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Response of wheat '*Triticumaestivum L.*' to humic acid and organic fertilizer application under varying Siwa Oasis conditions

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Abstract : *A field experiment was carried out at Siwa Oasis, Matrouh governorate, during 2012/2013 growing winter season, to study the response of wheat (Triticumaestivum, L.) cv. Sakha 94, to applications of humic acid rates (8.3, 10.7 and 13.1 kg/ha) and organic fertilizer rates (35, 47.5 and 60 m^3/ha) under varying Siwa conditions. The most important results are summarized as follows:1) Variation in soil salinity had an impact on studied characters, especially those subjected to combined analysis over locations. 2) Spike length, no. of spikelet/spike and 1000-grain weight were increased with increasing both organic and humic acid rates in the three locations. 3) The data for combined analysis showed significant differences between locations, organic fertilizer rates and applied humic acid rates for plant height, no. of spikes/m^2, no. of grains/spike, biological yield and harvest index. 4) Location 2, with lowest E.C. values gave significantly higher values for plant height, biological yield, grain yield and yield components, i.e. number of spikes/m^2 and number of grains/spike, and harvest index compared to location 1 and 3. 5) Increase in grain yield reached 7.1 and 13.6 % by increasing humic acid rate from 8.3 to 10.7, and from 8.3 to 13.1, respectively.*

Keywords: *Wheat "Triticumaestivum L.',humic acid, organic fertilizer, yield, saline soil.*

I. Introduction

In Egypt, there is an increasing demand to increase wheat production to close the gap between local production and wheat imports. That necessitates growing wheat in marginal areas, where environmental conditions (soil, water and climate) exert several stresses on wheat plants, including drought, nutrient and salinity. Soil salinity is a limiting factor for wheat production in marginal areas (Mer*et al*., 2000). High concentrations of salts have detrimental effects on germination of seeds (Rahman *et al*., 2000) and plant growth (Pandey and Thakrar, 1997).Salinity reduces the number of spike per m^2, the number of kernels per spike (Araus*et al*., 2013) and hence thousand kernels weight and grain yield(Royo and Abiò, 2003).

Several strategies have been proposed to overcome the effect of soil salinity on wheat growth. Application of organic fertilizer and humic acid were proposed as alternatives to inorganic fertilization and a prompt source of nitrogen, in addition to their role in improving plant growth and yield, enhance stress tolerance as well as to improve soil physical properties and complex metalions(Zandonadi*et al*., 2007; Karakurt*et al*., 2009 and Khan *et al*., 2010). Asal*et al*. (2015) reported that application of humic acid enhanced root growth and that was directly correlated with enhanced uptake of macro and micronutrients. Chen *et al.* (2004)reported a stimulatory effect of humic substances on wheat development and productivity.

Siwa oasis represent a marginal area, limited to rare rainfall, and temperatures in winter season suitable for wheat growth and development. However, soil characteristics are variable from one location to another (Eco-Siwa, 2011). Soil, in several locations, is affected by salinity due to original soil chemical properties or due to the use of low quality irrigation water (high in salt content) from ground water (150 to 300 m) sources. Research work in Siwa indicated the efficiency of bio-organic fertilization (Abd El-Gawad and El-Sayed, 2006)and NPK, organic and biofertilization (Attia and Abd El Salam, 2016), on wheat growth and productivity. The present investigation was carried out to study the effect of organic fertilizer and humic acid application on wheat growth and productivity in different locations of Siwa Oasis affected by variable salinity levels.

II. Materials And Methods

A field experiment was carried out at Siwa Oasis, Matrouhgovernorate, during 2012/2013 growing winter season. Each experiment was conducted in three locations. Soil texture in the three locations was sandy.Chemical characteristics of soilatthe three locations are presented in table 1,

Chemical properties *:	Location 1	Location 2	Location 3
O.M %	0.75	0.70	0.86
E.C. (ds/m)	10.05	4.7	6.12
PH	7.44	7.8	7.88
Ca^{++} meg/L	42.0	27.0	36.0
Mg^{++} meg/L	34.0	12.0	15.0
Na^{+} meg/L	83.0	33.5	50.3
K^{+} meg/L	3.3	0.8	1.7
CO_3^{--} meg/L	0.0	0.0	0.0
HCO_3^{-} meg/L	4.0	2.0	4.0
Cl^{-} meg/L	115.0	35.0	45.0
SO_4^{--} meg/L	43.3	36.2	54.0
SAR	13.5	7.6	10.0

*Chemical analysis of soil was conducted according to (Chapman and Pratt, 1961).

