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Study the effects of iron nano chelated fertilizers foliar application on yield and yield components of new line of wheat cold region of kermanshah provence

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ABSTRACT

In order to study the effects of iron nano chelated fertilizers foliar application on yield and yield components of new line of wheat cold region of Kermanshah provence this study was conducted for one year (2012) in the cold climate of Kermanshah. Experiment was conducted as a split plot in a randomized complete block design with three replications. Factors studied were at three levels of foliar (a1= Tillering, a2= heading, a3= no spray (control)) and the figure of six was (b1= C-87-11, b2= C-87-12, b3= C-87-13, b4= Mihan, b5= Zare and b6= Urom), respectively. Spraying time as the main factor in the main plots and cultivars as sub plots were placed in the subplots. In this study plant height, spike number, 1000 grain weight, grain number per spike, biological yield, grain yield and harvest index of wheat were evaluated. Results showed that effect of iron nano chelate foliar application, wheat cultivars and interaction of them had significant effects on Plant height, spike number, 1000 grain weight, Grain number per spike, biological yield, grain yield and harvest index ($p \leq 0.01$ and $p \leq 0.05$). The highest grain yield, biological yield and harvest index of treatment a1b5 (sprayed at tillering varieties, and still) are respectively the mean 4668/6 kg.ha-1, 9769/3 kg.ha-1 and 65/53% and the lowest it belonged to a3b3 (control (no spray) and line C-87-11), respectively, with the mean 2983/6 kg.ha-1,

8723 kg.ha⁻¹ and 39/66 percent. According to the results of the best and most suitable time for crop spraying chelated iron was still detected. In climatic conditions of Kermanshah during the crop tillering and the best varieties for obtaining maximum yield was determined the figure of urom.

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1. Introduction

Wheat (*Triticum aestivum* L.) is the most widely grown crop in the world with its unique protein characteristics that serves as an important source of food and energy in Iran (Abedi et al., 2010). Mature wheat grains contain 8–20% protein, which are divided into two major categories: prolamins including gliadins and glutenins and non-prolamins consisting of water-soluble albumins and salt-soluble globulins (Singh and Skerritt, 2001). Suitable and useful usage of different kind of fertilizers is the main way for reformation and maintain of soil fertility and increasing of crops yield (Hoseini Talaei, 2012). Iron is one of the essential elements but low use and less mobility for plants. Among all the micronutrients plants need to iron more than other (Taiz and Zeiger., 2001). Among micronutrients, Iron (Fe) is a cofactor for approximately 140 enzymes that catalyze unique biochemical reactions (Brittenham., 2004). Deficiency or low activity of iron in the plant causes chlorophyll is not produced in sufficient quantities and the leaves are pale the decrease of chlorophyll leading to the reduction of the plant food Processor and Finally the yield is reduced. Iron shortage symptoms are first seen as the yellowish color between leaf veins, especially in young leaves, which could result in the necrosis of all these leaves (Malakooti., 2008). Although due to the deposition, usability iron sulfate in the soil is limited, however, experiments show that It can be used for iron deficiency, especially when it is mixed with organic materials and prevent from the deposition (Samar, 2008). Iron chelate example Fe-EDTA is absorbed and useable for plants too however it depends to soils conditions particularly soil pH and being lime or not (Khoshkhouy et al., 2005). Iron chelates based on EDDHA is stable in soil and prevents from iron deposition for a reasonable period of time. Chelation agent EDDHA stores ferric iron with high power and prevents from its deposition in soil. Thus the iron concentration in the soil increases but these fertilizers have a problem that is they very high cost (Malakooti., 2008). With production of nano fertilizers, this nano compounds rapidly and completely absorbed by plants and fix its nutrients shortages and needs (Barmaki et al., 2011). Base of iron nano fertilizer is natural quality and it made of organic and mineral material. This fertilizer is fully compatible with the environment and agricultural farms and organic materials with added to the soil to make it more organic material is to be (Anonymous., 2010). The use of nano fertilizer leads to an increased efficiency of the elements, reduce the toxicity of the soil, to at least reach the negative effects caused by the consumption of excessive consumption of fertilizers and reduce the frequency of application of fertilizers (Naderi and DaneshShahraki., 2011). Yarnia et al. (2007) reported that Fe intake, increase yield and quantity of rapeseed and increase the height of the plant, the amount of nitrate reeducates activity and photosynthesis too. As well as studies showed that there was a significant linear relationship between Fe concentration and yield (Almaliotis et al., 2012). And similarly, Karp et al (2002) indicated that Strawberry fruit quality increased with foliar Fe fertilization. Chen et al. (2002) in an experiment comparison the effect of various Fe fertilizers on growth and propagation of *Gladiolus* and concluded that flowering *Gladiolus* occurs a few days earlier in Fe-enriched Peat and as well as cormel number per corm increase in this substrate. In another study, influence of Khazra iron nano fertilizer on rice yield Was examined and was shown that applied treatments have a significant effect to all Characteristics except grain Thousand weigh (Baghaie et al., 2011). the results of the comparison of nano Fe chelate with Fe chelate effect on growth parameters of *Ocimum basilicum* showed that the replacement of iron fertilizer produced with nanotechnology in comparison with common Fe fertilizer can increase the growth of quantitative and qualitative plant in appropriate concentrations or less (Peyvendi., 2011). Regarding leaf Fe concentration, it was seen that the effect of foliar FeSo₄ on leaf Fe concentrations was higher than of Fe-EDTA in Strawberry cultivars (Erdal., 2004). This trial was conducted to examine and determine the appropriate of Fe fertilizer and time of its use to dispel the need for Fe in wheat plant.

