Indian Journal of Agricultural Sciences **83** (4): 472–6, April 2013/Short Communication

Effect of sulphur and iron fertilization on yield attributes, yield and nutrient uptake of mungbean (*Vigna radiata*)

K K MEENA[1], R S MEENA[2] and S M KUMAWAT[3]

Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan 334 006

Received: 11 October 2012; Revised accepted: 5 February 2013

Key word: Fertilization, Iron, Mungbean, Nutrient uptake, Sulphur, Yield attributes

Pulses are the main source of protein particularly for vegetarians and contribute about 14 per cent of the total protein of an Indian average diet. Pulse crop, mungbean [*Vigna radiata* (L.) Wilczek] every 100 g of edible portion of mungbean seed contains 75 mg calcium, 4.5 mg phosphorus, 24.5 g protein and 348 K Cal energy. At global level India share prime position in mungbean production. In India, it is cultivated over a wide range of climatic conditions in the states of Maharashtra, Andhra Pradesh, Rajasthan, Odisha and Bihar. Rajasthan is one of the major mungbean growing states of the country. Whereas, potential yield level of available improved varieties of mungbean varied between 1 200 to 1 600 kg /ha. This indicates a wide gap between the potential yield and average yield being harvested at cultivators fields. There may be several possible reasons for low yield harvested by the farmers. Lack of optimum mineral nutrition particularly sulphur and micronutrients management may be one of them, limiting higher productivity of pulses in general and mungbean crop in particular. Farmers usually apply nitrogenous and phosphatic fertilizers but sulphur fertilization is lacking in their fertilizer schedule. Further, micronutrients, viz. zinc and iron deficiencies, now a days becoming major limiting factor in harvesting higher yields of crops. Hence, optimum mineral nutrient management including sulphur and micronutrient (iron) is a basic requirement to realize potential yield of major crops and mungbean as well. Pulses not only have high sulphur requirements but also have the potentiality to remove sulphur from soil nutrient pool *vis-à-vis* fertilizer applied, as is evident from the radio sulphur investigations. Sulphur uptake by several crops revealed that the highest sulphur requirement (12 kg/tonne of yield) has been attributed to oilseeds followed by pulses (8 kg/tonne), millets (5-8 kg/tonne) and cereals (3-4 kg/tonne) (Tandon 1986). Likewise, iron as a micronutrient play an important role for plant growth and development. The soils of western Rajasthan are desertic, coarse textured, moderately to highly alkaline in reaction, calcareous and very low in organic matter. Crops grown under such soil conditions would suffer multi-nutrient deficiency including sulphur and iron. A field survey on iron chlorosis problem in groundnut carried out at various locations of the state clearly indicated severity of the problem in different areas (Sahu *et al.* 2007). Foliar spray of $FeSO_4$ is commonly used as a mean to control lime induced chlorosis in field crops grown on calcareous soils, but spraying with iron salts alone has usually been found to be relatively less effective because of precipitation of iron from the spray solution and poor translocation of applied iron within the plant. Hence, in zone Ic (hyper arid and partially irrigated western plain) agro-climatic conditions of the Rajasthan, these findings need evaluation and verification for enhancing productivity and quality of mungbean.

A field experiment was conducted on loamy sand soil at Agronomy Farm, College of Agriculture, SKRAU, Bikaner during (*kharif*) season 2008-09. The treatments comprise four levels of sulphur [control, 40 kg S/ha as gypsum, 40 kg S/ha as elemental sulphur and 40 kg S/ha as gypsum + elemental sulphur (1:1)] and four levels of iron (control, 0.5% $FeSO_4$ foliar spray at 25 and 40 DAS, 0.5% $FeSO_4$ + 0.5% citric acid solution spray at 25 and 40 DAS and 25 kg $FeSO_4$ /ha as basal application). The experiment was laid out in factorial randomized block design with four replications. The mean weekly maximum and minimum temperature during the growing season fluctuated between 35.3 to 39.8^{0}C and 23.4 to 29.3^{0}C, respectively. The crop received 123.0 mm rainfall in 5 rainy days during the crop season.

