The Journal of Rural and Agricultural Research Vol. 13 No. 2, 79-83 (2013)
Received January 2012; Acceptance Septmber 2013

Effect of sulphur and magnesium application on yield, quality and nutrients uptake by mustard

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Abstract

A pot experiment was carried out in the green house to study the effect of sulphur and magnesium application on yield, quality and nutrients uptake by mustard. Application of sulphur (20 mg kg^{-1}) reported maximum seed yield (2.50g/pot), strover yield (3.85g/pot),seed protein (21.79%), strover protein (6.27%), seed N (3.49%), strover N (1.0%), seed P (0.43%), strover P (0.21%), seed K (0.68%), strover K (1.83%), seed S (0.44%), and strover S (0.21%), seed protein (21.80%), in mustard while (20 mg kg^{-1}) magnesium dose maximized seed yield (2.17g/pot), strover yield (3.30g/pot), seed protein (21.80%), strover protein (6.12%), seed N (3.49%), strover N (0.98%), seed P (0.10%), strover P (0.19%), seed Mg (0.35%) and Seed N uptake (75.73% mg/pot), strover N uptake (32.56 mg/pot), seed mustard P uptake (8.81 mg/pot), strover P uptake (6.49 mg/pot), strover K uptake (59.18 mg/pot), seed Mg uptake (7.52 mg/pot), strover Mg uptake (6.01 mg/pot), seed S uptake (8.65 mg/pot) and strover S uptake (6.07 mg/pot), by mustard crop. The interaction effect on yield was synergistic only at lower levels of Mg and thereafter, it was antagonistic. Magnesium application tended to reduce S content but increased the uptake of S by mustard.

Key words: mustard, sulphur, magnesium, interaction, uptake

Introduction

Nutritional needs including secondary and primary nutrients of crop need to be properly satisfied as the soil nutrients are depleted more quickly. High analysis chemical fertilizer do not provide secondary nutrients for the crops. Therefore, essential nutrients should be use in adequate amount in integrated fertilization. Sulphur, is an essential element for plant growth, ranks in importance with N and P in the formation of plant protein. It also plays important role in the synthesis of the sulphur containing amino acids, cysteine, cystine and methionine . Quality of sulphohydryl groups (-SH) in plant has relation to increase cold resistance in some cases. Sulphur also plays an important role in chlorophyll. The deficiency of sulphur causes an accumulation of nitrate, amides and carbohydrates, which retard the formation of proteins. The interaction of sulphur with other nutrients improves the quality of crops (Chaube and Dwivedi, 1995). Magnesium is popularly known as secondary nutrient because of its requirement being less than that of primary nutrients. It is a constituent of chlorophyll and therefore, essential for photosynthesis. It increases resistance to harmful environment influence such as drought and diseases. Magnesium is also an activator for many enzymes and takes part in protein synthesis. Other major role of Mg^{2+} Cofactor is in almost all enzymes activating phosphorylation processes. It forms a bridge between the pyrophosphate structure of ATP or ADP and the enzyme molecule. Generally, when plants are Mg deficient the proportion of protein N decreases and that of non- protein increases (Haider and Mengel, 1969).Evidently the nutrition of plants depends on several factors like absorption, moblity within the plant and its distribution to functional sites. Each one of these processes is affected by interactions between nutrients. Such interactions take place in soil and in the plant. Because these interactions modify the nutrition of plants, they must be understand and considered in providing an adequate nutrient supply. Moreover, there are limited reports on interactions and their effect on concentration in plants. Because of this season, the investigation was undertaken to study the S-Mg interaction in relation to their effect on yield, content and uptake of nutrients in mustard.

Materials and methods

Experiment was conducted in earthen pots, under green house at Department of Agricultural Chemistry and Soil Science, R.B.S. College, Bichpuri, Agra located at about 10 km away from Agra city on Agra –Bharatpur road during Rabi. A composite soil sample representing 0-23 cm depth was from a cultivated field and subjected to physical and chemical analysis. Mechanical composition of soil was having 62.42 % sand , 18.64% silt, 17.96% clay and sandy loam textural class while physico-chemical characteristics were 8.2 pH (1:2.5 ratio), 0.36 dSm^{-1} EC, 4.6 g kg^{-1}

