Response of four bread wheat genotypes to application methods of Zinc fertilizer

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Abstract

The study was carried out in the field of Agriculture College, Duhok University in 2015-2016 growing season to study the growth and yield of four different wheat cultivars (Adana99, Iraq; locals, Zinzbar and Nigal; newly introduced cultivars) using different methods of fertilizers application; fluid seed treatment in ecoZinc, foliar ecoZinc (Black Rocks company, Turkey 0.01Zn), in addition to traditional NPK and control treatments under rain fed conditions of Duhok Governorate. Randomized complete block design was used with four replications.

The results showed that Adana99 and Iraq surpassed new introduced cultivars in field emergence and plant height, while the new cultivars were superior in some of spike traits in addition to harvest index but inferior in 1000 grains weight which was the crucial characteristic for reducing the seed quality for these two cultivars as compared to the locals in spite of their superiority in final grain yield and above ground biomass. Regarding fertilizers application, ecoZinc in both fluid and foliar ways were not significant on most of growth characteristics but the spike density enhanced significantly; seed yield was increased significantly (4.6 $t.ha^{-1}$) in fluid seed treatment in ecoZinc. The newly introduced wheat cultivars are not recommended under Duhok environment conditions due to their late in maturity which consequently effect final seed quality and quantity due to high temperatures at the end of the season.

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Introduction

In Iraqi Kurdistan region, rainfed cultivation of wheat is dominated depends on the annual precipitation during the growing season which is usually not regular in both amount and distribution. On the other hand, low yield cultivars along with traditional cultural practices, all of the mentioned factors consequently reduce wheat yield. According to Ministry of Agriculture and Water Resources(14), the average yield per unit area in all Kurdistan region areas from 2009 to 2013 was about 855 kg. ha^{-1}.There are numerous reasons behind low wheat productivity in Iraq and Kurdistan region, cultivars, environment conditions and cultural practices such as fertilization which are the clearest examples in a broad sense. Accordingly, wheat growth and yield can be enhanced by comprising new cultivars and approaching improved cultural practices such as newly developed fertilizers and fertilization methods (i.e. ecoZinc).

Application of NPK has been reported in respect to increase of wheat yield under different environmental conditions. Rashid *et al.* (27) demonstrated that wheat yield enhanced significantly by using of NPK (120 $kg.ha^{-1}$) fertilizer and all related traits such as spike characteristics and above ground biomass. The authors also stated that the final grain yield was higher when NPK used along with each of Sulfur and Zinc fertilizers. Improvement of growth and yield of wheat crop via application of NPK fertilizers was also reported by (32 and 36).

Zinc (Zn) is one of the most functional micronutrients in all organisms including human, plant and animals; it has an important physiological role in human growth and development (6). Fraga (10) and White and Broadly(33)declared that Zinc deficiency is very usual in each of animals and plants leading to serious health problem slake growth inhibition susceptibility to diseases, mental complexes because of complication in brain development. Children and women especially pregnant are estimated to be more susceptible to Zn deficiency than others .Soil Zn availability can be affected by numerous factors and the status of soil nutrition and pH are at the top which can be overcome through foliar application of Zn (4and 5);also they stated that Zn in wheat seeds is varies according to the cultivars which has important role in growth and seeds quality. In addition, Zinc is important for enzyme activation such as proteinase and dehydrogenase as well as enhancing of growth characteristics in wheat (16).

Zinc is reversely affected by some nutrients status in soil, high levels of phosphorusin the soil reduce Zn uptake by plants; this antagonism between these two elements led to serious yield reduction in wheat (27). In the same direction, (13)reported that wheat yield and harvest index have increased by application of Zn fertilizer and also the nutrient uptake enhanced excluding phosphorus; they advised 20 $kg.ha^{-1}$ Zn with traditional NPK fertilizer. El-Habbasha *et al.*(8), Muhammad *et al.*(17)and Rashid *et al.*(22) reported that wheat cultivars respond variously to the Zinc foliar application it increased wheat yield components significantly especially spike related traits in addition to grains weight which then increase the final yield.

