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Effect of Iron Application to Calcareous Soil on Growth and Yield of Wheat in Sulaimani, Governorate-Kurdistan-Iraq

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Abstract: A field experiment was conducted during the winter season of 2013-2014, at Bakrajow Agricultural Research Farm. The area of the field experiment is lies between 35°32˙36˝ north latitude and 45°21˙08.7˝ east longitude. The present study was conducted to investigate the effect of iron application to the soil in the form of Fe-EDDHA, which contain 6% Fe on some vegetative growth and grain nutrients content of wheat variety *Semito*. The treatments were included T_1 = control, T_2 = 10, T_3 = 20 and T_4 = 30 kg Fe ha^{-1}. The field experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Most criteria of vegetative growth and some nutrients content of wheat plant include, plant height, grain yield, 1000 grain weight, biological yield, number of tiller per plant, grain protein content, harvest index and NPK content of wheat grain were studied. Data analysis showed that the application of iron to the soil had a significant effect on grain yield and harvest index at 5% level. Maximum grain yield and harvest index (5.10 kg ha^{-1} and 45.70% respectively) referred to the application of 30 kg Fe ha^{-1}. These may be due to the genetic structure of wheat variety *Semito*, the mode of utilization of metabolic products and hindering effect of high pH on the availability of applied Fe to calcareous soil.

Key words: Wheat yield · Iron · Yield components

INTRODUCTION

Wheat (*Triticum aestivum* L.) plays an important role among the few crops cultivated at a large level in the world as a main food as well as in Kurdistan Region of Iraq. Micronutrients deficiency especially Fe and Zn are very common in the area with calcareous soil type with a high pH value, low organic matter content and high calcium carbonate equivalent content [1]. The importance of micronutrients in plant growth is limited to their role in balancing plant nutrients and increasing the soil productivity [2]. Micronutrients have the vital role in chlorophyll formation, protein synthesis, activation of some photosynthesis and respiration enzymes [3]. To increase the production of crops with high yield and quality, an adequate fertilization of macro and micronutrients should be implemented in plant nutrition [4].

Spraying of micronutrients led to the improving root growth of wheat and caused the increasing in macro and micronutrients uptake [5]. The importance of micronutrients is not less than that of macronutrients for adequate plant nutrition. A deficiency of only one micronutrient can significantly reduce the yield [6].

Fe is a necessary element for the synthesis of chlorophyll, production of carbohydrate, respiration, as well as oxidation and reduction operation in plants, thus its deficiency appears on young leaves more than the matured, due to the immobility of this element [7].

The present study was carried out to investigate the effect of Iron application in the form of Fe-EDDHA to soil on growth and yield components of wheat in calcareous soils.

MATERIALS AND METHODS

This study was carried out at Bakrajow Agricultural Research farm that lies between 35°32˙36˝ north latitude and 45°21˙08.7˝ east longitude, under rain-fed condition during winter growing season of 2013-2014. Iron application to the soil was as Fe-EDDHA 6% Fe. The treatments including T_1=0, T_2=10, T_3= 20 and T_4= 30

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kg Fe ha^{-1} were applied to the soil in a deep of 30 cm at the sowing time. The field experiment was laid out in Randomized Complete Block Design (RCBD) with three replicates and the plot area was 6 m^2. The wheat variety *Semito* was sown on 3rd December during winter growing season 2013 with hand drill using seeding rate of 140 kg ha^{-1}. The macronutrient fertilizers were applied at the rate of 200 kg N, 200 kg P_2O_5 and 150kg K_2O ha^{-1} as urea, triple super phosphate(TSP) and potassium sulfate, respectively. The phosphate and potassium fertilizers were applied in all treatments, through broadcast at the time of sowing. While, nitrogen fertilizer was applied in two equal doses at a different time. The first dose was at the date of sowing and the second was after 25 days of germination. The weeds were controlled manually. The crop was harvested at maturity (six months after sowing). The SAS software package was used to analysis the data collection [8] and the means were compared by the least significant difference(LSD) at 5% probability level.

Soil samples were taken before sowing of the crop from 0 to 30 cm of the soil used in the field experiment and were prepared for physical and chemical analysis. In the report of soil samples it is showe that the ratio of sand 60.69 g kg^{-1}, silt 538.60 g kg^{-1} and clay 400.80 g kg^{-1}. The soil texture class was silty clay (SiC) having pH= 7.68, EC 0.29 dS m^{-1}. Other soil characteristics were; organic matter 12.6 g kg^{-1}, total $CaCO_3$ 245 g kg^{-1}, cation exchange capacity (CEC) 45.50 $cmol_c$ kg^{-1} available total nitrogen 1.0 g kg^{-1}, soluble Ca^{2+} 0.9 mmol L^{-1}, soluble Mg^{2+} 1.50 mmol L^{-1}, soluble HCO_3^- 2.0 mmol L^{-1}, soluble Cl^- 0.3 mmol L^{-1} soluble K^+ 0.095mmol L^{-1}, soluble Na^+0.10 mmol L^{-1}, available P 12.00 mg kg^{-1}. All the physical and chemical analyses of soil sample were determined according to the methods described by Rowell [9].

