammonium nitrate (33.5% N) super phosphate fertilizer (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 seed bed preparation at rate of 50 kg/fed in the form of potassium sulfate (48% K_2O) (The recommended dose).

The inoculation with Cerealine was performed by coating wheat grains with each product individually using a sticking substance (Arabic gum at 5%) just before planting inoculation of A- mycorrhizal fungi an inoculates for wheat grains with fungi (Glomusmacrarpium) strain from plant production Dept. (Saba Basha), Alex. Univ. at a rate of 250 ml of infected roots and was mixed with grains. The biofertilizers (Cerealine) which was produced by the General Organization for Agric. Equalization Ministry of Agriculture. Analyses of chemical and physical properties of the experimental soil (0- 30 cm) are shown in Table (1). The determination of soil physical and chemical analysis was carried out according to the methods reported by (Page et al., 1982).

Table (1).Some physical and chemical properties of the experimental soil during 2014/2015 and 2015/2016 seasons

Soil properties	2014/2015	2015/2016
A- Mechanical analysis		
Sand%	15.00	14.80
Clay%	42.00	42.20
Silt%	43.00	43.20
Soil texture	**Clay loam soil**	
B- Chemical analysis		
pH (1:1)	7.90	7.80
EC (1:1) dS/m	2.20	2.30
1- Soluble cations (1:2) (cmol/kg soil)		
K^+	0.95	0.96
Ca^{++}	4.15	4.20
Mg^{++}	3.20	3.25
Na^{++}	8.20	8.30
2- Soluble anions (1:2) (cmol/kg soil)		
CO^-_3+ HCO^-_3	2.80	2.70
CL^-	11.50	11.70
SO^-_4	0.50	0.52
Calcium carbonate (%)	7.70	7.80
Organic matter (%)	1.40	1.42
Total nitrogen (mg/kg)	1.00	0.91
Available Phosphorus (mg/kg)	3.70	3.55
Available K (mg/kg)	120.4	1240.6

At harvest one square meter was taken randomly from each sub- sub plot for the last two replication to determine yield and its components.

A- Yield and its components
Spike length (cm)
Number of spikes/m^2
Weight of spikes/m^2 (g)
Number of spikelets/spike
1000- grain weight (g)
Grain yield (ton)/ha
Straw yield (ton)/ha
Biological yield (ton)/ha

B- Grain quality

Powder of grains taken at harvest was wet- digested with H_2SO_4- H_2O_2 digest (Lowther 1980) and the following determinations were carried in the digested solution.

1-Total nitrogen content (%): the Micro- Kjeldahl method was used to determine the total nitrogen in the grain.
2-Phosphorus content percentage: Was determined by using the methods described by John (1970).
3-Potassium content percentage: Was determined photometrically by using a Flam Photometer Model corning as described by Johnson and Ulrich (1959).
4-Grain protein percentage: The total nitrogen in the grain multiplied by 5.75 to obtain percentage of crude protein according to A. O. A. C. (1980).

Data obtained were exposed to the proper method of statistical analysis of variance as described by Gomez and Gomez (1984). The treatments means were compared using the least significant differences (L.S.D.) test at 0.05% level of probability.

RESULTS AND DISCUSSION

A- Yield and its components:

Data presented in Tables (2 and 3) showed that spike length, number of spike/m^2, weight of spikes (g/m^2) number of spikelets/spike, 1000- grain weight (g), grain, straw and biological yields (ton/fed) during the two growing seasons were significantly affected by adding sulfur fertilizer levels. Application sulfur at 400 kg/fed caused a significant increase in yield and its components as compared with the other treatments. The S content in plant increases and the plant will accumulate more nutrients in reach the balance between cations and anions. Therefore, push the plant to give the best dry matter and length of roots which offer the plant to absorb more nutrients and assimilate the bio chemical processes by plant. Similar results were reported by Nassaret al. (2014), Zakaria (2004), Mars et al. (2006) and Mahmoud (2008).

Yield and yield components of wheat plant as affected by nitrogen fertilizer application methods described that nitrogen fertilizer application had significantly affected the yield and its components Tables (2 and 3). Data showed that the highest all yield and its components i.e. spike length, number of spike/m^2, weight of spikes/m^2, number of spikelets/spike, 1000- grain weight (g), grain, straw and biological yields (ton/fed), were observed in mixture nitrogen application (soil + foliar) It could be due to mixture application (soil + folair) of nitrogen at yield and its components of improving the ability of grain for best vigor, viability and among source – sink relationship to minimize application of N resulted the best grain yield of wheat (Saeedet al., 2012). Similar results, more or less were obtained by El- Shaarawy (2003), Saleh (2003), Hussein (2005), Bakhatet al (2010) and Gomaaet al (2015).

