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Research Article

EVALUATION OF FOLIAR APPLICATION EFFECTS OF ZN AND FE ON YIELD AND ITS COMPONENTS OF LENTIL (LENS CULINARIS, MEDIK), IRAN

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ABSTRACT
In order to investigate Zn, Fe and Zn+Fe foliar application effects on Lentil (*lens culinaris*, Medik) yield and its components, a field experiment was conducted at Dylaman, Iran during 2012 and 2013 growth season. The experiment was arranged in split plot of a randomized complete block design and replicated three times. Parameters measured were grain yield, plant height, number of pods per plant, number of seeds per pod and 1000 grain weight. Analysis of variance showed that the effect of micronutrients foliar application on all traits was significant. Mean comparison showed that Fe+Zn combination and Fe treatment yields were 37.71 and 27.12 percent higher than control treatment, respectively. The interaction of fertilizer and time of fertilizer application showed that Fe+Zn treatment at two time of fertilizer application (10-leaf and flowering stages) maximum number of seed per pod (2.28). Maximum 1000 grain weight was found the spraying in two times of foliar application (10-leaf + flowering), too. Zn+Fe combination treatment produced maximum1000 grain weight. Results showed significant effect of micrunutrient fertilizers treatment on grain yield, number of pods per plant ($p < 0.01$) and 1000 grain weight ($p < 0.05$). The foliar application at different growth stages on number of pods per plant ($p < 0.01$) and 1000 grain weight ($p < 0.05$) was also significant. In general, the highest yield was produced by Zn+Fe combination treatment. Application of micronutrients successfully prevented occurrence of chlorosis and increased plant height, number of pods/plant, seed yield/plant and1000-seed weight and macro as well as micronutrients uptake as compared with control.

Keyword: *Lentil, Foliar Application, Yield, Zinc, Iron*

INTRODUCTION
Lentil (*Lens culinaris*, Medik) is one of the most important leguminous crops grown in Iran. Lentil is predominantly grown in Asia which accounts for 80 percent of global area and 75% of world production. It is an important cool season food legume grown under marginal Lands by resilience poor farmers. Lentil is the fourth most important pulse (legume) crop in the world after bean (*Phaseolus vulgaris* L.), pea (*Pisum sativum* L.), and chickpea (*Cicer arietinum* L.). According to the Statistical Bureau of the Food and Agriculture Organization of the United Nations, lentil is currently cultivated on 4 million ha in warm temperate, subtropical, and tropical regions of more than 40 countries and is grown in all continents except Antarctica (1970).

Zinc and iron take over different roles in crop, such as formation, partitioning and utilization of photosynthesis assimilates (Sawan et al., 2008). The major role of zinc element in crops is not clear Nasri et al. (2011). These authors found that although zinc is an important element which should be provided for crop growth, but it could be poisonous in large amount.

As a matter of fact, the importance of zinc foliar application is due to being given to crop immediately (Alloway, 2003). Gul *et al.*, (2011) claimed that profitability of micronutrients will be obtained in combination with macro elements, such as nitrogen and potassium. Ghasemian et al. (2010) declared that zinc element is essential in chlorophyll production and pollen function. Iron (Fe) contributes in very enzymatic activities, such as cytochromes, ferredoxine, superoxide dismutase (SOD), catalase (CAT), peroxidase and nitrate reductase. It was reported by Kobraee *et al.*, (2011) that growth limitation, symbiosis, nodulation, photosynthesis, dry matter production and plant nutrient disorder were caused by the lack of zinc and iron. Furthermore, reactions of electron transportation are needed for zinc and iron. Zinc and iron deficiency in soils could be a restricted factor of yield and extremely decrease crop yield quality (Salwa et al., 2011). Kobraee *et al.*, (2011) and Ghasemian *et al.*, (2010) claimed that young leaves chlorosis and plant metabolism disorder will be caused by lack of iron, and in condition of iron stress, the absorption of Fe would be enhanced. Since iron is not soluble in soil, foliar application of this nutrient is necessary. Several researchers have reported increasing in yield as a result of macro–and micronutrients. Fawzi *et al* (1993) reported that intensive use of nitrogen and phosphorus fertilization and micronutrients for high yielding varieties resulted in nutrient imbalance shown by wide–spread micronutrients deficiency symptoms particularly of Zn, Mn and Fe. Khalil and Khlifa (1991) reported that application of NPK and micronutrients in combination with (Zn + Mn + Fe) significantly increased seed yield by 58 %. Okaz *et al.*, (1994) reported that lentil plants responded significantly to micronutrients. Application of macro–as well as micro–nutrients caused increase in pod yield by 60 % of which 17 % could be ascribed to the micronutrients, he also found that application of micronutrients successfully prevented occurrence of chlorosis and increased chlorophyll content and micronutrient uptake. Regions with Zn deficient soils, such as India, Pakistan, China, Iran, and Turkey, are also regions where human Zn deficiency is most widespread. Zeidan *et al.*, (2006) reported that yield components in lentil enhanced by foliar application of micronutrients. Due to the enzymatic activity enhancement, microelements effectively increased. Photosynthesis and translocation of assimilates to the seed. Arif et al., (2006) reported that higher yield could be achievable by foliar spraying which ensures crop dry matter production. Lack of zinc in crop plants is due to the fact that this element cannot able to solve in soils and Reduction of cell growth and development is one of the symptoms of Zn deficiency Ghasemian et al., (2010).