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organic carbon, 0.04 % total nitrogen , 67.5 mg kg^{-1} available N, 4.5 mg kg^{-1} available P, 8.5 mg kg^{-1} available S and 10.0 mg kg^{-1} available Mg. The experiment with three levels (0,10 and 20 mg kg^{-1} soil) each of S and Mg was conducted in a factorial randomized design with three replications having 9 treatment combinations using mustard as test crop. Twenty seven earthen pots lined with polythene sheet of similar size and shape were selected. After mixing the soil lot thoroughly, 5 kg of soil were filled in each pot. The calculated amount of sulphur and magnesium were given at the time of sowing in solution form to pots as elemental sulphur and magnesium chloride, respectively. The application of S and Mg was super imposed over a basal application of N, P_2O_5 and K_2O in mustard as 10,30 and 20 mg kg^{-1} by urea, DAP and murate of potash, respectively . Total quantity of all fertilizers was supplied at the time of sowing. Appropriate moisture having pulverised soil was filled in pots. Then each pot was seeded with ten healthy seeds of mustard on Nov. 25, 2001. Irrigation was done as when needed . The seed and strover samples were analyzed for nitrogen , phosphorus, potassium, sulphur, calcium and magnesium. Nitrogen was estimated as quoted by Snell and Snell (1955). From the nitrogen content values , the protein percentage in mustard seed and strover was calculated according to formula protein percentage= N% x 6.25. The phosphorus was digested by the method outlined by Johnson and Ulrich (1959). Phosphorus content was determined by in the acid extract by ammonium vanadate molybdate yellow colour method as described by Chapman and Pratt (1961). The aliquots obtained after wet digestion of P estimation were diluted to the desired level and were analyzed for K by a direct reading flame photometer. Sulphur was determined in the plant extract by turbidimetric method (Chesin and Yien, 1951). The amount of calcium and magnesium were estimated by versenate method using formula.

$$\text{Ca+Mg in me/l} = \frac{\text{Vol. of EDTA used for titration} \times \text{Normality of EDTA}}{\text{Volume of extract taken}} \times 1000$$

The uptake of nitrogen by plants was worked out by multiplying N content values with corresponding yield data. The same procedure was adopted for calculation of phosphorus, potassium, calcium, magnesium and sulphur uptake by seed and strover. The data were subjected to statistical analysis.

Results and discussion

Yield

The level of both (sulphur and magnesium) tried in the present investigation were 0, 10 and 20 mg kg^{-1} soil. The increasing levels of sulphur have profound effect on the yield of mustard seed and strover. The corresponding increase in mustard seed and strover yield due to 10 and 20 mg S kg^{-1} were 23.7 and 59.7 and 22.0 and 58.7 per cent, respectively. The data on soil chemical analysis show that the soil used in the experiment fell in the low category of available sulphur. A significant increase in seed yield upto 20 mg kg^{-1} applied S was an indication of its being the best dose of sulphur for mustard under such condition. Dhillon and Dev (1978), Singh and Singh (1990) and Raj and Kanthaliya (2004) reported significant response of crops to sulphur application.The crop, exhibited significant response to magnesium addition in mustard seed yield were 4.3 and 8.6 per cent for 10 and 20 mg Mg kg^{-1} , respectively. Ananthanarayana and Vankatarao (1982), Nad and Goswami (1983), Gupta (1985) and Krishnamurthi and Mathan (1996) also reported similar results. The S x Mg interaction had a Significant beneficial effect on the strover yield in mustard. The maximum yield was recorded with 20 mg S + 20 mg Mg kg^{-1} treatment.

Qualitative studies

Application of sulphur increase the oil content of

Table 1 : Effect of S and Mg application on seed and strover yield and protein content of mustard

Mg levels (mg kg^{-1})	S levels (mg kg^{-1}) 0	10	20	Mean
Seed yield (g/pot)				
0	1.50	2.05	2.43	1.99
10	1.73	2.20	2.50	2.14
20	1.70	2.23	2.57	2.17
Mean	1.64	2.16	2.50	
	S	Mg	Sx Mg	
SEm ±	0.05	0.05	0.09	
CD at 5%	0.15	0.15	N S	
Strover yield (g/pot)				
0	2.33	3.15	3.67	3.05
10	2.57	3.35	3.88	3.27
20	2.49	3.40	4.00	3.30
Mean	2.46	3.30	3.85	
	S	Mg	S x Mg	
SEm ±	0.004	0.004	0.006	
CD at 5%	0.011	0.011	0.02	
Seed %				
0	21.19	21.43	21.56	21.39
10	21.37	21.69	21.81	21.61
20	21.50	21.90	22.00	21.80
Mean	21.35	21.68	21.79	
	S	Mg	S x Mg	
SEm ±	0.024	0.024	0.022	
CD at 5%	0.073	0.073	N S	
Strover%				
0	5.54	5.93	6.12	5.86
10	5.68	6.06	6.25	6.00
20	5.81	6.12	6.43	6.12
Mean	5.68	6.04	6.27	
	S	Mg	S x Mg	
SEm ±	0.02	0.05	0.03	
CD at 5%	0.02	0.05	N S	