The aim of investigation was to study the response of wheat (*Triticumaestivum, L.*) cv. Sakha 94, to applications of humic acid rates (8.3, 10.7 and 13.1 kg/ha) and organic fertilizer rates (35, 47.5 and 60 m^3/ha).The experimental design in each location was split plot with three replications. Organic fertilizer and humic acid rates were allocated to main and sub plots, respectively. Where test of homogeneity of error, of studied characters, indicated homogeneous experimental error, combined analysis of variance was performed. The sub plot area was 10.5 m^2 (3.5 m long x 3 m wide). Grains of Sakha 94 wheat cv. were broadcast at the rate of 140 kg/ha. Sowing date was November 28, prior to sowing, organic fertilizer rates (sheep manure) were added and incorporated into the soil with analysis of manure as follows: organic carbon= 19.46 % , Nitrogen =1.4 %, C/N= 13.9, PH= 7.6, P=17, K= 89, Fe= 371, Mn= 47, Zn= 21 and Cu= 5.8 ppm. Humic acid rates were applied at completion of tillering stage by broadcasting followed by irrigation. Irrigation was applied as recommended using underground non-saline water source. Mineral fertilizers were not applied.

At harvest, the following characters were recorded for each sub plot:
1- Number of spikes/m^2
2- Number of spikelets/spike: as an average of 10 random spikes
3- Number of grains/spike: as an average of 10 random spikes
4- 1000-grain weight (g): average of two 1000-grain samples taken random.
5- Grain yield (ton/ha): weight of grain harvested from 10 m^2 and converted to ton/ha
6- Biological yield (ton/ha): total weight of plants harvested from 10 m^2 and converted to ton/ha
7- Plant height (cm): was measured from soil surface to tip of plant, excluding awns, as an average of three readings.
8- Spike length (cm): as an average of 10 random spikes.
9- Harvest index(%): grain yield/biological yield X 100.

Data were subjected to the proper analysis according to Gomez and Gomez (1984) using SAS (Statistical Analyses Systems) ver. 9.1.3 (2007). Means were compared, using the least significant difference (LSD) value at 5% level of probability.

III. Results And Discussion

Soil analysis (Table 1) indicated a variation in soil salinity between the three locations where location 1 had the highest E.C. value (10.05 ds/m), location 2 had the lowest E.C. value (4.7 ds/m) while location 3 had an intermediate E.C. value (6.12 ds/m). That variation in soil salinity had an impact on studied characters, especially those subjected to combined analysis over locations (Table 4). However, the same trend could be observed from data recorded for each location for spike length, number of spikelets per spike and 1000-grain weight (Table 2). Means presented for the effect of organic fertilizer and humic acid rates for spike length, no. of spikelets/spike and 1000-grain weight indicated an increase in all characters with increasing both organic and humic acid rates in the three locations. However, the values for those characters were higher in location 2 compared to location 1 and 3, which coincides with distribution of soil salinity levels.

Table (2): Mean values for spike length, no. of spikelets/spike and 1000-grain weight as affected by organic and humic acid rates at three locations in 2012/2013 season.

Characters / Treatments	Spike Length (cm)	No. spikelet/spike	1000-grain weight (g)	Spike Length (cm)	No. spikelet/spike	1000-grain weight (g)	Spike Length (cm)	No. spikelet/ spike	1000-grain weight (g)
	Location 1			**Location 2**			**Location 3**		
Organic fertilizer (m^3/ha):									
35	10.77	18.72	40.50	12.15	18.71	43.38	11.84	19.25	43.38
47.5	11.73	19.34	46.13	11.05	19.23	48.96	11.96	19.81	47.60
60	12.10	19.53	49.37	12.70	19.79	53.20	12.26	19.96	51.30
LSD 0.05	**0.16**	**0.18**	**0.80**	**0.42**	**0.65**	**1.05**	**NS**	**0.16**	**7.65**
Humic acid (kg/ha):									
8.3	11.31	18.61	41.5	12.07	18.52	46.11	11.70	19.07	44.62
10.7	11.38	19.25	46.33	12.39	19.27	48.71	12.05	19.75	48.00
13.1	11.92	19.73	48.38	11.44	19.93	50.72	12.32	20.19	49.90
LSD 0.05	**0.12**	**0.11**	**0.65**	**0.36**	**0.54**	**0.89**	**NS**	**0.13**	**4.03**

