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Effect of Zn foliar application on growth and yield characteristics of two wheat cultivars

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ABSTRACT

Two field experiments were carried out at private farm in Wadi El-Rayyan, El- Fayoum Governorate, Egypt in 2016/2017 and 2017/2018 seasons, to study the effect of zinc foliar fertilizer on growth and yield characters of two wheat cultivars (Sids-12 and Misr-2) under newly reclaimed sandy soil to improve productivity and minimizing pollution.

Results could be summarized as follows:

Misr-2 cultivar significant surpassed Sids-12 cultivar in all growth characters under study i.e. plant height "cm", number of tillers/m^2, number of leaves/m^2, number of spikes/m^2, weight of spikes (g/m^2), total dry weight (g/m^2), leaf area (dm^2) and leaf area index at 90 and 105 days after sowing except plant height (cm) and leaf area (dm^2) at 90 days from sowing, while Sids-12 cultivar significant surpassed Misr-2 cultivar in number of leaves/ m^2 at 90 days from sowing. Adding zinc foliar fertilizer increased significantly all growth characters under study at 90 and 105 days from sowing. The best treatment was 0.8% zinc foliar fertilizer. The interaction between wheat cultivars and zinc foliar fertilizer was significant in number of leaves/m^2, number of spikes/m^2, total dry weight (g/m^2) and leaf area index at 90 and 105 days after sowing, while weight of spikes (g/m^2) at 90 days from sowing.

Misr-2 wheat cultivar significantly surpassed Sids-12 wheat cultivar in all yield and its components i.e.(plant height (cm), number of tillers/ m^2, number of spikes/ m^2, weight of spikes (g / m^2), grain index (g), grain yield (g/m^2), grain yield (ton/feddan), straw yield (ton/feddan) and biological yield (ton/feddan), except shelling percentage and harvest index. Adding zinc foliar fertilizer increased significant yield and its components compared with control, the best treatment was 0.8% zinc foliar fertilizer. The interaction between wheat cultivars and zinc foliar fertilizer was significant in all yield and its components except plant height (cm), number of tillers/ m^2 and harvest index in both seasons.

Keywords**:** Wheat, cultivars, zinc fertilizer, growth, yield, yield components.

Introduction

Wheat (*Triticum aestivum* L.) is an important crop in Egypt and over the world used in human food and animal feed as well as, with regard to cultivated area and total production, as well as nutritive value. It provides 37% of the total calories for the people and 40% of the protein in the Egyptian diet (El-Habbasha *et al*., 2015). Recently, a great attention has been devoted to cultivate wheat in the newly reclaimed sandy soils. In general under unfavorable conditions of such soil which characterized with low fertility, low organic matter content, micronutrients deficiency, high leaching rate and salinity (Abd El-Ghany, 2007 and El-Fouly *et al*., 2011). A great attention of several investigators has been directed to increase the productivity and quality of wheat especially in newly reclaimed sandy soil to reduce the gap between the production and consumption in Egypt.There are several ways for increasing wheat production, one of them is the appropriate application of micronutrient especially with balanced and recommended N, P and K in the newly reclaimed areas (Zeidan *et al*., 2010 and El-Dahshouri *et al*., 2017).

Zinc is well known to have an important role either as a metal component of enzymes or as a functional, structural or regulatory co-factor of a great number of enzymes (Hotz and Braun, 2004). Furthermore, Zn have an influence on some plant life process , such as nitrogen uptake and metabolism, photosynthesis synthesis, resistance to a biotic and biotic stresses , pollen function and

