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ORIGINAL ARTICLE

Effect of Zinc Sulfate and Iron Sulfate Fertilizers on some Morphological Characteristic of *Phaseolus vulgaris*

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ABSTRACT
This study was conducted to investigate the effect of various levels of zinc sulfate and ferrous sulfate fertilizers on the number of seed in a pod, the number of pod in a bush and the length of main root of pinto bean cultivar (phaseolus vulgaris). A field experiment was conducted in 2013 in Sarvak region of Boyer-Ahmad Province, Iran. It was a factorial study on the basis of randomized complete block design with treatments including three levels of ferrous sulfate (0, 50, 100 kg / ha) and three levels of zinc sulfate (0,50,100 kg / ha). Data analyses indicated that the interaction effect of ferrous sulfate and zinc sulfate on number of pod in a bush was significant at 1% level, whereas no significant effect observed on number of seed on pod and rot length. Treatments of Fe50Zn0, Fe0Zn100, produced the highest (14.03) and lowest (8.2) amounts of number of pod in bush respectively. Results showed that Treatments of Fe0Zn100, Fe0Zn0, produced the highest (14) and lowest (12) of Root length.
Keywords: *Bean, Iron, Performance, Phaseolus vulgaris, Zinc*

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INTRODUCTION

In many parts of the world, the performance of bean can be considerably increased by the improvement of agricultural activities, planting date, amount of seeds, planting distances and depth, irrigation management, using fertilizers, controlling of pest, diseases, and weeds. In tropical and subtropical conditions, bean is cultivated in any soil, but it cannot be cultivated in clay and heavy soils in which the level of groundwater is high. Salty soils considerably decrease bean performance [1].

Common bean *(Phaseolus vulgaris)* is an important source of food throughout the world and contains protein, fiber and vitamins that increased food value of this product [2 & 3& 4]. It is one of the most important crops in terms of both economy and nutrition and is cultivated in different regions of Iran including the Markazi, Lorestan and Isfahan provinces [5].Different types of common bean by, 20-25% protein and annual production of more than 19.3 million tons are in the first place of pulses production [6].According to FAO (2008) report, global average of beans yield is 568 kg/ha. Total area under cultivation in Iran is 115833 ha and total production is 218858 Tons of which 97.1% is cultivated as irrigated and 2.9% as dry farming [7 &8].

Deficiency of micronutrients in lands under cultivation is a global concern, and millions of hectares of cultivable lands around the world suffer micronutrients shortage, andabout 40% of people around the world suffer micronutrients shortage, especially zinc [9].In agriculture practices fertilizer is an important source to increase crop yields. Among fertilizer application methods, one of the most important methods of application is foliar nutrition because foliar nutrients facilitate easy and quick consumption of nutrients by penetrating the stomata or leaf cuticle and enters the cells [10 & 11].

The main reason for iron deficiency is the abundance of bicarbonate in soil. Most soils in Iran have considerable bicarbonate, so the plant roots.Creating a special condition around it, decreases soil and provides the needed iron. Heavy irrigation and any factor decreasing soil ventilation increase carbon dioxide concentration of soil, as a result, the iron absorption decreases [11].

Common bean is very sensitive to Zn deficiency particularly under high light intensity [12]. Results of Ghanepour et al (2014) showed that Physiological elements underline the necessity of improved Zn nutrition in common bean crop [13]. Hosseinpour et al. [14] examined the application of magnesium sulfate, zinc sulfate, manganese sulfate, copper sulfate, sequestrene iron, and boric acid in different ways. They found that the maximum performance of beet root relates to the way of seed treatment and it's foliar, and the minimum performance relates to the control treatment. Yilmaz*et al* [15]) also studied the effect of different uses of zinc on the performance and concentration of zinc in seeds and aerobic organs of wheat. They concluded that zinc application, in any way, increases the seed performance. Consequently, using the mixture of soil and foliars puts the maximum effect on the seeds performance, and only using foliars puts the maximum effect on zinc concentration of seeds .Another research shows that using 20 kg of sequestrene iron in a hectare causes 16% performance increase in corn in Fars province, Iran and 42% performance increase in cotton in Varamin, Iran. Malakuti [16] reported that with optimum use of fertilizers, especially micronutrients 143% performance and increase in protein level was obtained [16].

This paper has analyzed the effect of micronutrient fertilizers of iron and zinc on the number of seeds in a pod, the number of pods in a bush, and the length of main root.