On the other hand, wheat cultivars respond differently to the fertilizer application, the environmental conditions and in particularly heat and water stress is high in Mediterranean regions on wheat productivity. According to numerous studies included various wheat cultivars in some Syrian areas with rainfall ranged between 280-480 mm; the results revealed significant variations in final grain yield varied between 2.17 - 4.71 $t.ha^{-1}$concluding that the early maturing cultivars are more comfortable for the driest areas (32).The yield of wheat can be improved by introducing of new cultivars and improving cultural practices especially fertilization and particularly those which are not harmful for the environment such organic fertilizers. Accordingly, new introduced wheat cultivars along with different ecoZinc fluid fertilizer applications in comparison to local wheat and conventional fertilizers were suggested in this study to investigate their growth and yield performance under rainfed conditions of Duhok area.

Material and Methods

This experiment was carried out in the research fields of College of Agriculture, Duhok University, Kurdistan Region, Iraq in the 2015- 2016growing season. The research consisted of two factors :bread wheat (*Triticumae stivum* L.) cultivars, Zinzbar(ITA.B1-06)) and Nigal (ITA.B1-03)(new introduced cultivars), Adana99 and Iraq (locals) cultivars with initial 1000 grains weight 48, 38, 29, and 38 g. respectively, and four fertilizer application (seed priming in ecoZinc solution, foliar spaying of ecoZincin addition to traditional uses of NPK and check or control unit(without any treatments)under rainfed conditions of Duhok Governorate.

The field of study was plowed ten days before sowing; plowed soil was pulverized by rotivator and the soil was leveled. The prepared seeds were planted in third week of December, 2015. Each unit of experiments included six rows with 2 * 0.2m a parts (2.4 m^2, the area of each experiment unit); and the distance between replications and units was 1m and 0.6 m respectively. Sowing of seeds was implemented manually in a rate of 120 $kg.ha^{-1}$. For controlling the sowing process, the required weight of seeds per each line was reserved separately(19) and (20).EcoZinc solution was prepared for seed priming treatment using the mini equation of mixing 100 ml of ecoZinc with

400 liters of tap water which is equivalent to 1:4 ml.L^{-1};seeds were soaked for 2 minutes in the prepared solution for each cultivar then air dried and sown at the same time. Traditional compound fertilizer (NPK) was implemented at a rate of 120 kg.ha^{-1}while the second half of urea fertilizer was added at the tillers stage. Foliar spraying of ecoZinc was carried out at the beginning of tillers stage duringthe first half of March, 1.2 mlfor each experimental unit was applied which equivalent to 5000mlof ecoZince solution per hectare.

All cultural practices were used when required. Topic (250 ml.100L^{-1}) and Granistar (25g.100L^{-1}) herbicides sprayed to control broad and narrow leaved weeds at 4-5 leaf stage. Superserin(cypermithren+ chlorpyrephus) insecticide at a rate of 150 ml.100 L^{-1} used before the grain development stage for Sun insect control according to initial survey implemented for this purpose. Growth measurements were recorded for each treatment at a proper time: field emergence recorded at the 2-4 leaves stage; the seedlings of single middle rows (1 m^2) were counted, divided by the sowing rate and then expressed as percentage(35), leaf chlorophyll by SPAD tool was measured, flag leaf area was calculated according to(12):

$$\text{Flag leaf area } (\text{cm}^2) = \text{W} \times \text{L} \times 0.75$$

Where W is the flag leaf width and L the flag leaf length

Plant height was measured in harvest for 10 plants and then the average was calculated (from the soil surface to the top of the spike excluding awns). One of the middle lines was harvested manually in the first week of June for yield and its components measurements; in addition, five spikes were selected randomly for the spike measurements. Meteorological data for the site of experiment were obtained from the research station college of Agriculture (Fig. 1).