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fertilization (Cakmak, 2008 and Pandey *et al.*, 2006) . Zinc deficiency is a global nutritional constraint for plant growth, particularly in calcareous soils of arid and semi arid regions (Takkar and Walker, 1993). One of the most important micronutrient deficiencies is attributed to zinc deficiency that is a worldwide problem in human nutrition. More than 2 billion people suffer from micronutrient deficiency including zinc deficiency (Welch and Graham, 1999). Zinc deficiency causes a number of health problems like impairment in linear growth, sexual maturation, learning ability,immune functions and central nervous system (Prasad, 1985).Zinc plays an important physiological role in their growth (Cakmak, 2008). It causing various serious health complications such as stunting, increased susceptibility to infection diseases, impaired brain function and mental development. Application of zinc fertilizer not only improves nutritional quality but also contributes significantly to grain production in Zn deficient soils (Peck *et al.,* 2008). Hao *et al.,* (2003) found that after applying Zn fertilizer, Zn absorption in wheat increased its concentration in wheat grains by 18% and improve significantly dry weight of seedling roots and shoots. Zinc is required for the growth and grain nutritional quality of wheat (Arif *et al.,* 2017). Hassanein *et al* (2001), Zaki *et al* (2012), Zaki *et al* (2015), Ahmed *et al* (2018), Hassanein *et al* (2018), Zaki *et al* (2018)and Hassanein *et al* (2019) reported that there were significant differences among cultivars.

The aim of this investigation was designed to study the effect of foliar spray by zinc fertilizer on growth and yield of two wheat cultivars.

Materials and methods

The study pertaining to evaluation of different levels of zinc fertilizer on the growth and yield of wheat cultivars was conducted at new land at Wadi El-Rayyan, El- Fayoum Governorate, Egypt during 2016/2017 and 2017/2018 seasons.The experiments were conducted to study the effect of zinc foliar fertilizer on two wheat cultivars. Soil samples was taken at depth of 30 cm for mechanical and chemical analysis as described by Chapman and Pratt (1961). The mechanical and chemical analysis of the soil of the experimental site were illustrated in Table (1).

Table 1: Mechanical and chemical analysis of soil at experimental sites

Sand %	Silt %	Clay %	Texture	pH	Organic matter O.M.%	Available N ppm	Available K ppm	Available P ppm
73.59	22.47	3.45	Sandy	8.00	0.49	84.00	134.00	12.5

The experimental design was split plot design with four replications. Wheat cultivars were allocated randomly in the main plots and foliar zinc fertilizer were randomly allocated in sup- plot. The experimental site was ploughed twice and divided into plots of 10.5 m^2. Each plot included 15 rows 3.5 m long and 0.2 m apart. Each experiment included 8 treatments which were the combination among two cultivars and four foliar zinc fertilizer levels.

The experimental treatments can be described as follows: Two cultivars (Sids- 12 and Misr 2) and four treatments of Zinc foliar fertilizer (Control (without zinc foliar application, 0.4%, 0.6% and 0.8% $ZnSO_4 . H_2O$/feddan).

Potassium fertilizer was applied before sowing at rate of 50 kg/ fed., in the form of potassium sulphate (48% K_2O). Super phosphate fertilizer (15.5% P_2O_5) was applied before sowing at the rate of 150 kg/ fed. The recommended dose of nitrogen fertilizer was added at the rate of 100 kg/ fed., as ammonium nitrate (33.5% N). Sowing dates were November 15th and November 20th in both seasons, respectively, while seed rate was 60 kg/ fed. Zinc Sulphate Monohydrate ($ZnSO_4 . H_2O$) was used as sources of Zn. Zinc foliar application treatments were applied during 40 and 75 days (both of tillering and elongation growth stages).The normal agronomic practices of wheat were followed until harvest as recommended by Wheat Research Dep., Agric. Research Centre.

Samples of one meter were taken random from each plot of the three replication to measure growth characters at 90 and 105 days from sowing, where; number of tillers (m^2), number of leaves (m^2), number of spikes (m^2), spikes dry weight (g/ m^2), total dry weight (g/ m^2), also, five plants was taken from each plot to determine plant height "cm", leaf area (dm^2) and leaf area index. Leaves area was determined according to Bremner and Taha (1966), whereas, leaf area index (LAI) was determined according to Watson (1952).

