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EFFECT OF SULPHUR AND ZINC ON YIELD, UPTAKE OF NUTRIENTS AND QUALITY OF MUSTARD

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ABSTRACT

Field experiments were conducted for two years (2003-05) with mustard [Brassica juncea (L.) Czern and Cross] as a test crop with four doses each of sulphur (0, 20, 40 and 60 kg S ha^{-1}) and Zinc (0, 4, 8 and 12 kg ha^{-1}). Seed and stover yield increased significantly up to 40 kg S and 8 kg Zn ha^{-1} application. The maximum seed (20.57 q ha^{-1}) and stover (58.48 q ha^{-1}) yield at 40 kg S ha^{-1} was 36.8 and 39.8% higher as compared to control. Application of 8 kg Zn ha^{-1} produced maximum seed (20.19 q ha-1) and stover (56.91 q ha^{-1}) which was 22.0 and 23.1% higher to control. Interaction between S and Zn (21.85 and 62.75 q ha^{-1}) produced 60.0 and 64.5% more seed and stover yield over control (S_0Zn_0). Nitrogen, phosphorus, potassium and sulphur uptake increased significantly upto 60 kg S and 8 kg Zn ha^{-1} application except zinc uptake in seed where significant increase was recorded only upto 40 kg S ha^{-1}. Increase in levels of S and Zn increased significantly the oil and protein content in seed.

Keywords: Sulphur, zinc, yield, quality, mustard

INTRODUCTION

Indian mustard is an important crop which is primarily grown as an oil food but its productivity is very low due to many reasons. It is generally grown under rainfed conditions, inadequate fertilizer management and a light textured soil which are low in available nutrients. Apart from NPK, sulphur and Zn have started limiting the yield and quality of oil seed crops. The importance of S is well emphasized in oil seed crops because of its specific role in biosynthesis of oil (Tisdale et al. (1985). In recent years sulphur deficiency has been aggravated in the soil due to continuous crop removal and use of sulphur and zinc free high analysis NPK fertilizers. The deficiency of sulphur reduces the crop yield to an extent of 10-30%. The present study was under taken to evaluate the effect of sulphur and zinc on yield, uptake of nutrients and quality of mustard.

MATERIAL AND METHODS

A field experiment was undertaken at R.B.S College Research farm Bichpuri (Agra) during rabi seasons of 2003-05. There were 16 treatment combinations having four levels of S (0, 20, 40 and 60 kg S ha^{-1}) through elemental sulphur and zinc (0, 4, 8 and 12 kg Zn ha^{-1}) through zinc chloride in randomized block design with three replications. The experimental soil was sandy loam in texture and had pH 7.6, EC 0.34 dSm^{-1}, organic carbon 4.5 g kg^{-1}, available N 200 kg ha^{-1}, available P 12.0 kg ha^{-1}, available K 175.0 kg ha^{-1}, available S 18.5 kg ha^{-1} and available (DTPA) Zn 0.46 mg kg^{-1}. Nitrogen, P_2O_5 and K_2O were applied for lentil at the rate of 20 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} through di-ammonium phosphate and muriate of potash, respectively. Full dose of P and K were applied at sowing. Mustard (Rohini) was sown in second week of October using 5 kg seed ha^{-1}. At harvest, seed and stover yields were recorded. The seed samples were digested in HNO_3 and $HClO_4$ mixture and sulphur and zinc were determined by turbidimetric method (Chesnin and Yien 1951) and atomic absorption spectrophotometer, respectively. Phosphorus in the acid extract was determinrd by vanadomolybdate yellow colour method and K by flame photometer. The nitrogen was determined by Kjeldahl method (Jackson 1973). The oil from seed was extracted with petroleum ether and protein content was calculated by multiplying N content with 6.25.

