Effect of Wheat Grains Soaking in Micro-element Solutions on Yield and its Components

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Abstract:

This investigation was carried out in the Agricultural Experimental Farm at Fac. Agric., Assiut Univ., during the two winter growing seasons 2009/2010 and 2010/2011 to study the effect of wheat grains soaking in micro-element solutions on yield and its components. The used experimental design was a Randomized Complete Block Design in split-plot with four replications. Wheat varieties (Giza 168 and Bani-Swef 1) were allocated in the main plot, while micronutrient treatments (Fe, Zn, Mn, Fe+Mn, Zn+Mn, Fe+Zn and Fe+Mn+Zn) were distributed in the sup-plot. The plot area was 3x3.5 m^2. The results could be summarized as follows:

- Giza 168 variety surpassed and gave significant increase in the spike length, 1000-grains weight and straw yield in both season, as well as in the first season only gave significant increase in number of spikelets/spike and number of spike/m^2 over Bani-Swef 1.
- The maximum values for plant height, spike length, 1000-grains weight, number of spikelets/spike, number of spikes/m^2, grain yield/fed., straw yield/fed. were recorded by Fe+Mn+Zn treatment in both seasons.
- The interaction between varieties and micronutrient treatments had non-significant effect on the all studied traits in both seasons.

Keywords: Soaking, micro-element, solution.

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Introduction:

In Egypt, wheat has been considered to be the first strategic cereal crop for making bread as well as the wheat straw is important for hay feeding. Therefore, it is the first food crop in Egypt and the whole world. Wheat occupied an area estimated at about 3.6 million fed. with total production 8.28 million ton with average grain yield 18.00 ardab/fed. (FAO, 2013). However, this production did not meet consumption party due to crop leakage for other misused as well as the over growing population and hence consumption.

Zinc is micronutrient required in traces for normal plant growth, zinc plays essential metabolic roles in plant and works as regulatory cofactor for several enzymes. It is very closely involved in N metabolism of the plant. In levels are markedly zinc deficient plants protein synthesis, protein reduced, and amino acids and amides are accumulated. Iron is involved in the production of chlorophyll and iron chlorosis is easily recognized on iron sensitive crops growing calcareous soils. Iron also a component of many enzymes associated with energy transfer, nitrogen reduction and fixation, and lignin formation. Manganese is necessary in photosynthesis, nitrogen metabolism to form other compounds required for plant metabolism. Few reports examined the effect of grains soaking in micronutrients on maize uptake of nitrogen.

Harb (1992) used seed soaking of faba bean and cotton with micronutrients or growth regulator. He reported that the treatment led to an increase in seed yield. Zhang *et al.* (1992) reported that seed treatment of maize and rice with zinc sulphate increased zinc uptake in both crops. Furthermore, they reported that yield increases in rice due to soaking. Jeyabal and Kuppuswamy (1998), found that seed soaking with zinc along with other organic biofertilizers improved rice seedling characteristics. Nitrogen uptake improved by up to 11.8% in early seedling age (30 days) growth and yield attributes increased due to seed soaking. Grain yield increased by 8.8% over unsoaked seeds. Saad *et al.* (1999) studied small cereal soaking with zinc sulphate; they found that 0.01% zinc sulphate increased grain yield of wheat, barley and triticale.

Brennan (2001) observed that applied zinc fertilizers increased wheat dry matter, zinc content of the dry matter and grain yields. In nutrient priming, seeds are pretreated (primed) in solutions containing the limiting nutrients instead of being soaking simply in water (Arif *et al.*, 2005). Iron (Fe), zinc (Zn), manganese (Mn) are essential micronutrients for plant and humans (Kaya *et al.*, 1999; Asad and Rafique, 2000). Hao *et al.* (2007) reported that a deficiency of just one of these nutrients can greatly reduce plant yield and even cause plant death. Micronutrient deficiency, especially Fe and Zn deficiency, is widespread in humans (Graham *et al.*, 1999; Stoltzfus, 2001 and Liu *et al.*, 2006). Crop management strategies are an important complement to on going breeding programs. Studies have shown that Fe, Zn, Cu and Mn concentration in rice or wheat grain can be increased by proper irrigation management, N fertilization, and late planting (Hao *et al.*, 2007 and Pearson *et al.*, 2008). A number of studies have reported that the application of micronutrient fertilizers to the soil or crop foliage increased micronutrient concentrations in grain. However, some authors found that foliar sprays resulted in nutritional disorders and imbalances (Ghasemi-Fassaei and Ronaghi, 2008; Pahlavan-Rael and Pessarakli, 2009).