At harvest, 10 plants at random were taken from each plot to determine plant height (cm) and grain index(g),also, one meter was taken from each plot to determine number of tillers/ m^2, number of spikes/ m^2, weight of spikes (g/ m^2) , grain yield(g/m^2). Grain yield (ton/fed), straw yield (ton/fed) and biological yield (ton/fed) were determined from the whole plot and then converted to yield/ feddan. Shelling percentage and harvest index% were also determined.

All data were subjected to statistical analysis according to procedure outlined by Gomez and Gomez (1984). Treatments means were compared by L.S.D at 5% level test. Combined analysis was made for the two growing seasons as results followed similar trend.

Results and discussion

Effect of wheat cultivars:

Data in Table (2) showed that the differences between wheat cultivars Sids-12 and Misr-2 were significant in all growth characters under study i.e. plant height "cm", number of tillers/m^2, number of leaves/m^2, number of spikes/m^2, weight of spikes (g/m^2), total dry weight (g/m^2), leaf area (dm^2) and leaf area index at 90 and 105 days after sowing except plant height (cm) and leaf area (dm^2) at 90 days from sowing. Data illustrated that Misr-2 wheat cultivar exceeded Sids-12 wheat cultivar in all growth characters under study except number of leaves (m^2), where Sids-12 wheat cultivar surpassed the other one.These differences between the two wheat cultivars may be due to the genetic structure differences between cultivars and to the genetic background for the cultivars and its behaviour under these conditions in which zinc foliar application and sandy soil (Clark *et al.*, 1997, Hassanein *et al.*, 2014, Zaki *et al*., 2016 and Ahmed *et al.*, 2017).

These results was in agreement with those obtained by Abu-Grab *et al.*, (2006), Koriem (2008), Radwan *et al.*, 92014), Zaki *et al*., (2015), El-Dahshouri *et al.*, (2017) and Ahmed *et al.*, (2018).

Effect of foliar zinc fertilizer:

Data in Table (2) indicated that zinc foliar increased significantly growth characters under study at 90 and 105 days from sowing. It is clear from data that all the zinc treatments significantly increased growth characters as compared to control, also it indicated the best treatment was 0.8% zinc foliar fertilizer. The increase of growth characters of wheat cultivars due to Zn foliar spraying might be attributed to the fact that Zn in known to have an important role as a metal component of enzymes or as a functional, structural or regulatory co-factor of a wide number of enzymes (Hotz and Braun, 2004). Cakmak, (2008) and El-Dahshouri *et al.*, (2017) reported that zinc plays an important role in the production of biomass.

Effect of interaction:

Data in Table (3) indicated that the interaction between wheat cultivars and zinc foliar fertilizer was significant in number of leaves/m^2, number of spikes/m^2, total dry weight (g/m^2) and leaf area index at 90 and 105 days after sowing, also weight of spikes (g/m^2) at 90 days from sowing only, while the other characters under study failed to reach significant level. Data showed that the best treatment was Misr-2 wheat cultivar + 0.8% zinc foliar fertilizer.

Yield and yield components:

Effect of wheat cultivars:

Data in Table (4) showed that significant differences were observed between wheat cultivars Sids-12 and Misr-2 in all yield and its components characters i.e. plant height (cm), number of tillers (m^2), number of spikes (m^2), weight of spikes (g/ m^2), grain index (g), grain yield (g/m^2), grain yield (ton/fed), straw yield (ton/ feddan) and biological yield (ton/ feddan) except shelling percentage and harvest index.These results indicated that the highest value of all yield and its components were observed in Misr-2 wheat cultivar compared with Sids-12 wheat cultivar in both seasons. These differences may be due to the genetic differences among the two cultivars, while the differences in grain index might be attributed to the variation in translocation rate of photosynthate from leaves to

Table 2: Effect of cultivars and zinc foliar fertilizer on growth characters of wheat at 90 and 105 days after sowing. (Average of 2016/2017and 2017/ 2018 seasons).

