Effect of sulphur and zinc on nutrient uptake and yield of soybean

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ABSTRACT

The field experiment was conducted to study the effect of sulphur and zinc on nutrient uptake and yield of soybean var. JS 335 crop on vertisol during year *Kharif* 2009. The different doses of sulphur were applied singly with recommended dose of fertilizer and along with constant dose of zinc also. Results indicated that application of 30 kg S ha^{-1} and 2.5 kg Zn ha^{-1} with fertilizer dose of 30:75:0 kg NPK ha^{-1} recorded higher grain yield and straw yield. Total uptake of nutrients and micronutrients was recorded significantly highest in same treatment after harvest of crop.

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Key words : Sulphur, Zinc, Yield, Nutrient uptake, Vertisol, Soybean

INTRODUCTION

Soybean (*Glycine max* L. merill) is a well-known oilseed and pulse crop. It is the richest and cheapest source of high quality proteins, minerals, vitamins, and fats. Soybean is called as miracle, Golden Bean of 21st century mainly due to its high protein (40%), oil (20%) content, and now making headway in Indian Agriculture. It is called as Gold of Soil due to its various qualities such as ease in cultivation, less requirement of fertilizer and labour. With adoption of intensive farming the farmers have shifted from using organic to inorganic high analysis to S free fertilizer leading to move widespread and more intense S-deficiency in Indian soils (Krishnamurti and Mothan, 1996). Micronutrients have assumed increasing in crop production under modern agriculture. Increased yield through intensive cultivation with high yielding crop varieties. Use of chemically pure NPK fertilizer free from micronutrients as contaminant restricted recycling of organic wastes in soil are dominant factors contributing towards accelerated exhaustion of micronutrients from soil in general and zinc in particular. At several places normal yield of crops should not be achieved despite judicious application of nitrogen, phosphorus and potassium due to the micronutrient deficiency in soils. The distribution of zinc found more in roots and it is taken up by plant in Zn^{2+} form, uptake is done by root as well as foliar spray (Nandanwar *et al.,* 2007). In years to come the deficiency problem of micronutrients will go on intensifying, the land has to be cultivated more intensively to produce extra food, fibre, fuel, fodder, fruits etc. to meet the requirements of increasing population. Keeping this in view, the present investigation was undertaken to study the effect of sulphur and zinc on nutrient uptake and yield of soybean.

MATERIALS AND METHODS

The present investigation was conducted at Agriculture Research Station (ARS), Washim, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif,* 2009. The experimental soil was montmorillonite, hyperthermic, family of Typic Haplusterts. The initial status of soil having pH 8.07 and Ec 0.17 dSm^{-1} which was moderately alkaline in nature and low in organic carbon (5.86 g kg^{-1}) , low in available nitrogen (153.15 kg ha^{-1}), medium in phosphorus (14.56 kg ha^{-1}), high in potassium (369.14 kg ha^{-1}) and medium in sulphur (14.62 kg ha^{-1}) . Whereas it was deficient in Zn (0.45 ppm) and Fe (1.51ppm) while sufficient level of Cu (0.27 ppm) and Mn (2.13 ppm). The experiment was laid out in Randomized Block Design with soybean crop. The seven treatments with three replications applied to experimental field. Where treatment T_1 (control), T_2 (10 kg S ha^{-1}+ RDF), T_3 (20 kg S ha^{-1}+ RDF), T_4 (30 kg S ha^{-1}+ RDF), T_5 (2.5 kg Zn ha^{-1} +10 kg S ha^{-1}+RDF), T_6 (2.5 kg Zn ha^{-1} +20 kg S ha^{-1}+RDF), T_7 (2.5 kg Zn ha^{-1} +30 kg S ha^{-1}+RDF) was taken randomly in 21 plots. Soil sample (0 - 15 cm depth) were taken from entire field and analyzed for various physicochemical properties in order to asses the initial fertility status of the soil while the plant samples were collected at harvest. The samples were air dried and subsequently oven dried at 60^{0}C. The treatment wise samples were ground by using Willey grinding machine. Zinc was applied in the form of zinc sulphate and sulphur

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was applied in the form of gypsum and DAP fertilizer were used for recommended dose of fertilizer. The ground seed and stover samples were digested with nitric and perchloric acid (9:4) di-acid mixture for analysis of all elements except nitrogen.