RESULTS AND DISCUSSION

Yield: Data (Table 1) show that the application of sulphur significantly increased the seed and stover yield of mustard up to 40 kg ha^{-1}. Application of 40 kg S ha^{-1} increased the mean seed yield by 36.8 and 39.8 % over control, respectively. With increasing supply of sulphur the process of tissue differentiation from somatic to reproductive, meristematic activity and development of floral primordial might have increased, resulting in more flowers and siliqua, longer siliqua and higher seed yield as reported by Jat and Mehra (2007). Increase in stover yield can be ascribed to the overall improvement in plant organs associated with faster and uniform vegetative growth of the crop under the effect of sulphur application. Similar results were reported by Singh (2001).A perusal of data (Table 1) revealed that across the years of experimentation there was significant increase in seed and stover yield of mustard upto 8.0 kg Zn ha^{-1} application. The magnitude of percent increase in seed and stover yield of mustard due to 8 kg Zn ha-^{1} over control was 22.0 and 23.1, respectively. The increase in yield might be due to role of zinc in biosynthesis of indole acetic acid (IAA) and especially due to its role in initiation of primordial for reproductive parts and partitioning of photosynthates towards them, which resulted in better flowering and fruiting. The findings of present investigation are supported by Jat and Mehra (2007). The interaction effect between S and Zn positively and significantly influenced the seed and stover yield of mustard which was observed to be highest at 40 kg S ha^{-1} applied in combination with 8 kg Zn ha^{-1}S.

Table 1: Effect of S and Zn levels on seed and stover yield of mustard (mean of 2 years)

Sulphur (kg ha^{-1})	Zinc levels (kg ha^{-1})				
	0	4	8	12	Mean
Seed yield (q ha^{-1})					
0	13.64	15.49	15.53	15.34	15.03
20	16.63	20.48	21.57	20.73	19.85
40	17.84	21.71	21.85	20.88	20.57
60	17.95	21.82	21.79	21.23	20.70
Mean	16.54	19.88	20.19	19.55	
CD (P=0.05)	S=0.15	Zn=0.15	S x Zn	0.30	
Stover yield (q ha^{-1})					
0	38.14	42.95	43.48	42.70	41.82
20	46.21	57.08	60.35	58.86	55.63
40	50.08	61.44	62.75	59.64	58.48
60	50.43	61.52	61.06	59.11	58.03
Mean	46.22	55.75	56.91	55.08	
CD (P=0.05)	S=0.07	Zn=0.07	S x Zn	0.14	

Quality of seed: A significantly high oil (41.91 %) and protein (22.0 %) content was obtained with the application of 60 kg S ha-1 which was respectively 3.26 and 2.5 % higher over non application of S (Table 2). The S levels were differed from each other so far as oil content is concerned. Higher availability of sulphur might have favoured the synthesis and conversion of amino acids in to protein and glucosides in to oil in seed. Similar results were reported by Bhat et al. (2007). Zinc application with or without S recorded significant effect on oil content. These findings confirmed the results of Babhulkar et al. (2000). Increase in application of zinc increased the protein content significantly, the highest being at 8 kg Zn ha^{-1}. Similar results were recorded on mustard by Sharma et al. (1990).

The interaction effect was significant for protein content, with the maximum being at combined application of 60 kg ha^{-1} S and 8 kg ha^{-1} Zn. It indicates the role of sulphur for improvement of quality. Tisdale et al. (1985) reported that 50 to 80 per cent of total S in oil seed crops goes to making S-containing amino acids and rest is required for other S-containing compounds.

Table 2: Effect of S and Zn levels on oil and protein content of mustard (mean of 2 years)

Sulphur (kg ha^{-1})	Zinc levels (kg ha^{-1})				
	0	4	8	12	Mean
Oil content (%)					
0	37.84	38.55	38.89	38.91	38.55
20	40.25	40.37	40.57	40.70	40.47
40	41.33	41.42	41.48	41.60	41.46
60	41.87	41.87	41.94	41.96	41.91
Mean	40.33	40.55	40.72	40.79	
CD (P=0.05)	S=0.14	Zn= 0.14	S x Zn	NS	
Protein Content (%)					
0	19.0	19.5	19.9	19.6	19.5
20	20.1	21.2	21.8	21.3	21.1
40	20.9	21.7	22.2	21.8	21.6
60	21.3	22.1	22.5	22.1	22.0
Mean	20.3	21.1	21.6	21.2	
CD (P=0.05)	S = 0.09	Zn = 0.09	S x Zn	0.18	