The treatments were arranged in a randomized complete block design (RCBD) with four replicates; the data were statistically analyzed using the computerized statistical analysis system (29) and Least Significant Differences (LSD) was used for the mean comparisons at the probability of 0.05.

Results and Discussion

The data in table (1) showed that the most of wheat growth characteristics affected significantly by wheat cultivars excluding of leaf flag leaf chlorophyll content, while in regards to fertilizers treatment, only leaf chlorophyll content was significantly influenced. The interaction of wheat cultivars and ecoZinc treatments was not significant for all growth measurements. The local cultivars (Iraq andAdana99) were superior in field emergence (95and 96 %) and plant height (86 and 87 cm) as compared to new introduced cultivars (Nigal and Zinzbar) respectively.

Banziger and Cooper (1) reported that most of growth characters for wheat crop varieties responded variously to the environmental conditions. Differences in field emergence can be interpreted by the variation of the seed size and vigor for the studied cultivars. Variation of plant height among wheat cultivars be related to the genetic background as this trait is controlled mainly by genes (24 and25), and also environment conditions have an effect on plant height (Fig. 1). Sojka*et al.(*31) found that tall bread wheat and barley more resistance to drought conditions; semi-dwarf wheat is intermediate while durum wheat is most susceptible. In addition, it has been reported that semi dwarf cultivars usually simulate less CO_2 compared to tall cultivars in stress conditions due to less leaf water content (18). Similar results concerning plant height among

Table (1):Mean values for wheat cultivars andecoZinc fertilizer treatments on somewheat growth characteristics.

Traits / Treatments	Field emergence (%)	Chlorophyll (SPAD)	Flag leaf area (cm^2)	Plant height (cm)
Means of wheat cultivars				
Nigal	83.86	53.23	36.04	75.80
Zinzbar	84.42	53.62	30.22	77.25
Adana99	96.05	52.21	36.81	86.37
Iraq	94.86	51.54	45.38	87.77
LSD	5.422	1.852	4.760	1.387
Means of fertilizers treatment				
Control treatment	90.80	52.10	37.90	81.73
Seed priming in ecoZinc	87.22	52.58	35.94	81.18
Foliar application of ecoZinc	87.48	51.62	36.66	82.30
Conventional NPK	93.69	54.28	37.94	82.00
LSD	5.42	1.85	4.76	1.38

wheat cultivars were also reported by (23 and 30) under numerous differed conditions.

Iraqi Local wheat cultivar surpassed all others significantly in flag leaf area which recorded 45.38 cm^2. Regarding flag leaf chlorophyll content, both seed primingin ecoZinc solution and foliar application along with control unit significantly were inferior as compared to traditional application of NPK fertilizer; these results are highly agreed with those of (34)as they concluded that under stress conditions of water shortage, foliar treatments will not improved the chlorophyll content or leaf area of plants

Table (2) demonstrated the effect of wheat cultivars and fertilizer treatments on spike characteristics. All spike traits were significantly affected in regards to wheat cultivars, but the fertilizer application treatment was significant only for the spike density. On the other hand their interactions between both studied factors were not significant. Nigal cultivar was superior in most of spike traits; also, this variety along with both local cultivars (Iraq and Adan-99) surpassed Zinzbar cultivar in spike length. Both newly introduced cultivars surpassed locals in spike density and number of spikelets per spike characteristics as they obtained about 21 spikelets per 10 cm spike length compared to 17 spikelets for the Iraqis or local cultivars.

Zinc application significantly influenced only on the spike density trait, while the other treatments were not significant in relation to the spike characteristics. Seed priming in ecoZinc solution along with the control treatment significantly produced denser spikes. Spike density is the fraction of number of spikelets and spike length; therefore, there was a positive correlation (*r*= 64**) between number of spikelets and

Table (2): Mean values for wheat cultivars and fertilizer application on some of spike characteristics.