RESULTS AND DISCUSSION

The results obtained from the present investigation have been discussed in the following sub heads :

Yield:

Data (Table 1) show that there was an increase in the grain and straw yield of soybean as the dose of sulphur fertilizer increased. The highest increase in grain yield and straw yield was 17.55 q ha^{-1} and 31.14 q ha^{-1}, respectively which was observed in the T_7 (30 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + RDF) treatment. It was significant over all treatments but was at par with T_4 (30 kg S ha^{-1}+ RDF) treatment which obtained grain yield 17.48 q ha^{-1} and straw yield 30.90 q ha^{-1}. The T_6 (30 kg S ha^{-1}+ 2.5 kg Zn ha^{-1}+ RDF) treatment vary significantly over T_3 (30 kg S ha^{-1}+ RDF) treatment. And all these treatments vary significantly over control (grain yield 12.96 q ha^{-1} and straw yield 26.48 q ha^{-1}) treatment. Sulphur increases root growth and stimulate seed formation in leguminous crop which directly affect yield. Similar results were also observed by Jat and Mehra (2007) that the yield of soybean increases due to application of 60 kg S ha^{-1} sulphur and 2.5 kg Zn ha^{-1}.

Table 1 : Effect of sulphur and zinc on yield of soybean

Treatment	Grain (q ha^{-1})	Straw (q ha^{-1})
T_1	12.96	26.48
T_2	15.06	29.09
T_3	17.21	30.20
T_4	17.48	30.90
T_5	16.24	29.12
T_6	17.42	30.86
T_7	17.55	31.14
S.E. (m±)	0.35	0.10
C.D. (P=0.05)	0.98	0.29

Nitrogen uptake:

The uptake of nitrogen in grain and straw was increased and varied significantly (Table 2). The highest significant uptake of nitrogen (213.39 kg ha^{-1}) was found in treatment T_7 (30 kg S ha^{-1}+ 2.5 kg Zn ha^{-1} + RDF) and was at par with uptake of nitrogen 212.28 kg ha^{-1} was found in treatment T_4 (30 kg S ha^{-1} + RDF). The treatment T_6 (20 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + RDF) showed 211.04 kg N ha^{-1} uptake which was significant over treatment T_3 (203.55 kg N ha^{-1}). All these treatments were significantly superior over control (166.82 kg N ha^{-1}) treatment. From above discussion it can be observed that as level of S and Zn increased there was an increase in nitrogen uptake because sulphur increases root growth and promotes nodule formation in roots of leguminous plants while zinc improves plant growth and carbohydrate metabolism. The increased in nitrogen uptake at level of sulphur upto 60 kg S ha^{-1} has been reported by Ganeshmurthy (1996).

Table 2 : Effect of sulphur and zinc on uptake of nutrients

Treatments	Nitrogen (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	S (kg ha^{-1})
T_1	166.82	22.19	54.01	18.51
T_2	192.85	26.68	63.42	21.18
T_3	203.55	31.31	68.37	23.10
T_4	212.28	35.47	75.60	25.41
T_5	197.43	31.43	66.70	22.51
T_6	211.04	34.58	71.69	23.92
T_7	213.39	36.38	76.28	26.50
S.E. (m±)	0.78	0.47	0.43	0.55
C.D. (P=0.05)	2.22	1.34	1.15	1.57

Phosphorus uptake:

