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Research Article

# Response of wheat yield and its components to zinc and iron application under different levels of nitrogen

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## ABSTRACT

To evaluate the effect of nitrogen, zinc and iron as soil application on yield and yield component of wheat, the present study was conducted at Agricultural and Experimental Research Station at Giza, Faculty of Agriculture Cairo University, Egypt during 2015/2016 and 2016/2017 seasons. The experimental design was split-plot in randomized complete block design with three replications. Results showed that positive significant effect on plant height, number of spike/$m^2$, spike length; number of grain per spike, grain yield per unit area in both seasons and grain protein content in one season were achieved by application of N and the micronutrients. Whoever, the highest significant in the above mentioned characters was obtained either by application the highest N levels (100kg N /fed.) or in addition to mixture of Zn and Fe. The interaction between the studied factors had significant effect on plant height and grain yield in both seasons as well as on grain protein content in the second season, where the highest values of these parameters were recorded by application of 100kg N/fed., Zn and Fe in mixture.
***Keywords:*** *Wheat yield, nitrogen, zinc and iron*.

## INTRODUCTION

Wheat (*Triticun aestivum* L.) is the most important cereal crop in the world, because it is now the important grain crop in international commerce and it is excellent storing and shipping quality make it available to people almost everywhere. In Egypt, the total production of the wheat is still far below the annual demand. This gap can be filled by increasing wheat area especially in the reclaimed lands, increasing the productivity at the plant area and decreasing the losses in production and consumption., Consequently, Increasing wheat production under Egyptian conditions is a major concern of the Agronomist.

Balanced nutrition of the plant is one of the main factors that affects the yield quality of plant. Nitrogen fertilization is an important factor in front of wheat agronomists for achieving yield targets. Several investigator found positive response of wheat to nitrogen fertilization (Anssari *et al.* , 2010; Wahid, 2013; Saraka *et al.*, 2014). Another essential nutrients are Zn and Fe. Zn plays a special role in synthesizing protein, RNA and DNA, chlorophyll synthesis, thylakoid synthesis and chloroplast development. Fe play an active role in several enzymatic activates of photosynthesis as well respiration (Ali *et al.*, 2012 and Mosoud *et al.*, 2012). Moreover, Zn and Fe take over different roles in crop such as a formation partitioning and utilization of photosynthesis assimilates. Several investigators recorded positive response of wheat to Zn and Fe fertilization (Nasiri *et al.*, 2010; Nadim *et al.*, 2011; Habib, 2012; Inayat *et al.*, 2014; Ghafoor *et al.*, 2015 and Zain *et al.*, 2015). Consequently, the present study aimed to investigated the response of wheat yield and its components to Zn and Fe application under different N levels.

## MATEREALS AND METHODS

Grain yield and its components of wheat (*Triticum aestivum* L.) cv. Giza 168 as affected by soil application of Zn Fe and Zn + Fe under tree N levels, i.e. 60, 80 and 100 kg N/fed. (one Fedden = 4200$m^2$) were studied. Experiments were conducted at Agricultural and Experimental Research Station at Giza, Faculty of Agriculture, Cairo University, Egypt during two successive winter seasons 2015/2016 and 2016/2017. As mean of the two seasons, the soil type of the experiments was loamy in texture where the soil fertility status cleared that soil was low in N, Zn and Fe (available N, Zn and Fe were 30.3 - 32.6, 10.02 – 10.11 and 2.01 - 2.03 ppm, respectively). The experimental design was split-plot in randomized complete block design in three replications. Nitrogen fertilizer levels occupied the main plots and micronutrients were allocated in sub-plots.

The preceding crop was corn in both seasons. Grains were sown on the third week of November in both seasons. Nitrogen fertilizer in the form of urea 46%N was added in a split application, one half was applied at sowing time and the rest before the first irrigation (21 days after planting). Zn and Fe in sulfate form at the rate of 20 kg/fed. were added to the soil before the first irrigation. Zn and Fe were added either individually or in mixture. At harvest time, wheat plants were collected from each sub-plot and plant height, number of spike/m$^2$ , spike length, number of grains/spike, 1000-grain weight, grain yield per unit area and grain protein content were estimated. All the data collected during the both seasons were subjected to statistical software package *MSTAT*-C (Michigan Stat University,1190). Least Significant Differences Test ( L. S. D.) at 0.05 probability was used to test significances among mean values of each treatment (Steel and Torrie, 1997).