Inoculation of biofertilizers significantly increased, spike length, number of spike/m^2, weight of spikes (g/m^2), number of spikelets/spike, 1000- grain weight, grain, straw and biological yields (ton/fed) in both seasons. Hence, the highest yield and its components were recorded with inoculation A- mycorrhiazl as compared to other treatments. It could be concluded that inoculation of wheat grain with biofertilizers encourages the increase of yield and its components. This may be due to the effect of biofertilization which plays an important role in the assimilation of wheat plants that reflected on enhancing this characteristic. Also, this could be attributed to the role of plant phytohormones like IAA, GAs and CKs which promote plant growth cell division, breaking the special dominances, hence encouraging the photosynthesis and assimilates accumulation (Abdel- Allaet al., 2007). Many investigators reported the positive effect of biofertilization on these characters, Basha (2004), Ibrahim et al. (2004), El-Esh (2007), Zakiet al. (2007), Gomaaet al. (2011) and Radwanet al. (2015).

The effect of the interaction between sulfur levels and nitrogen application methods on spike length, number of spike/m^2, weight of spikes g/m^2 , number of spikelets/spike, 1000-grain weight (g) , grain, straw and biological yields (ton/fed) were significant (Tables 2 and 3) in both growing seasons. Applying sulfur at 400 kg/fed with application nitrogen mixture (soil + foliar) gave the highest values of yield and its components in the first and the second seasons.

The effect of interaction between sulfur levels and biofertilizers was significant for yield and its components Tables (2 and 3). However, the highest values of yield and its components were obtained by applying sulfur at 400 kg/fed with A- mycorrhizal inoculation in both seasons.

The effect of interaction between nitrogen application methods and biofertilizer was significant for all yield and its components in both seasons.
Second order interaction among three factors was significant for all yield and its components in the two growing seasons Tables (2 and 3). Applying sulfur at 400 kg/fed and nitrogen application mixture (soil + foliar) with A-mycorrhizal inoculation gave the highest values of yield and its components of wheat plant.

B- Grain quality

The obtained results recorded in Table (4) revealed that crude protein in grains and percentages of nitrogen, phosphorus, potassium were significantly affected by adding sulfur levels.

The highest values of crude protein and all chemical composition characters were obtained by applying sulfur at 400 kg/fed while, the lowest one were recorded by untreated treatment in both seasons. The positive impacts of sulfur levels on wheat crop production and its elemental composition are mainly due to improving the soil physical, chemical and biological properties and preparing the suitable bed of germination and development of plant growth, that effect on the resultant yield (Nassaret al., 2014). These results are in agreement with Azersohaiet al. (2000), Mahmoud (2008) and Muftah (2011).

Data showed in Table (4) revealed that crude protein percentage N, P and K content in grain were affected significantly by nitrogen application methods in both seasons. The highest mean value of crude protein percentage and all chemical composition were obtained by soil application than foliar spraying in both seasons. The present results are in line with those obtained by Hassanein (2001), Arifet al. (2006), Khan et al. (2006) and Zeidanet al. (2010).

The highest value of crude protein (%) and all chemical composition i.e. N, P and K content in grain with mixture of nitrogen application methods (soil + foliar) fertilizer, while the lowest one was recorded by foliar spraying in both seasons, Table (4). This may be attributed mainly to the vital physiological roles in plant cell which root up take of plant nutrition (Arifet al., 2006).

Table (2).Wheat yield and its components as affected by sulfur levels, nitrogen application methods and biofertilization during 2014/2015 and 2015/2016 seasons