RESULTS AND DISCUSSION

Plant Height: The results of variance analysis and mean comparison indicated that plant height was not influenced by the concentrations of iron application to soil and the results were not significant at 5% level of probability (Table 1). These results are in agreement with those obtained by Abbas *et al*.[6] showing a non-significant difference compared with recommended NPK.

Grain Yield (ton ha^{-1}): Grain yield of wheat was affected by various Fe rates. Statistical analysis of data present in Table 2 indicated that there was a significant difference between T_4 and T_1 at 5% level of probability. These results are in agreement with the results obtained by Nadim *et al*. [10]. They reported that micronutrient and their doses had a significant effect on grain yield.

1000 Grains Weight (g): The statistical analysis of data present in Table 1 revealed that 1000-grain weight of wheat was not affected by Fe application and there is no significant difference between the treatments at 5% level of probability. The present result is in accordance with the results of Habib [11], who found that 1000 kernel weight is not affected by foliar feeding of Fe, Zn chelates to the wheat crop.

Table 1: Effect of Iron application to soil on some vegetative growth traits, yield and some yield components of wheat

Treatments	Plant height (cm)	Grain yield ton ha^{-1}	1000 grain weight (g)	Biological yield ton ha^{-1}	Number of tiller $plant^{-1}$	Grain protein%	Grain $spike^{-1}$	Harvest index%
T_1	80.67[a]	4.37[b]	40.67[a]	10.84[a]	4.67[a]	18.57[a]	58.00[a]	40.00[b]
T_2	78.67[a]	4.84[ab]	41.73[a]	11.67[a]	4.67[a]	18.93[a]	57.33[a]	41.30[b]
T_3	81.00[a]	4.43[ab]	42.00[a]	10.34[a]	4.67[a]	19.73[a]	62.67[a]	42.30[ab]
T_4	82.33[a]	5.10[a]	43.33[a]	11.17[a]	5.00[a]	18.90[a]	60.33[a]	45.70[a]

Means of each category followed by the same letters are not significantly different at 5% level of probabilities

Means of each category followed by different letters are significantly different at 5% level probabilities

Table 2: Effect of Iron application to the soil on some nutrient contents of wheat grain

Treatments	N%	P ppm	K ppm
T_1	2.97[a]	44.76[a]	3429.00[a]
T_2	3.03[a]	45.16[a]	2751.00[a]
T_3	3.16[a]	43.26[a]	3583.00[a]
T_4	3.02[a]	44.99[a]	2583.33[a]

Means of each category followed by the same letters are not significantly different at 5% level of probabilities.

Biological Yield (ton ha^{-1}): The analysis of variance of trait means showed that there was no significant difference between Fe application rates for the biological trait at 5% level of probability (Table 1).These results disagree with the results of Bameri *et al*. [5] as they found the highest biological yield when Fe and Mn were applied to the plant.

Number of Tillers Plant^{-1}: Statistical analysis of data presented in Table 1 showed that all treatments receiving Fe application were statistically similar to each other at 5% level of probability. The result is in agreement with finding by Abba *et al.* [6]; who found that the Fe application treatments were statistically at par with each other. While, Zain *et al*. [2] obtained different results of affecting plant tillers by the environment, plant nutrition and genotypes.

Grain Protein Content%: Statistical analysis of the means variance showed that grain's protein content was not influenced by different rates of Fe application to the soil. This result may be due to antagonistic effect among Fe and other micronutrients especially Zn and Mn. The present result is not matching the results of Shahrokhi *et al*. [7]. They found that the spraying of the wheat plant with different concentrations of iron sulfate was significant at one percent level of probability.

Grains Spike^{-1}: One of the most important yield determination is the number of grains per spike which is affected by various factors including balanced nutrition. Statistical analysis of the means variance illustrated that the number of grains per spike was similar for all treatments. These results are in agreement with the finding of Nadim *et al*.[10], who obtained that the treatments of micronutrients application were statistically at par with each other.

Harvest Index%: Harvest index is an important physiological criterion in crops and is obtained from the ratio of grain yield to the biological yield [12]. The data presented in Table 1 indicated that the maximum harvest index (45.70%) was observed in T_4, that had differences significantly with the data obtained from T_1 and T_2 treatments, that have (40.00 and 41.30%) of harvest index value, respectively. The results of present work were in agreement with what was obtained by Bameri *et al*. [5]. They found that the foliar application of micronutrients either separately or in the mixture increased the harvest index, significantly.

Data presented in Table 2 show the effect of iron application in the form of Fe-EDDHA on some macronutrient content NPK. It was indicated that the application of Fe-EDDHA has not affected significantly the grain NPK content of *Semito* wheat variety. This may be due to the genetic structure and the mode of utilization of metabolic products. These results are in agreement with the results reported by Yilmaz *et al*. [13] and Abd El-Ghany *et al*. [14].

CONCLISION

According to the results of the present research the Fe application to the soil in form of Fe-EDDHA%6 Fe had significant effect on wheat grain yield and harvest index. The use of 30 kg Fe ha^{-1} recorded the highest grain yield and harvest index comparing with other treatments.

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