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RESPONSE OF AZARGOL SUNFLOWER CULTIVAR TO DIFFERENT MICRONUTRIENTS IN JIROFT REGION, SOUTHEAST OF IRAN

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ABSTRACT. *Micronutrients are very important for increasing yield and quality of crops, and they develop plant nutrition and increase soil efficiency. In order to determine the effects of different micronutrients (zinc sulfate ($ZnSO_4$), iron sulfate and boron) either single or combined on the yield and its components of Azargol sunflower cultivar in Jiroft region, southeast of Iran. The experiment was conducted in factorial experiment based on a randomized completely block design with three replications. According to interaction effect between $ZnSO_4$ and boron the most seed yield and biological yield was in 40 and 20 kg/ha $ZnSO_4$ consumption under both levels of boron consumption conditions. Also, the highest seed number in head was in 40 kg/ha $ZnSO_4$ in 2/1000 level of boron consumption. Overall, it could be concluded that the application of 40 kg/ha $ZnSO_4$ either single or in combination improves yield and yield components.*

KEY WORDS: *Micro elements, seed yield, yield components, zinc sulfate.*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops containing high quality edible oil, and it is easy to cultivate and grown in different conditions and soils. Moreover, sunflower oil has excellent nutritional properties, and sunflower seed contains high oil content ranging from 35-48% with some types yielding up to 50%, 20-27% protein and high percentage of polyunsaturated fatty acids (60%) including oleic acid (16.0%) and linoleic acid (72.5%), which control cholesterol in blood (Patra et al. 2013, Amirian et al. 2013). Furthermore, sunflower seeds are eaten as salted whole seeds as roasted nut meats (Al- Qubaie 2011, Arshad et al. 2013).

One of the most important issues about increase of crop yield and improving the quality of agricultural products is balanced plant nutrition. Foliar application of nutrients has become an efficient way to increase yield and quality of crops (Ghofran-Maghsud et al. 2014). Also, they develop plant nutrition and increase soil efficiency (Irmak et al. 2012). 48% of soils in the world are Zn deficient whereas crops showed significant responses to Zn fertilization in nearly 72% field experiments due to widespread hidden hunger. In addition, zinc is main composition of ribosome and is essential for their development. Amino acids accumulated in plant tissues and protein synthesis decline by zinc deficit. (Cui et al. 2004). Zinc also plays an important role in the production of biomass (Cakmak 2008). Iron (Fe) is another micronutrient that is a cofactor for approximately 140 enzymes that catalyze unique biochemical reactions. Hence, iron has many essential roles in plant growth and development including chlorophyll synthesis, thylakoid synthesis and chloroplast development (Kazemi 2013). Boron deficiency among microelements is the most harmful to the crop after iron and zinc (Arabporian et al. 2014). A main function of boron is correlated to cell wall formation, nitrogen fixation, sugar transportation, and phenol, nucleic acid, membrane stability carbohydrate, indolic acetic acid (IAA) metabolism. Flower retention and pollen formation and germination also are affected by boron (Farzanian et al. 2010; Wimmer & Eichert; 2013, Rawashdeh & Sala, 2013).

Brighenti & Castro (2008) demonstrated that seed yield and oil yield were increased by boron consumption, and stated that boron consumption increased the pollen fertility. Thus, with increase the number of filled grain, yield is increased. Marschner (1995) reported that critical concentration of zinc in plant leaves ranged 15-20 mg/kg dry weight. Gitte et al. (2005)

indicated that adding 5.25 kg Zn/ha to the soil, produce maximum values of 1000 seed weight (65 gm), seed yield (3400 kg/ha) and oil percentage (41%). Vahedi (2011) stated that lack of zinc is a major problem in the world and shortage of zinc will reduce crop yield. The objective of the present study was to determine the effect of iron sulfate, zinc sulfate and boron fertilizer on yield and its components of Azargol sunflower cultivar in Jiroft region, southeast of Iran.

