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The Effect of Phosphorus and Zinc Fertilizer on the Elements Concentration of Soybean Cultivars Seed *(Glycine max* L.)

Jaber Mehdiniya Afra[1*], Marzieh Mozafar[2]
*1-Young Researchers and Elite Club, Ayatollah Amoli Branch, Islamic Azad University, Amol, Iran
2- M.Sc. of Agronomy, Islamic Azad University, Chalus Branch, Chalus. Iran.
*Corresponding author: Mehdiniya.Jaber@gmail.com

ABSTRACT
In order to evaluate the effect of phosphorus and zinc sulfate fertilizer on elements concentration of soybean cultivars an experiments was conducted in the north of Ghaemshahr in 2012. The factors examined included the factor A with three levels of phosphorus zero, 50 and 100 mg /kg from the source of triple superphosphate, factor B with three levels of zinc in concentrations of zero, 5, 10 mg/kg from the source of zinc sulfate and factor C of two soybean cultivars Telare BP, Sari (JK), respectively. The results showed that the highest phosphorus seed was achieved by taking 100 mg per kg (1.59) percent phosphorus and the consumption of 5 mg per kg of (1.57) percent zinc sulfate. There was also no statistical difference between JK and BP cultivar. By the effect of triple interaction between cultivar in phosphorus and zinc, the maximum amount of phosphorus seed in BP cultivar was achieved by the consumption of 100 mg/kg phosphorus and 5 mg/kg ,1.75% zinc and for the same cultivar by taking 100 mg/kg phosphorus and without using 1.73% zinc. The results showed that the amount of zinc seed in BP cultivar (104.9) microgr/gr was more than JK cultivar (97.9) Micro-g/gr that increased for 6.6% in comparison with JK. Also the results of the analysis of variance showed that phosphorus and zinc sulfate fertilizer and cultivar statistically had significant effect on all evaluated traits except nitrogen seed and protein seed. The results showed that seed oil content in JK cultivar in the treatment of non-application of phosphorus and zinc and the lowest amount of oil seed in BP cultivar in the treatment of 100 and 10 mg per kg phosphorus was obtained. In general, by using fertilizer and zinc sulfate in different cultivars can be caused changes in the concentration of seed quality and as well in some of the traits, the effect of phosphorus and zinc sulfate fertilizer were once had antagonistic relationship.
Keywords: *Cultivar, Zinc, Soybeans, Phosphorus*

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INTRODUCTION

Soybean is an important seed, legume, the unique chemical composition of soybean has made it one of the most valuable agronomic crops [1]. Phosphorus and zinc are essential elements for plants which can have different effects on different plants [2]. Phosphorus is one of the key elements in plants, which is responsible for important tasks in them. It participates in energy transfer processes in plant metabolism, cell division, phospholipids building walls of plant cells, plant reproductive development areas, development of secondary roots and hair, as well as in the formation and transfer of substances such as plant sugars and starch company provides [3]. The heavy use of phosphorus fertilizers in the soil that has a small amount of applicable zinc will impose the deficiency of zinc on plants, in soil, and the phosphorus and zinc can form poorly soluble and resistant compounds that decrease the available zinc absorption in plants. Also a lot of soil phosphorus, reduces the growth of plant roots and mycorrhizal volume, which will reduce the absorption of zinc by plants. In plants, the presence of high concentrations of phosphorus,will reduce the solubility of zinc and decreases its transmission form the roots to the rest of the plant's organs [4]. The use of different levels of phosphorus increased the grain weight, protein content and nitrogen fixation in pea, and as well there was a significant difference between the use of phosphorus and not using it. Meir Ansari *et al* [5] by using different levels of zinc in zinc sulfate observed that using zinc sulfate not only significantly increases the performance but also causes grain richness. Studying the effect of heavy metals on germination of alfalfa showed that the concentration of 40 ppm zinc had no significant effect on germination but zinc is very important for the growth and development of plants [6]. Also study of the toxic effect of zinc on the growth and metabolism of many plants concluded that too much of zinc decreases the growth parameters [7]. The researchers reported that the consumption of micronutrients in any way in the sugar beet crop with the increase in leaf area and photosynthetic capacity combined with the increase metabolic activities can lead to the production of products with higher sugar content [8]. The researchers believe that soil and nutrients are very important for plant growth and development. In addition to carbon, oxygen and hydrogen that are provided by the atmosphere and water, macronutrients such as phosphorus are essential for growth and yield of plants. Nutrient loss in world agricultural soil due to excessive agriculture has made the use of fertilizers necessary [9].