Characters	Plant height (cm)		No. of tillers /m²		No. of leaves / m²		No. of spikes / m²		Weight of spikes "g/ m²"		Total dry weight/ "g/ m²"		Leaf area (dm²)		LAI	
Treatments	**90**	**105**	**90**	**105**	**90**	**105**	**90**	**105**	**90**	**105**	**90**	**105**	**90**	**105**	**90**	**105**
Cultivars																
Sids - 12	123.0	126.3	595.6	605.8	603.2	594.5	590.6	599.5	884.2	896.4	1274.5	1387.7	64.67	55.06	5.33	4.60
Misr – 2	124.1	127.4	599.8	608.2	598.5	595.8	596.0	602.4	891.5	902.1	1311.0	1406.5	65.87	57.24	5.53	4.83
L.S.D. at 5%	n.s	1.0	0.9	0.2	3.9	0.6	0.9	1.2	1.5	1.6	2.9	4.6	n.s	0.53	0.07	0.11
Zinc foliar fertilizer																
Control	117.6	121.7	591.2	600.0	595.1	583.7	584.5	595.7	875.8	888.4	1243.0	1336.0	59.89	51.97	3.56	4.41
0.4%	122.4	126.0	595.4	605.9	597.0	594.1	591.9	600.4	888.1	898.4	1273.4	1377.3	64.59	54.64	3.04	4.63
0.6%	125.4	128.2	599.3	609.5	603.4	600.2	596.4	601.8	892.1	901.9	1313.7	1421.5	66.23	57.00	2.57	4.78
0.8%	128.8	131.5	604.8	612.7	607.9	602.7	600.4	606.0	895.3	908.4	1340.9	1453.7	70.37	60.98	2.15	5.06
L.S.D. at 5%	1.0	0.6	0.7	0.5	2.7	0.6	0.8	0.4	1.2	1.4	3.8	4.0	1.04	0.88	0.12	0.08

Table 3: Effect of interaction between cultivars and zinc foliar fertilizer on growth characters of wheat at 90 and 105 days after sowing. (Average of 2016/2017 and 2017/ 2018seasons).

Characters		Plant height (cm)		No. of tillers /m²		No. of leaves / m²		No. of spikes / m²		Weight of spikes "g/ m²"		Total dry weight "g/ m²"		Leaf area (dm²)		LAI	
Treatments		**90**	**105**	**90**	**105**	**90**	**105**	**90**	**105**	**90**	**105**	**90**	**105**	**90**	**105**	**90**	**105**
Cultivars x **Zinc foliar fertilizer**																	
Sids - 12	**Control**	116.6	121.4	589.2	599.0	594.8	581.2	581.9	595.0	872.8	885.6	1227.0	1320.6	58.86	51.19	4.65	4.25
	0.4%	122.4	125.4	592.8	604.4	599.8	592.3	588.2	599.4	882.8	895.3	1258.1	1368.5	63.78	53.22	5.57	4.50
	0.6%	124.9	127.4	597.4	608.4	607.5	601.2	593.8	600.2	888.2	899.2	1297.1	1414.9	66.14	55.74	5.35	4.64
	0.8%	128.1	130.8	603.0	611.4	610.8	603.3	598.5	603.4	892.8	905.6	1315.6	1446.9	69.89	60.07	5.77	5.02
Misr – 2	**Control**	118.5	122.1	593.3	601.1	595.4	586.2	587.0	596.3	878.8	891.3	1258.9	1351.4	60.92	52.74	5.23	4.57
	0.4%	122.5	126.6	598.1	607.4	594.3	596.0	595.6	601.5	893.4	901.6	1288.7	1386.1	65.40	56.06	5.38	4.75
	0.6%	125.9	128.9	601.3	610.5	599.3	599.2	599.1	603.4	896.1	904.5	1330.3	1428.2	66.32	58.27	5.65	4.91
	0.8%	129.4	132.2	606.7	613.9	605.0	602.1	602.3	608.5	897.8	911.2	1366.1	1460.4	70.85	61.89	5.86	5.09
L.S.D. at 5%		n.s	n.s	n.s	n.s	3.8	0.8	1.2	0.6	1.7	n.s	5.4	5.7	n.s	n.s	0.29	0.11

Table 4: Effect of cultivar differences and zinc foliar fertilizer on yield and its components of wheat (combined analysis of 2016/2017 and 2017/2018 seasons).