Treatments	Spike length (cm)		Number of spikes/m^2		Weight of (g) spikes/m^2		Number of spikelets/spike	
	2014/2015	**2015/2016**	**2014/2015**	**2015/2016**	**2014/2015**	**2015/2016**	**2014/2015**	**2015/2016**
A) Sulfur levels								
Untreated	11.31 c	12.58c	212.74c	230.38c	304.26c	337.79c	28.27c	31.47c
200 kg/fed	12.17 b	13.50b	240.57b	٢٦٧.31b	400.57b	433.95b	31.75b	35.26b
400 kg/fed	12.97 a	14.42a	266.12a	295.83a	520.00a	578.02a	36.29a	40.33a
L.S.D. (0.05)	**0.52**	**0.55**	**10.70**	**11.50**	**9.80**	**10.5**	**2.60**	**2.40**
B) Nitrogen application methods								
Soil application	12.23 b	13.62b	237.8b	263.42b	414.23b	460.42b	31.99b	35.36b
Foliar spraying	11.37 c	12.63c	220.26c	238.70c	367.76c	397.48c	29.14c	32.37c
Soil + Foliar	12.84 a	14.24a	261.29a	291.39a	442.82a	492.04a	35.15a	39.06a
L.S.D. (0.05)	**0.53**	**0.55**	**10.60**	**11.50**	**9.90**	**10.6**	**2.60**	**2.45**
C) Biofertilization								
Uninoculation	11.34 c	12.58c	209.48c	226.73c	334.16c	371.40c	29.17c	32.43c
A-mycorrhizal	12.90 a	14.32a	269.73a	299.45c	474.00a	515.58a	35.40a	39.26a
Cerealine	12.19 b	13.59b	240.08b	265.64b	416.44b	462.94b	31.76b	35.40b
L.S.D. (0.05)	**0.50**	**0.54**	**10.2**	**11.30**	**8.40**	**9.50**	**2.05**	**2.00**
Interactions								
AxB	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*
AxBxC	*	*	*	*	*	*	*	*

Mean followed by the same letter (s) in each column are not significantly differed at 0.05 level ofprobability

Table (3).Cont.

Treatments	1000- grain weight (g)		Grain yield (ton/fed)		Straw yield (ton/fed)		Biological yield (ton/ fed)	
	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
A) Sulfur levels								
Untreated	40.92c	45.83c	4.24b	4.69b	6.47c	7.18c	10.68c	11.87c
200 kg/fed	46.10b	51.22b	4.33b	4.88b	7.42b	8.21b	11.88b	13.06b
400 kg/fed	49.18a	54.48a	5.35a	5.92a	7.67a	8.45a	12.93a	14.37a
L.S.D. (0.05)	**2.80**	**3.10**	**0.40**	**0.30**	**0.22**	**0.20**	**0.45**	**0.50**
B) Nitrogen application methods								
Soil application	45.19b	50.27b	4.69b	5.28b	7.39b	8.22b	12.19b	13.42b
Foliar spraying	40.37c	45.19c	4.19c	4.62c	6.53c	7.21c	10.65c	11.83c
Soil + Foliar	50.60a	56.06a	5.10a	5.67a	7.64a	8.41a	12.65a	14.06a
L.S.D. (0.05)	**2.70**	**3.10**	**0.41**	**0.30**	**0.22**	**0.21**	**0.45**	**0.50**
C) Biofertilization								
Uninoculation	40.49c	44.98c	3.67c	4.07c	6.82b	7.66b	10.53c	11.71c
A-mycorrhizal	50.16a	56.08a	5.51a	6.13a	7.92a	8.79a	13.43a	14.91a
Cerealine	45.54b	50.45b	4.77b	5.29b	6.70b	7.42a	11.53b	12.68b
L.S.D. (0.05)	**2.20**	**2.60**	**0.35**	**0.28**	**0.18**	**0.20**	**0.40**	**0.43**
Interactions								
AxB	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*
AxBxC	*	*	*	*	*	*	*	*

Mean followed by the same letter (s) in each column are not significantly differed at 0.05 levels of probaility

Data in Table (4) indicated that crude protein and percentages of nitrogen, phosphours potassium increased significantly by inoculation of wheat grain with biofertilizer during the two seasons. The maximum increment was obtained by A-Mycorrhizal followed by cerealine. The increment percentages attained were 12.64- 15.56% and 11.24- 12.50 for crude protein, 2.00- 2.19 and 1.81- 2.00 for N%, 0.614- 0.683 and 0.553- 0.619 for P% and 2.20 – 2.40 and 2.00- 2.23 for K in the two seasons for treatment A-mycorrhizal and cerealine compared with Uninoculation (control) treatment. This may be due to the role of dissolving phosphate and nitrogen fixation bacteria on increasing the endogenous phytohormons (IAA, GAs and CKs) which play an important role in formation a big active root system, increasing the nutrients uptake and photosynthesis rate and translocation as well as accumulation within different plarts(El- Khawas, 1990).This results are in agreement with those obtained by Hussein and Radwan (2002) Shomanet al (2006) Zakiet al. (2007), Abo-Marzoka (2009) Gomaaet al. (2011) and Radwanet al. (2015).