The highest uptake of phosphorus (Table 2) was 36.38 kg ha^{-1} in treatment T_7 (30 kg S ha^{-1} + 2.5 kg Zn ha^{-1}+RDF) and it was at par with phosphorus uptake (35.47 kg ha^{-1}) in treatment T_4 (30 kg S ha^{-1}+ RDF). The treatment T_6 (20 kg S ha^{-1} +2.5 kg Zn ha^{-1}+ RDF) showed uptake of 34.58 kg P ha^{-1} which found superior over treatment T_3 (31.31 kg P ha^{-1}). Thus all treatments vary significantly over control (22.19 kg ha^{-1}) treatment. From the above results it was observed that S and Zn influenced uptake of phosphorus because Zn increased the absorbance and translocation of phosphorus from roots to above ground parts due to formation of $Zn_3(PO_4)_2$ compound. The results are in agreement with Wasmatkar *et al.* (2002) who concluded that application of 30 kg S ha^{-1} and 5 kg Zn ha^{-1} had significant effect on uptake of phosphorus.

Potassium uptake:

The highest uptake of potassium (Table 2) was recorded (76.28 kg ha^{-1}) in the treatment T_7 (30 kg S ha^{-1} + 2.5 kg Zn kg ha^{-1} +RDF) which was at par with potassium uptake (75.60 kg ha^{-1}) in treatment T_4 (30 kg S ha^{-1}+ RDF). While the T_6 (20 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + RDF) showed, respectively 71.69 kg K ha^{-1} and was superior over T_3 (68.37 kg K ha^{-1}), also T_5 (66.70 kg K ha^{-1}) was significant over T_3. All these treatments were superior over control (54.01 kg K ha^{-1}) treatment. It was observed that increased uptake of potassium may be due to its most availability in soil which related to the plant. Similar result were observed by Kartikeyan and Shukla (2008).

Sulphur uptake:

Amount of sulphur absorbance by crop may range from a few kg to 75-80 kg S ha^{-1} per year. In general sulphur uptake is comparable to P uptake in the case of cruciferous crops such as mustard and rape seed, while it is less than P uptake in oil seeds and legumes usually need 2-3 times more S than cereals (Kemmler and Hobt, 1985). The uptake of sulphur was increased after harvest of crop significantly under the various treatments of sulphur and zinc. The highest uptake (26.50 kg ha^{-1}) of sulphur was observed in T_7 (30 kg S ha^{-1} +2.5 kg Zn ha^{-1}+ RDF) and this was superior over all treatments except T_4, thus it was at par with sulphur uptake (25.41 kg S ha^{-1}) in treatment T_4 (30 kg S ha^{-1} + RDF). The treatment T_6 (20 kg s ha^{-1} + 2.5 kg Zn ha^{-1} + RDF) showed uptake of 23.92 kg S ha^{-1} and was at par with T_3 (20 kg S ha^{-1} +RDF) which showed uptake of 23.10 kg S ha^{-1}. All the treatments were significantly superior over control (18.50 kg ha^{-1}) treatment. The sequence of increasing level of sulphur was $T_7 > T_4 > T_6 > T_3 > T_5 > T_2 > T_1$ obtained. Thus from the above results it can be observed that uptake of sulphur was increased with increasing level of sulphur and zinc because the interaction effect of S and Zn was significant so it helped for translocation of nutrient from soil solution to root. Sangale and Sonar (2004) reported that at each level of sulphur upto 30 kg ha^{-1} significantly recorded highest nitrogen and sulphur uptake by soybean in clayey soil.

Micronutrient uptake:

In majority of soils the amount of total zinc exceeds the crop requirement and availability is the important limiting factor. Some highly leached acid soils very poor in zinc. Soil solution concentration and liable zinc level in particular are often low and zinc deficiency may result from the inherently low zinc content of the soil. Zinc mobility in soils has been found to be more important. The most soils of Vidharbha regions are deficient in zinc and iron, however, it is sufficient in copper and manganese. Therefore, during this investigation efforts were made to study their concentration by application of sulphur and zinc, the deficiency of zinc and iron in plant were not recovered while manganese and copper found sufficient in plant due to their sufficient available concentration in soil. Hence, the study of effect of sulphur and zinc on soybean as influenced on uptake of micronutrients was undertaken.