Characters / Treatments	Plant height "cm"	No. of tillers /m²	No. of spikes / m²	Weight of spikes "g/ m²"	Grain index "g"	Grain yield "g/ m²"	Grain yield "ton/fed."	Straw yield "ton/fed."	Biological yield "ton/fed."	Shelling %	Harvest index %
Cultivars											
Sids - 12	128.5	598.0	591.4	904.2	42.2	648.4	5.832	9.643	15.475	72.8	37.66
Misr – 2	129.3	600.2	596.8	911.0	45.9	688.9	6.328	10.382	16.710	75.3	37.85
L.S.D. at 5% level	0.6	1.8	0.3	1.2	0.8	1.2	0.013	0.101	0.088	n.s	n.s
Zinc foliar fertilizer											
Control	124.0	590.2	584.5	894.8	40.5	635.3	5.548	9.342	14.890	72.0	37.26
0.4%	127.5	597.2	592.3	904.0	43.3	662.8	5.987	10.010	15.997	73.0	37.42
0.6%	130.3	601.8	596.8	912.7	45.4	677.8	6.212	10.183	16.395	74.7	37.88
0.8%	133.8	607.4	602.7	918.9	47.2	698.5	6.573	10.513	17.086	76.5	38.47
L.S.D. at 5% level	1.4	2.0	0.9	1.1	0.6	2.7	0.108	0.087	0.156	3.4	0.41

Table 5: Effect of interaction between cultivars and zinc foliar fertilizer on yield and its components of wheat (combined analysis of 2016/2017 and 2017/2018 seasons).

Treatments	Characters	Plant height "cm"	No. of tillers /m²	No. of spikes /m²	Weight of spikes "g/ m²"	Grain index "g"	Grain yield "g/ m²"	Grain yield "ton/fed."	Straw yield "ton/fed."	Biological yield "ton/fed."	Shelling %	Harvest index %
Cultivars x Zinc foliar fertilizer												
Sids - 12	**Control**	123.6	588.2	581.6	891.5	38.9	623.0	5.463	9.227	14.690	73.2	37.19
	0.4%	127.6	595.7	590.0	898.9	42.1	639.5	5.610	9.397	15.007	71.3	37.38
	0.6%	129.8	601.6	595.3	909.9	43.5	657.4	5.840	9.677	15.517	72.3	37.64
	0.8%	133.2	606.7	598.6	916.4	44.5	673.6	6.413	10.270	16.683	74.4	38.44
Misr – 2	**Control**	124.5	592.2	587.3	898.1	42.0	647.6	5.633	9.457	15.090	70.8	37.33
	0.4%	127.4	598.6	594.6	909.1	44.5	686.2	6.363	10.623	16.986	74.7	37.46
	0.6%	130.9	602.0	598.3	915.5	47.3	698.3	6.583	10.690	17.273	77.0	38.12
	0.8%	134.3	608.2	606.8	921.4	49.9	723..4	6.733	10.757	17.490	78.5	38.50
L.S.D. at 5% level		n.s	n.s	1.2	1.6	0.9	3.8	0.153	0.123	0.221	3.4	n.s

the strong organs, the differences in genetic structure between cultivars, addition to the differences between cultivars in glucose required for synthesis of different chemical constituents compound at different plant organs, to the differences in carbon equivalent and partitioning of photosynthesis between the plant organs of (Ahmed *et al.*, 2016).

Similar finding were obtained by Hassanein *et al* (2001), Abu-Grab *et al* (2006), Ranjbar and Bahmaniar (2007), Koriem (2008), Zaki *et al* (2012), Radwan *et al* (2014), , Zaki *et al* (2015), El-Dahshouei *et al* (2017), Ahmed *et al* (2018), Hassanein *et al* (2018), Zaki *et al* (2018) and Hassanein *et al* (2019) in wheat, while, Ortiz *et al* (2002 a,b), Ibrahim *et al* (2011) and Ahmed *et al* (2017) in barley.