Application of 40 kg S/ha as gypsum + elemental sulphur (1:1) significant increase in dry matter production and chlorophyll content over control and whereas all three sulphur sources, viz. gypsum, elemental sulphur and gypsum +

[1]M Sc Student, Department of Agronomy (e mail: kkmeena_agro@rediffmail); [2]Assistant professor (e mail: rsmeenaagro@gmail.com), Institute of Agricultural Sciences, BHU, Varanasi (UP); [3]Associate Professor, Agronomy

Table 1 Effect of sulphur and iron fertilization on yield attributes, yields and harvest index of mungbean

Treatment	Dry matter accumulation (g/plant)				Leaf area	Chlorophyll content (mg/g fresh weight)	Number of nodules/ plant	Number of pods/ plant	Test weight (g)	Seed yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
	20 DAS	40 DAS	60 DAS	At maturity									
Sulphur levels and source													
Control	0.508	3.82	11.83	14.31	1.66	1.92	15.03	11.79	38.58	926.03	2170.62	3096.65	29.93
40 kg S/ha as gypsum	0.517	4.27	12.70	15.50	1.73	2.09	17.06	13.18	39.36	1082.81	2281.75	3364.56	32.24
40 kg S/ha as elemental sulphur	0.535	4.12	12.38	15.20	1.79	2.08	17.97	12.19	39.13	1052.27	2304.20	3356.47	31.38
40 kg/S ha as Gyp+ ES (1:1)	0.526	4.23	12.84	15.63	1.77	2.17	16.69	13.18	39.11	1107.32	2291.95	3399.27	32.60
S.Em±	0.012	0.10	0.24	0.20	0.02	0.03	0.52	0.33	0.39	12.74	34.17	36.28	0.41
CD (P=0.05)	NS	0.29	0.69	0.57	0.06	0.09	1.48	0.93	NS	36.28	97.33	103.34	1.18
Iron levels													
Control	0.500	3.68	11.81	14.28	1.62	1.96	14.13	11.71	38.66	990.53	2148.61	3139.14	31.50
0.5% $FeSO_4$ foliar spray at 25 and 40 DAS	0.521	4.33	12.94	15.39	1.75	2.10	16.63	12.80	39.41	1058.81	2281.59	3340.40	31.72
0.5% $FeSO_4$ + 0.1% citric acid foliar spray at 25 and 40 DAS	0.530	4.28	12.31	15.89	1.81	2.00	17.00	12.25	38.96	1037.73	2235.59	3273.32	31.69
25 kg $FeSO_4$/ha as basal application	0.537	4.16	12.69	15.09	1.78	2.19	19.00	13.57	39.13	1081.35	2382.73	3464.08	31.24
SEm±	0.011	0.09	0.22	0.18	0.02	0.03	0.46	0.29	0.34	11.39	30.56	32.45	0.37
CD (P = 0.05)	NS	0.26	0.62	0.51	0.06	0.08	1.32	0.84	NS	32.45	87.06	92.43	NS

NS, Non-significant; DAS, days after sowing; ES, elemental sulphur and Gyp, gypsum

Table 2 Effect of sulphur and iron fertilization on nutrient uptake of mungbean

Treatment	Nitrogen uptake (kg/ ha)		Total nitrogen uptake (kg/ha)	Phosphorus uptake (kg/ha)		Total phosphorus uptake (kg/ha)	Sulphur uptake (kg/ha)		Total sulphur uptake (kg/ha)	Iron uptake (kg/ha)		Total iron uptake (kg/ha)
	Seed	Straw		Seed	Straw		Seed	Straw		Seed	Straw	
Sulphur levels and source												
Control	30.79	47.06	77.85	2.10	4.14	6.24	1.43	1.85	3.28	0.136	0.820	0.96
40 kg S/ha as gypsum	36.06	50.50	86.55	2.56	4.67	7.22	1.74	2.09	3.83	0.161	0.877	1.04
40 kg S/ha as elemental sulphur	36.22	52.53	88.75	2.49	4.66	7.15	1.76	2.40	4.16	0.161	0.926	1.09
40 kg S/ha as Gyp+ ES (1:1)	38.79	52.98	91.77	2.70	4.84	7.54	1.88	2.51	4.39	0.171	0.928	1.10
SEm±	0.50	1.02	1.12	0.05	0.10	0.10	0.04	0.05	0.06	0.002	0.013	0.01
CD (P=0.05)	1.44	2.92	3.18	0.14	0.30	0.30	0.10	0.14	0.18	0.007	0.037	0.04
Iron levels												
Control	32.39	46.73	79.12	2.18	4.07	6.25	1.52	1.96	3.48	0.143	0.80	0.95
0.5% $FeSO_4$ foliar spray at 25 and 40 DAS	36.50	51.62	88.12	2.44	4.71	7.15	1.69	2.21	3.90	0.161	0.90	1.06
0.5% $FeSO_4$ + 0.1% citric acid foliar spray at 25 and 40 DAS	35.11	50.33	85.45	2.51	4.44	6.95	1.68	2.18	3.86	0.156	0.92	1.08
25 kg $FeSO_4$/ha as basal application	37.85	54.39	92.24	2.71	5.09	7.80	1.93	2.50	4.43	0.168	0.93	1.10
SEm±	0.45	0.92	1.00	0.05	0.09	0.09	0.03	0.05	0.06	0.002	0.01	0.01
CD (P=0.05)	1.28	2.61	2.84	0.13	0.27	0.27	0.09	0.13	0.16	0.006	0.03	0.03