Also the use of micronutrients in agronomic management is recommended [8]. So to achieve enrichment strategies for soybean and taking into account the fact that no similar experiment has been done in this area, this study was done to evaluate the effect of phosphorus and zinc sulfate chemical fertilizers on concentration of soybean cultivar seeds.

MATERIALS AND METHODS

In order to evaluate the effect of chemical phosphorus and zinc sulfate fertilizers on concentration of Soybean cultivars an experiment was conducted in the north of Qaemshahr with latitude 36 degrees 26 minutes north and longitude 52 degrees 48 minutes east with a height of 65 meters above sea level in crop 2012. Factorial experiment in a completely randomized design with three replications was done. Examined factors include factor A with three levels of phosphorus zero, 50 and 100 mg/kg of triple superphosphate, factor B with three levels of zinc in concentrations of zero, 5, 10 mg/kg from the source of Zinc and factor C of two soybean cultivars Telar (BP), Sari (JK). 54 pots were used for this test. Each pot sized 30 × 27 to the extent being appropriate for soybean roots and in each 10 kg of soil was dumped on the soybean roots. Based on soil analysis the amount of high and low consumption levels of other micronutrients needed is calculated and 540 kg soil was added..The analysis of soil samples tested are shown in Table 1. Then phosphorus and zinc concentrations were calculated and weighted and added to each pot. Phosphorus and zinc fertilizer was mixed with 1 mm sieved sand. The conculated zinc and phosphorus was added to each pot in the form of soil application and preplan and mixed well with the soil. The soybean seeds were inoculated with Rhizobium and then 3 seeds were placed in each pot.

After the emergence of the first trifoliate stage, thinning was done and 2 plants remained in each pot. Watering the pots was conducted in a manner that moisture hadn't been less than 80 percent of the capacity of pots in the growing season. For measuring iron ,zinc, copper, manganese and phosphorous, first, a plant was chosen randomly from each pot and the plant seeds were separated from the pod, then each placed in an envelope of paper and put in a fan oven for 72 hours at 60 ° C, and after drying, the plant samples were fully milled and transferred to the lab for measuring the amount of elements. then the seed by the method of digestion by dry burning and use of HCI, like other micronutrients were read by atomic absorption spectrophotometer and the read data are calculated and the amount of the iron of seeds, leaves, stems, plant organs was recorded. The measure of nitrogen seed was read by titration method after distillation and the use of automated systems (Kajal single auto analyzer) were measured and the read data was calculated and the amount of nitrogen in plant organs was recorded. That is the measurement was carried out in the resulted extract by the method of wet digestion in special pipes with sulfuric acid, salicylic acid, hydrogen peroxide and selenium. To analyze the data, statistical programs SAS and for the comparison of the average of desired traits Duncan test was used at 5 percent level.

Table 1 - Physical and chemical properties of soil tested

Depth (cm)	soil texture	Sand	Silt	Clay	Organic carbon (%)	Total nitrogen (%)	Total Phosphate (mg/kg)	Total K (mg/kg)	Total Fe (mg/kg)	Total Mn (mg/kg)	Total Zn (mg/kg)	Total Cu (mg/kg)
0-30	Silt loam	18	70	12	2.54	025	7.7	314	5.4	5.4	0.4	0.5

