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Response of some Wheat Varieties to Humic Acid, Mineral and Biofertilization on Productivity and Quality

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ABSTRACT

Two field experiments were conducted at the experimental station farm of Agriculture (Saba Basha), Alexandria University, Egypt, during 2012/2013 and 2013/2014 growing seasons. The objective of this study was to investigate in three wheat cultivars in improve productivity and minimizing pollution. The results could be summarized in follows: Sakha 94 cultivar gave higher number of tillers/m^2, number of spike/m^2, number of spikelets/spike, 1000-grain weight, grain, straw and biological yields tons/fed., than Misr 1 and Giza 168 cultivars in both seasons. Also, Sakha 94 cultivar significantly surpassed Giza 168 and Misr 1cultivars or crude protein percentage, nitrogen content (%), phosphorus (%) and potassium content (%) in both seasons. The addition of mineral and humic acid at rate of half recommend dose of mineral with 2 kg humic acid resulted insignificant increment in yield components, grain protein (%) and chemical compositionof wheat grains in both seasons. Inoculation A- Mycorrhizal + 7.5 P_2O_5/fed., gave the highest values of yield, yield components and chemical compositions of wheat grain in both seasons. The effective treatments for number tillers/m^2, number of spike/m^2, number of spikelets/spike, 1000-grain weight, grain, straw and biological yields tons/fed., were obtained from Sakha 94 cultivar with adding the half recommend dose with 2 kg humic acid in both seasons. The effective treatments for grain protein (%), nitrogen content (%), phosphorus content (%) and potassium content (%) in both seasons were obtained from Sakha 94 cultivar with inoculation A- Mycorrhizal + 7.5 P_2O_5/fed. (Feddan=4200 m^2).

Key words: Wheat, humic acid, biofertilization , mineral, yield, components, chemical, composition

Introduction

Wheat (*Triticum aestivum*, 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.

Humic acid is an organically charged bio-stimulant that significantly affects plant growth and development and increases crop yield. It has been extensively investigated (Nardi *et al*., 2004) that humic acid improves physical (Varanini *et al*., 1995), chemical and biological properties of soils (Mikkelsen, 2005). The role of humic acid is well known in controlling, soil-borne diseases and improving soil health and nutrient uptake by plants, mineral availability, fruit quality, etc (Mauromicale *et al.,* 2011).

Humic acid based fertilizers increase crop yield (Mohamed *et al*., 2009), stimulate plantenzymes/hormones and improve soil fertility in an ecologically and environmentally benign manner (Mart, 2007).

The total biomass is a result of the investigation of metabolic reaction in the plants consequently; any factor influencing the metabolic activity of the plant at any period of its growth can affect the yield. Metabolic processes in wheat plants are greatly governed by both internal i.e. genetic makeups of the plant and external conditions which, namely climatic and edaphically environmental factors. Thus, increasing wheat production per unit area can be achieved by breeding and cultivating the promising wheat cultivars and applying the optimum cultural practices El-Esh (2007), Hafez (2007), Koreim (2008) and Abo-Marzoka (2009).

Nutrition is essential for plant life and yield, therefore, mineral fertilization is a common agronomic practice that leads to improve productivity, but with the steadily increasing prices of chemical fertilizers, especially, nitrogen and potassium fertilizers and the pollution problems of soil and water, the humic acid have been found to a profound effect on not only the biological activity and soil structure but also, on the plat as self, this is due to their positive effect on the increment in plant nutrients and their availability to the growth plants (El-Kalla*et al.* (2002) and Salib, 2002).

Mycorrhizal and phosphorein are recognized as a biofertilization product containing active phosphate solubilising bacteria and fungi, so they could be used to enhance the solubility of phosphorus and to facilitate the uptake of phosphorus by plants, moreover, such biofertilization product plays an important role in supplying growth plants with available forms of phosphorus by its capability of producing organic and inorganic acids and

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CO_2, biofertilizers were effective in increasing N, P and K percentages in leaves, as well as, the total carbohydrate (Abdel-Rasoul *et al.,* 2003 and AbdAlla *et al.,* 2007).