## RESULS AND DISSCTIONS

### Effect of nitrogen fertilizer levels

Increasing N levels up to 100 kg N/fed. caused a significant and gradually increase in plant height, number of spikes/m$^2$ , spike length, number of grain /spike and grain yield/fed. in both seasons and grain protein content in the second one (Table 1 and 2). As an average of two season, increasing N levels up to 100 kg N/fed. caused an obvious increase in the above mentioned characters by 1.3, 4.4, 8.1, 7.1, 24.6 and 9.1 % over the application of the lower nitrogen levels (60 and 80 kg N/fed.). Moreover, grain yield response per kg of N was calculated as 15 and 20 kg of grains for 80 and 100 kg N/fed., respectively. These results expected that nitrogen is one of the most important component of cytoplasm, nucleic acid and chlorophyll. Therefore, as the level of nitrogen increased rapid multiplication of cells occurs which in turn enhanced the amount of metabolist necessary for building plant organs. These results are in harmony with these recording by Anssari *et al.*(2010), Gheith *et al.* (2013), Guo *et al.* (2013), Wahid (2013) and Szmigiel *et al.* (2014) who reported that grain yield per unit area was increased significantly with increasing N levels. Moreover, Sarka *et al.* (2014) found that protein content in grains increased significantly was increased N levels.

### Effect of Zn and Fe fertilizer

Results presented in Table (3 & 4) showed that plant height (in first season), number of spikes/m$^2$ and grain yield /fed. in both seasons were significantly affected by application of Zn and Fe. On the contrary, this effect was not true regarding spike length, number of grains /spike, grain weight/spike, thousand grain weight and grain protein content in both seasons. In general, application of Zn + Fe combination treatment produced the highest values for the studied characters, while the lowest values were recording with application of Fe alone in both seasons. The previous finding may be dye to that Zn and Fe, in general, are required to a healthy growth and life cycle completion (Ali *et al.*, 2012).

**Table 1: Yield and its components as affected by nitrogen levels in 2014/2015 season.**

| Yield and its components | N levels (kg/fed.) 60 | 80 | 100 | F | L.S.D. |
|---|---|---|---|---|---|
| Plant height (cm) | 110.3 | 110.9 | 112.6 | * | 1.5 |
| Number of spikes/m$^2$ | 440.6 | 445.3 | 468.2 | * | 14.3 |
| Spike length (cm) | 10.1 | 10.3 | 10.8 | * | 0.2 |
| Number of grains/spike | 51.7 | 53.9 | 56.3 | * | 2.2 |
| Weight of grains/spike(g) | 2.5 | 2.6 | 2.8 | ns | - |
| 1000-grain weight (g) | 42.6 | 42.9 | 43.3 | ns | - |
| Grain yield (t/fed.) | 2.7 | 3.0 | 3.4 | * | 0.2 |
| Grain protein content (%) | 14.2 | 14.3 | 14.5 | ns | - |

* = Significant and ns = Not significant at 0.05 level.

**Table 2: Yield and its components as affected by nitrogen levels in 2015/2016 season.**

| Yield and its components | N levels (kg/fed.) 60 | 80 | 100 | F | L.S.D. |
|---|---|---|---|---|---|
| Plant height (cm) | 114.2 | 114.5 | 114.8 | * | 1.2 |
| Number of spikes/m$^2$ | 439.3 | 440.1 | 441.8 | * | 0.4 |
| Spike length (cm) | 9.8 | 10.3 | 10.7 | * | 0.3 |
| Number of grains/spike | 57.5 | 60.5 | 60.8 | * | 3.0 |
| Weight of grains/spike(g) | 2.4 | 2.5 | 2.6 | ns | - |
| 1000-grain weight (g) | 42.7 | 42.8 | 44.1 | ns | - |
| Grain yield (t/fed.) | 3.0 | 3.3 | 3.7 | * | 0.3 |
| Grain protein content (%) | 12.1 | 14.5 | 14.2 | * | 0.4 |

* = Significant and ns = Not significant at 0.05 level.

Its plays a role in many function in plant growth and development. This function includes chlorophyll synthesis, enzymatic activities of photosynthesis, synthesizing protein, RNA and DNA (Ali *et al.* 2012 and Mosoud *et al.*,2012). The present results are in harmony with those obtained by many researchers of them Nasiri *et al.* (2010), Yassen *et al.* (2010), Nadim *et al.* (2011), Bameri *et al.* (2012), Habib *et al.* (2012), Khan *et al.* (2012), Inayat *et al.* (2014), Ghafoor *et al.*

(2015) and Zain *et al.* (2015) who reported that application of micronutrient to wheat caused an increase in either grain yield or yield components.