Effect of foliar zinc fertilizer:

Data in Table (4) illustrated that all yield and its components characters i.e. (plant height (cm), number of tillers (m^2), number of spikes (m^2), weight of spikes (g/ m^2), grain index (g), grain yield(g/m^2), grain yield (ton/fed), straw yield (ton/ feddan), biological yield (ton/ feddan), shelling percentage and harvest index) were significantly affected by different rates of zinc foliar fertilizer compared to control. Data indicated that increased zinc foliar fertilizer from 0.4% to 0.8% increased significantly yield and its components. The greatest value of all characters under study was 0.8% zinc foliar fertilizer. According to Yilmaz *et al* (1997) there are different outcomes for wheat when zinc fertilizer were applied. The increase in grain yield by zinc foliar fertilizer were relatively high indicated the necessary of zinc to plant. Many studies have been shown that one of the effective ways to improvement in cereal is application of zinc fertilizer (El-Metwally *et al.,* 2012), zinc foliar fertilizer is effective to improve grain (Bameri *et al.*, 2012). El-Habbasha *et al* (2015) and Esfandiari *et al* (2016) reported that foliar application of Zn had positive significant effect on wheat grain yield and its components.

These results are in a harmony with those obtained by Zeidan *et al*., 2010, Arif *et al.*, 2017 and El-Dahshouri *et al*., 2017).

Effect of interaction:

Data in Table (5) showed that the interaction between wheat cultivars and zinc foliar fertilizer was significant in all yield and its components under study except plant height (cm), number of tillers (m^2) and harvest index. Concerning the genetic variation in response to foliar application of Zn, El-Habbasha *et al* (2015) and Sharifi-Soltani *et al* (2016) found significant differences among wheat cultivars and genetic variation in terms of growth trait. The best treatment for yield and its components was Misr-2 wheat cultivar + 0.8% zinc foliar fertilizer.

References

Abd El-Ghany, H. M., 2007. Wheat production under water-limited sandy soil conditions using bio-organic fertilizer systems. Egypt. J. of Agron., 29(1): 17–27.

Abu-Grab, O.S., A.M. Mouss and G. A. El-Shaarawy, 2006. Photosynthesis and N-use efficiencies for some wheat cultivars in relation to planting density and nitrogen fertilization levels. Egypt. J. Appl. Sci., 2 (2B): 479-492.

Ahmed, A.G., M.A. Ahmed, M.S. Hassanein, Nabila M. Zaki and Ebtesam A. El-Housini, 2016. Effect of the complete foliar fertilizer nitrophoska foliar 20 /19/19/TE and yeast on growth and yield of tow sunflower cultivars under newly reclaimed sandy soil condition. Res. J. of Pharmaceutical, Biological and Chemical Sci., 7(6): 417-428.

Ahmed, A. G., Nabila M. Zaki and M. S. Hassanein, 2018. Effect of nitrogen fertilizer and bio-fertilizer on growth characters of two wheat cultivars under sandy soil. Middle East J. Agric. Res., 7(1): 110-116.

Ahmed,A. G., Nabila M. Zaki, M. S. Hassanein and Manal F. Mohamed, 2017. Effect of the complete foliar fertilizer nitrophoska foliar 20 /19/19/TE on growth, yield, yield components and some chemical composition of tow barley cultivars under newly reclaimed sandy soil. Middle East J. Agric. Res., 6(4): 1038-1044.

Arif, M., M. Tasneem, F. Bashir, G. Yaseen and A. Anwar, 2017.Evaluation of different levels of potassium and zinc fertilizer on the growth and yield of wheat. Int. J. of Biosensors & Bioelectronics, 3(2):242–246.