The effects of soaking whole cereal (rice, maize, sorghum) and legume seeds (mung bean, cow pea, soybean) on iron (Fe), zinc (Zn) contents were investigated. In all the above cereals, except millet, the molar rations of Phy/Fe were above 20, while, in legumes, ration were lower. Soaking whole seeds for 24 h led to leaching of iron and to a lesser extent, of zinc ions into the soaking medium. This work aimed to investigate the effect of wheat grains soaking in micro-element solutions on the yield and its components.

Materials and Methods:

This work was carried out at the Experimental Farm of the Faculty of Agriculture, Assiut University, during the two winter growing seasons 2009/2010 and 2010/2011, to study the effect of wheat grains soaking in micro-element solutions on yield and its components. The soil of the experimental site was clay. The main properties of the soil are given in Table (1).

Table 1: Average of the main properties of the experimental soil in 2009/2010 and 2010/2011 seasons.

Soil properties	values	
	2009/2010	2010/2011
Analysis:		
Sand %	26.6	27.2
Silt %	25.2	22.3
Clay %	48.8	48.4
Texture	Clay	Clay
E.C. (%)	42.0	41.0
Organic matter	1.80	2.0
pH	7.8	7.9
Available P (ppm)	9.0	10.0
Available Fe (ppm)	129.0	128.0
Available Mn (ppm)	24.2	25.4
Available Zn (ppm)	20.7	21.8
Total N %	0.08	0.081

The used experiment design was a Randomized Complete Block Design in split-plot arrangement of treatments with four replications. Wheat varieties (Giza 168 and Bani-Swef 1) were allocated in the main plots, while micro-element solutions were randomly distributed in the subplots.

The experiment was planted on the 26 November in both seasons. The area of each plot was 3x3.5 m^2 in each season. Wheat grains were soaked for 24 hours before planting in one of the seven different solutions along with a control treatment of distilled water. The solutions contained 100 ppm of either; $MnSO_4.H_2O$, $FeSO_4.7H_2O$, $ZnSO_4.7H_2O$ as single compound or their combinations of the above micronutrients as two elements mixture for Fe and Zn, Zn and Mn and Fe and Mn as well as three elements mixture for Fe, Mn and Zn.

The seeding rate were 60 kg/fed. in Giza 168 and 70 kg/fed. in Bani-Swef 1. recommended rates of 70 kg nitrogen was applied as ammonium nitrate (33.5% N) and 31 kg phosphorus was applied as a single super-phosphate (15.5% P_2O_5) during soil preparation as well as potassium was applied as potassium sulphate (48% K_2O).

The characters studied in this respect were:

1- Plant height: at harvest, measured in cm from surface of the soil to the top of the spike of five main stems.
2- Spike length, cm.
3- Number of spikelets per spike.
4- Number of spikes/m^2.
5- Seed index, i.e. 1000 grain weight, gm.
6- Grain yield ardab/fed.
7- Straw yield in ton/fed.

Statistical analysis:

The obtained data in each season were statistically analyzed according to procedure outlined by Gomez and Gomez (1984). Means comparison were done using revised least significant differences (RLSD) at 5% level of probability.

Results and Discussion:

Effect of varieties:

Data in table 2 showed that the spike length, 1000 grains weight and straw yield/fed. in both seasons had a highly significantly as well as the number of spikelets/ spike and number of spikes/m^2 in the 1st season only had a significantly affected by the wheat varieties. On the other hand, the plant height and grain yield/fed. in both season as well as the number of spikelets/spike and number of spikes/m^2 in the 2nd season had non-significant affected by the wheat varieties. It is clear that the wheat variety (Giza 168) gave a significant increase in the spike length (cm), 1000 grains weight (gm) and straw yield/fed. (ton) in both seasons as well as in the 1st season only for the number of spikelets/spike and number of spikes/m^2. The results indicated that the wheat variety (Bani-Swef 1) gave the lowest values for the all studied traits. Moreover, the tallest plants gave maximum straw yield/fed., as well as the increase of spike length and 1000 grains weight (gm) may be realized increase in the grain yield/fed. This result may be due to the genotypes make up reflecting improvement in yield components. Zaki *et al.* (2012) reported that Sakha 93 cultivar gave higher number of spikes/m^2 and grain yield (ton/fed.) than Gemmiza in both seasons. Varietal differences in yield components between wheat varieties were in conformity with those obtained by El-Habbal *et al.* (2000), Hassan and GabAllah (2000), Hossain *et al.* (2002), Allam *et al.* (2007), El-Metwally and Saudy (2009) and Noureldin *et al.* (2013) who reported that a significant differences among the tested wheat cultivars in the two seasons for number of spike/m^2, spike length, kernel number/spike, weight of 1000 kernels and grain and straw yields/fed.