Data in Table (4) clear that the applying sulfur at 400 kg/fed with application of mixture nitrogen (soil + foliar) gave the highest values of crude protein and all chemical composition as illustrated in Table (4). That the effective treatment of crude protein and all chemical composition in two seasons were obtained from applying sulfur at 400 kg/fed with A- mycorrhizal inoculation in both seasons.

Data in Table (4) showed that the effect of interaction between nitrogen application methods with biofertilization on crude protein and all chemical compositions in both seasons. It is clear from data in Table (4) that there is a high significant increase for all treatments compared with the non- inoculation with foliar spraying in the interaction effect on all studied chemical composition. The highest values of crude protein and all chemical compositions were recorded by using the sulfur application at 400 kg/fed and mixture nitrogen (soil + foliar) with A- mycorrhizal inoculation in both seasons.

Table (4).Protein percentage and chemical composition (N, P and K %) as affected by sulfur levels, methods of nitrogen application and biofertilization during 2014/2015 and 2015/2016 seasons0.

Treatments	Protein content (%)		Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
A) Sulfur levels								
Untreated	10.22c	11.32c	1.63c	1.82b	0.482c	0.537c	1.61b	1.75b
200 kg/fed	10.89b	12.13b	1.76b	1.91b	0.541b	0.605b	1.78b	1.97b
400 kg/fed	13.10a	14.34a	2.09a	2.32a	0.623a	0.692a	2.60a	2.83a
L.S.D. (0.05)	**0.60**	**0.75**	**0.12**	**0.13**	**0.042**	**0.060**	**0.25**	**0.23**
B) Nitrogen application methods								
Soil application	11.37b	12.63b	1.82b	2.00b	0.546b	0.608b	1.97b	2.19b
Foliar spraying	10.39c	11.48c	1.67c	1.85c	0.499c	0.558c	1.81b	2.01b
Soil + Foliar	12.53a	13.67c	1.97a	2.19a	0.601a	0.668a	2.17a	2.36a
L.S.D. (0.05)	**0.60**	**0.70**	**0.11**	**0.13**	**0.042**	**0.060**	**0.24**	**0.23**
C) Biofertilization								
Uninoculation	10.33c	11.40c	1.65c	1.84c	0.479c	0.533c	1.74c	1.93c
A-mycorrhizal	12.64a	15.56a	2.00a	2.19a	0.614a	0.683a	2.20a	2.40a
Cerealine	11.24b	12.50b	1.81b	2.00b	0.553b	0.619b	2.00b	2.23b
L.S.D. (0.05)	**0.50**	**0.65**	**0.10**	**0.11**	**0.040**	0.55	**0.19**	**0.15**
Interactions								
AxB	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*
AxBxC	*	*	*	*	*	*	*	*

Mean followed by the same letter (s) in each column are not significantly differed at 0.05 levels of probaility

REFERENCES

A.O.A.C. (1980). Officinal Methods of Analysis Assocition of Agricultural Chemists 1 sted Washington . D.C.U.S.A.

Abdel-Alla, Y. S. A., S .A. Taha, M. A. Mohamad and M. F. Abdel-Ghany (2007). Effect of inoculation with vesicular- ArbusaularMycorrhizae fungi and phosphate solubilizing bacteria, on growth and phosphorus uptake of wheat plant J. Agric. Sci. Mansoura Univ.,32 (6): 5048-5061**.**

Abo- Marzoka, S. A. M. (2009). Response of some wheat cultivars to biofertilization.Ph. D. Thesis.Fac. of Agric. Kafr El-Sheikh, Univ., Egypt.

Arif, M., M. A. Khan, H. Akbar and S. Ali (2006). Response of wheat as dual purpose crop and its impact on weeds. Pak. J. Weed Sci. Res., 12 (1-2) 15-17.

Azersohai, A.A., M. Awad, J. G. Sakdek, F. A. Khalil and E. M. A. El-Aggory (2000).A comparative study on the effect of elementals and biophosphatic fertilizer on the response of faba been (Viceafaba, L.) to P fertilization. Egypt J. Appl. Sci., 18 (7): 324- 363.

Bakhat, J., M. Shafi, M. Zubair, M. Aman and Z. Shah (2010). Effect of foliar Vs soil application of nitrogen on yield and yield components of wheat varieties. Pak. J. Bot., 42 (2): 2737- 2745.

Basha, M. B. I. (2004). Agronomic studies on wheat. M.S. Thesis. Agric. Tanta Univ., Egypt.