2. Materials and methods

An experiment was conducted during 2011-2012 in Kangavar, Kermanshah, Iran. In this cold climatic condition average annual rainfall is 487.3 mm and the average temperature is 15.8° C. In order to determining of chemical and physical properties of farm soil samples were prepared from 0-30 cm depth. Samples were sieved and were analyzed at laboratory. Soil analysis results showed in table 1. Experiment was conducted as a split plot in a randomized complete block design with three replications. Factors studied were at three levels of foliar (a1= at Tillering, a2= the heading, a3= no spray (control)) and the figure of six was (b1= C-87-11, b2= C-87-12, b3= C-87-13, b4= Mihan, b5= Zare and b6= urom), respectively. Spraying time as the main factor in the main plots and cultivars as sub plots were placed in the subplots. Khazra iron nano chelated fertilizer included different microelements such as iron (8.9%), zinc (0.92%), manganese (0.96%) sodium (9.9%) and brimstone (9.5%). Triple super phosphate added as a phosphate resource at the sowing time and urea as a nitrogen resource at sowing and tillering stages. Each plot consists of 8 sowing rows with 20 cm between rows and 1-2 cm on rows spaces. For sowing 135 kg.ha⁻¹ wheat grain was used. Weeds were controlled by 2,4-D herbicides and for evaluating of grain number per spike, 10 plants at physiologic ripening were selected randomly and after the removing of spikes grain number were counted and average of them were reported. After harvesting for measurement of 1000 grain weight, some grains were selected randomly and counted by grain counter and then weighted accurately. After physiological ripening biological yield were determined by draining of whole plants which were harvested at 2.4 m2 of center of each plot at 75c for 48h at even. For evaluating of grain yield after measurement of biological yield, spikes were removed from stems and after winnow net grain weight were determined. Harvest index were calculated by Sarmadnia and Koocheki (1996) method:

$$\text{Harvest index} = \frac{\text{grain yield}}{\text{biological yield}} \times 100$$

The data were analyzed by MSTAT-C soft-ware and the figures were drawn by Excel 2010.

Table 1

Soil analysis of physical and chemical properties.

Ec		Cu	Zn	Mn	Fe	N	K	P	O.C	Deep
EC dSm-1	pH	ppm	ppm	ppm	ppm	(%)	ppm	ppm	(%)	(cm)
0.73	7.6	0.68	0.8	6.6	7.6	0.13	230	9.2	1.26	0-30

3. Results and discussion

3.1. Plant height

Analyze of variance of data indicated that iron chelate fertilizer application time (tillering, heading and control) and different varieties had significant effect on wheat height (table 2) ($P \leq 0.01$) moreover there was a meaningful differences between application time and different varieties while the highest wheat plant height was observed in C-87-13 line (89.42 cm) and the lowest was related to Mihan variety (78.47 cm). At different iron chelate fertilizer foliar application time's maximum plant height was observed in tillering stage with 85.12 cm and in non-foliar application of iron chelate the minimum plant height with 77.99 cm was observed (table 3). As iron is microelement for wheat then, it had great role in biochemical activities and vegetation growth period and if it be available in plant vegetation period the desirable effect will have been seen. Foliar application of microelements such as Fe, Cu and Zn at the lowest amount in sugarcane caused increasing of plant weight, internode number, internode length and subsequently increasing of stem length and plant height. Kumar et al., (2009) reported that using of copper (1.5 mg.kg), increased in about 23% wheat height in compare with control treatment.