mustard seed, highest oil content being recorded higher doses of S (Table 4.3). Application of 20 mg S kg^{-1} increase oil content from 36.90 to 39.1 per cent. The results are in agreement with those obtained by Singh *et. al.*,1986. The protein percentage in mustard seed and strover increased significantly with increasing levels. Verma *et. al.* (1973) also reported similar results. Magnesium application also improved the content of protein in mustard. The interaction (S X Mg) had a significantly beneficial effect on protein content in mustard seed.

Chemical composition of plants

Application of sulphur increased the nitrogen content in mustard seed and strover significantly over control. The increase in N content is attributed to the application of sulphur to plants which resulted in profuse vegetative and root growth by the fact that sulphur deficiency prevents utilization of nitrogen and brings about an accumulation of soluble nitrogen within the plant which checks further absorption of nitrogen leading to decrease in its content in plants. Similar results were reported by Yadav and Sharma

Table 2: Effect of S and Mg application on nutrients content of mustard

Mg level (mg kg^{-1})	S level (mg kg^{-1}) 0	10	20	Mean
Nitrogen content in Seed (%)				
0	3.39	3.43	3.45	3.42
10	3.42	3.48	3.49	3.46
20	3.44	3.51	3.52	3.49
Mean	3.42	3.47	3.49	
	S	Mg	S x Mg	
SEm ±	0.004	0.004	0.007	
CD at 5%	0.012	0.012	N S	
Nitrogen content in Strover (%)				
0	0.89	0.95	0.98	0.94
10	0.91	0.97	1.00	0.96
20	0.93	0.98	1.03	0.98
Mean	0.91	0.97	1.0	
	S	Mg	S x Mg	
SEm ±	0.003	0.003	0.005	
CD at 5%	0.009	0.009	N S	
Phosphorus content in Seed (%)				
0	0.37	0.39	0.42	0.39
10	0.37	0.39	0.43	0.40
20	0.38	0.40	0.43	0.40
Mean	0.37	0.39	0.43	
	S	Mg	Sx Mg	
SEm ±	0.004	0.004	0.006	
CD at 5%	0.011	0.011	N S	
Phosphorus content in Strover (%)				
0	0.15	0.17	0.20	0.17
10	0.17	0.18	0.21	0.19
20	0.17	0.19	0.22	0.19
Mean	0.16	0.18	0.21	
	S	Mg	S x Mg	
SEm ±	0.003	0.003	0.005	
CD at 5%	0.009	0.009	N S	
K content in Seed (%)				
0	0.64	0.66	0.69	0.66
10	0.64	0.65	0.68	0.65
20	0.62	0.64	0.67	0.64
Mean	0.63	0.65	0.68	
	S	Mg	S x Mg	
SEm ±	0.003	0.003	0.006	
CD at 5%	0.010	0.010	N S	
K content in Strover (%)				
0	1.78	1.81	1.84	1.81
10	1.77	1.80	1.83	1.80
20	1.76	1.78	1.83	1.79
Mean	1.77	1.80	1.83	
	S	Mg	S x Mg	
SEm ±	0.002	0.002	0.003	
CD at 5%	0.005	0.005	N S	
Mg content in content in Seed (%)				
0	0.22	0.26	0.26	0.25
10	0.32	0.27	0.28	0.29
20	0.39	0.36	0.30	0.35
Mean	0.31	0.30	0.28	
	S	Mg	S x Mg	
SEm ±	0.003	0.003	0.005	
CD at 5%	0.009	0.009	N S	
Mg content in Strover (%)				
0	0.18	0.15	0.12	0.15
10	0.20	0.18	0.14	0.17
20	0.20	0.15	0.13	0.16
Mean	0.20	0.16	0.13	
	S	Mg	S x Mg	
SEm ±	0.009	0.009	0.017	
CD at 5%	0.027	0.027	N S	
S Seed (%)				
0	0.36	0.41	0.44	0.40
10	0.35	0.41	0.44	0.40
20	0.35	0.40	0.43	0.39
Mean	0.35	0.41	0.44	
	S	Mg	S x Mg	
SEm ±	0.002	0.002	0.007	
CD at 5%	0.005	0.005	N S	
S Strover (%)				
0	0.15	0.19	0.22	0.19
10	0.14	0.19	0.21	0.18
20	0.13	0.18	0.21	0.17
Mean	0.14	0.19	0.21	
	S	Mg	S x Mg	
SEm ±	0.003	0.003	0.005	
CD at 5%	0.008	0.008	N S	