Traits / Treatments	Spike length (cm)	Spikelets/ spike (n)	Grain yield/spike (g)	Spike[1] density
Means of wheat cultivars				
Nigal	9.413	19.38	1.482	20.6
Zinzbar	8.425	17.28	1.295	20.5
Adana99	9.320	16.10	1.212	17.3
Iraq	9.497	16.32	1.152	17.2
LSD	0.4386	0.807	0.2231	0.53
Means of fertilizers treatment				
Control treatment	9.028	17.40	1.375	19.3
Seed priming in ecoZinc	9.193	17.55	1.332	19.1
Foliar application of ecoZinc	9.097	16.98	1.270	18.7
Conventional NPK	9.337	17.15	1.163	18.4
LSD	0.44	0.81	0.22	0.53

[1] Spike density; number of spikelets per 10 cm length of spike

spike density (Table 4).Increasing and decreasing of the spikelets fertility and especially the basal spikelets and also most of other spike characteristics is mostly associated with the environment conditions (26). On the other hands and according to (15), there was a possibility for increasing the spikelet sterility in high plant densities, but in our study the sterility was probably associated with the stress of environmental condition especially high temperature (Fig. 1).

Wheat cultivars were significantly different in all yield and yield components excluding number of spikes per unit area (Table 3).Fertilizers application treatment significantly influenced on the final grain yield, but all other yield components were not affected by the application of fertilizers. The interaction of cultivars and fertilizers application was not significant for all yield and related components measurements. Both newly introduced cultivars were superior in number of seeds per spike and harvest index but inferior in 1000 grains weight as compared the local cultivars and this was the most effective characteristics in which affected on the final grain yield for the two new cultivars; as it was about half (50%) from the initial grain weight (48 and 38 gm. for Zinzbar and Nigal respectively). Each of Nigal (4.57 t.ha-1) and Adana99 (4.55 t.ha-1) cultivars significantly produced higher grain yield when compared the two other cultivars; also these cultivars were superior in above ground biomass yield (Table 3).

As for the fertilizer application treatments, only final grain yield was significant and higher when seed soaked or primed in ecoZinc solution (4.60 t.ha-1) when compared to other treatments. The obtained results for ecoZinc fertilizer were agreed with those of (8, 13 and 17). The final grain yield was positively correlated with number of spikes (fertile or active tillers) (r= 0.52**) and biomass (r= 0.77**) (Table, 4).

Table (3): Mean values for wheat cultivars, ecoZinc fertilizer application on yield and yield components characteristics.

Traits / Treatments	Number of spikes ($n.m^{-2}$)	Number of seeds ($n.spike^{-1}$)	1000 grain weight (g)	Grain yield ($t.ha^{-1}$)	Biomass ($t.ha^{-1}$)	Harvest index
Means of wheat cultivars						
Nigal	187.5	57.52	25.54	4.57	12.57	0.38
Zinzbar	184.0	51.08	25.42	4.10	10.80	0.39
Adana99	205.3	39.28	30.77	4.55	13.16	0.35
Iraq	187.0	41.03	28.15	4.03	11.72	0.34
LSD	22.36	3.827	3.198	3.404	11.385	0.037
Means of fertilizers treatment						
Control treatment	189.7	48.36	28.79	4.17	12.07	0.37
Seed priming in ecoZinc	192.4	49.30	27.45	4.60	12.19	0.38
Foliar application of ecoZinc	181.7	45.92	27.63	4.23	11.89	0.36
Conventional NPK	200.1	45.35	26.00	4.24	12.11	0.35
LSD	22.36	3.83	3.19	0.34	1.14	0.037

Table (4): Simple correlation between some studied characteristics.