Effect of the seed soaking in micronutrient solution:

The data in table 2 showed that the all studied traits had a highly significant affected by the soaking in micronutrients solution in both seasons. The tallest plants (99.90 and 99.03 cm), the tallest spike (10.58 and 11.30 cm), the heaviest 1000 grains (48.16 and 50.40 gm), the highest values of number of

Table 2: Effect of varieties and grains soaking in micronutrient solutions on wheat plant height, yield and yield attributes in 2009/2010 and 2010/2011 seasons.

Traits / Treatments	Plant height (cm)		Spike length (cm)		No. of spikelets/ spike		No. of spikes/m²		1000 grains weight (gm)		Grain yield/ fed. (ardab)		Straw yield/fed. (ton)	
Varieties	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011
Giza 168	94.57	94.57	10.54	11.06	19.41	19.97	390.0	390.0	42.66	44.66	17.66	17.63	4..06	4.48
Bani-Swef-1	92.65	93.38	8.34	8.93	17.64	18.26	299.2	302.8	48.29	49.63	17.05	17.02	3.41	3.70
F-test	Ns	Ns	**	**	*	Ns	**	Ns	**	**	Ns	Ns	**	**
Micronutrient														
Control	89.53 e	88.99 e	8.29 f	6.70 f	16.93 f	17.41 g	217.8 f	224.4 f	41.74 d	43.06 f	16.04 e	15.79 f	3.47 h	3.71 h
Fe	92.68 d	93.20 c	8.93 e	9.46 e	17.85 e	18.39 e	307.1 e	298.4 e	45.39 bc	46.30 e	16.91 d	16.69 f	3.65 f	3.91 f
Zn	93.16 cd	94.00 c	9.31 d	9.84 d	18.38 d	18.96 d	332.6 de	332.4 d	46.09 ab	47.14 de	17.19 cd	17.10 e	3.70 e	3.99 e
Mn	90.60 e	91.08 d	8.54 f	8.95 f	17.53 e	17.88 f	235.1 f	236.8 f	43.67 cd	44.34 f	16.40 e	16.20 g	3.55 g	3.84 g
Fe+Zn	95.03 b	96.25 b	10.26 b	10.98 a	19.60 b	20.30 b	445.1 b	433.5 b	46.93 ab	49.48 b	18.89 a	18.55 b	3.89 b	4.28 b
Zn+Mn	94.35 bc	95.01 bc	9.90 c	10.55 b	19.13 c	19.75 bc	383.1 e	397.6 c	46.27 ab	48.64 bc	18.20 b	17.93 c	3.82 c	4.18 c
Fe+Mn	93.66 cd	94.2 4c	9.70 c	10.20 c	18.65 d	19.34 d	348.9 d	358.9 d	45.55 bc	47.80 cd	17.78 bc	17.38 d	3.80 d	4.07 d
Fe+Mn+Zn	99.90 a	99.0 3a	10.58 a	11.30 a	20.13 a	20.86 a	486.9 a	491.8 a	48.16 a	50.40 a	19.32 a	18.95 a	3.97 a	4.37 a
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**
R.LSD 5%	1.24	1.88	0.31	0.33	0.33	0.40	30.01	33.65	2.33	1.42	0.61	0.20	0.01	0.01

*, ** indicate a significant and highly significant at 5% and 1% levels of probability.
Ns = non-significant differences.
R.LSD = Revised least significant difference.
Means have the same letter(s) within column did not differ significantly at 5% level of probability.

spikelets/spike (20.13 and 20.86), number of spikes/m^2 (486.9 and 491.8) the maximum grains yield/fed. (19.32 and 18.96 ard.) and the maximum straw yields/fed. (3.97 and 4.37 ton) were recorded by the three elements mixture treatment (Fe + Mn + Zn) in the 1st and the 2nd seasons, respectively. Moreover, the plants treated with Fe+Zn, Zn+Mn and Fe+Mn treatments had significant increase in all studied traits over the control treatment (unsoaked grains) in both seasons. Generally, all treatments receiving micronutrient: Fe, Zn and Mn either alone or combined together gave the highest values over the control in both seasons. Here, the results emphasized the important role for the trace elements (Fe, Zn and Mn) to increase the plant height, yield and yield attributes under this study, as well as showed that the synergetic role of micronutrients in improving plant growth and other biochemical and physiological activities. Brennan (2001) observed that applied zinc fertilizers increased wheat dry weight and grain yield. Similar findings were reported by Teama (2001) who found that the use of a single element for soaking was better than the control. All the two element mixtures were better than single element as well as the three-element mixture was the best of all soaking treatments. Massoud *et al.* (2004) reported that applying zinc increased grain yield, straw yield and 1000 grain weight. Moreover, zinc is the essential act as a metal-activator for the synthesis of plant growth regulators like auxin, also of several enzymes, involved in the synthesis of protein and nucleic acids in plants. These are in agreement with those reported by Zaki *et al.* (1992), Saad *et al.* (1999), Asad and Rafique (2000), Brennen (2001), Liu *et al.* (2006), Hao *et al.* (2007), Pearson *et al.* (2008), Pahlavan-Rael and Pessarkli (2009) and Salem and El-Gizawy (2012) who reported that number of ears/plant, number of grains/ear, 100-grain weight and grain yield increased by applying Zn, Mn and Fe singly or combined. Such increases were particularly significant by the Zn+Mn+Fe treatment with regard to 100-grain weight, ear weight and grain yield.