Ai-Qing et al. (2011) and Sliman and Motto (1990) reported that there is an antagonistic interaction between zinc and iron in soybean which influences their absorption, partitioning and utilization. These authors announced that zinc affects absorption and translocation of iron and vice versa. The aim of this study was to investigate zinc and iron foliar application effects on lentil yield and its components (grain yield, number of pods per plant, number of seeds per pod and 1000 grain weight).

MATERIALS AND METHODS

This study was conducted at Iran during 2012-2013 growth seasons in Deylaman, guilan province, Iran. The experiment was arranged in split plot of a randomized complete block design and replicated three times. Main factor were different times of foliar application (10-leaf and 10-leaf+ flowering), sub plots were (Control, Zn 116 ppm treatment, Fe 116 ppm treatment and Zn+Fe combination treatment). Lentil cultivar used in this experiment was local. The trial was harvested after physiologic maturity. Each plot consisted of six rows with 4 meter length and the row spacing was 25 cm, ten selected plants were used to take the data from each plot of each replication. Data were recorded for grain yield, first pod height, number of pods per plant, number of seeds per pod and 1000 grain weight. Data collected were analyzed statistically using SAS and correlation coefficient by SPSS. The means differences among the treatments were compared by least significance difference test (LSD) at 0.05 levels.

RESULTS AND DISCUSSION

Results of analysis of variance showed that there was a significant difference between treatments of spraying at different growth stages effecting lentil yield in traits 1000-seed weight, seed yield, plant high, number of pod in plant, number of seed per pod (Table1). Also, results of analysis of variance showed that there was a significant difference between treatments of Micronutrient fertilizers effecting lentil yield in traits1000-seed weight, seed yield, plant high, number of pod in plant, number of seed per pod(Table 1). Interaction TF×MF was significant in traits of 1000-seed weight, seed yield, number of pod in plant, number of seed per pod(Table 1).

In general, Fe+Zn combination and Fe treatment yields were 37.71 and 27.12 percent higher than control treatment, respectively(Table 2). The interaction of fertilizer and time of fertilizer application showed that

Fe+Zn combination at two times of fertilizer application(10-leaf+flowering) produced maximum number of seed per pod (2.28). Maximum 1000 grain weight was found at foliar application in two time sparing in 10-leaf and flowering stages (67.40gr). Zn+Fe combination treatment produced maximum 1000-grain weight(Table 2). Analysis of variance showed that the effect of micronutrients foliar application on all traits was significant(Table 1). Mean comparison showed that Fe+Zn combination and Fe treatment yields were 37.71 and 27.12 percent higher than control treatment, respectively(Table 2). The interaction of fertilizer and time of fertilizer application showed that Fe+Zn treatment at the spring in two stages(10-leaf + flowering) maximum number of seed per pod (2.28). Maximum 1000 grain weight was found the sparing in two times of foliar application (10-leaf + flowering) too(Table 3). Zn+Fe combination treatment produced maximum1000 grain weight (Table 2). Results showed significant effect of micrunutrient fertilizers treatment on grain yield, number of pods per plant ($p < 0.01$) and 1000 grain weight ($p < 0.05$). The foliar application at different growth stages on number of pods per plant ($p < 0.01$) and 1000 grain weight ($p < 0.05$) was also significant.