El- Khawas, H. M. (1990). Ecological studies on a symbiotic N_2- fixing bacterium in soil and rhizoshphere of certain plants. M. Sc. Thesis Fac. Agric. Cairo Univ.

El- Shaarawy, G. A. M. (2003). Evaluation of some new wheat cultivars under some agricultural treatments. Ph. D. Thesis, Fac. Agric. Al- AzharUniv..

El-Esh, I. F. I. (2007). Effect of both mineral and biofertilization on yield and quality of wheat Ph. D. Thesis Fac. Agric. Alex. Univ., Egypt.

FAO, (2013).FAOSTAT database collections. Food and Agriculture Organization of the United Nations. Rome. Access date: 2013-04-22. URL: http://faostat.fao.org.

Gomaa, A. A., N. M. Zaki, F. I. Radwan, M. N. Hassanein and A.M. Wali (2011). The combintion effect of mineral.organic and bio- fertilizers on growth of some wheat cultivars. J. Appl. Sci. Res., 7 (11): 1591- 1608**.**

Gomaa, M. A., F. I. Radwan, E. E. Kandil and Seham M. A. El- Zweek (2015). Effect of some macro and micro nutrients application Methods on productivity and quality of wheat (Triticumaestivum, L.). Middle East J. Agric. Res., 4: 1-11.

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

Hassanein, M. S. (2001). Effect of variety and nitrogen levels on growth, yield and compounds of wheat (Triticumaestivum, L.) in newly cultivated land. Egypt J. Agron., 23 (1): 111- 131.

Hussein, H. F. and S. M. A. Radwan (2002). Effect of biofertilization with different level of nitrogen and phosphorus on wheat and associated weeds under weed control treatments, Paki J. of Biological Sci., 1 (4): 435- 441.

Hussein, S. M. A. (2005). Effect of supplemental irrigation, seeding rates and folair application element on productivity under rainha conditions.Bult.Fac. of Agric. Cairo Univ., 56 (3). 431- 453.

Ibrahim, E. M., S. A. A. Bassal and M. M. A. Badr (2004). Effect of tillage systems, biofertilization and spraying urea on wheat productivity.Zagazig. J. Agric. Res., 31 (2): 491- 507.

John, M.K. (1970). Colorimetric determination of phosphorus in soil and plant materials with ascorbic acid. Soil Sci., 109(4):214–220

Johnson,C.M.andA.Ulrich (1959). Analytical Methods For use plant analysis.U.S.Dept. Agric., California Agric. In form Bull.766.

Khan, M. Z., S. Muhammed, M. Naeem, A. E. A. Khatar and Khaild (2006). Response of some wheat (Triticumaestivum, L.) varieties to foliar application under rainfed conditions.Pak. J. Bot., 38 (4) 1027- 1034.

Ling, F. and M. Silberbush (2002). Response of maize to foliar vs. soil application of nitrogen, phospourus–potassium fertilizer. J. plant Nutr., 25: 2333- 2342.

Lowther. J.R.(1980). Useof singleH_2SO_4 and H_2O_2 digest for the analysis of Pinus radiate seedless. Com. Soil Sci. Plant analysis,(11):173-188.

Mahmoud, N. A. F. (2008). Effect of urea fertilization and sulfur application as soil amendment on growth, quality and chemical composition of wheat. M. Sc. Thesis. Fac. Agric. (Saba Basha) Alex.Univ.

Mars, E., P. Sipos, A. Toth and Z. Gyori (2006). Quality and yield of winter wheat sulfur content formulations. Cereal Res. Comm. 34 (1): 577- 580.

Muftah, M.K. (2011). Effect of biofertilization and sulfur application on barley grown in salt affected soils. M. Sc. Thesis, Fac. Agric. (Saba Basha) Alex. Univ.

Nassar, K. E.M.; M. M. El- Shoung and E. M. K. Behiry (2014).Improving the quality and quality of wheat in salt affected soil.Zagazig J. Agric. Res., (31) (6): 2861- 2883.

Page, A. L., R. H. Miller and D. R. Keenny (1982). Methods of soil analysis 2nd .American Society of Agronomy Madison.WI. USA.

Radwan, F. I., M. A. Gomaa, E. E. Kandi and Samira A. Adam (2015). Influence of humic acid, foliar application of micro nutrients and biofertilization on growth. Productivity and quality of wheat Middle East J. Agric. Res. 4(1):12-23

Radwan, F. I., M. A. Gomaa, M. A. Nasser, E. E. Kandil and S. F. Lamiom (2014). Effect of sowing methods and bio- organic fertilization on growth, yield and yield components of wheat (Triticumaestivum, L.). J. Agric. Biol. Sci., 9 (1): 70 – 78.