NS, Non-significant; DAS, days after sowing; ES, elemental sulphur and Gyp, gypsum elemental sulphur (1:1) proved statistically at par in respect of dry matter production and chlorophyll content. Overall improvement in the crop growth under the influence of sulphur fertilization, i e. gypsum, elemental sulphur and gypsum + elemental sulphur (1:1) seems to be on account of their impact on nutritional environment and involve in various physiological processes in the plant system which are considered to be pre requisite growth of better plant development. Thus, the improved growth and development of the crop plant in the present investigation might be the result of enhanced metabolic activities and photosynthetic rate, leading to improvement in the assimilation of dry matter at the successive growth stages and at maturity. The results of present investigation are in conformity with the findings by Yadav (2004) and Kumawat (2006) in mungbean. Significant increase in number of pods/plant was recorded with 40 kg S/ha as gypsum and gypsum + elemental sulphur (1:1) source used as compared to control treatment (Table 1). The improvement in yield attributing characters might be due to the important role of sulphur in energy transformation, activation of number of enzymes and also in carbohydrate metabolism. These results are also in close agreement with the findings of Sharma *et al.* (2001) and Budhar and Tamilselvan (2001). Application of 40 kg S/ha as gypsum, elemental sulphur and gypsum + elemental sulphur (1:1) registered significantly higher yields and harvest index of mungbean compared to no sulphur control treatment (Table 1). Further, application of 40 kg S/ ha as gypsum + elemental sulphur (1:1) recorded the highest seed yield and harvest index which were found at par with 40 kg S/ ha as gypsum source but significantly superior over 40 kg S/ ha as elemental sulphur source (Table1) (Sharma *et al.* 2001). In the present investigation also, the beneficial effect of 40 kg S/ha as gypsum and gypsum + elemental sulphur (1:1) compared to elemental sulphur in improving seed yield and harvest index seems to be due to the fact that gypsum as sulphur source possibly enhances sulphur availability more faster to plants as compared to elemental sulphur alone. Yadav (2004) and Kumawat *et al.* (2006). Application of 40 kg S/ ha as gypsum + elemental sulphur (1:1) increased uptake of N, P, S and Fe in straw was comparable with 40 kg S/ha as elemental sulphur (Table 2) and showed marked improvement over 40 kg S/ha as gypsum source. The increase in nutrient concentration might be attributed due to increase in supply of sulphur to plant, which in turn has resulted in profused shoot and root growth, thereby activating greater absorption of N, P, S and Fe from soil. The increased photosynthetic efficiency, which favoured dry matter production and nutrient concentration in plant, seems to be the major factor responsible for higher nutrient uptake under the influence of sulphur application (Ghanshyam and Pareek 2002, Kumawat *et al.* 2006).