MATERIAL AND METHODS

The experiment was conducted at the Agriculture Research Farm of Islamic Azad University, Jiroft, Iran in 2014. The site lies at longitude 25°57´, and latitude 28°30´ and the altitude of the area is 627 m above sea level. It has a warm dry climate with the minimum daily average air temperature during the growing season was 13.4°C, while the maximum daily average air temperature was 48°C. The mean annual rainfall is about 150 mm. Soil sample was taken from depth 0-30 cm and analyzed for some physico-chemical characteristics. The soil texture was a sandy clay loam, electrical conductivity (ECe) was 0.98 dS m^{-1} and soil pH was 7.9. This study carried out in factorial experiment based on a Randomized Completely Block Design (RCBD) with three replications. Three factors including three consumption of iron sulfate (0, 4 and 6 per thousand), zinc sulfate (0, 20 and 40 kg/ha) and boron (0 and 2 per thousand). Each experimental plot consisted of 4 lines planting with 50 cm distance and 4 m length of rows were considered. Also, the distance between plots and plants were 100 and 25 cm, respectively. For measuring the traits five plants were randomly selected that to be representative of the whole plot. The following traits were measured: 1000 seed weight (g), seed number in head, husk to grain ratio (%), seed yield, harvest index and biological yield. Analysis of variance and comparison of data carried out with using of SAS software.

RESULTS AND DISCUSSION

1000 seed weight

1000 seed weight is commonly a major determinant of sunflower yield. The analysis of variance revealed that $ZnSO_4$ had significant effect ($P < 0.05$)

on 1000 seed weight. Also showed similar result in different levels of boron (Table 1). The most 1000 seed weight was in consumption of 20 and 40 kg/ha zinc sulfate but absence of zinc sulfate had the lowest 1000 seed weight. The result showed that apply $ZnSO_4$ increased the 1000 seed weight. Also there were not significant different between the amount of 20 and 40 kg/ha $ZnSO_4$ (Figure 1). Shakoori (2003) reported that foliar application of zinc, manganese and boron had significant effect on weight of 1000 seeds. 1000 seed weight is a cultivar characteristic and is affected by genetic factors but its amount is affected by conditions of ripening period. These conditions may cause changes of between 20 and 30% of seed weight (Arabporian et al. 2014). Low 1000 seed weight in low levels of fertilizer or in the absence of fertilizer is due to competition of grains in obtaining nutrition and reduce the carbohydrates stored in plants. These results were in agreement with reported by Shakoori (2003).

Seed number in head

The seed number is an important and efficient component in yield. The analysis of variance showed significant differences ($P < 0.01$) between levels of $ZnSO_4$ in terms of seed number in head (Table 1). The most seed number in head was in consumption of 40 kg/ha zinc sulfate. The result showed that apply 40 kg/ha $ZnSO_4$ increased the seed number in head. Also there was not significant different between without consumption and 20 kg/ha $ZnSO_4$ (Figure 2). Interaction effect of zinc sulfate and boron was significant for seed number in head (Table 1). The highest seed number in head was in 40 kg/ha $ZnSO_4$ in both levels of boron consumption that there was no statistically significant difference with 20 kg/ha $ZnSO_4$ in 2/1000 level of boron consumption (Figure 3A). B is an important micronutrient required for plant growth and yield (Soomro et al. 2011). Seed and grain production are reduced with low boron supply (Pandey & Gupta 2013). Vilalobos et al. (1996) indicated that seed number in head influenced by environmental factors before pollination and will be changed afterwards. Praksh & Halaswamy (2004) found that spraying plant leaves with 0.3 $ZnSo_4$ gave a high values of head diameter (20 cm), number of seeds per head, 1000 seed weight (62.2 g) and seed yield (1600 kg/ha).

Table 1. Analysis of variance of the evaluated traits.