Table 2

Analysis of variance of data on yield and yield components.

Resource changes	df	Plant height	Spike number	1000 grain weight	Grain yield	Biological yield	Harvest index
Repetition	2	200.8 ns	18557.2 *	35.33 *	2664128.4 **	570873.5 **	0.362 ns
Factor A	2	229.9 **	43255.5 *	48.52 **	1312926.5 **	6928741.4 **	221.5 **
Error A	4	32.12	1956.07	2.60	61576.3	62387.88	3.237
Factor B	5	150.08 **	7138.7 *	15.51 **	212862.3 ns	422971.1 **	52.3 **
A×B	10	20.06 ns	6667.7 *	3.36 ns	266806.9 *	2306352.7 **	11.79 **
Error B	30	10.015	368.7	2.147	98032.4	787472.4	4.79
CV (%)	-	3.9	7.8	3.8	3.4	20.8	4.7

*,**, ns, significant at $p \leq 0.01$ and $p \leq 0.05$, no significant, respectively.**Table 3**

Means comparison yield and yield components of new line of wheat.

Factors	Plant height (cm)	Spike number (m ²)	Grain number per spike (m ²)	1000 grain weight (gr)
Tillering	85.12 a	819.66 a	34.58 a	40.08 a
heading	82.03 b	787.01 a	28.47 a	38.86 b
control	77.99 c	723.28 b	21.31 b	36.83 c
C-87-13	89.42 a	777.33 ab	29.88 ab	37.21 b
C-87-12	81.26 bc	768.55 b	28.93 ab	39.06 a
C-87-11	78.60 c	727.66 b	24.18 c	36.65 b
Mihan	78.47 c	778.50 b	28.53 ab	39.50 a
Urom	80.01 c	806.44 a	31.68 ab	39.47 a
Zare	88.09 a	801.33 a	35.49 a	39.67 a

Different letters in each column indicate significant difference at $p \leq 0.05$

3.2. Spike number

In about spike number there was a significant difference between iron chelate foliar application times and varieties (table 2) ($p \leq 0.05$). Iron chelate application times had meaningful effect on spike number while maximum spike number were observed in tillering stage (819.66 m²) which this result is agree with Hemantaranjan and Garg (1988) results. Although there were significant differences between wheat varieties, however, Urom variety had the highest value (806.44 m²) (table 3). Chaker Al Hosseini et al., (2009) reported that both using of zinc sulfate (40 kg.ha⁻¹) and foliar using of zinc sulfate at 3per thousand concentration caused to increasing of fertile tillers numbers and subsequently spike number.

3.3. Grain number per spike

Iron chelate foliar application times had meaningful effect on grain number per spike (table 2) ($p \leq 0.01$). According to comparison of means it is resulted in about iron chelate fertilizer application times, maximum and minimum grain number per spike were observed in tillering and control treatments respectively. Effect of variety on grain number per spike was significant at $p \leq 0.01$ thereby comparison of means showed that maximum and minimum grain number per spike were achieved from Zare and C-87-11 varieties (table 3). Pahlavan Rad et al., (2009) in the study of application of zinc, iron and magnesium on yield and yield component of wheat find that interaction of these elements had statically meaningful effect on grain number per spike and in other study indicated that application of iron and zinc cause to increasing in grain number per spike and other yield components of wheat.

3.4. 1000 grain weight

Analyze of variance of data showed that iron chelate fertilizer application times and different wheat varieties had significant effects on 1000 grain number (table 2) ($p \leq 0.01$). Although there was a meaningful differences between iron chelate application times and different varieties, however, maximum 1000 grain weight was belong to Zare variety (39.67g) and minimum 1000 grain weight was belong to C-87-13 variety. Application of iron chelate in tillering stage let to the maximum 1000 grain weight (40.08 g) while at non-application treatment the lowest 1000 grain weight (36.83 g) was achieved (table 3). Pahlavan Rad et al., (2009) reported that using of microelements such as iron and zinc will increase wheat 1000 grain weight. Application of Iron and zinc significantly increased 1000 grain weight.