Growth stages (40 and 60 DAS) and at maturity dry matter accumulation/plant significantly increased with all iron treatments in comparison to control. The maximum dry matter production at 40 DAS and 60 DAS was recorded with foliar sprays of 0.5 per cent $FeSO_4$, whereas foliar spray of 0.5% $FeSO_4$ + 0.1% citric acid treatment registered the highest dry matter accumulation at maturity of the crop as against the minimum dry matter accumulation under control. All Iron treatments, viz. 25 kg $FeSO_4$ /ha as basal dose, foliar spray of 0.5% $FeSO_4$ and 0.5% $FeSO_4$ + 0.1% citric acid solution proved statistical at par at growth stages in this respect, but foliar spray of 0.5% $FeSO_4$ + 0.1% citric acid treatment showed statistical superiority over 25 kg $FeSO_4$ / ha as basal application. The increased leaf area index coupled with higher chlorophyll content resulted increased interception of sunlight. Likewise the higher content of iron in straw with $FeSO_4$ + citric acid treatments could be due to the fact that plants absorb iron efficiently in its citrate form. In present study, increase in nodule number could be due to increased infection and rhizobial colonization in rhizosphere because of increased availability of iron. Thus the foliar spray of 0.5% $FeSO_4$ + 0.1% citric acid and $FeSO_4$ alone treated plots probably because of increased availability of Fe to the plants. Significant improvement in the synthesis of chlorophyll with iron nutrition were also reported by several researchers Bhardwaj (2003) and Shau *et al.* (2007). Application of 25 kg $FeSO_4$/ha as basal dose and foliar applied treatments, viz. 0.5% $FeSO_4$, 0.5% $FeSO_4$ +0.1% citric acid has consistent effect on yield attributing character and yield of mungbean. A reference to data (Table 2) would reveal that these treatments improved the yield attributes cumulative effects were reflected through increased seed yield/ha. But since the cellular environment is not conducive to the utilization of iron at the site of chlorophyll synthesis, iron is consequently rendered inactive. The beneficial elects of iron nutrition on mungbean were also reported by several researchers, Gupta *et al.* (2002) and Kumawat *et al.* (2006).The data (Table 1) revealed uptake of N, P, S and Fe by the mungbean crop increased significantly with both soil application of $FeSO_4$ and foliar spray treatments compared to control. This might be due to increased availability of physiologically active iron (Fe^{2+}) in the plant system which in turns affects various physiological functions of plants favourably. Translocation of the same to reproductive structures, i e seed in mungbean. Since uptake is the function of seed and straw yield and their nutrient concentration, the significant improvement in concentration of these nutrients coupled with seed and straw yield, increased the uptake of N, P, S and Fe substantially (Table 2). Increased concentration of N, P, S and Fe with the application of iron fertilizer has also been reported by several researchers (Kumawat *et al.* 2006).

SUMMARY

An experiment was conducted during rainy (*kharif*) season of 2008–09 to study the effect of sulphur and iron fertilization on productivity of mungbean [*Vigna radiata* (L.) Wilczek] to fertilized under different fertility levels of

sulphur and iron. It is concluded that application of 40 kg S/ha as gypsum + elemental sulphur (1:1) and 25 kg $FeSO_4$/ha as basal application significantly increased growth parameters and yields and nutrient uptake of nitrogen, phosphorus, potassium, sulphur and iron.

REFERENCES

Bhardwaj A. 2003. Integrated amelioration of lime induced iron chlorosis of groundnut (*Arachis hypogeal* L.). M Sc (Ag.) thesis, RAU, Bikaner.

Budhar M N and Tamilselvan N. 2001. Effect of sulphur on yield attributes and yield of rainfed greengram (*Vigna radiata* L.). *Madras Journal of Agricultural Sciences* **88**(7-9): 504–5.

Ghanshyam and Pareek B L 2002. Effect of sulphur and thiourea on sulphur uptake, yield and net returns of mothbean (*Vigna acconitifolia*). (*In*) Extended summaries, vol 1: 2nd International Agronomy Congress, 26-30 Nov. New Delhi.

Gupta P K, Sharma N N, Acharaya H K, Gupta S K and Mali G C. 2002. Response of mungbean to zinc and iron on vertisols in South-Western Plains of Rajasthan. (*In*) *National Symposium on Arid Legumes for Food Nutrition Security and Promotion of Trade*, October 2002. Sponsored by Indian Arid Legume Society, CAZRI, Jodhpur.

Kumawat R N and Rathore P S. 2006. Effects of sulphur and iron nutrition on the morpho-biochmical characteristics of summer mungbean in western Rajasthan. *Journal of Arid Legumes* **3**(1): 19–26

Kumawat R N, Rathore P S and Pareek N. 2006. Response of moongbean to S and Fe nutrition grown on calcareous soil of Western Rajasthan. *Indian Journal of Pulse Research* **19**(2): 228–30.

Sahu M P, Kumawat S M, Singh G, Ramaswamy N K and D'Souza S F. 2007. Consolidated progress report of the research project Establishment of radio tracer laboratory and multilocation testing of crop varieties developed at BARC. RAU, Bikaner. pp 89–108.

Sharma R K, Singh Vijay, Chauhan Shashi and Verma Sheela. 2001. Effect of source and level of sulphur on yield attributes and seed yield of soybean (*Glycine max*). *Agronomy Digest* **1**: 95–6.

Tandon H L S. 1986. *Sulphur Research and Agricultural Production in India*, II Ed. Pub. FDCO, New Delhi, pp 76.

Yadav S S. 2004. Growth and yield of greengram (*Vigna radiata* L.) as influenced by phosphorus and sulphur fertilization under rainfed conditions. *Haryana Journal of Agronomy* **20**(1): 10–2.