MATERIALS AND METHODS

Conducting a field of experiment

The experiment was conducted with nine treatments and three replications in 2013 in Boyer-Ahmad city, Iran (Sarvak area). The treatments of iron sulfate (20%) at three levels of 0, 50,100 kg/ ha (Fe_0.Fe_{50}, Fe_{100}) and zinc sulfate (24%) at three levels of 0, 50, 100 kg/ha (Zn_0, Zn_{50}, Zn_{100}) were applied based on factorial design in randomized complete block designs. The treatments included $Zn_{50}Fe_{100}$, $Zn_{100}Fe_{50}$, $Zn_{100}Fe_{100}$, $Zn_{50}Fe_{50}$, Zn_0Fe_{100}, Zn_0Fe_{50}, $Zn_{100}Fe_0$, $Zn_{50}Fe_0$, Zn_0Fe_0, and pinto bean cultivar, with thousand grain weights 430 grams. Each plot area was 10 square meters(1×10). Seeds were planted with 10 cm distance on the rows with 15 cm distance. Based on soil test, the basic fertilizer (triple super phosphate, potassium sulfate, and urea) was 180 kg/ha. Potassium, phosphor, one third of urea fertilizers, and experimental fertilizers were integrated into the soil at the time of planting (23.06.2013). The remaining urea fertilizer was sprayed over the farm twice prior to harvesting. The data analysis was performed via SAS software and mean scores were compared through Dunkan's test.Analyses of combined soil samples taken from the farm, before cultivation, were shown in Table 1[17].

Measured qualities

The number of pods in a bush:

The pods of three bushes in each plot and 14 bushes in one square meter from the middle of the plot were separately counted and recorded[17].

The number of seeds in a pod

The number of seeds of every pod in the middle of one square meter of each plot for each bush was separately counted[17].

The average length of main root

The lengths of 14 bushes from the middle of one square meter of each plot were marked down and after excavating the depth of root length were measured by a ruler [17].

RESULTS

The number of pods in a bush

Variance analyses show that using zinc sulfate and the mutual effect of iron and zinc sulfate on the number of pods in a bush are significant in the probability level of 0% and 1% respectively.

Comparing the mean values show that the different levels of iron sulfate on the number of pods in a bush are significantly effective. Using 50 kg of iron sulfate in a hectare with an average number of 11.08 pods in abush shows superiority over other treatments, and it was put in class A, whereas using 100 kg and 0 kg of iron sulfate in a hectare which resulted in 10.56 and 10.52 pods in a bush showed no significant difference and was put in class B (Table 3).

Comparing data averages show that the effect of different levels of zinc sulfate on the number of pods in a bush is significant. Using 0 kg of zinc sulfate in a hectare, with an average of 12.12 pods in a bush, shows superiority over other treatments, and is put in class A, while using 50 kg and 100 kg of zinc sulfate in a hectare with 10.34 and 10.20 pods in a bush, shows no significant difference, and it is put in class B (table 3).

Comparing the mean values of treatments' mutual effects shows that there is a significant difference among treatments with respect to the number of pods in a bush. 50 kg iron sulfate treatment in a hectare and without using zinc sulfate with an average of 14.03 pods in a bush shows superiority over other treatments and it is put in class A. This treatment shows 20% increasing over the control treatment[17].

The number of seeds in a pod

Variance analyses show that using zinc sulfate is significance in the number of seeds in a pod in probability level of 0%. The effect of using iron sulfate and the mutual effects of iron and zinc sulfate are not significant in the number of seeds of a pod.

The effect of different levels of zinc sulfate on the number of seeds in a pod is insignificant. Treatments of 0, 50, 100 kg of iron sulfate in a hectare with 3.43, 3.32, seeds in a pod were all put in class A (Table 3).

Different levels of zinc sulfate on the number of seeds in a pod had a significant difference. Treatments of 0 and 100 kg of zinc sulfate in a hectare with the average number of 3.44 seeds in a pod showed superiority over the treatment of 50 kg in a hectare and they were put in class A, while 50kg of zinc sulfate treatment in a hectare with 3.24 seeds in a pod was put in class B.

The results from comparing the averages of mutual effects of zinc and iron sulfate show that there is a significant difference between the treatments with the respect to the number of seeds in a pod. Treatments of iron sulfate and zinc sulfate 0, iron sulfate 50 and zinc sulfate 0, iron sulfate 100 and zinc sulfate 0 kg in a hectare, with the average number of 3.47 seeds in a pod, show superiority over other treatments and were put in class a[17].(Table 4).

Root Lengths

Variance analyses show that using iron and zinc sulfate fertilizers and mutual effects of iron and zinc sulfate do not have any significant effect on the main root average length.

Comparing averages show that the effect of different levels of iron sulfate on the root average length is insignificant. Treatments of 0, 50, and 100 kg iron sulfate in hectare with the lengths 10.06, 12.78, 12.89 cm were all put in class a (Table 3).

Furthermore, different levels of zinc sulfate do not have any significant difference on the average length of the root. Treatments of 0, 50, 100 kg zinc sulfate in a hectare with root lengths of 12.67, 12.94, 13.11 cm, were all put in class A (Table 3). Treatment of not using iron sulfate and using 100 kg zinc sulfate in hectare showed superiority over other treatments; with the average length of 14cm. other treatments were put in class AB. This treatment showed 14% increasing over the control sample[17](Table 4).