The interaction between organic fertilizer and humic acid for 1000-grain weight in location 2 and number of spikelets per spike in location 3 (Table 3) showed that increasing the rate of organic fertilizer from 35 to 47.5 m^3/ha, at the same humic acid rate, or increasing humic acid rate from 8.3 to 10.7 kg/ha, at the same organic fertilizer rate, gave significantly higher increments for the two characters, whereas the increase in both characters, due to increasing organic fertilizer or humic acid from intermediate to highest rate, was lower or insignificant compared to increase from the lowest to intermediate rate. Tufail*et al.* (2014) reported that, spike length, number of spikelets per spike and 100-grain weight of wheat plants increased with increasing humic acid concentration up to 12.5 kg/ha. Similarly, Haghighi*et al*. (2014) found that application of 7.0 L humic acid/ha had significant effect on spike length, 1000-grain weight and harvest index. On the other hand, Abd El-Gawad and El-Sayed (2006) and Zaki*et al.* (2012) found that organic fertilizer increased spike length, 1000-grain weight and grain yield of wheat. Moreover, Khaled and Fawy (2011) reported an enhancement in uptake of nutrients by soil or foliar applied humic acid, and hence better growth of maize plants under saline soil conditions.

Table (3): Means for the interaction between organic fertilizer and humic acid rates for 1000-grain weight (location 2) and no. of spikelets/spike (location 3) in 2012/2013 season.

Characters / Treatment	Location 2			Location 3		
	1000-grain weight (g)			**No. spikelets/spike**		
	Humic acid (kg/ha)			**Humic acid (kg/ha)**		
Organic (m^3/ha)	**8.3**	**10.7**	**13.1**	**8.3**	**10.7**	**13.1**
35	38.58	44.57	47.00	18.72	19.14	19.88
47.5	47.77	48.74	50.37	19.07	20.03	20.33
60	51.97	52.83	54.80	19.41	20.09	20.36
LSD 0.05	**1.82**			**0.27**		

The data for combined analysis (Table 4) showed significant differences between locations, organic fertilizer rates and applied humic acid rates for all studied characters. The differences between locations could be attributed to the variation in soil salinity level of the three locations. It is evident that location 2, with lowest E.C. values gave significantly higher values for plant height, biological yield, grain yield and yield components, i.e. number of spikes/m^2 and number of grains/spike, and harvest index compared to location 1 and 3. Increase in soil salinity from location 2 (E.C= 4.7 ds/m) to location 3 (E.C= 6.12 ds/m) to location 1 (E.c= 10.05 ds/m) led to decrease in grain yield by 18.24 and 23.5 %, respectively. Several researchers reported that increase in soil salinity led to decrease in wheat growth (Mojid*et al*., 2013), grain yield and yield components (Turki*et al*., 2012, Chamekh*et al*., 2015), and vegetative plant growth (Khaled and Fawy, 2011).

Increase in application rates of organic fertilizer and humic acid showed the same trend (Table 4) where that led to significant increase in all studied characters with each increment of both organic fertilizer and humic acid, except grain yield where the intermediate and highest rates were statistically equal and both were significantly higher than the lowest rate. Increase in grain yield reached 7.1 and 13.6 % by increasing humic acid rate from 8.3 to 10.7, and from 8.3 to 13.1, respectively.The increase in grain yield was, however, less and reached 6.16 % with increasing organic fertilizer rate from 35 to 47.5 m^3/ha, and then levelled. The increase in studied characters, due application of both organic fertilizer and humic acid, may be attributed to the role played by both in enhancement of plant growth due to enrichment of soil (increase in soil fertility, improvement of soil physical properties and water holding capacity, decrease of the effect of salinity stress) and providing wheat plants with necessary growth nutrients (Radwan *et al*., 2014, Jan and Boswal, 2015 and Radwan *et al*., 2015).

Table (4): Mean values of combined analysis over location for yield and its components of wheat in 2012/2013 season.