Therefore, this investigation aimed to study the response of some wheat varieties to humic acid, mineral and biofertilization on productivity and quality.

Materials and Methods

Two field experiments were conducted at the experimental farm of the Faculty of Agriculture (Saba Basha) at abbes, Alexandria University during 2012/2013 and 2013/2014 seasons. The experiments were carried out to study the response of some wheat varieties to humic acid, mineral and biofertilization on productivity and quality.

The experimental design was split- split plot design with three replicates. Wheat cultivars (Misr 1, Sakha 94 and Giza 168) were allocated in the main plots, both mineral and humic acid fertilizers (48 K_2O + 60 kg N/fed., 24 kg K_2O + 30 kg N/fed + 2 kg humic acid/fed., 12 K_2O + 15 kg N/fed + 4 kg humic acid/fed.) were allocated to the sub-plots and mineral-biofertilization phosphorus (Uninoculation +15 kg P_2O_5/fed., Mycorrhizal +15 kg P_2O_5/fed., Phosphorein + 7.5 kg P_2O_5/fed.) was allocated in the sub-sub plots. The size of each plot was (10.5 m^2) (1/400 feddan), 3.5 long and 3.1 m wide.

Nitrogen fertilizer was added at rate 60 kg N/fed. (the recommended dose) where 20 kg N/fed was added at sowing time, 20 kg N/fed., added at the first irrigation (25 days after sowing) and the third dose 20 kg N/fed., were applied 25 days after the first irrigation. In the two experiments N fertilizer was added on the form of urea (46%N), super phosphate fertilizer (15 kg P_2O_5/fed.) was applied before sowing at rates of 15 kg P_2O_5/fed and 7.5 kg P_2O_5/fed, potassium fertilizer was applied before sowing (during seedbed preparation) at rate of 48 kg/fed in the form of potassium sulphate (48% K_2O) (the recommended dose), the humic acid from K-humate of rates 2 kg and 4 kg.

The three inoculation treatments were uninoculated, Phosphorein and Mycorrhizal which were irrigated in the sub-sub plots. Inoculation with phosphorein of *Bacillus megatherium var. phosphaticum* dissolving was performed by coating *triticum aestivum* grains with each product individually using a sticking substans at a rate 200 gm (Arbic gum 5%) just before sowing. The bio-fertilizer wasproducted by general organization for Agricultural Equalization Ministry of Agriculture and land-redamation, Egypt (Abou-El-Naga, 1993). A-Mycorrhizal fungi *Glomus macrocarpum* strain was obtained from the plant production Dept., the Faculty of Agriculture (Saba Basha), Alexandria Univ. at rate of 250 ml-infected roots and was mixed with the soil.

Soil samples of the experimental sites were taken at the depth of (0-30 cm). Physical and chemical analysis are presented in Table (1) was done according to Chapman and Pratt (1978).

Table 1: Some Physical and chemical properties of the experimental soil in 2012/2013 and 2013/2014 seasons.

Soil properties		
	season	
	2012/2013	2013/2014
A) Mechanical analysis :		
Clay %	38	37
Sand %	32	33
Silt %	30	30
Soil texture	Clay loam soil	
B) Chemical properties		
PH (1 : 1)	8.20	8.31
E.C. (ds/m)	3.80	3.70
1) Soluble cations (1 : 2) (cmol/kg soil)		
K^+	1.52	1.54
Ca^{++}	9.4	8.7
Mg^{++}	18.3	18.5
Na^{++}	13.50	13.8
2) Soluble anions (1 : 2) (cmol/kg soil)		
CO_3^{--}+ HCO_3^-	2.90	2.80
Cl^-	20.4	19.80
SO_4^{--}	12.50	12.60
Calcium carbonate (%)	6.50	7.00
Total nitrogen %	1.00	0.91
Available phosphate (mg/kg)	3.70	3.55
Organic matter (%)	1.41	1.40