Bameri, M., R. Abdolshahi, G. Mohammadi-Nejad, K. Yousefi and S. M. Tabatabaie, 2012. Effect of different microelement treatment on wheat (*Triticum aestivum* L.) growth and yield. Inter. J. of Basic and Applied Science, 3(1):219–223.

Bremner, P. M. and M.A. Taha, 1966. Studies in potato agronomy, development and yield. J. Agric. Sci., 66: 241-252.

Cakmak, I., 2008. Enrichment of cereal grains with zinc: Agronomic or genetic biofortification? Plant Soil, 302: 1–17.

Chapman, H.D. and P.F. Pratt, 1961. Methods of Analysis for Soils, Plants and Water. Univ. of California, Berkeley, CA, USA.

Clark, R.B., S.K. Zeto, V.C. Baligar and K.D. Ritchey, 1997. Growth traits and mineral concentrations of maize hybrids grown on unlimed and limed acid soil. J. of plant Nutr., 20(12): 1773-1795.

El-Dahshouri. M. F., M. M. El-Fouly, R. Kh. M. Khalifa and H. M. Abd El-Ghany, 2017. Effect of zinc foliar application at different physiological growth stages on yield and quality of wheat under sandy soil conditions. Agric. Eng. Int.: CIGR J., Special issue: 193–200.

El-Fouly, M. M., Z. M. Mobarak, and Z. A. Salama, 2011. Micronutrients (Fe, Mn, Zn) foliar spray for increasing salinity tolerance in wheat (*Triticum aestivum* L.). The African J. Plant Sci., 5(5): 314–322.

El-Habbasha, E. S., E. A. Badr, and E. A. Latef, 2015. Effect of zinc foliar application on growth characteristics and Grain Yield of some wheat varieties under Zn deficient sandy soil condition. Inter.J. Chemtech Res., 8(6): 452–458.

El-Metwally, A., N. A. Khalil, M. M. El-Fouly, and M. F. El-Dahshouri, 2012. Growth, nutrients uptake and grain yieldof some wheat cultivars as affected by zinc application undersandy soil conditions. J. Plant Production, 3(5):773–783.

Esfandiari, E., M. Abdoli, S. B. Mousavi, and B.Sadeghzadeh, 2016. Impact of foliar zinc application onagronomic traits and grain quality parameters of wheat grownin zinc deficient soil. Indian J. of Plant Physiology, 21(3): 263–270.

Gomez, A.K. and A.A. Gomez, 1984. Statistical procedure for agricultural research.2nd edition John Wiley and Sons, Inc., New York.

Hao, M.D., X.R. Wei and T.H. Dang, 2003. Effect of long-term applying zinc fertilizer on wheat yield and zinc absorption by wheat in dry land. Ecol Environ Sci., 12(1):46–48.

Hassanein, M. S., Amal G. Ahmed and Nabila M. Zaki, 2018. Effect of nitrogen fertilizer and bio-fertilizer on yield and yield components of two wheat cultivars under sandy soil. Middle East J. Appl. Sci., 8(1): 37-42.

Hassanein, M.S., M.A. Ahmed, Magda A.F. Shalaby and Amal G. Ahmed, 2014. Partition and migration of dry matter in newly cultivated wheat cultivars in Egypt. Middle East J. of Agric. Res., 3(2): 353-362.

Hassanein, M.S., D.M. El-Hariri, and M.A. Ahmed, 2001. Effect of variety and seed rate on yield and yield components of wheat. Annals of Agric. Sci., Moshtohor 39(1): 1-13.

Hassanein M. S., Nabila M. Zaki and Amal G. Ahmed, 2019. Effect of foliar nutrition micro mix fertilizer on yield and yield components of twowheat cultivars.Middle East J. Appl. Sci., 9(1): 86-90.

Hotz, C., and K. H. Braun, 2004. Assessment of the risk of zinc deficiency in populations and options for its control. Food and Nutrition Bulletin, 2: 194–204.

Ibrahim, O.M., Magda H. Mohamed, M.M. Tawfik and Elham A. Badr, 2011. Genetic diversity assessment of barley (*Hordeum vulgare* L.) genotypes using cluster analysis. Inter. J. of Academic Res., 3(2):81-85.