The total uptake of micronutrients vary significantly (Table 3) and it was more in treatment T_7 (30 kg S ha^{-1} +2.5 kg Zn ha^{-1}+ RDF) which showed uptake of Z 120.92 g ha^{-1}, Fe 281.57 g ha^{-1}, Cu 71.91 g ha^{-1} and Mn 197.83 g ha^{1} .This treatment was found to be significant over T_6 (116.11 g Zn ha^{-1}, 275.60 g Fe ha^{-1}, 63.42 g Cu ha^{1},191.85 g Mn ha^{-1})All these treatments were found to be significant over control treatment. From the Table 3 it was observed that the deficiency of Zn and Fe was not recovered while Cu and Mn were in increased level. This possibility was due to alkaline soil of experiment so that the mobility of cation decreased in soil solution and it directly affected micronutrient uptake. Low concentration of nutrient above ground portion of plant lowered the total uptake, Zinc absorption and its thermodynamics in some soil and concluded that Zn absorption was higher in Vertisol followed by Inceptisol and Entisol as suggested by Dhane and Shukla (1995).

Table 3 : Effect of sulphur and zinc on uptake of micronutrients

Treatment	Zn (g ha^{-1})	Fe (g ha^{-1})	Cu (g ha^{-1})	Mn (g ha^{-1})
T_1	73.42	251.11	30.14	139.68
T_2	87.65	257.23	36.12	160.96
T_3	93.60	261.27	43.53	176.70
T_4	100.37	266.32	49.00	179.36
T_4	111.19	270.52	57.13	185.43
T_6	116.11	275.60	63.42	191.85
T_7	120.92	281.57	71.91	197.83
S.E. (m$\pm$)	1.97	1.27	0.73	1.53
C.D. (P=0.05)	5.56	3.60	2.08	4.31

Conclusion:

The study revealed that, application of 30 kg sulphur + 2.5 kg zinc ha^{-1} with dose of fertilizer (30:75:0 NPK kg ha^{-1}) was found to be beneficial in increasing the uptake of nutrients and yield of soybean in vertisol under rainfed condition.

REFERENCES

Dhane, S.S. and Shukla, L.M. (1995). Zinc absorption and its thermodynamics in some soil series of Maharashtra. *J. Indian Soc. Soil Sci.,* **43(4)** : 590-593.

Ganeshamurthy, A.N. (1996). Critical and sulphur content and effect of S application on grain and oil yield of rainfed soybean in vertic Ustochrepts. *J. Indian Soc. Soil Sci.,* **44**(2) : 290-294.

Jat, J.R. and Mehra, R.K. (2007). Effect of sulphur and zinc on yield, macronutrient content in and uptake by mustard on haplustepts. *J. Indian Soc. Soil Sci.,* **55**(2) : 190-195.

Karthikeyan, K. and Shukla, L.M. (2008). Effect of boron sulphur interaction on their uptake and quality parameters of mustard and sunflower. *J. Indian Soc. Soil Sci.,* **56**(2) : 225-230.

Krishnamurti and Mothan (1996). effect of S and Mg on seed and oil yield of sunflower. *Madras Agric. J.,* **83**(10) : 644-646.

Kemmler, G. and Hobt, H. (1985). Potassium a product of nature. Kali and Sal, West Germany,112 pp.

Nandanwar, V.B., Nandanwar, S.B., Jadhao, V.V. and Bhoyar, S.M. (2007). Effect of zinc and PSB with FYM on uptake of nutreints by soybean. *PKV. Res. J.,* **31**(2) : 300-302.

Sangale, R.V. and Sonar, K.R. (2004). Yield and quality of soybean as influenced by sulphur application. *J. Maharashtra Agric. Univ.,* **29**(1) : 117-118.

Wasmatkar, R.P., Ingole, G.L. and Raut, P.D. (2002). Effect of different levels of sulphur and zinc on quality and uptake of nutrient of soybean. *J. Maharashtra Agric. Univ.,* **27**(3) : 244-246.

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