RESULTS AND DISCUSSION

Phosphorous Seed

The results of the analysis of variance showed that phosphorus and zinc fertilizer and genotypes had a statistically significant effect on all traits except nitrogen seed and protein. (Table 2). Based on the results of this test in addition to the main effects of treatments (chemical phosphorous fertilizer, cultivar, zinc sulfate)the interactions between cultivar and zinc sulfate and phosphorus fertilizer and phosphorus in zinc and the triple interaction in trait of seed phosphorous was statistically significant (at 5% probability level), but the rest of the treatments on these traits was significant (table 2). The highest phosphorus intake by consumption 100 mg /kg (1/59) percent of seed phosphorus and 5 mg/kg of zinc sulfate (1.57) % was attained. Also no statistical difference between the JK and BP cultivar was observed (Table 3). The maximum amount of phosphorous influenced by the triple interaction in phosphorus and zinc in order for the BP taking 100 mg P per kg and with taking 5 mg per kg of (1.75) percent zinc and that cultivar resulted by taking 100 mg kg phosphorus without using (1.73) percent zinc, respectively (table 4). Studies showed that phosphorus increases the amount of glycine in soybean seeds [10]. Iron and zinc have significant effects on growth, yield and nutrient uptake in safflower and increased plant height, number of leaves and lateral branches, dry matter and seed protein and oil content [11].

Zinc seed

Based on the results of this test only the main effect of treatment and the effect of triple interaction on the amount of zinc at the level of 5% was significant and the effect of rest of the treatments on the trait was insignificant (Table 2).The amount of zinc seed BP (104.9) microgram per gram was higher than JK (97.9) microgram per gram,which respectively Compared to JK 6.6 percent (Table 3). It seems that the greatest amount of zinc in the BP obtained. The maximum aggregate amount of zinc influenced by the triple interaction of phosphorus and zinc to the BP taking 50 mg/kg phosphorus and with taking 5 mg/kg of zinc (110.4) micro g/g, was obtained respectively (Table 4). One of the reasons for the negative interaction was the existence of antagonistic relationship-element between zinc and phosphorus. The amount of micronutrients (zinc, iron, Mn and copper) in seed depends on the concentrations of these elements by the roots during seed development stage and re-seed the elements of the phloem tissue, and remobilization depends heavily on each elements moving through the phloem [12].

Cu seed

Based on the results of the test, the main effect of cultivar treatment and interaction between the treatments in zinc sulfate and triple interaction had a statistically significant effect (at the level of 5%), and the interaction of phosphorus fertilizer and zinc sulfate was statistically significant at the level of 1% but the mutual effect of other treatments on this trait was not significant (Table 2). The highest Cu seed under the effect of interaction between phosphorus and zinc for the treatment with 100 mg/kg and 5 mg/kg of zinc (28.40) microgram per gram and the lowest for treatment with 100 mg kg without taking the (24 microgram per gram) were obtained (Fig. 1). The maximum Cu seed, affect by the interaction between cultivar and zinc for BP's with the consumption of 5 mg kg (27.46) microgram per gram is attained and that's without taking on (26.87) JK microgram per gram and the consumption of 10 mm g kg and the lowest for the JK was obtained in avoiding the use of zinc sulfate (23.65) microgram per gram, respectively (fig. 2). The maximum amount of copper aggregate, obtained under the influence of the triple interaction between phosphorus and zinc sulfate in order for the BP on the non-application of phosphorus and zinc (29.26 microgram per gram) and for BP by taking 100 mg phosphorus and zinc 27.03 microgram per gram, respectively (Table 4). According to the research, the imbalanced use of fertilizers, especially phosphorus fertilizers has caused the balance of nutrients, especially micronutrients in the soil has reduced the absorption of iron, zinc, copper and manganese by the plant and as well the alkaline and calcareous condition of soil are the other factors limiting the uptake of [13]. The other similar investigation showed that the consumption of copper and zinc will increase the amount of dismutase superoxide in soybeans [14].