**Effect of the interaction**

Results in Table (5) indicated that the interaction between the two studied factors had significant effect on plant height and grain yield pre unit area in both seasons and grain protein content in the second season. The tallest plants (114.6 and 115.5 cm ) and maximum grain yield (3.9 and 3.6 t/fed.) in both seasons, respectively recorded by application of the highest N level (100 kg N/fed.) and mixture of Zn + Fe treatment. As regarding the grain protein content, the highest value (14.6%) was produced under the same treatment in the second season.

The results of this study showed that under the condition of this experiment, there was positive significant effect on grain yield and its related characters were achieved by application of 100 kg N/fed. and mixture of Zn + Fe. It is evident also application of 100 kg N/fed. with mixture of Zn + Fe was the best treatment recorded the highest values of all studied character comparing with other treatments.

**Table 3: Yield and its components as affected by different micronutrients in 2014/2015 season.**

| Yield and its components | Micronutrients Zn | Fe | Zn + Fe | F | L.S.D. |
|---|---|---|---|---|---|
| Plant height (cm) | 112.9 | 106.9 | 114.5 | * | 2.1 |
| Number of spikes/m$^2$ | 448.3 | 440.2 | 458.3 | * | 7.9 |
| Spike length (cm) | 10.3 | 10.1 | 10.5 | ns | - |
| Number of grains/spike | 50.6 | 51.2 | 52.3 | ns | - |
| Weight of grains/spike(g) | 1.9 | 2.2 | 2.3 | ns | - |
| 1000-grain weight (g) | 43.7 | 43.2 | 44.5 | ns | - |
| Grain yield (t/fed.) | 2.4 | 2.2 | 2.6 | * | 0.2 |
| Grain protein content (%) | 14.0 | 14.1 | 14.3 | ns | - |

* = Significant and ns = Not significant at 0.05 level.

**Table 4: Yield and its components as affected by different micronutrients in 2015/2016 season.**

| Yield and its components | Micronutrients Zn | Fe | Zn + Fe | F | L.S.D. |
|---|---|---|---|---|---|
| Plant height (cm) | 114.5 | 114.2 | 114.7 | ns | - |
| Number of spikes/m$^2$ | 444.0 | 450.1 | 453.2 | * | 2.8 |
| Spike length (cm) | 10.1 | 10.3 | 10.4 | ns | - |
| Number of grains/spike | 49.5 | 50.3 | 51.6 | ns | - |
| Weight of grains/spike(g) | 2.2 | 2.4 | 2.5 | ns | - |
| 1000-grain weight (g) | 41.2 | 41.6 | 42.5 | ns | - |
| Grain yield (t/fed.) | 3.3 | 3.2 | 3.6 | * | 0.3 |
| Grain protein content (%) | 12.8 | 12.3 | 13.5 | ns | - |

* = Significant and ns = Not significant at 0.05 level

**Table 5: Effect of interaction on plant height (cm), grain yield (t/fed.) and grain protein content(%) .**

| N levels (kg/fed.) | Micro-nutrients | Plant height 1st season | Plant height 2nd season | Grain yield 1st season | Grain yield 2nd season | Grain protein 2nd season |
|---|---|---|---|---|---|---|
| 60 | Zn | 113.9 | 114.5 | 3.0 | 3.1 | 11.5 |
| | Fe | 102.6 | 113.9 | 2.8 | 3.0 | 12.1 |
| | Zn+Fe | 114.5 | 114.3 | 3.3 | 3.1 | 12.7 |
| 80 | Zn | 112.4 | 114.5 | 3.3 | 3.2 | 13.0 |
| | Fe | 109.5 | 114.3 | 3.2 | 3.1 | 12.3 |
| | Zn+Fe | 114.5 | 114.8 | 3.5 | 3.4 | 13.2 |
| 100 | Zn | 112.8 | 114.6 | 3.5 | 3.5 | 14.0 |
| | Fe | 108.3 | 114.2 | 3.4 | 3.1 | 12.6 |
| | Zn+Fe | 114.6 | 115.5 | 3.9 | 3.6 | 14.6 |
| F- test | | * | * | * | * | * |
| L.S.D. 0.05 % | | 2.5 | 0.5 | 0.4 | 0.3 | 1.5 |

* = Significant at 0.05 level

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