Sowing dates were done November 18th in both seasons, while, seeding rate was 50 kg grains/fed, first irrigation was applied at 25 days after sowing and then plants were irrigated every 25 days till the dough stage. At harvest one square meter was taken randomly from each sub-sub plot for the last two replications to determine

A) yield and its components:

- Spike length (cm)
- Number tillers/m^2
- Number of spike/m^2
- Number of spikelets /spike
- Number of grains/spike
- Weight of grains /spike (g)
- 1000-grains weight (g)
- Grain yield (ton)/fed.
- Straw yield (ton)/fed.
- Biological yield (ton)/fed.
- Harvest index %.

B) Grain quality:

- Grain protein percentage
- Total nitrogen percentage
- Total phosphorus percentage
- Total potassium percentage

Data obtained was exposed to the proper method of statistical analysis of variance difference among mean 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 o probability.

Results and Discussions

Data in Tables (2 and 3) revealed that the differences among the studied cultivars in yield components i.e. spike length (cm),number of tillers/m^2, number of spike/m^2, number of spikelets /spike, Number of grains/spike, Weight of grains /spike (g), 1000-grains weight (g), Grain yield (tons)/fed, Straw yield (tons)/fed, Harvest index and Biological yield (tons)/fed., in both seasons were significant Sakha 94 cultivar significantly surpassed other two cultivars (Misr 1 and Giza 168) in all characters under study except spike length and number of grains/spike in both seasons, where, Giza 168 and Misr 1overcome Sakha 94 in these characters.

These results revealed that Sakha 94 cultivar recorded the greatest number of spike/m^2 (310.22 and 319.30), number of tillers/m^2 (316.00 and 319.55), number of spikelets/spike (43.56 and 47.07), 1000-grains weight (g) (39.56 and 39.82), and Grain yield (tons) /fed. (2.55 and 2.89), straw yield (ton)/fed (4.39 and 3.55) and Biological yield (tons)/fed. (6.39 and 6.30). These differences may be due to the genetic differences among the three cultivars. Also, the differences in 1000-grains weight (g) might be attributed to the variation in translocation rate of photosynthate from leaves to the storing organic i.e. the grain. These finding are in similar trend with those of Hafez (2007) and Abo-Marzoka (2009). These results reported by Abedel-Maksoud (2002), Abdel-Razik (2002), El-Kalla*et al.* (2002), Abu-Grab *et al.,*(2006) and Koriem (2008).

Data presented in Tables (2 and 3) showed that spike length (cm), number of tillers/m^2, number of spike/m^2, number of spikelets /spike, Number of grains/spike, 1000-grains weight (g), Grain yield (ton)/fed, Straw yield (ton)/fed, Harvest index and Biological yield (ton)/fed during two growing seasons were affected significantly by adding mineral fertilizer instead to humic acid. Also, data in Tables (2 and 3) clear that application half mineral recommended dose with 2 kg humic acid significantly increased, grain straw and biological yields (ton/fed) in both seasons. This increase in grain could be attributed to the significant increase in number of spike/m^2, spike length (cm), number of spikelets /spike, Number of grains/spike, 1000-grains weight (g) in both seasons. In addition, the increase in grain yield and other studied traits could be due to the increase in dry weight of vegetative organs, which might consider as a criterion for the photosynthetic efficiency of the plants. Similar results were Abd-Alla, (2002), Salib (2002),Hussein (2005) and Abdel – Alla *et al.,* (2007).

With regarded to the effect of mineral-biofertilization phosphorus on wheat yield and its components, the results given in Tables (2 and 3), generally, showed that all characters under this study were significantly by inoculation of wheat grain with A-Mycorrhizal+7.5 kg P_2O_5/fed when compared with 15 kg P_2O_5/fed + un inoculation (control). Results presented in Tables (2) show that effect of bacteria and fungi inoculation on number of tillers/m^2 andspike length of wheat plants. The obtained results revealed that were significant effect might be attributed to better development of inoculation plants compared to15 kg P_2O_5/fed + uninoculation ones orating, a more favorable environment, in terms of natural and concentration of root exudates, for cell growth and metabolic activities rhizosphore microorganisms (El-Kalla*et al.,* 2002).