Effect of the interactions:

The data in table 3 revealed that the all studied traits had non-significant affects by the varieties with soaking grains in micronutrient interactions in the both seasons. Although the insignificant effect for all the studied traits by the interactions, the results indicated that the best values (102.20 and 100.10 cm), (11.7 and 12.4 cm), (21.20 and 21.83), (546.5 and 551.0), (19.05 and 19.32 ard/fed.) and (4.34 and 4.73 ton/fed.) were realized by V1xC8 interaction (Giza 168 variety x soaking grains in Fe+Mn+Zn micronutrients) for the plant height, spike length, number of spikelets/spike, number of spikes/m^2, grain yield/fed. and straw yield/fed. in the 1st and the 2nd seasons, respectively. The lowest values (88.75 and 89.00 cm), (74.3 and 7.60 cm), (16.20 and 16.65), (180.0 and 190.0), (15.95 and 15.43 ard.) and (3.18 and 3.38 ton) were detected by the V2xC1 interaction of Bani-Swef 1 variety x control treatment for the above same traits in the 1st and 2nd seasons, respectively. On the other hand, the heaviest 1000 grains (90.48 and 53.03 gm) followed by (49.98 and 52.54 gm) were obtained by interaction of Bani-Swef 1 var. x Fe+Mn+Zn micronutrient treatment followed by

Table 3: Effect of interaction between varieties and grains soaking in micronutrient solutions on wheat plant height, yield and yield attributes in 2009/2010 and 2010/2011 seasons.

Traits / Treatments		Plant height (cm)		Spike length (cm)		No. of spikelets/ spike		No. of spikes/m^2		1000 grains weight (gm)		Grain yield/ fed. (ardab)		Straw yield/fed. (ton)	
		2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011	2009/ 2010	2010/ 2011
V1	C1	90.30efg	88.98g	9.15fg	9.80ef	17.65fgh	18.18ghi	255.5gh	258.8hi	38.09i	40.66a	16.16gh	16.16g	3.76g	4.04h
	C2	93.50cde	94.00cde	10.05de	10.58a	18.75de	19.18def	339.0def	341.0fg	42.15gh	43.93hi	17.10c-g	16.96f	3.95e	4.24f
	C3	94.00cde	94.00h-e	10.50cd	10.93cd	19.40cd	19.93cd	361.3cde	365.0ef	42.89fgh	44.92gh	17.36cde	17.29f	4.00d	4.31e
	C4	91.50efg	91.75efg	9.48ef	9.95ef	18.35ef	18.60e-h	260.3gh	261.0hi	40.83hi	42.13ij	17.25c-f	16.40g	3.85f	4.16g
	C5	95.95bc	96.55bc	11.45ab	12.05ab	20.50ab	21.20ab	518.0a	498.0de	43.87e-h	46.41fg	18.51ab	18.89ab	4.23b	4.63b
	C6	94.75cd	95.43bcd	11.05abc	11.50bc	19.95bc	20.55bc	446.3b	451.5bc	43.95e-h	46.00fgh	18.09abc	18.20c	4.15c	4.54c
	C7	93.83cde	94.85h-e	10.95bc	11.30c	19.45cd	20.28c	392.8bcd	398.5de	43.65e-h	45.48gh	17.77bcd	17.78d	4.16c	4.44d
	C8	102.20a	100.10a	11.70a	12.40a	21.20a	21.84a	546.5a	551.0a	45.84c-g	47.77def	19.05a	19.32a	4.34a	4.73a
V2	C1	88.75g	89.00g	7.43j	7.60k	16.20ij	16.65k	180.0i	190.0j	45.38d-g	45.46gh	15.92h	15.43h	3.18o	3.38p
	C2	91.85ef	92.40ef	7.80ij	8.35ij	16.95hi	17.60ij	275.3fgh	255.8hij	48.62a-d	48.68cde	16.72d-g	16.42g	3.34m	3.58h
	C3	92.30def	93.10def	8.13hi	8.75hi	17.35gh	18.00ij	304.0efg	299.8gh	49.30abc	49.36bcd	17.02d-g	16.90f	3.40*l*	3.67m
	C4	89.70fg	90.40fg	7.60j	7.95jk	16.40i	17.15jk	210.0hi	212.5ij	46.51b-f	46.55efg	16.29fgh	16.00g	3.26n	3.52o
	C5	94.10cde	95.95bcd	9.08fg	9.90ef	18.70de	19.40de	372.3b-e	369.0ef	49.98ab	52.54a	17.75b-e	18.20c	3.55i	3.93j
	C6	93.95cde	94.90h-e	8.75gh	9.60fg	18.30ef	18.95efg	320.0efg	343.8fg	48.68a-d	51.27ab	17.49cde	17.67e	3.49j	3.82k
	C7	92.95def	93.63c-f	8.75gh	9.10gh	17.85fg	18.40h-i	305.0efg	319.3fg	47.44a-e	50.12bc	17.21c-f	16.99f	3.44k	3.69*l*
	C8	97.60b	97.95ab	9.45efg	10.20de	19.05de	19.90cd	427.3bc	432.5cd	50.48a	53.03d	18.02a-d	18.58bc	3.60h	4.01a
F-test		Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
RLSD 5%		2.84	3.31	0.73	0.58	0.76	0.87	70.35	52.75	3.90	2.21	1.05	0.40	0.02	0.02