Uptake of nutrients: Nitrogen uptake by mustard seed increased significantly from 46.7 kg ha^{-1} at control to 73.9 kg ha^{-1} with 60 kg S ha^{-1}. This increase in N uptake is attributed to application of sulphur to plants which in turn provides vigorous root and shoots growth resulting in greater absorption of nitrogen from the soil. The increased N uptake due to sulphur application has also been reported by Mishra (2001) in mustard. The beneficial effect of zinc application on nitrogen uptake was observed significantly up to the level of 8.0 kg Zn ha^{-1} application. The magnitude of significant increase in nitrogen uptake was 30.4% in seed over control. Thus, the favourable influence of zinc on photosynthesis and metabolic processes augments the production of photosynthates and their translocation to different plants parts including seed, which ultimately increased the uptake of N in seed. The results are in accordance with the findings of Mishra (2001). The maximum uptake was observed at 40 kg S + 8 kg Zn ha^{-1} treatment.

Data presented in Table 3 show that the phosphorus uptake increased significantly with increasing levels of sulphur upto 60 kg S ha^{-1}. The magnitude of increase in P uptake was 59.6% over control. Release of nutrients in available form and other physical properties might have influenced the availability of other nutrients leading to their absorption, thereby showing a higher uptake with application of sulphur. Increase in uptake of nutrients with sulphur application at varying levels has been reported by Jat and Mehra (2007). It is clear from the data that P uptake increased significantly up to the levels of 4 kg Zn ha^{-1}. Application of 12 kg Zn ha^{-1} was found to be significantly inferior as compared to 4 kg Zn ha^{-1} application. Phosphorus uptake first increased due to increase in yield but at the higher levels of zinc it decreased due to reduced phosphorus content in the seed and stover. Similar results were also reported by Mishra (2001). The interaction effect of S and Zn on P uptake was found significant and maximum value was recorded at 60 kg S + 4 kg Zn ha^{-1} treatment.

Potassium uptake in mustard seed increased significantly with increasing levels of sulphur upto 60 kg ha^{-1}. This increase in K uptake may be attributed to increased seed yield and K content in seeds due to S application. Further reference to data in Table 3 indicates that there was a significant increase in potassium uptake upto 8 kg Zn ha^{-1} application. The magnitude of significant increase in potassium uptake from 8 kg Zn ha^{-1} was 26.5 % in seed over control. The maximum value was recorded at 60 kg S + 8 kg Zn ha^{-1} level which was at par with 60 kg S + 4 kg Zn and 40 kg S + 8 kg Zn level.

Table 3: Effect of S and Zn levels on uptake of nutrients by mustard (mean of 2 years)

Sulphur (kg ha^{-1})	Zn levels (kg ha^{-1})				
	0	4	8	12	Mean
Nitrogen (kg ha^{-1})					
0	41.5	45.9	49.6	49.7	46.7
20	53.5	69.6	75.6	73.6	68.1
40	59.8	75.5	77.9	75.4	72.1
60	61.4	77.9	78.5	77.7	73.9
Mean	54.0	67.2	70.4	70.1	
CD (P=0.05)	S=0.61	Zn=0.61	S x Zn	1.22	
Phosphorus(kg ha^{-1})					
0	11.1	11.9	11.5	11.0	11.4
20	14.2	17.2	17.5	16.1	16.3
40	16.0	18.4	18.1	17.0	17.4
60	16.4	19.6	18.7	18.1	18.2
Mean	14.4	16.8	16.4	15.6	
CD (P=0.05)	S = 0.22	Zn=0.22	S x Zn	0.45	
Potassium (kg ha^{-1})					
0	5.1	5.9	6.0	6.0	5.8
20	6.3	8.1	8.7	8.3	7.8
40	6.9	8.6	8.9	8.6	8.2
60	7.3	8.9	8.9	8.7	8.4
Mean	6.4	7.9	8.1	7.9	
CD (P=0.05)	S=0.07	Zn=0.07	S x Zn	0.14	
Sulphur(kg ha^{-1})					
0	12.2	13.8	13.3	12.8	13.0
20	17.4	19.6	20.3	18.8	19.0
40	20.6	24.3	23.5	22.1	22.6
60	21.2	25.0	23.1	23.6	23.2
Mean	17.8	20.7	20.1	19.3	
CD (P=0.05)	S=0.54	Zn=0.54	S x Zn	1.08	
Zinc(g ha^{-1})					
0	69.1	84.2	86.5	88.0	81.9
20	82.0	105.1	113.6	111.2	103.0
40	84.4	105.6	108.5	107.2	101.4
60	83.1	101.8	101.7	101.7	97.1
Mean	79.7	99.2	102.6	102.0	
CD (P=0.05)	S=1.19	Zn=1.19	S x Zn	2.38	