Also, it could be conducted that inoculation of wheat grains with biofertilizers encourages, 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 plant phytohormones like, IAA, GAs and CKs which promote plant growth, cell division, breaking the special dominances, hence, encouraging the photosynthesis and assimilation accumulation (El-Khawas, 1990). Similar results were obtained by Abd-Alla, (2002), Basha (2004) andTawfik and Gomaa (2005).

Table 2: Effect of wheat cultivars, mineral fertilizer and P-biofertilizer on Spike length (cm), No. of spike/m^2, No. of tillers/m^2, No. of spikelets/ spike and No. of grains/ spike in 2012/2013 and 2013/2014 seasons.

Treatments	Spike length (cm)		No. of spike/m^2		No. of tillers/m^2		No. of spikelets/ spike		No. of grains/ spike	
	2012/013	2013/014	2012/013	2013/014	2012/013	2013/014	2012/013	2013/014	2012/013	2013/014
A) Wheat cultivars										
Misr 1	15.18b	15.48 c	303.82 b	309.25 b	302.23c	307.63b	40.37c	44.59c	45.55a	46.30a
Sakha 94	15.04c	15.74 b	310.22 a	319.30 a	316.00a	319.55a	43.56a	47.07a	39.89c	45.85b
Giza 168	15.70a	16.26 a	300.44 c	304.48 c	312.00b	308.67c	42.50b	46.30b	42.22b	42.89c
L.S.D. (0.05)	0.07	0.10	1.70	2.60	2.10	3.20	0.55	0.27	0.35	0.30
B) Mineral and humic acid										
48k+60 N										
24k+30 N+ 2Kg HA	15.25b	15.67 b	301.74 c	310.33 b	310.70	312.37b	40.93c	45.67b	40.78c	42.28c
12k+15 N+ 4Kg HA	16.9a	16.14 a	308.05 a	313.11 a	311.04	321.96a	44.07a	48.30a	44.07a	48.37a
L.S.D. (0.05)	14.48c	14.67 c	304.44 b	302.74 c	308.85	301.74c	41.52b	44.00c	41.81b	44.46b
	0.10	0.15	1.60	1.40	ns	3.70	0.45	0.52	0.40	0.55
C) P-biofertilizer										
15 P + Uninoculation										
7.5 kg P+ Mycorrhizal	13.99c	14.21c	274.15 c	284.74 c	278.74c	289.63c	40.04c	42.93c	40.26c	40.22c
7.5 kg P+phosphorein	16.70a	17.61a	338.25 a	333.80 a	344.78a	331.26a	44.07a	49.78a	44.59a	47.33a
L.S.D. (0.05)	15.22b	15.66b	303.14 b	309.70 b	307.08b	314.07b	42.41b	45.22b	41.82b	45.41b
	0.12	0.15	5.20	4.60	6.10	6.90	0.70	1.00	0.60	0.55
Interactions										
AXB	**	**	*	*	*	*	*	*	*	*
AXC	**	**	*	*	*	*	*	*	*	*
BXC	**	**	*	*	*	*	*	*	*	*
AXBXC	**	**	ns	ns	ns	ns	*	*	*	*

**, **: significant difference at level of probability 0.05.*
ns: not significant difference at 0.05 of probability level.

Table 3: Effect of wheat cultivars, mineral fertilizer and P-biofertilizer on 1000-grain weight, grain yield, straw yield and biological in 2012/2013 and 2013/2014 seasons.