3.5. Grain yield

Analyze of variance table showed that interaction between iron chelate and wheat different varieties was statically meaningful ($p \leq 0.05$) (table 2). according to figure 1 maximum and minimum grain yield were belong to Urom variety which was foliar in heading stage (4668.6 kg.ha⁻¹) and C-87-11 line which was without foliar application (2983.6 kg.ha⁻¹). Iron chelate foliar application in early plant growth stage caused to increasing of nutrient content, helped to better absorption of macro elements and production of primary and secondary metabolites and transition of these to grain which all let to increasing of yield while in this study foliar application could promote 20% yield compared to non-application treatment. Malakooti (2008) reported that by increasing of microelements concentration such as iron, grain yield of wheat had been increased. Ziaeian and Malakooti (1997) revealed that by application of zinc, iron and magnesium grain number per spike and wheat yield significantly increased. Hemantaranjan and Garg (1988) indicated that application of iron and zinc significantly increased grain number per spike and subsequently increased wheat yield. Foliar application of iron in corn (*Zea mays*) increased grain yield and iron concentration in grain (Ziaeian and Malakooti, 1997). Nazaran et al., (2009) results showed that foliar application of iron nano chelate at stem elongation stage by 99% yield increasing had the best results. Iron foliar application had effective impact on pigments production such as chlorophyll, carotene and xanthophyll. Iron-sulfur proteins which the famous of them is ferredoxin involved in metabolic process such as photosynthesis sulfate to sulfite restoration, respiration and nitrogen fixation. Increasing of photosynthesis let to increasing of grain number and yield (Ziaeian and Malakooti, 1997).

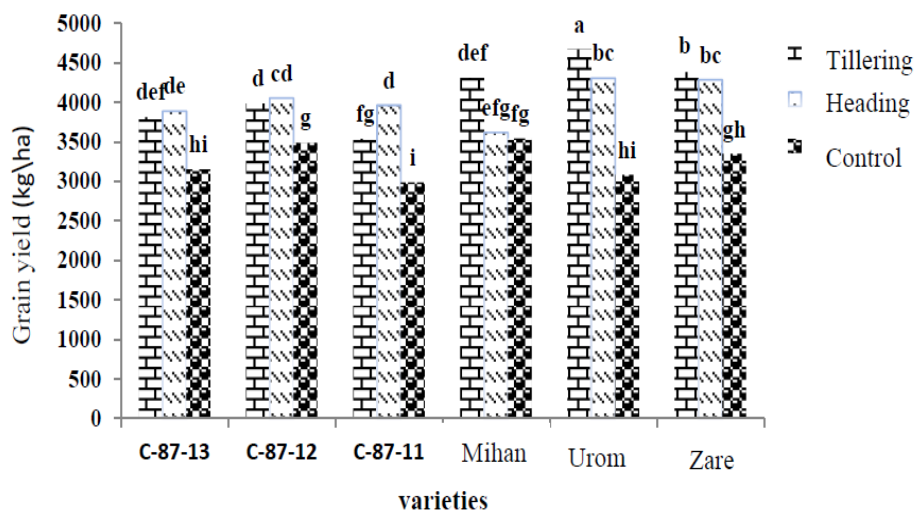


Fig. 1. Effect of treatments on grain yield.

3.6. Biological yield

From analyze of variance it resulted that interaction of iron chelate foliar application and wheat varieties on biological yield of wheat was significant (table 2) ($p \leq 0.01$) while maximum and minimum biological yield were belong to Zare variety which was treated at tillering stage (9623.7 kg.ha⁻¹) and uroom variety without treatment

(8529.3 kg.ha⁻¹) respectively (Figure 2). Increasing of biological yield in this study is related to iron nutrient effect on leaf chlorophyll and indole 3-acetic acid so, by increasing chlorophyll content dry matter yield and biological yield were increased via increasing of photosynthesis; these results is agree with Hemantaranjan and Garg (1988) results. Treham and Sharma (2000) in a study on wheat mentioned that application microelements such as iron and zinc increased biological yield compare with control treatment.