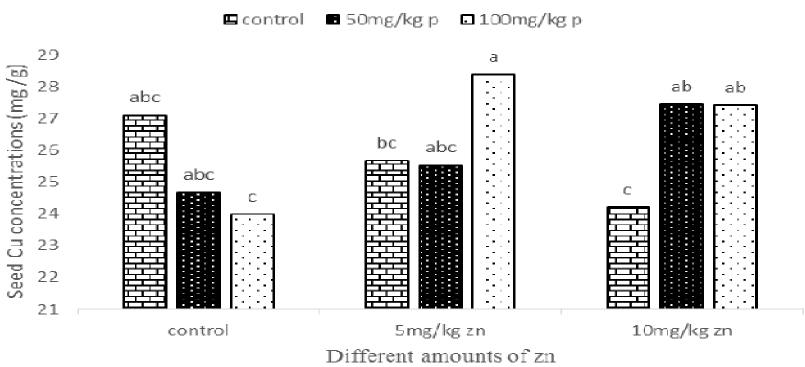

Figure 1- The interaction between phosphorus and zinc on the Cu seed

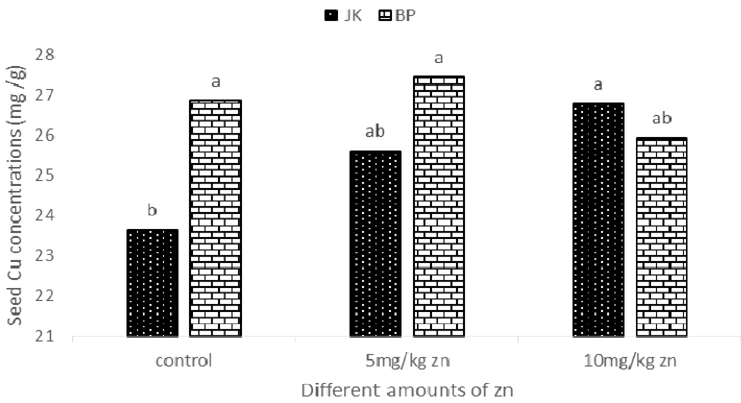

Figure 2- The interaction of cultivar and zinc on the Cu seed

Manganese seed

Based on the results of this test the main effects of treatments (cultivar, phosphorus, zinc sulfate) and the interaction of phosphorus in zinc sulfate at 1% level was significant, but in the rest of the treatments on these traits was not significant (Table 2). The highest amount of manganese seed by intake of 100 mg P kg, 46.444 microgram per gram and taking 5 mg of zinc sulfate 46.217 mcro g/kg of seed was obtained, also the results didn't show significant difference in terms of statistical averages between BP and JK cultivar (Table 3). If you use zinc, the maximum manganese seed treated with 5 milligrams per kilogram zinc (46.217) micro g caused 11.39 percent manganese increase compared to the non-application of zinc (40.956), Also if you use phosphorus, the maximum manganese seed, treated with 100 mg P kg (46.444) phosphorus caused 12.36% manganese increase compared to the non-application of phosphorus (40.706). And also in accordance with the maximum mean comparisons effects of manganese in the JK (47.159) microgram per gram and the least in the BP (39/9) microgram per gram, it was observed that JK in comparison to fertilizer treatments could absorb manganese from the soil much better (table 3). And the triple effects of phosphorus in zinc and cultivar in the table of mean comparisons show that the maximum absorption of manganese in treatment is with 50 mg and 10 mg/kg (62.832) microgram per gram, that is the cause of an increase of 46 percent Mn absorption compared to the control (33.933) microgram per gram for JK and as well for BP the maximum absorption of manganese is for treatment, 100 and 5 mg per kg of phosphorus and zinc (52.367) mg g that causes the increase of (37.79), percent of the absorption of manganese compared to control (31.533) microgram per gram (Table 4). Overall the comparisons and an average of three P in the figure shows that the JK in comparison to BP showed better effects on manganese absorption(5.88)%. Researchers have shown that the unbalanced use of chemical fertilizers, especially phosphorus fertilizers has caused disturbance in the balance of nutrients, especially micronutrients in the soil and may result in decreased absorption of iron, zinc, copper and manganese by the plant and as well the alkaline and calcareous condition of soil is another factor in limiting the absorption of micronutrients [15].