Treatments	1000-grain weight (g)		Grain yield (ton)/fed		Straw yield (ton)/fed		Biological yield (ton)/fed	
	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014
A) Wheat cultivars	38.85b	39.18c	2.18b	2.53b	3.68b	3.18b	6.45a	5.96b
Misr 1	39.56a	39.82a	2.55a	2.89a	4.39a	3.55a	6.47a	6.30a
Sakha 94	38.96b	38.74b	2.14b	2.56	3.83b	3.16b	5.9b	5.72b
Giza 168	0.12	0.16	0.02	0.03	0.30	0.05	0.25	0. 30
L.S.D. (0.05)								
B) Mineral and humic acid								
48k+60 N								
24k+30 N+ 2Kg HA	38.37c	37.85c	2.13c	2.41c	3.94b	3.32b	6.11b	5.70b
12k+15 N+ 4Kg HA	40.52a	40.96a	2.51a	3.02a	4.35a	3.60a	7.08a	6.74a
L.S.D. (0.05)	39.48b	38.93b	2.24b	2.57b	3.49c	3.10c	5.72c	5.53c
	0.20	0.21	0. 05	0.06	0.35	0.21	0.27	0.15
C) P-biofertilizer								
15 P + Uninoculation								
7.5 kg P+ Mycorrhizal	34.44c	37.00c	2.15c	2.58c	3.49b	3.10c	5.75c	5.57c
7.5 kg P+phosphorein	42.37a	41.04a	2.41a	2.89a	4.28a	3.56a	6.82a	6.43a
L.S.D. (0.05)	39.67b	39.22b	2.31b	2.68b	3.99a	3.31b	6.33b	5.98b
	0.25	0.22	0.05	0.05	0.31	0.18	0.30	0.30
Interactions								
AXB	*	*	*	*	*	*	*	*
AXC	*	*	*	*	*	*	*	*
BXC	*	*	*	*	*	*	*	*
AXBXC	ns	ns	ns	ns	*	*	ns	ns

**, **: significant difference at level of probability 0.05.*
ns: not significant difference at 0.05 of probability level.

The effect of the interaction between wheat cultivars x mineral and humic acid fertilizers on all yield and its components were significant (Tables 2 and 3) in both growing seasons Sakha 94 cultivar with the application of half recommended dose of NK with 2 kg humic acid gave the highest values of number of spike/m^2, number of tillers/m^2, number of spikelets /spike, 1000-grains weight, Grain, Straw and Biological yield (ton)/fed in both seasons.

The effect of interaction between wheat cultivars and P-biofertilization were significant for all yield and its components (Tables 2 and 3). The highest values of all yield and its components were recorded by Sakha 94 cultivar with inoculation A-Mycorrhizal+7.5 kg P_2O_5/fed in both seasons.

The effect of interaction between mineral and humic acid fertilizers and P-biofertilization were significant for all yield and its components in both seasons The highest values of all yield and its components were produced by half recommended dose of NK with A-Mycorrhizal+7.5 kg P_2O_5/fed in both seasons.

The interaction among wheat cultivars mineral fertilizers + humic acid x P-biofertilizer were significant spike length, number of grains/spike, straw yield in both seasons (Tables 2 and 3).

Data in Tables (4) indicated that percentages of crude protein, nitrogen, phosphorus and potassium in wheat grains were affected by wheat cultivars in both seasons, where, Sakha 94 cultivar significantly surpassed two others cultivars (Giza 168 and Misr 1) for crude protein percentage, nitrogen, phosphorus and potassium percentages in both seasons. The variation between the three studied cultivars may be due to their genetic differences. These results are in good harmony with those obtained by Abo-Shetata*et al.,* (2001), Abdel-Razik (2002), Koriem (2002) and El-Esh (2007).

Obtained results recorded in Tables (4) revealed that that percentage of crude protein, nitrogen, phosphorus and potassium in grains were significantly affected by adding mineral fertilizer instead of humic acid.

The highest values of crude protein (%) and all chemical composition characters was obtained by 100% mineral recommended dose (48k+60 N fertilizer) than other treatments in both seasons. Similar results were obtained by Hussein and Radwan (2001) and Salib(2002).