S.O.V	D.F.	Means Square					
		1000 seed weight	Seed number in head	Husk to grain ratio	Seed yield	Harvest index	Biological yield
Replication	2	181.977**	31979.2**	12.624 ns	542330 ns	37.89 ns	1763169 ns
$FeSO_4$	2	20.200 ns	4152.7 ns	342.024**	2203945*	1422.37**	9505218 ns
$ZnSO_4$	2	119.53*	136433.9**	351.849**	664063 ns	64.317 ns	6755632 ns
Boron (B)	1	150.00*	12721.1 ns	178.65**	548432 ns	5.064 ns	2912639 ns
$FeSO_4 \times ZnSO_4$	4	26.146 ns	12746.8 ns	79.665**	897380 ns	46.921 ns	715080 ns
$FeSO_4 \times B$	2	7.407 ns	2023.6 ns	5.762 ns	677871 ns	9.132 ns	2256005 ns
$ZnSO_4 \times B$	2	80.702 ns	24609.1**	69.231**	1818860*	0.0087 ns	20103737*
$FeSO_4 \times ZnSO_4 \times B$	4	8.962 ns	8832.4 ns	32.726**	463309 ns	42.064 ns	3818373 ns
Error	34	31.008	5474.58	6.585	560738.6	71.62	4279690.3
CV	(%)	9.27	13.08	3.6	21.3	20.2	23.7

ns: non-significant differences; *: significant at $p<0.05$;** : significant at $p<0.01$

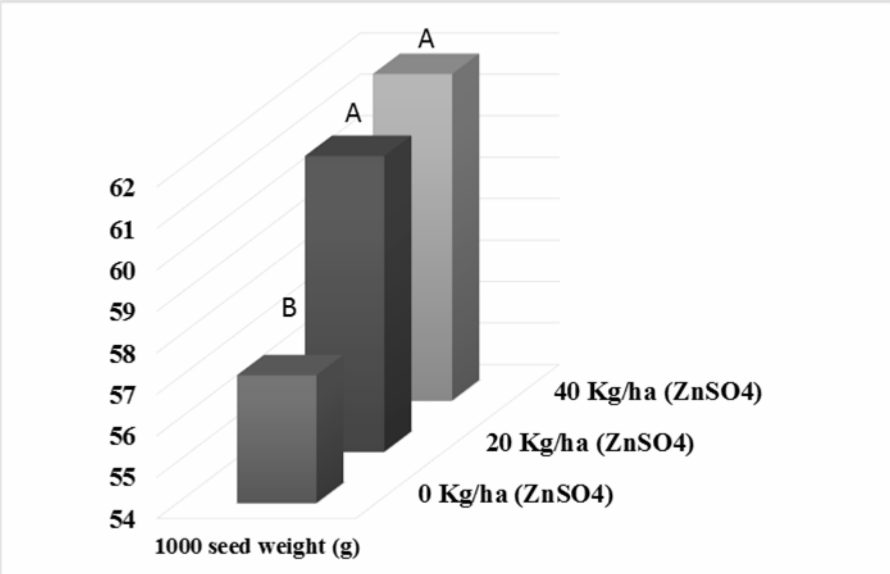

Figure 1. Effects of zinc sulfate on 1000 seed weight in Azargol sunflower cultivar.