#	Grain yield	Spikes/m^2	Spikelets/spike	Seeds/spike	Seeds/spike	Spike density	Grain weight	Leaf area	Leaf chlorophyll	biomass
Spikes/m^2	0.52 **									
Spikelets/spike	0.14 ns	0.05 Ns								
Seeds/spike	0.02 ns	-0.12 ns	0.88 **							
Seed yield/spike	0.27 ns	-0.02 ns	0.44 *	0.61 **						
Spike density	-0.19 ns	-0.19 ns	0.64 **	0.79 **	0.26 ns					

Grain weight	0.30	0.17	-0.58	-0.57	0.30	-0.68				
	ns	Ns	**	**	ns	**				
Leaf area	0.05	0.24	-0.21	-0.36	-0.04	-0.60	0.42			
	ns	Ns	ns	ns	ns	**	*			
Leaf chlorophyll	-0.03	0.10	0.27	0.18	0.18	0.12	-0.04	-0.03		
	ns	Ns	ns	ns	ns	ns	ns	ns		
biomass	0.77	0.72	0.20	-0.08	0.02	-0.29	0.16	0.35	0.15	
	**	**	ns	ns	ns	ns	ns	ns	ns	
Harvest index	0.12	-0.43	-0.16	0.16	0.36	0.23	0.15	-0.49	-0.24	-0.54
	ns	*	ns	ns	ns	ns	ns	**	ns	**