Table 1: Soil results of the place of fields experiment before Bean cultivation:

Soil profile	amount	Soil profile	Amount
Depth(cm)	0-30	Clay percentage	43
Saturation percent(sp)	62	Silt percentage	37
Electrical conductivity($d_{s/m}$)	0.5	Sand percentage	20
Mud saturation acidity(PH)	8.1	Soil texture	sandy (c)
Percentage of neutral solutesTNV%	21	Organic Carbon percentage	0.6
Percentage of total nitrogen	0.06	Absorbable phosphor(mg/kg)	12
Absorbable potassium (mg/kg)	401		

Table 2: Analyses of average square variances of the effect of different levels of Iron and Zinc sulfate on the performance of wax bean agricultural variety:

Changes sources	Freedom degree	Squares means		
		The number of seed in pod	The number of pod in bush	Root length (cm)
Blocks	2	0.008^{ns}	2.03^{ns}	1.23^{ns}
Iron Sulfate	2	0.028^{ns}	$^{*}3.31$	0.17^{ns}
Zinc Sulfate	2	0.0120^{*}	$^{**}10.31$	0.45^{ns}
Zinc and Iron sulfate	4	0.058^{ns}	$^{**}10.57$	1.56^{ns}
Error	16	0.035	0.931	0.88
Changes coefficient percentage		14.78	5.56	7.25

Ns are insignificance, significance in level of 5%, significance in level of 1%.

Table 3: The results of different simple effects of Iron and Zinc sulfate on the performance of wax bean agricultural variety:

Analyzing factors	Unit of Kg in a hectare	Measured qualities		
		Number of seed in pod	Number of pod in a bush	Root length
Iron sulfate	0	3.43 [a]	10.52[b]	10.06 [a]
	50	3.32 [a]	11.58[a]	12.78 [a]
	100	3.38 [a]	10.56[b]	12.89 [a]
Zinc Sulfate	0	3.44 [a]	12.12 [a]	12.67 [a]
	50	3.24 [b]	10.34[b]	12.94 [a]
	100	3.44 [a]	10.2 [b]	13.11 [a]

In each column, averages, which have at least one common letter, do not have any significant difference with respect to statistics.

Table 4: Mutual effect averages of different levels of Iron and Zinc sulfate on the performance of wax bean

treatment	Root length	Number of pod in a bush	Number of seed in a pod
Fe0Zn0	12[b]	11.33[bc]	3.47[a]
Fe0Zn50	13.17[ab]	11.97[b]	3.47[a]
Fe0Zn100	14[a]	8.2[e]	3.37[ab]
Fe50Zn0	13[ab]	14.03[a]	3.4[a]
Fe50Zn50	12.5[ab]	9[e]	3.07[b]
Fe50Zn100	12.83[ab]	11.73[bc]	3.5[a]
Fe100Zn0	13[ab]	11[bc]	3.47[a]
Fe100Zn50	13.17[ab]	10.07[d]	3.2[ab]

In each column, averages, which have at least one common letter, do not have any significant difference with respect to statistics.

DISCUSSION

The soil of the district is calcareous and with high acidity (high PH). In this condition, shortage of nutrients, especially micronutrients are expected. Among these micronutrients are Zinc and Iron. With applying treatments on the number of pod in a bush, it is found that application of Iron and Zinc causes increasing and decreasing in the performance of plant over witness treatment. Maximum performance relates to the treatment of not using Zinc with using 50 kg Iron in a hectare, which shows 24% increasing over witness treatment. Minimum performance relates to the treatment of not using Iron with using 100 kg Zinc a hectare, which shows a 28% increasing over witness treatment. Average performance of seed in a pod in experiment treatments; show that application of Iron and Zinc does not increase the performance of plant over witness treatment. The performance of treatments was in the same level of witness performance. However, treatments of using 50 kg Zinc with 50 kg Iron in a hectare and 50 kg Zinc with 100 kg Iron in a hectare, show 10/5 and 8 percent decreasing over witness treatment.Average performance of root length in experiment treatments shows that there is not any significant difference between treatments. Treatment of not using Iron with using 100 kg Zinc sulfate in a hectare, with the average length of 14cm, show superiority over other treatments and was put in class A. Other treatments were put in class AB. This treatment shows a 14% increasing over witness treatment. Using Iron and Zink less than 50 kg in a hectare is necessary for the soil of the district. Analyzing the results of the experiment shows that the iron needed is two times greater than Zinc and this is proved in analyzing the soil of the district. Therefore, the results of this experiment, like reports from[1,9, 14, 15 & 16], explains that Bean shows a good reaction to the use of Iron and Zinc.

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