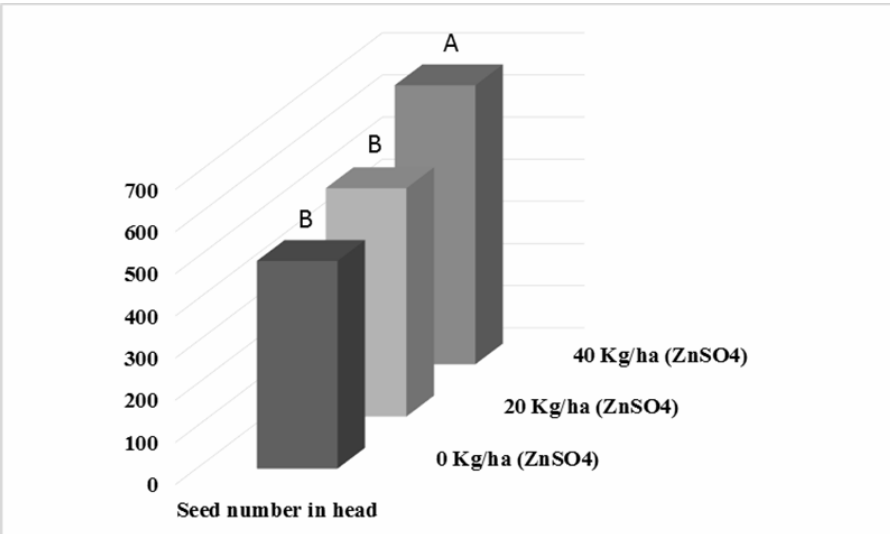

Figure 2. Effects of zinc sulfate on seed number in head in Azargol sunflower cultivar.