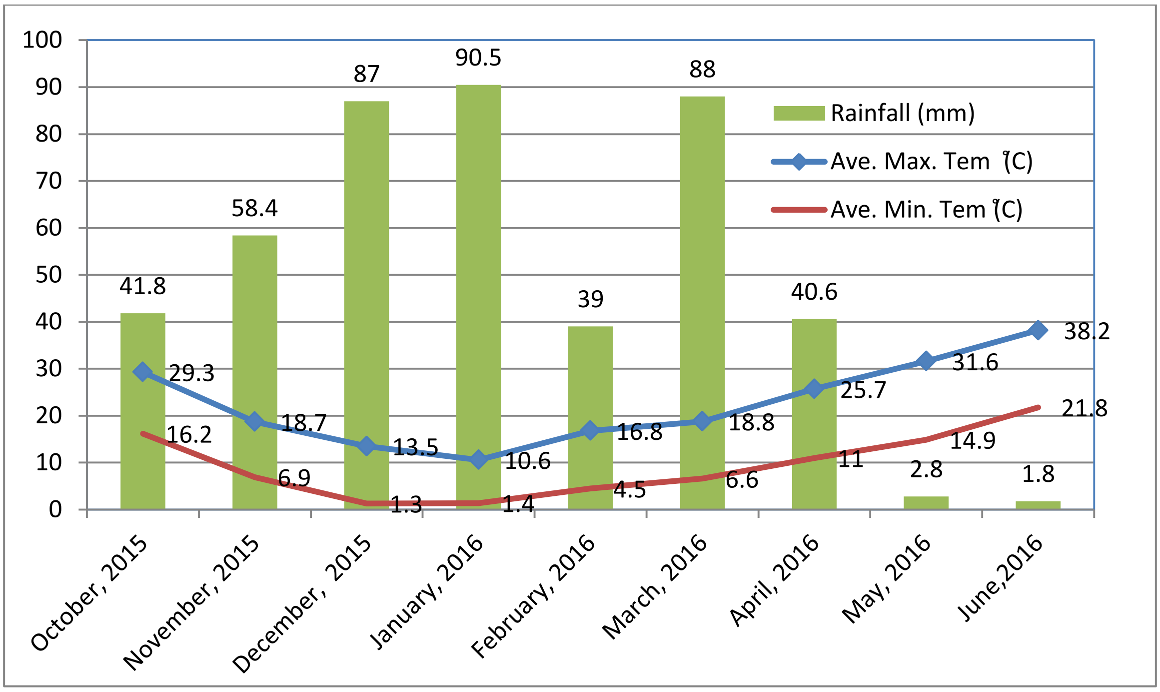

Figure (1): Meteorological data of the research sites for the studied cultivars

Both introduced wheat cultivars were late about 10 days in maturity (161 days) from the local cultivars (152 days) and this was the reason behind extending the grain filling period to match the high temperatures and low rainfall in May (Fig. 1), while the local cultivars which were earlier and escaped the stress of high temperatures and low moisture which enabled them to fill the grain more efficiently (Table 3).Borghi *et al.* (2) described that early maturing wheat cultivars with a fast grain filling can reach optimum grain weight. In this concern, (25) also reported that the grain filling is the most critical stage, any stress during this stage was negatively affect grain weight and final seed yield.

The effect of high temperature and water stress at flowering stage and grain filling stage was also reported by (7),(11), (20), (21) and (28) and accordingly the wheat cultivars that flower too late are at higher risk of stress that may lead to spike and grain damages and also effect on the stem water soluble carbohydrate remobilization to the grain. unless an alternative source of supplementary irrigation is available to overcome the low rainfall confliction; and this was behind the bad grains qualities and shrinkage of seeds as they exposed to the stress during the grain filling stage in May. Therefore, based on the obtained results both newly introduced cultivars (Zinzbar and Nigal) are not recommended for the unsecure rainfall areas. On the other hand, supplementary irrigation can suggested and approach to overcome any stress at flowering and grain filling stages. Further studies are required to support the obtained results under different environmental conditions.

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استجابة أربعة أصناف من حنطة الخبز لطرائق إضافة الزنك

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المستخلص

أجريت دراسة في حقول كلية الزراعة، جامعة دهوك للموسم الزراعي 2016/2015 لدراسة اداء نمو وحاصل اربعة اصناف من الحنطة الناعمة {ادنة-99، العراق (اصناف محلية) ، زينزبار، نيكول (اصناف مدخلة حديثا)}باستعمال طريقتين من اضافة الزنك (معاملة البذور بسائل الايكوزنك، التسميد الورقي بالايكونك(شركة بلاك رووكس، تركيا 0.01 زنك)، بالاضافة الى الاستخدام التقليدي للسماد المركب NPKو معاملة المقارنة تحت الظروف الديمية لمحافظة دهوك، طبق تصميم القطاعات العشوائية الكامل باربع مكررات. اظهرت النتائج تفوق كل من الاصناف المحلية في صفتي البزوغ الحقلي وارتفاع النبات بينما تفوقت الاصناف المدخلة في بعض صفات السنبلة و دليل الحصاد بينما كانت الاخيرة متنحية بشكل معنوي في وزن الالف بذرة وهذه كانت السبب في انخفاض نوعية البذور لهذين الصنفين بالمقارنة مع الاصناف المحلية على الرغم من تفوقهما في حاصل البذور و الحاصل الحيوي. بالنسبة لمعاملة طرائق الاسمدة، استخدام الايكوزنك بالطريقتين (معاملة البذور والرش الورقي) لم يؤثر بشكل معنوي على معظم صفات النمو الخضري بينما ادى استخدام الايكوزنك الى زيادة كثافة السنبلة بشكل معنوي وكذلك الحاصل النهائي للبذور كان معنويا ومتفوقا عند معاملة البذور بمحلول الايكوزنك واعطت 4.6 طن.هكتار$^{-1}$. استخلصت الدراسة بعدم التوصية بزراعة الاصناف الجديدة تحت ظروف محافظة دهوك والمناطق المماثلة لكونها اصناف متأخرة النضج وبالتالي تتاثر البذور في مرحلة الامتلاء بارتفاع درجات الحرارة في نهاية الموسم مما يؤثر سلبا على نوعية وحاصل الحنطة.

الكلمات المفتاحية: الحنطة، الاصناف، الاسمدة، النمو، الحاصل، الايكوزنك

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