(2002). Nitrogen content in mustard seed and strover increased significantly with increasing levels of magnesium. Kumar *et. al.* (1981) also reported an increase in N content with Mg application. The seeds of mustard were found to contain more nitrogen than strover of mustard. The sulphur and magnesium (S x Mg) interaction was non-significant. However, the maximum concentration of N in mustard seed and strover was recorded under S_{20} Mg_{20} treatment (Table 4.4a and 4.4b).The results of plant analysis indicate that the content of phosphorus was higher in plants supplied with S as compared to those unfertilized with

Table 3 : Effect of S and Mg application on nutrients uptake by musterd

Mg level (mg kg^{-1})	S level (mg kg^{-1}) 0	10	20	Mean
N Seed (g/pot)				
0	50.86	70.31	83.35	68.37
10	59.28	76.47	87.24	74.33
20	58.49	78.39	90.31	75.73
Mean	56.21	75.06	87.17	
	S	Mg	S x Mg	
SEm ±	1.72	1.72	2.57	
CD at 5%	5.15	5.15	7.71	
N uptake in Strover (mg/pot)				
0	20.50	29.92	35.95	28.79
10	23.39	32.28	38.80	31.49
20	23.16	33.32	41.20	32.56
Mean	22.35	31.84	38.65	
	S	Mg	S x Mg	
SEm +	0.08	0.085	1.50	
CD at 5%	0.25	0.25	0.44	
P uptake in Seed (mg/pot)				
0	5.56	7.99	10.22	7.92
10	6.42	8.60	10.74	8.59
20	6.45	8.93	11.05	8.81
Mean	6.14	8.51	10.67	
	S	Mg	S x Mg	
SEm ±	0.17	0.17	0.29	
CD at 5%	0.50	0.50	N S	
P uptake in Strover (mg/pot)				
0	3.49	5.35	7.33	5.39
10	4.37	6.03	8.14	6.18
20	4.23	5.94	8.80	6.49
Mean	4.03	5.94	8.09	
	S	Mg	S x Mg	
SEm ±	0.099	0.099	0.17	
CD at 5%	0.300	0.300	N S	
K uptake in Seed (mg/pot)				
0	9.61	13.53	16.78	13.31
10	10.10	14.29	17.00	14.13
20	10.55	14.30	17.21	14.02
Mean	10.42	14.04	17.00	
	S	Mg	S x Mg	
SEm ±	0.16	0.16	0.28	
CD at 5%	0.49	0.49	N S	
K uptake in Strover (mg/pot)				
0	41.47	57.01	67.52	55.33
10	45.45	60.30	71.00	58.93
20	43.82	60.51	73.20	59.18
Mean	43.59	59.27	70.57	
	S	Mg	S x Mg	
SEm +	0.07	0.07	0.13	
CD at 5%	0.23	0.23	0.39	
Mg uptake in Seed (mg/pot)				
0	3.23	5.33	6.33	4.96
10	5.54	5.95	7.07	6.19
20	6.63	8.22	7.72	7.52
Mean	5.13	6.50	7.04	
	S	Mg	S x Mg	
SEm +	0.19	0.19	0.34	
CD at 5%	0.58	0.58	N S	
Mg uptake in Strover (mg/pot)				
0	2.79	4.41	4.77	3.99
10	4.36	5.02	5.82	5.07
20	4.98	6.12	6.93	6.01
Mean	4.04	5.18	5.84	
	S	Mg	S x Mg	
SEm +	0.11	0.11	0.19	
CD at 5%	0.32	0.32	N S	
S uptake in Seed (mg/pot)				
0	5.41	8.40	10.70	8.17
10	6.07	6.01	11.08	8.72
20	5.96	8.93	11.05	8.65
Mean	5.81	8.78	10.95	
	S	Mg	S x Mg	
SEm +	0.97	0.97	0.16	
CD at 5%	0.29	0.29	N S	
S uptake in Strover (mg/pot)				
0	3.51	4.75	8.51	5.59
10	3.41	5.52	8.75	5.89
20	3.34	5.58	9.30	6.07
Mean	3.42	5.28	8.85	
	S	Mg	S x Mg	
SEm +	0.11	0.11	0.19	
CD at 5%	0.33	0.33	N S	