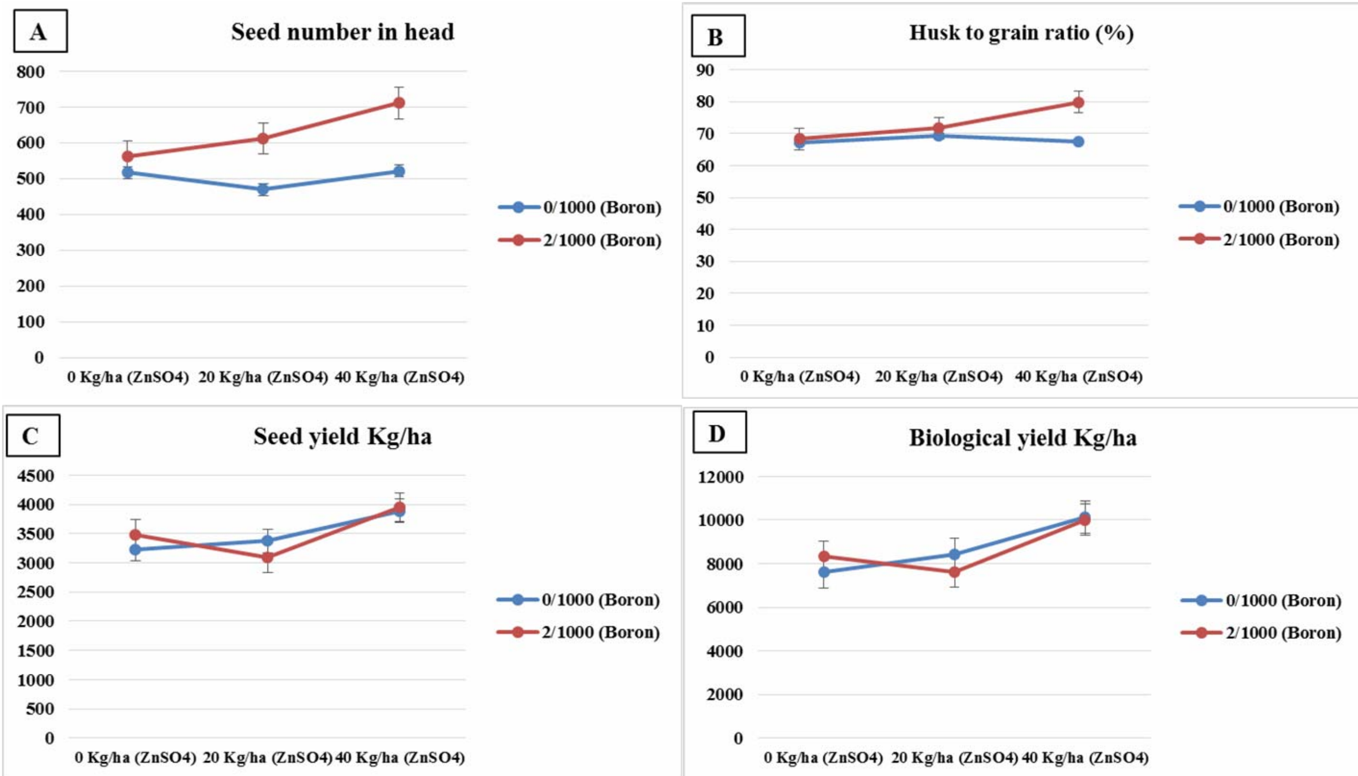

Figure 3 (A-D). Interaction effect of different levels of zing sulfate and boron.

Husk to grain ratio

The analysis of variance showed that all main and interaction effect had significant effect ($P < 0.01$) on husk to grain ratio percentage except $FeSO_4$ × B (Table 1). According to interaction effect between $ZnSO_4$ and $FeSO_4$ the most husk to grain ratio percentage was in 40 kg/ha $ZnSO_4$ consumption under without consumption $FeSO_4$ condition, and the 4/1000 spray $FeSO_4$ in level of 20 kg/ha $ZnSO_4$ had the lowest husk to grain ratio percentage (Figure 4). Also, the 2/1000 boron in level of 40 kg/ha $ZnSO_4$ condition had the most husk to grain ratio percentage (Figure 3B). Sunflower seed husk has a lot of cellulose, and cellulose can absorb a lot of oil, so the amount of oil in the kernel will be reduced (Emami-Bistgani et al. 2012). Barmaki et al. (2009) indicated that husk to grain percentage were increased with consumption of $ZnSO_4$ and $FeSO_4$.

Seed yield

The micronutrients play an important role in increasing crop yield (Ghofran-Maghsud et al. 2014). The analysis of variance showed that $FeSO_4$ had significant effect ($P < 0.05$) on seed yield (Table 1). According to interaction effect between $ZnSO_4$ and boron the most seed yield was in 40 and 20 kg/ha $ZnSO_4$ consumption under both levels of boron consumption conditions (Figure 3C). Ahmadkhan et al. (1990) declared that boron application increased seed yield in EC68414 sunflower cultivar. Lindsay (1972) found that the increases in yield through zinc application may be due to the increase in the plant internal translocation capacity and auxing in plants and it activates many enzymes such as proteinase and peptidases. Ramesh (2001) reported that iron and zinc have significant effect on sunflower. Also, the positive effect of consuming micronutritional fertilizers like zinc sulfate on yield, whether in soil or spraying on leaves has been reported by many researchers (Khurana & Chatterjee, 2001; Baniabbass Shahri et al. 2012).

Harvest index

Harvest index implies the relative distribution of photosynthesis products between economical sinks and other existing sinks in the plant

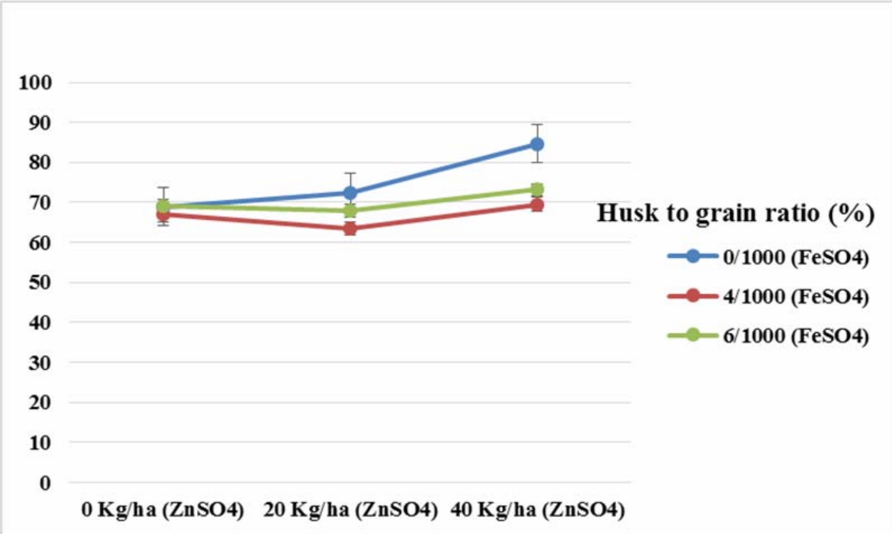

Figure 4. Interaction effect of different levels of zing sulfate and iron sulfate on husk to grain ratio.