3.7. Harvest index

Analyze of variance indicated that interaction of iron chelate foliar application and wheat varieties on harvest index was significant (table 2) ($p \leq 0.01$). According to figure 3-4, maximum and minimum harvest index were related to Zare variety when treated at tillering (53.65) and C-87-11 line which had not treated (39.66) respectively (Figure 3). Siadat et al. (2008) in a study on wheat reported that by increasing of micro elements such as iron and zinc and urea as a foliar fertilizer, increased harvest index, grain yield and protein percentage of grain compare with control treatment. Morshedi i et al., (1999) find that foliar application time had meaningful effect on harvest index and foliar application at early stage of plant growth is effective.

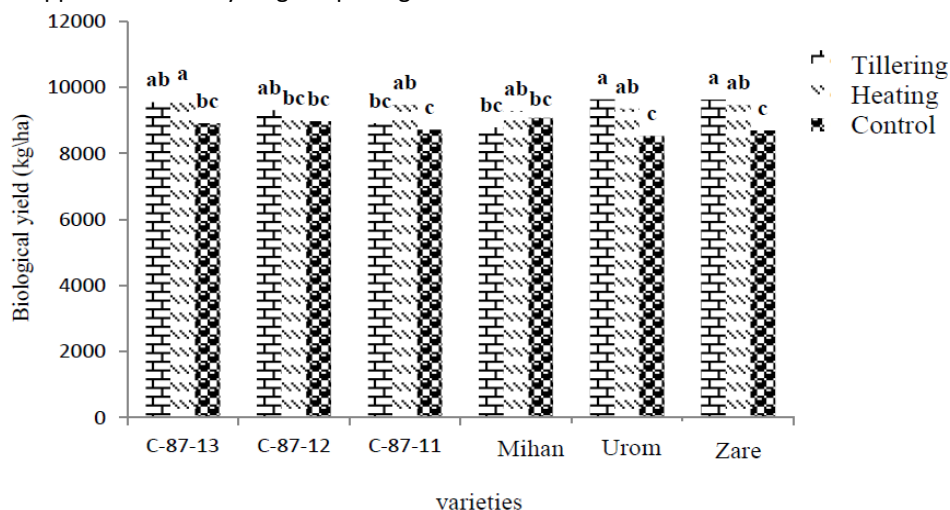


Fig. 2. Effect of treatments on biological yield.

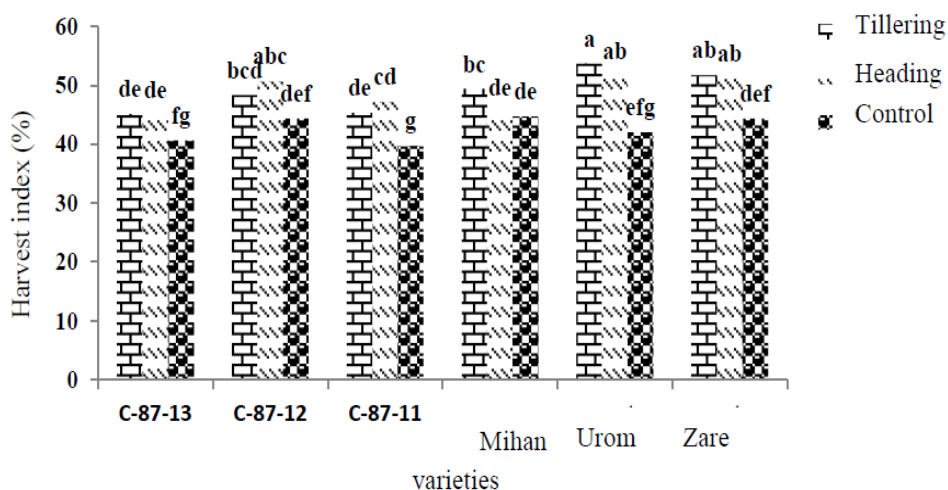


Fig. 3. Effect of treatments on harvest index.

4. Conclusion

According to the results, Urom and Zare varieties had maximum yield and yield components. This study indicated that foliar treatments (tillering, heading) in all studied values were predominant compare to non-foliar application treatments. Among the two foliar application of iron chelate (tillering and heading), foliar application at tillering stage was more effective. Foliar application in this stage had the effective impact on yield and yield component of wheat. Non-foliar application (control treatment) had the lowest yield and yield component while iron chelate application could promote grain yield up to 20% compared to control treatment. Maximum Fe, starch, dry matter, crude protein and crude fiber percentage between the varieties was related to Zare variety. Between the iron chelate foliar application times, its application at tillering stage and control treatment had maximum and minimum effect on qualitative characters of wheat.

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