respect of S. Mehta and Singh (1988) also obtained similar results with S application. Phosphorus content in mustard seed and strover was increased significantly with magnesium application. Kumar *et. al.* (1981) also reported an increase in P content with Mg application. The interaction between S and Mg was found to be non- significant. Regarding the effect of S treatment on potassium content of mustard there was a significant increase in the level of K due to soil application of S. Metha and Singh (1988) also reported an increase in K concentration in mustard seed and strover with increasing S levels. On the other hand, potassium concentration decreased significantly with sulphur application. However, there was a slight reduction in Mg content in mustard strover with 20 Mg S kg^{-1} treatment. The concentration of Mg in mustard seed increased significantly with its application. Gupta and Singh (1985), Patel *et. al.* (1989) and Singh and Singh (1990) also reported similar results. Application of sulphur under present investigation tended to increase the concentration of S in mustard significantly over control. The increase may be due to rapid absorption and translocation of it by the plant with adequate supply of S to the soil . Singh and Singh (1990), Krishnamurthi and Mathan (1996) also reported similar results . The sulphur content of mustard seed and strover on the other hand declined with Mg addition. However this decrease was statistically non- significant. Aulakh *et. al.* (1977) reported similar results. The interaction effect was non- significant.

Uptake studies

The utilization of nitrogen by mustard seed and strover significantly increased over control with the

application of sulphur. This increase in N uptake may be attributed to increased yields due to S application. The maximum values of N uptake by crop was recorded under S_{20} Mg_{20} treatment. The uptake of nitrogen by mustard increased by magnesium application significantly. Ananthanarayana and Venkatarao (1982) also reported similar results. The seed of mustard utilized greater amounts of N than those of strover. The interaction effect of S x Mg was significant. The uptake of N increased with 10 and 20 mg Mg Kg^{-1} application in the presence and absence of applied S. There was a significant increase in P uptake by mustard seed and strover with S application. Biswas *et. al.* (1995) the impact of magnesium on phosphorus uptake was significant and a consistent increase in P utilization was recorded with increasing levels of Mg. Ananthanarayana and Venkatarao (1982) also reported an increase in P uptake with magnesium application. Both S and Mg were found to have a beneficial effect on the utilization of P by mustard seed and strover and maximum amount of P was utilized under 20 mg Mg kg^{-1} and 20 mg S kg^{-1} treatment (Table 3). However, the effect of interaction was non- significant. Potassium uptake by mustard increased with S application. Singh *et. al.* (1987) also reported an increase in K uptake by S application. A significant rise in the uptake of K by mustard crop (Table 3) was also noted due to Mg application. Kumar *et. al.* (1981) also reported similar results. The interation effect was significant with respect to K uptake by mustard seed only.The significant rise in Mg uptake by mustard with increasing levels of sulphur was brought about not only by greater yield of seed but also due to marked enrichment in the concentration of Mg in mustard. The utilization of magnesium by mustard also increased significantly with its application Patel *et. al.* (1989) and Singh and Singh (1990) also reported an increase in Mg uptake with its application. The interaction was non- significant.The significant increase in the uptake of S by mustard due to increasing level so sulphur application was the combined effect to higher yields along with a marked increase in S content. The mean S uptake by mustard seed and strover increased from 5.81 to 10.95 and 3.42 to 8.85 mg/pot, respectively. Bahl *et. al.* (1986), Yadav and Sharma (2002) also found similar trend regarding the uptake of sulphur with its application. Magnesium addition, on the other hand, decreased the utilization of sulphur by mustard significantly over control. This reduction may be described to lower S content at higher Mg levels. The interaction effect was non- significant.

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