Koriem, M.H.M., 2008. Response of some wheat cultivars in nitrogen and biofertilization. Ph. D. Thesis, Fac. Agric. Kafr El-Sheikh Univ.

Ortiz, R., M. Nurminiemi, S. Madsen, O.A. Rognli and A. Bjornstad, 2002a. Genetic gains in Nordicspring barley breeding over sixty years. Euphytica, 126: 283-293.

Ortiz, R., M. Nurminiemi, S. Madsen, O.A. Rognli and A. Bjornstad, 2002b. Cultivar diversity in Nordic spring barley breeding (1930 – 1991). Euphytica, 123: 111-119. P. 309.

Pandey, N., G. C. Pathak, and C. P. Sharma, 2006. Zinc is critically required for pollen function and fertilization in lentil. J. of Trace Elements in Medicine and Biology, 20: 89–96.

Peck, A.W., G. K. Mc Donald and R.D. Graham, 2008. Zinc nutrition influences the protein composition of flour in bread wheat (*Triticum aestivum* L.). J Cereal Sci., 47(2):266–274.

Prasad, A. S., 1985. Discovery and importance of zinc in human nutrition. Fed. Proc., 43:2829-2834.

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 on productivity and quality. Middle East J. of Agric. Res., 3 (3): 631-637.

Ranjbar, G. A. and M. A. Bahmaniar, 2007. Effects of soil and foliar application of Zn fertilizer on yield and growth characteristics of bread wheat (*Triicum aestivum* L.) cultivars. Asian J. of Plant Sci., 6 (6): 1000-1005.

Sharifi-Soltani, N., S. S. Alavi-Kia, M. M. Vahed, and S. Aharizad, 2016. Genetic variation of bread wheat varieties in terms of Zn and Fe accumulation in grain under Zinc foliar application. Biological Forum–An Inter. J., 8(1):391–396.

Takkar, P.N. and C.D. Walker, 1993. The distribution and correction of zinc deficiency. In: Zinc in Soils and Plants. Robson, A.D. (Ed.), Kluwer Academic Publishers, Dordrecht, The Netherlands, ppP151-166.

Watson, D.J., 1952. The physiological basis of variation in yield. Adv. Agron. 4:101-145.

Welch, R.M. and R.D. Graham, 1999. A new paradigm for world agriculture: Meeting human needs. Productive, Sustainable, Nutritious. Field Crops Res., 60: 2-10.

Yilmaz, A., H. Ekiz, B. Torun, I. Gultekin, S. Karanlik, S. A. Bagci and I. Cakmak, 1997. Effect of different zinc application methods on grain yield and zinc concentration in wheat cultivars grown on zinc-deficient calcareous soils. J. plant Nutr., 20: 461-471.

Zaki, N. M., A. G. Ahmed, M. S. Hassanein and M. E. Gobarah, 2015. Response of two wheat cultivars to foliar fertilizer in newly cultivated land. Middle East J. Agric. Res., 4 (2): 283-290.

Zaki, N.M., M.A. Gomaa, F.I. Radwan, M.S. Hassanein and A.M. Wali, 2012. Effect of mineral, organic and bio-fertilizers on yield, yield components and chemical composition of some wheat cultivars. J. of Applied Sci. Res., 8 (1): 174-191.

Zaki,N. M., M. S. Hassanein and Amal G. Ahmed, 2018.Effect of foliar nutrition grow vit on yield and yield components of two wheat cultivars.Middle East J. Agric. Res., 7(2): 248-253.

Zaki, N. M., M.S. Hassanein, Amal G. Ahmed, M.A. Ahmed and M.M. Tawifk, 2016. Response of two wheat cultivars to different nitrogen sources in newly cultivated land. Res. J. of Pharmaceutical, Biolog. and Chem. Sci.,7 (6): 410-416.

Zeidan, M. S., F. M. Manal, 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. of Agric. Sci., 6(6):696–699.