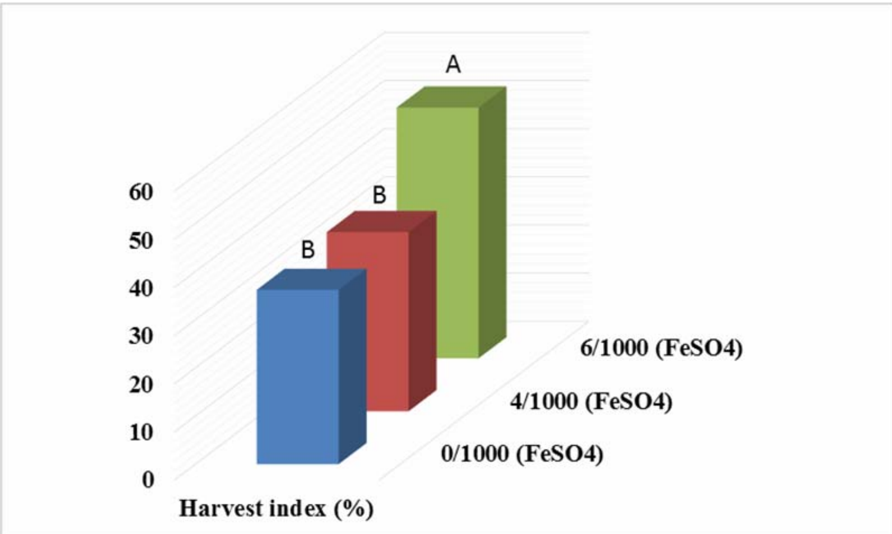

Figure 5. Effects of iron sulfate on harvest index in Azargol sunflower cultivar.

(Baniabbass-Shahri et al. 2012). The analysis of variance showed significant differences ($P < 0.01$) between levels of $FeSO_4$ in terms of harvest index (Table 1). The most harvest index was in 6/1000 $FeSO_4$ consumption (Figure 5). Harvesting index is one of the important physiological indices which indicates transfer rate of photosynthetic substances from vegetative organs to grains (Arabporian et al. 2014).

Biological yield

Interaction effect between $FeSO_4$ and boron was significant (Table 1). According to interaction effect between $FeSO_4$ and boron the most biological yield was in 40 and 20 kg/ha $ZnSO_4$ consumption under both levels of boron consumption conditions (Figure 3D). Masonic et al. (1996) studied the effect of deficiency of iron, sulfur, manganese and magnesium on sunflower, corn, wheat and barley. They indicated that micronutrition deficiency could be reduce the chlorophyll and finally decrease the yield and biological yield.

CONCLUSION

Micronutrients are required by plants in small quantities, but they are very important for increasing yield and quality of crops, and they develop plant nutrition and increase soil efficiency. The present study revealed varying results in sunflower production. Various micronutrients had significant effect on yield and yield components. It could be concluded that maximizing seed yield per unit area could be achieved by consumption of $FeSO_4$, and 40 and 20 kg/ha $ZnSO_4$ with boron and without boron consumption, respectively. The control treatment without application of micronutrients gave the lowest values of measured traits. Overall, the application of 40 kg/ha $ZnSO_4$ either single or in combination improves yield and yield components. Since, consuming zinc sulfate not only improves the performance of agricultural products, but also increases the quality of the final products followed by the richness and improvement of the health of the society.

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