Treatments	Plant height (cm)	No. spikes/m^2	No. grains/spike	Biological yield(t/ha)	Grain yield(t/ha)	Harvest index (%)
Locations:						
1	85.64	417.20	49.90	20.81	4.88	22.88
2	96.83	442.65	58.12	22.14	6.38	30.02
3	93.18	431.18	51.42	21.95	5.21	22.97
LSD 0.05	**0.74**	**2.35**	**1.73**	**0.35**	**0.18**	**0.38**
Organic fertilizer (m^3/ha):						
35	88.27	395.20	50.86	20.02	5.28	26.25
47.5	92.40	423.10	53.62	21.74	5.61	25.36
60	94.98	472.73	54.95	23.12	5.61	24.27
LSD 0.05	**1.02**	**7.14**	**0.82**	**0.319**	**0.11**	**0.35**
Humic acid (kg/ha):						
8.3	88.68	396.68	50.97	19.36	5.08	26.36
10.7	91.63	432.23	53.21	22.20	5.44	24.72
13.1	95.34	462.12	55.25	23.32	5.75	24.80
LSD 0.05	**0.85**	**3.82**	**0.70**	**0.11**	**0.05**	**0.30**

The location X organic fertilizer interaction (Table 5) was significant for plant height, number of spikes/m^2 and grain yield. Regarding plant height, increasing organic fertilizer rate showed higher increase in plant height in location with optimal or low soil salinity (location 2 and 3) compared to location 1. The opposite trend was found for number of spikes per m^2 and, consequently, grain yield, where application of organic fertilizer showed higher efficiency in increasing those two characters in salt-affected locations compared to non-saline conditions. That may be an indicator of the possibility of using organic fertilizers to mediate the effect of salinity on wheat plants Similar findings were reported by Zaki*et al*. 2012, who reported that incorporation of organic fertilizer in the soil, with or without mineral fertilizers, increased grain yield and yield components of two bread wheat cultivars.

Table (5): Mean values for the interaction between location and organic fertilizer for plant height, no of spikes/m^2 and grain yield in 2012/2013 season.

Locations	Organic fertilizer (m^3/ha)	Plant height (cm)	No. spikes/m^2	Grain yield(t/ha)
1	**35**	84.00	368.90	4.57
	47.5	85.96	389.24	4.97
	60	86.96	413.50	5.11
2	**35**	92.07	456.23	6.26
	47.5	97.45	468.52	6.38
	60	100.96	493.45	6.50
3	**35**	88.75	403.21	4.71
	47.5	93.77	434.10	5.11
	60	97.02	445.93	5.23
LSD 0.05		**7.4**	**11.3**	**0.43**

The organic X humic acid interaction was significant for plant height and grain yield (Table 6). The highest value for plant height (98.67 cm) was recorded with the highest level of both organic soil amendments, whereas the lowest value (84.35) resulted from application of the lowest levels of both amendments. The same trend was found for grain yield, however the increase in that trait, due to application of humic acid rates, varied with the applied organic fertilizer rate. At the lowest organic fertilizer rate, the increase in grain yield was more pronounced with increasing humic acid from intermediate to highest rate. Conversely, at the intermediate and higher organic fertilizer rates, the increase in grain yield was more pronounced with increasing humic acid from the lowest to intermediate rate.

That may be explained by the fact that humic acid is a constituent of organic fertilizers (Karakurt *et al.*, 2009), thus increasing the rate of organic fertilizer application provides more humic acid to the soil that may obscure the effect of the added humic acid.The three factor interaction, i.e. location X organic fertilizer X humic acid (Table 7) was significant for biological yield and harvest index. In both characters, the highest value was obtained at location 2 (least E.C. value) and the highest application rate of both organic fertilizer and humic acid (25.67 t/ha), whereas the lowest value (17.01 t/ha) was recorded at location 1 (highest E.C. value) and lowest application rate of both organic soil amendments.

Table (6): Mean values for the interaction between organic and humicacid rates for plant height and grain yield in 2012/2013 season.

Organic fertilizer (m^3/ha)	Humic acid (kg/ha)	Plant height (cm)	Grain yield (t/ha)
35	**8.3**	84.35	4.97
	10.7	89.08	5.16
	13.1	91.4	5.40
47.5	**8.3**	89.44	5.08
	10.7	91.8	5.50
	13.1	95.95	5.86
60	**8.3**	92.26	5.20
	10.7	94.01	5.66
	13.1	98.67	5.98
LSD 0.05		**4.55**	**0.46**

Table (7): Mean values for the interaction between locations X organicfertilizer Xhumicacid rates for biological yield and harvest index in 2012/2013 season.