Bozoglu et al. (2007) found that in 25 countries, zinc deficiency is a soil common problem. Babaeian et al. (2011) announced that zinc and iron deficiencies are common in 30 and 50% of soils, respectively in the world. Zeidan et al., (2006) reported that yield components in lentil enhanced by foliar application of micronutrients. Due to the enzymatic activity enhancement, microelements effectively increased. Photosynthesis and translocation of assimilates to the seed. Arif et al., (2006) reported that higher yield could be achievable by foliar spraying which ensures crop dry matter production. Lack of zinc in crop plants is due to the fact that this element cannot able to solve in soils and Reduction of cell growth and development is one of the symptoms of Zn deficiency Ghasemian et al., (2010).Vahedi (2011) stated that lack of zinc is a major problem in the world and shortage of zinc will reduce crop yield. Generally, dry matter production and its division into different parts of plant will be weakened by lack of micronutrients (Sawan et al., 2008). Lack of zinc in crop plants is due to the fact that this element cannot be solved in soils, and reduction of cell growth and development is one of the symptoms of Zn deficiency (Ghasemian et al., 2010). In general, the highest yield was produced by Zn+Fe combination treatment. zinc element is essential in chlorophyll production and pollen function. Iron (Fe) contributes in very enzymatic activities, such as cytochromes, ferredoxine, superoxide dismutase (SOD), catalase (CAT), peroxidase and nitrate reductase. It was reported by Kobraee et al. (2011) that growth limitation, symbiosis, nodulation, photosynthesis, dry matter production and plant nutrient disorder were caused by the lack of zinc and iron. Results showed that zinc foliar application in eight-leaf stage with increasing leaf area, dry weight and length of flowering period enhanced number of seeds per pod.

Table1: Analysis of variance (Mean of square) of some agronomical traits of lentil

S.O.V	df	MS				
		1000-seed weight (g)	Seed yield (kg/ha)	Plant high (cm)	Pod/plant No.	Number of seed per pod
Replication	2	1.59	914.94	33.6	12.32	0.141
Time of fertilizer application	1	90.72*	93470.15**	218.20**	138.58**	3.012**
Error a	2	25.493	1138.15	37.8	10.25	0.160
Micronutrient fertilizers	3	6.25*	1588.54**	23.235**	34.25**	0.149**
TF×MF	3	5.79*	1412.35**	3.25ns	35.25**	0.125**
Error b	12	1.21	251.24	2.21	3.75	0.011
C.V%		5.25	8.63	7.32	4.22	4.78

***, *, ns: Significant at 1 and 5 % probability levels and non significant, respectively*
TF: Time of fertilizer application
MF: Micronutrient fertilizers

Table 2: Mean comparison of seed yield and yield components at different micronutrient fertilizer

Treatment	1000-seed weight(g)	Seed yield (kg/ha)	Plant hight(cm)	Pod/plant no	Number of seed per pod
Control	60.04c	1058.3c	24.34b	21.40d	1.77c
Fe	64.06b	1345.2b	24.44b	27.30c	1.99b
Zn	62.49bc	1286.7b	20.94ab	29.15b	1.77c
Zn+Fe	69.47a	1457.0a	26.67a	32.10a	2.28a

Means, in each column, following similar letter(s) are not significantly different at the 5% level of probability using LSD.

Table 3: Mean comparison of seed yield and yield components after different times of foliar application at different growth stages

Treat ment	1000-seed weight(g)	Seed yield(kg/ha)	Plant hight(cm)	Pod/plant no	Number of seed per pod
10- leaf	63.28b	1301.8b	25.34b	27.04b	1.94a
10- leaf+ flowering	67.40a	1424.3a	26.01a	31.98a	2.01a

Means, in each column, following similar letter(s) are not significantly different at the 5% level of probability using LSD.

Table 4: Mean comparison of seed yield and yield components at different micronutrient fertilizers

Interaction	1000-seed weight(g)	Seed yield(kg/ha)	Plant height (cm)	Number of Pod per plant	Number of seed per pod
T1F1	59.02e	1005.1e	23.01b	22.25e	1.82d
T1F2	63.28cd	1058.9cd	23.05b	24.78d	1.96c
T1F3	60.64d	1100.4d	24.00ab	27.25c	1.92c
T1F4	67.07ab	1313.0b	24.06ab	28.65b	2.11b
T2F1	59.02e	1000.2e	23.00b	22.25e	1.82d
T2F2	65.68bc	1323.5b	23.85ab	29.22b	2.04b
T2F3	65.50bc	1012.4c	23.88ab	29.13b	2.08b
T2F4	68.34a	1405.2a	24.21a	31.08a	2.28a

Means, in each column, following similar letter(s) are not significantly different at the 5% level of probability using LSD.
T1 and T2: one time (10-leaf stage) and two time (10- leaf+ flowering stages) of foliar application, respectively.
F1, F2, F3 and F4: Spraying by micronutrient fertilizers, control, fe, zn, zn+ fe, respectively.

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