Iron seed

Iron seed statistically affected by the simple effect of cultivar, phosphorus and the interaction between cultivar and zinc sulfate at 5% level and the interaction between phosphorus and zinc and the triple interaction between cultivar, phosphorus and Zinc at 1% level showed significant difference but the triple treatments of cultivar, phosphorus and zinc did not show significant differences comparing to iron absorption (table 2). The highest manganese concentrations by the use of 50 milligrams per kg phosphorus (126.672) and taking 5 mg per kg zinc (120.644) microgram per gram was obtained and also statistical average difference between BP and JK cultivar was not observed (table 3). If using phosphorus, the Maximum iron seed in treatment of 50 mg kg (126.672) microgram per gram caused an increase of 8/68 percent compared to the non-use of phosphorus (115.678) microgram per gram and as well no difference was observed between the average of data between nonapplication of phosphorus and 100 mg/kg of phosphorus and if you use zinc, the maximum iron seed treated with 5 mg of iron per kilogram zinc (120.644) microgram per gram caused 2.91 percent of increase compared to the non-use of zinc (117.144) microgram per gram, as well according to the comparison table the average simple effect of granulated iron in the BP (123.633) microgram per gram and the least in the JK (114.881) was observed that shows the BP cultivar could absorb iron better from the soil in comparison with fertilizer treatment (table 3). The mean comparisons table of triple interaction between Phosphorus in zinc and cultivar shows the maximum iron absorption seed in treatment by the consumption of 50 mg per kg of phosphorus and 10 mg per kg Zn (155.467) microgram per gram, which increased 16.56% iron absorption seed in comparison with control iron absorption (129.732) microgram per gram in BP cultivar and as well in JK cultivar, the maximum iron absorption in the treatment of non-application of phosphorus and 5 mg/kg (131.433) microgram per gram zinc which increased 28 % in comparison with control iron absorption (94.633) microgram per gram (table 4). According to studies conducted on the phosphorus and iron response in a calcareous soil, it was shown that using phosphorus the absorption by the plant increased and the iron levels decreased [7]. Studies show that the effect of zinc and iron affected the concentration positively and increased the amount of it in soybeans [15]. The researchers showed that using zinc and iron increases its concentration in dill plant organs and it affects positively on the concentration of sulfate in plants organs, while the iron use in plant increased its concentration in its quality characteristics [5].

Oil seed

Oil seed statistically affected by the interaction between phosphorus and zinc and at the level of 5% showed a significant difference. But the simple treatment of cultivar, phosphorus, zinc and the interaction between cultivar, phosphorus and also cultivar and zinc and the triple interaction between cultivar, phosphorus and zinc showed no significant difference in respect of oil yield (table 2).

Regarding the comparison of the average effect of the triple interaction between phosphorus, zinc and oil seed cultivar in the case of using 50ml per kg of Zinc and 50 & 10 ml per kg of phosphorus and zinc, the highest amount of oil was observed in both cultivars (Table 4). But the least amount of oil seed in JK cultivar in the treatment of non-application of phosphorus and zinc,and as well the minimum amount of oil seed in BP cultivar, treated with 100 and 10 mg per kg of phosphorus and zinc was observed. That shows the interaction between phosphorus and zinc at high levels. The maximum oil seed was observed in the case of using zinc with the treatment of 50 mg kg phosphorus and also zinc can increase the oil seed from 19.5% to 20.8 % percentage that reflects the high impact of zinc on the increase in oil seed (Figure 3). The result was contrary to the results of a study which suggests that increasing the intake of phosphorus had no effect on the amount of seed protein and oil [16]. The effect of micronutrients on both quantitative and qualitative characteristics of two sunflower cultivars showed that the cultivar and the fertilizer treatment of zinc sulfate had significant effect on oil yield per hectare [17].