Location	Organic fertilizer (m^3/ha)	Humicacid (kg/ha)	Biological yield (t/ha)	Harvest index (%)
1	**35**	**8.3**	17.01	24.12
		10.7	18.61	21.85
		13.1	20.25	21.29
	47.5	**8.3**	18.45	24.77
		10.7	22.80	21.95
		13.1	23.68	22.59
	60	**8.3**	19.21	24.34
		10.7	23.16	22.31
		13.1	24.13	22.76
2	**35**	**8.3**	18.21	35.41
		10.7	21.04	33.24
		13.1	22.24	32.54
	47.5	**8.3**	20.73	28.97
		10.7	21.29	29.94
		13.1	22.21	30.56
	60	**8.3**	23.45	26.25
		10.7	24.44	26.63
		13.1	25.67	26.69
3	**35**	**8.3**	18.66	24.23
		10.7	21.46	22.07
		13.1	22.80	21.51
	47.5	**8.3**	18.93	24.80
		10.7	23.33	22.13
		13.1	24.27	22.57
	60	**8.3**	19.68	24.39
		10.7	23.73	22.39
		13.1	24.70	22.73
LSD 0.05			**1.11**	**3.22**

In conclusion, the results obtained from the present study indicated that, under the variable soil quality conditions (salinity level) of Siwa Oasis, it is imperative to apply both organic fertilizers and humic acid at high rates (60 m^3/ha and 13.1 kg/ha, respectively) to obtain high yield of wheat, and preserve the environment by decreasing pollution, resulting from application of mineral fertilizers, in addition to improvement of soil fertility and water holding capacity.The results also exhibited the beneficial effects of both organic soil amendments in overcoming the harmful effects of saline soil on wheat plants.

References

[1]. Abd El-Gawad, A.M and Zeinab, T. El-Sayed. 2006.Evaluation the Response of Wheat to Bio-Organic Agriculture under Siwa Oasis Conditions. Journal of Food Agriculture and Environment 4, pp:1-6.

[2]. Araus, J.L., L.Cabrera-Bosquet, M.D.Serret,J.Bort,M.T. Nieto-Taladriz. 2013.Comparative performance of13C,18O and15N for phenotyping durum wheatadaptation to a dryland environment. Funct. Plant Biol. 40, 595–608.

[3]. Asal, M. W., E. A. Badr, O.M. Ibrahim and E.G. Ghalab. 2015. Can humic acid replace part of the applied mineral fertilizers? A study on two wheat cultivars grown under calcareous soilconditions. International Journal of ChemTech Research, Vol.8, No.9, pp 20-26.

[4]. Attia, M.A. and A.A. Abd El Salam. 2016. Effect of mineral, organic and bio-fertilizer on yield and yield components of bread wheat at Siwa Oasis. Alex. J. Agric. Sci. vol. 61, No. 3, 211-219.

[5]. Chamekha, Z., C.Karmousb, S.Ayadia, A.Sahlia, Z.Hammamia,M. B.Frajc, N.Benaissaa, Y.Trifaa, H. S.Amaraaa. 2015. Stability analysis of yield component traits in 25 durum wheat(*Triticum durum Desf*.) genotypes under contrasting irrigationwater salinity. Agricultural Water Management, 152: 1–6

[6]. Chapman, H. D. and P.F. Pratt. 1961. Methods of analysis for soil, plants and waters. ReversideUniv., California. Div. Agric. Sci., California, U.S.A., 150-152.

[7]. ECO-SIWA. 2011. Sustainable Development of Fragile, Agro-ecosystems: The case of the Siwa Oasis.

[8]. Gomez, K.A. and A.A. Gomez. 1984. Statistical Procedures for Agriculture Research. 2nd ed. John Wiley and Sons, New York, U.S.A.