Ns = non-significant differences.
R.LSD = Revised least significant difference.
Means have the same letter(s) within column did not differ significantly at 5% level of probability.
V1= Giza 168 (bread wheat), V2= Bani-Swef 1 (durum wheat).
C1= Control, C2= Fe, C3= Zn, Cu= Mn, C5= Fe+Zn, C6= Zn+Mn, C7= Fe+Mn, C8= Fe+Mn+Zn.

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interaction of Bani-Swef 1 var. x Fe+Zn micronutrient treatment), while the thinnest 1000-grains (38.09 and 40.66 gm) were achieved by interaction of Giza 168 var. x control treatment in the 1[st] and the 2[nd] seasons, respectively. Generally, the results emphasized that the Giza 168 var. (bread wheat) surpassed the Bani-Swef 1 var. (durum wheat) under different soaking grains by micronutrients either alone and/or mixture and therefore, it may be recommended that soaked grains of Giza 168 variety in micronutrients solution of Fe+Mn+Zn.

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تأثير نقع حبوب القمح في محاليل العناصر الصغري علي المحصول ومكوناته

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الملخص:

أجري هذا البحث بمزرعة كلية الزراعة – جامعة أسيوط خلال موسمي الزراعة الشتوية ٢٠٠٩/٢٠١٠ و ٢٠١٠/٢٠١١ لدراسة تأثير نقع حبوب القمح في محاليل العناصر الصغري علي المحصول ومكوناته وكان التصميم المستخدم هو القطاعات الكاملة العشوائية للقطع المنشقة لمرة واحدة في أربع مكررات. وضعت الأصناف جيزة ١٦٨ وبني سويف ١ في القطع الرئيسية بينما وضعت معاملات العناصر المغذية (الحديد – الزنك – المنجنيز – الحديد والمنجنيز – الزنك والمنجنيز – الحديد والزنك - الحديد والمنجنيز والزنك) في القطع المنشقة. وكانت مساحة القطعة التجريبية هي ٣×٣,٥ م٢. ويمكن تلخيص النتائج كما يلي:

- تفوق الصنف جيزة ١٦٨ علي الصنف بني سويف ١ وأعطي زيادة معنوية لطول السنبلة ووزن الألف حبة ومحصول القش في كلا الموسمين، كما أعطي أيضاً في الموسم الأول فقط زيادة معنوية لعدد السنيبلات/سنبلة وعدد السنابل/ م٢.
- سجلت المعاملة الحديد والمنجنيز والزنك أعلا قيمة لكل من طول النبات، طول السنبلة، وزن الألف حبة، عدد السنيبلات / سنبلة، عدد السنابل/م٢ ، محصول الحبوب / فدان ومحصول القش / فدان في كلا الموسمين.
- لم تتأثر جميع الصفات المدروسة معنوياً بالتفاعل بين الأصناف ومعاملات العناصر المغذية في كلا الموسمين.