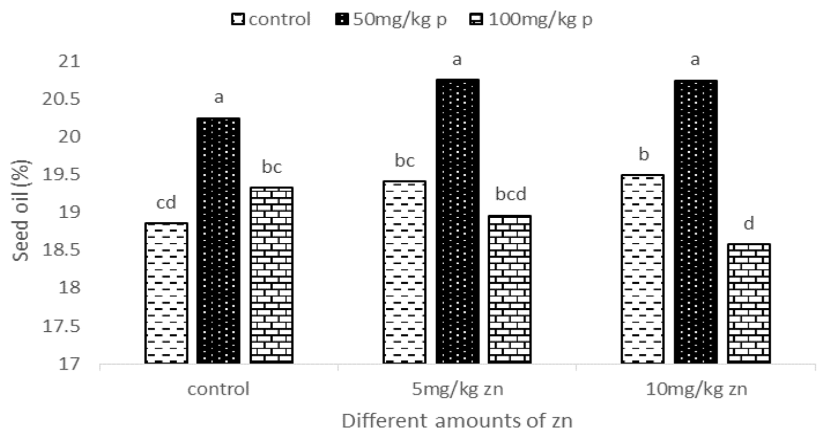

Figure 3- The interaction between phosphorus and zinc on oil soybean

Oil yield

Oil yield statistically affected by the interaction between cultivar and phosphorus and the triple interaction and at 5% level showed significant difference. But the simple effect of treatments, of cultivar,phosphorus, zinc and the interactions between cultivars and phosphorus and the interaction between cultivar and zinc showed no significant difference in respect of the amount of oil seed yield. (Table 2). The results showed that by the effect of the interaction between the cultivar treatment and phosphorus fertilizer ,the highest oil yield in JK cultivar and combined with the usage of 50 mg of phosphorus fertilizer at a rate of 371 kg per hectare was achieved. Compared to the same amount of phosphorus fertilizer in BP cultivar has an 28% increase in oil yield (Figure 4). By comparison, the average effect of the triple interaction between zinc,phosphorus and cultivar of oil yield in the case of using 50 mg per kg of phosphorus and non_application of zinc in non-oil JK cultivar the highest yield was obtained (Table 4). The researchers reported that on the application of phosphorus fertilizer with nano zinc consumption increased oil yield in soybean. The obtained results matched the other results by the researchers [17, 18, 11].

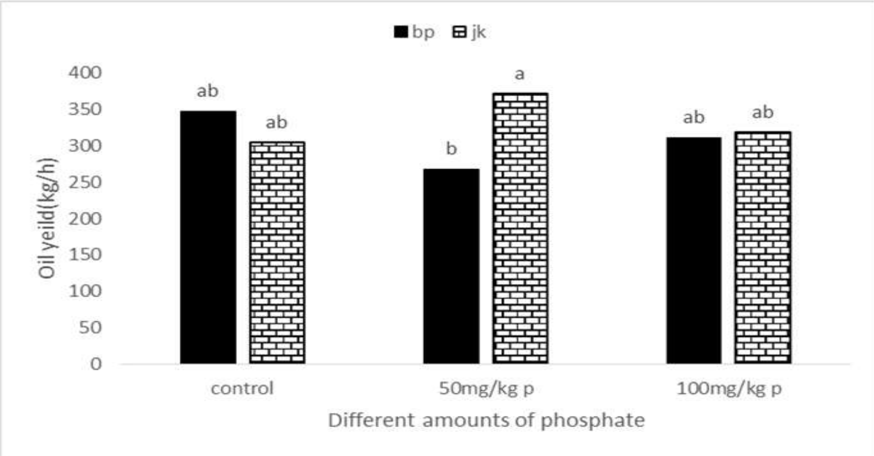

Figure 4- The interaction between cultivar and phosphorus on yield oil soybean

Seed yield

Seed yield statistically affected by the interaction between phosphorus and zinc and the interaction between cultivar and phosphorus, and the triple interaction which showed significant difference at the 5% level. But no significant difference with respect to seed yield was observed in the treatment effect of cultivar, phosphorus, zinc, and the interaction between cultivar and zinc (table 2). The results showed that by the interaction effect of cultivar treatment and phosphorus fertilizer, the highest Seed yield in JK cultivar and combined with the use of 50 mg of phosphorus fertilizer was attained that in comparison to the same amount of phosphorus fertilizer in BP cultivar, 28% increase was observed in seed yield (Figure 5).