[9]. Haghighi, P., D. Habibi and B. Sani. 2014. Wheat response to plant growth promoting rhizobacteria,humic acid and sn-brassinolide. International Journal of Biosciences, Vol. 5, No. 10, p. 51-60

[10]. Jan, K. and M.V.Boswal. 2015. Influence of jinong (organic liquidfertilizer) on seedling germination andgrowth and its comparison with bio-fertilizeron yield of bread wheat (*Triticumaestivum l.).*International Journal of Advanced Technology in Engineering and Science, Volume No 03, Special Issue No. 01, 2348 – 7550

[11]. Khaled, H. and H.A. Fawy. 2011. Effect of different levels of humic Acids on the NutrientContent, Plant Growth, and Soil Propertiesunder Conditions of Salinity. Soil & Water Res., 6 (1): 21–29.

[12]. Karakurt, Y.,H.Unlu, and H.Padem. 2009.The influence of foliar and soil fertilization of humic acid onyield and qualityof pepper. ActaAgriculturaeScandinavica, Section B, Soil and PlantScience 59: 233–237.

[13]. Khan, R.U., A. Rashid, M.S. Khan and E. Ozturk. 2010. Impact of humic acid and chemical fertilizer application on growth and grain yield of rainfed wheat (*Triticumaestivum L.*). Pakistan J. Agric. Res. Vol 23 No. 3-4. Pp 113-121

[14]. Mer, R.K., P.K. Prajith, D.H. Pandya and A.N. Pandey. 2000. Effect of salts on germination ofseeds and growth of young plants of *Hordeum vulgare, Triticumaestivum, Cicer arietinum* and *Brassica juncea*. J Agronomy and Crop Sciences, 185: 209-217.

[15]. Mojid,M. A., M. S. Mia1, A. K. Saha and S. S. Tabriz. 2013. Growth stage sensitivity of wheat toirrigation water salinity. J. Bangladesh Agril. Univ. 11(1): 147–152Pandey, A.N. and N.K. Thakrar. 1997. Effect of chloride salinity on survival and growth of Prosopischilensis seedlings. Trop. Ecol., 38: 145-148.

[16]. Radwan, F. I., M. A. Gomaa, I. F. Rehab and Samera, I. A. Adam. 2015. Impact of humicacid application, foliar micronutrients and biofertilization ongrowth, productivity and quality ofwheat (*Triticumaestivum, L.*). Middle East Journal of Agriculture, Volume: 4, Issue: 02(April-June), pp 130-140

[17]. Radwan, F.I.,M.A. Gomaa, M.A.A. Naser and I.F. Mussa. 2014. Response of some Wheat Varieties to humic acid, mineral and biofertilization onproductivity and quality.Middle East Journal of Agriculture Research, 3(3): 631-637

[18]. Rahman, M., S.A. Kayani and S. Gul. 2000. Combined effects of temperature and salinity stresson corn cv. Sunahry, Pak. J. Biological Sci., 3(9): 1459-1463.

[19]. Royo, A. and D.Abiò. 2003. Salt tolerance in durum wheat cultivars. Span. J. Agric. Res.1 (3), 27–35.

[20]. SAS Institute, Inc. (2007), SAS Technical Report SAS/STAT Software: Changes and Enhancements User's Guide, Volume 2,Version 9.1.3, Fourth Edition, Cary, NC: SAS Institute, Inc.

[21]. Shirazi, M.U., S.M. Asif, B. Khanzada, M.A. Khan and A. Mohammad. 2001. Growth and ion accumulation in some wheat genotypes under NaCl stress. Pak. J. Biol. Sci., 4: 388-391.

[22]. Tufail, M., K. Nawaz and M. Usman. 2014.Impact of humic acid on the morphologyand yield of wheat (*Triticumaestivum L.*). World Applied Sciences Journal 30 (4): 475-480.

[23]. Turki, N., M. Harrabi and K.Okuno. 2012. Effect of salinity on grain yield and quality of wheat andgenetic relationships among durum and common wheat. Journal of Arid LandStudies, 22-1, 311 -314.

[24]. Zandonadi, D.B. Canellas, L.P. and Facanha, A.R. 2007. Indolacetic and humic acids induce lateral root development through a concerted plasmalemma and tonoplast H+ pumps activation. Planta, 225:1583–1595.

[25]. Zaki, N.M., M.A.Gomaa, F.I.Radwan, M.S.Hassanein and A.M.Wali. 2012. Effect of mineral, organicand bio-fertilizers on yield, yield components andchemical composition of some wheat cultivars. Journal of Applied Sciences Research, 8(1): 174-191.