Saeed, B., H. Gal, A.Z. Khan, L. Parveen, N. I. Badshah and A. Khan (2012). Physiological and quality assessment of wheat (Triticumaestivum, L.) cultivers in response to soil and foliar fertilization of nitrogen and sulfur.Arpnl Agric. Biol. Sci., 7 (1): 121- 129.

Saleh, M. E. (2003). Response of Egyptian and Mexican wheat cultivar to different nitrogen fertilization levels under U.S.A. conditions. Zagazig J. Agric. Res., 30 (4)1203- 1221.

Shoman, H. A., A. M. Abo- Shataia, K. A. El- Shouny and M. A. Abdel-Gawad (2006). Effect of biological and organic fertilization on yield and its components of two wheat cultivars under Al-Wadi.Al-Gadeed condition. Alex. J. Agric. Res.,51: 49- 65.

Zakaria, Sahar, A. (2004). Biochemical studies on wheat plant. Ph. D. Thesis, Fac. Agric. Cairo. Univ., Egypt.

Zaki, N. M., M. A. Gomaa; F. I. Radwan, M. S. Hassanein and A. M. Wali (2012). Effect of mineral, organic and biofertilizers on yield, yield components and chemical composition of some wheat cultivars. J. Appl. Sci. Res., 8 (1): 174- 196.

Zaki, N. M., M. S. Hassaein and K. M. Gamal El- Din (2007). Growth and yield of some wheat cultivars irrigated with saline water in newly cultivated land as affected by bio- fertilization J. Appl. Sci., 1121-1162.

Zeidan, M. S., Manal, F. Mohamed and H. A. Hamouda (2010). Effect of foliar fertilization of Fe,Mn and Zn on wheat yield and quality in low sandy soils fertility. World J. Agric. Sci., 6 (6): 696- 699.

الملخص العربي

تأثير الكبريت وطرق إضافة النتروجين والتسميد الحيوي على الإنتاجية والجودة لمحصول القمح

***فتحي رضوان*إبراهيم فتح الله رحاب **جمال عبد الناصر خليل*محمد المهدي ابراهيم**

*قسم الإنتاج النباتي . كلية الزراعة سابا باشا . جامعة الإسكندرية . مصر

** قسمالأراضي و الكيمياء الزراعية– كلية الزراعة سابا باشا . جامعة الإسكندرية . مصر

أجريت تجربتان حقليتان بمزرعة كلية الزراعة (سابا باشا)– الإسكندرية – مصر أثناء موسمي النمو ٢٠١٤/٢٠١٥، ٢٠١٥/٢٠١٦ وكان الهدف من الدراسة تأثير الكبريت وطرق إضافة النتروجين والتسميد الحيوي على المحصول ومكوناته والمكونات الكيميائية في صنف قمح جميزة ٩ لتحسين إنتاجية القمح وتقليل التلوث.

ويمكن تلخيص أهم النتائج فيما يلي:

أدى إضافة الكبريت عند ٤٠٠ كجم/فدان الى زيادة معنوية في طول السنبلة، عدد السنابل/م٢ ووزن السنابل (جم/م٢) ، عدد السنيبلات/سنبلة، وزن ألف حبة، محصول الحبوب، والقش والمحصول البيولوجي (طن/فدان) مقارنة بالمعاملة بمعدل ٢٠٠ كجم/ فدان والمعاملة الغير مسمدة بالكبريت في كلا الموسمين. إضافة ٤٠٠ كجم كبريت/فدان تفوق معنوياً على المعاملة بدون إضافة في محتوى البروتين كنسبة مئوية، والنسبة المئوية للنتروجين والفوسفور والبوتاسيوم في كلا الموسمين. ادى طرق إضافة خليط من النتروجين (أرضي + رشاً) زيادة معنوية في المحصول ومكوناته والمحتوى الكيماوي لحبوب القمح في كلا الموسمين. تفوق التلقيح بالميكلوريزا معنوياً مقارنة بالمعاملة الغير ملقحة (كنترول) او المعاملة بالسريالين في المحصول ومكوناته والمكونات الكيميائية في كلا الموسمين. إضافة ٤٠٠ كجم كبريت/فدان مع خليط من طرق إضافة النتروجين (أرضي + رشاً) مع التلقيح بالميكوريزا كتسميد حيوي ادى الى زيادة معنوية في المحصول ومكوناته للقمح صنف جميزة ٩.