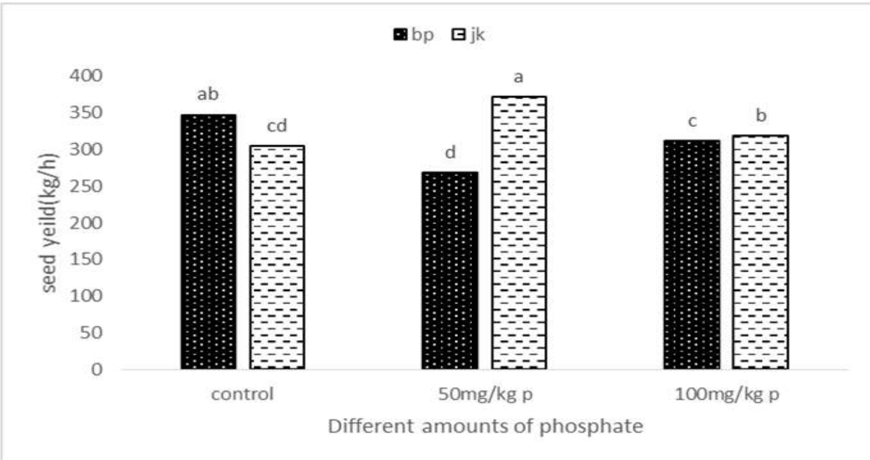

Figure 5- The interaction between cultivar and phosphorus on seed yield soybean

The results also showed that by the effect of the interaction between phosphorus and zinc sulfate,the highest amount of seed yield was achieved by the use of 50 mg of phosphorus fertilizer and in the absence of zinc sulfate and then in the lack of consumption of phosphorus fertilizer and the use of 10 mg of zinc sulfate (Figure 6).The results show that the interaction between phosphorus and zinc has got an antagonistic character, and neutralize the effects of each other.The results match the other researchers results [18,11].The effects of micronutrients on the quantitative and qualitative characteristics of two sunflower cultivars showed that the cultivar and the fertilizer treatment of zinc sulfate had a significant effect on the oil yield per hectare [17].

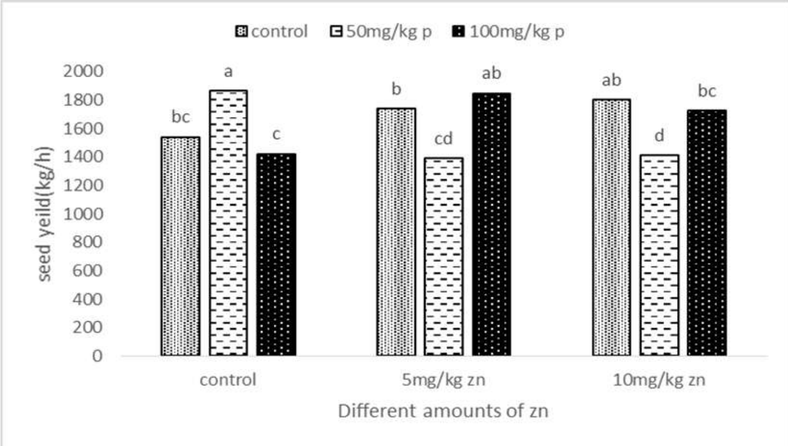

Figure 6- The interaction between phosphorus and Zn on Seed Yield soybean

Table 3- Comparison of the effects of cultivar, phosphorus and zinc sulfate on plant traits for Soybean

		Zn	Seed Oil
Phosphorus fertilizers	control	101.583a	19.21b
	50 mg k/gr	99.961a	20.59a
	100 mg k/gr	102.789b	18.61b

Number followed by the same latter are not significantly different at p≤0.05. (Duncan)