Sulphur uptake increased significantly with increasing levels of sulphur up to 60 kg S ha^{-1} in seed. The increase in sulphur uptake might be due to increased concentration of S and seed yield of mustard with the application of sulphur. The result of present investigation is corroboration with the findings of Jat and Mehra (2007). There was a significant increase in S uptake in mustard seed with the application of zinc up to 4 kg ha^{-1} significantly higher sulphur uptake was obtained with 4 kg Zn ha^{-1}, the increase being 25.7% over control. Similar results were reported by Jat and Mehra (2007).Significantly higher uptake of sulphur (25.0 kg ha^{-1}) by mustard seed was obtained due to interaction effect of both the nutrients (60 kg S + 4 kg Zn ha^{-1}) which was 108% more over the control (no S + no Zn).

The uptake of Zn by mustard seed increased significantly with S application and maximum values were recorded at 40 kg S ha^{-1}. Mishra (2001) also reported similar results. Application of zinc up to 8 kg ha^{-1} gradually and significantly increased the uptake of Zn by mustard seed. The increase in Zn uptake due to 8 kg Zn ha^{-1} over control was 28.7 %. The uptake of Zn was in accordance with seed yield of mustard and its content at different levels of Zn. These results are in agreement with the findings of Singh and Singh (2005). The highest value of Zn uptake recorded in mustard seed was 57% at 40 kg ha^{-1} of applied sulphur in combination with 8 kg ha^{-1} of zinc. On the basis of results, it is concluded that the application of 40 kg S and 8 kg Zn ha^{-1} may be recommended for mustard in alluvial soil. Application of 60kg S and 8 kg Zn ha^{-1} gave higher values of uptake of nutrients and quality (oil and protein content) of mustard seed.

REFERENCES

Babhulkar, P.S., Dineshkar, Badole, W.P. and Balpande, S.P. (2000) Effect of sulphur and zinc on yield quality and nutrient uptake by safflower in vertisol. *Journal of the Indian Society of soil Science* **48** (3): 541-543.

Chesnin, L. and Yien, C.H. (1951) Turbidimetric determination of available sulphate. *Soil Science Society of America Proceedings* **15**, 149-151.

Jackson, M.L. (1973) *Soil Chemical Analyses.* Prentice Hall of India Private Limited, New Delhi.

Jat, J.R. and Mehra, R.K. (2007) Effect of sulphur and zinc on yield, macronutrient content in and uptake by mustard on haplustepts. *Journal of the Indian Society of Soil Science* **55**, 190-95.

Mishra, S.K. (2001) Effect of sulphur and zinc on yield, uptake of nutrients and quality of mustard. *Annals of Plant and Soil Research* **3** (2): 206-213.

Misra, S.K. (2003) Effect of sulphur and potassium on yield, nutrient uptake and quality characteristics of mustard (*Brassica juncea* L.) in udic Haplustepts of Kanpur. *Journal of the Indian Society of Soil Science* **51**(4): 544-548

Sharma, U.C., Gangwar, M.S. and Srivastav, P.C. (1990) Effect of zinc and sulphur on nutrient uptake and yield of mustard. *Journal of the Indian Society of Soil Science* **38**, 696-701.

Singh, S.P. and Singh, V. (2005) Effect of nitrogen sulphur and zinc on Indian mustard (*Brassica Juncea*). *Indian Journal of Agricultural Sciences*. **75**(12): 828-30.

Tisdale, S.L., Nelson, W.L. and Beaton, J.D. (1985) *Soil Fertility of Fertilizers*. 4th ed. Collier Macmillan Publishers, Londan.