Data in Table (4) indicated that percentages of crude protein, nitrogen, phosphorus and potassium significantly increased by inoculation of wheat grain with A-Mycorrhizal+7.5 kg P_2O_5/fed when compared with 15 kg P_2O_5/fed + uninoculation (control) during the two seasons. This may be due to the role of phosphorus dissolving fungi on increasing the endogenous phytohormonas (IAA, GAs and CKs) which play on important role in formation a big active root system, increasing the nutrient uptake and photosynthesis rate and transaction, as well as, accumulation within different plant parts (El-Khawas, 1990). Similar results were obtained by Hussein and Radwan (2001), Hussein (2005) and Abdel – Alla *et al.,* (2007).

Table 4: Effect ofwheat cultivars, mineral fertilizer and P-biofertilizer on yield and yield components in 2012/2013 and 2013/2014 seasons.

Treatments	Grain protein (%)		N (%)		P (%)		K(%)	
	012/013	013/014	012/013	013/014	012/013	2013/2014	012/013	013/014
A)Wheat cultivars								2.56b
Misr 1	9.80c	10.32c	1.76c	1.85	0.555c	0.547c	2.88b	2.60a
Sakha 94	10.38a	10.46a	1.87a	1.88	0.691a	0.691a	3.04a	2.11c
Giza 168	10.10b	10.42b	1.81b	1.87	0.599b	0.605b	2.05c	0.03
L.S.D. (0.05)	0.08	0.03	0.02	ns	0.020	0.035	0.04	
B)Mineral and humic acid								2.79a
48k+60 N	10.54a	10.70a	1.89a	1.92a	0.652a	0.650a	2.84a	2.47b
24k+30 N+ 2Kg HA	10.08b	10.41b	1.81b	1.87b	0.615b	0.617b	2.46b	2.22c
12k+15 N+ 4Kg HA	7.70c	10.10c	1.74c	1.82c	0.570c	0.576c	2.20c	0.06
L.S.D. (0.05)	0.10	0.12	0.03	0.02	0.025	0.022	0.09	
C) P-biofertilizer								2.14c
15 P + Uninoculation	9.68c	9.93c	1.74c	1.78c	0.526c	0.530c	2.12c	2.92a
7.5 kg P+ Mycorrhizal	10.56a	10.73a	1.90a	1.95a	0.696a	0.700a	2.91a	2.42b
7.5 kg P+phosphorein	10.04b	10.43b	1.80b	1.87b	0.614b	0.613b	2.45b	0.12
L.S.D. (0.05)	0.12	0.15	0.04	0.03	0.030	0..040	0.11	
Interactions								
AXB	*	*	*	ns	*	*	*	*
AXC	*	*	*	*	*	*	*	*
BXC	*	*	*	*	*	*	*	*
AXBXC	*	*	*	*	*	*	*	*

*, **: *significant difference at level of probability 0.05.*
ns: not significant difference at 0.05 of probability level.

Data presented in Table (4) clear that, interaction between wheat cultivars x mineral and humic acid fertilizers on interaction between wheat cultivars x mineral and humic acid fertilizers on nitrogen content in the first season and crude protein, phosphorus and potassium percentages in both seasons. Sakha 94 cultivar with half recommended dose of NK (48 K + 60 N) surpassed all characters.

The effect of interaction between wheat cultivars x P-biofertilization were significant on crude protein (%) and all chemical composition in both seasons were significant. Also, in Table (4)showed the effect of interaction between mineral and humic acid fertilizers x P-biofertilization were significant on crude protein percentages, nitrogen content (%), phosphorus content (%) and potassium content (%), in both seasons.

The effect of interaction among wheat cultivars mineral fertilizers + humic acid x P-biofertilizer were significant for crude protein (%), nitrogen content (%), phosphorus content (%) and potassium content (%) in both seasons. Table (4) Sakha 94 under full recommended dose of NK with A-Mycorrhizal+7.5 kg P_2O_5/fed gave the highest all grain quality characters in both seasons.

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