Table 2- Analysis of variance of measured traits in experiment

S.O.V	DF	N	P	Zn	Cu	Mn	Fe	Seed protein	Seed Oil	Seed yield	Oil yield
Cultivar	1	0.011ns	0.024ns	644.8*	26.74*	711.47**	1034.03*	024ns	0.003ns	161418.64ns	6879.02ns
Phosphorus	2	0.015ns	0.059*	36.24ns	4.33ns	148.31**	742.57*	024ns	13.5ns	95004.92 ns	560.34ns
Cultivar* Phosphorus	2	0.207ns	0.082*	10.11ns	18.08ns	36.17ns	102.02ns	5.73ns	0.3ns	632191.96ns	24457.32ns
Zinc sulphate	2	0.098ns	0.051ns	20.75ns	8.6ns	124.72**	62.23ns	4.05ns	0.24ns	11468.08 ns	569.57*
Cultivar * Zinc sulphate	2	0.005ns	0.017ns	51.37ns	19.38*	14.23ns	308.06*	0.322ns	0.1ns	152421.22ns	7551.27ns
Phosphorus * Zinc sulphate	4	0.025ns	0.028ns	46.63ns	24.15**	195.76**	556.18**	1.23ns	0.91*	412232.72*	14529.99ns
Cultivar * Phosphorus * Zinc sulphate	4	0.086ns	0.05*	22.12*	12.59ns	424.42**	902.9**	3.014ns	029ns	545723.01*	20886.45*
Error	36	0.192	0.17	66.94	5.65	22.67	100.82	7.72	029	149076.86	5596.06
Total	53	8.006	1.354	3567.05	478.13	5055.23	12929.65	317.08	40.69	210229.83	7854.34
CV (%)	-	8.93	8.38	8.07	8.07	10.94	8.42	9.06	2.33	23.58	23.36
* and ** significant at 5% &1% respectively,											

Table 4- shows the comparison of the three (cultivar* phosphorus * zinc sulfate) on the traits of Soybean

v	P	Zn	Cu	Mn	Fe	Seed Oil	Oil Yield	Seed yield
JK								
P1Z1	1.54abcd	97.63ab	24.96abcd	33.93ef	94.63g	18.467f	266.2bc	1376.4bcd
P1 Z2	1.57abcd	98.13ab	23.13cde	51.2bc	131.43b	19.46bcde	276.5 bc	1426.4 bcd
P1 Z3	1.36d	98.9ab	26abcd	52.63bc	103.06efg	19.53bcde	372.2abc	1915.5abcd
P2 Z1	1.45bcd	93.7b	25.03abcd	41.16de	128.33bcd	20.3ab	501.2a	2483.1a
P2 Z2	1.55abcd	95.13ab	26.13abcd	62.83a	127.03bcd	20.9a	267.8 bc	1298.7cd
P2 Z3	1.46bcd	98.3ab	27.73abc	35.86def	119.73bcdef	20.5a	344.3 bc	1640.6 bcd
P3 Z1	1.73a	103.3ab	20.96e	55.63ab	115.63bcdef	19.6bcd	254.7 bc	1337.6 bcd
P3 Z2	1.76a	97.13ab	27.56abc	36.5def	102.6fg	19.06def	394.7ab	2096.8ab

P3 Z3	1.58abcd	99.66ab	26.66abcd	54.[illegible]6ab	11[illegible].46bcdefg	18.67ef	305.3 bc	1652.5 bcd
BP								
P1Z1	1.39cd	105.4ab	29.26a	31.53f	129.73bc	19.26gef	312.3 bc	1701.7 bcd
P1 Z2	1.38cd	103.9ab	28.23ab	33.77ef	120.73bcdef	19.37cde	398.7ab	2050.8abc
P1 Z3	1.64abc	105.53ab	22.43de	41.16de	114.47bcdef	19.46bcde	329.9 bc	1689.0 bcd
P2 Z1	1.59abcd	96.6ab	24.33bcde	44.4cd	109.77defg	20.2abc	253.3 bc	1249.5d
P2 Z2	1.67ab	110.43a	24.93abc	40.63def	119.7bcdef	20.63a	308.1 bc	1475.6 bcd
P2 Z3	1.44bcd	105.6ab	27.2abcd	35.73def	155.47a	21a	243.2c	1183.7d
P3 Z1	1.61abcd	104.6ab	27.03a	39.06def	124.76bcd	19.06def	296.0 bc	1505.0 bcd
P3 Z2	1.52abcd	107.9ab	29.23ab	52.36bc	122.36bcde	18.86def	303.9 bc	1594.6 bcd
P3 Z3	1.37d	104.13ab	28.2e	40.43def	115.7bcdef	18.5f	334.5 bc	1793.7abcd

Z1, P1: Lack of zinc and phosphorus. Z2, P2: respectively of 5 and 50 milligrams per kilogram of zinc and phosphorus. Z3, P3: respectively 10 and 100 milligrams per kilogram quantities of zinc and phosphorus.

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