Vegetable Science (2011) 38(1) : 95-97

Short communication

Effect of sulphur on yields of cowpea (*Vigina sinesis*) and french bean (*Phaseolus vulgaris* L.) as influenced by applied sulphur in acidic upland soils of Ranchi

Surendra Singh

Received : Dec 2008 / Accepted : Nov 2010

The acidic upland soils of Ranchi are in low base saturation, acidic reaction, low content of organic carbon, coarse textured with low water and nutrient retention capacities. Sulphur deficiency is wide spread in acidic upland of Ranchi due to poor content of organic matter and coarse textured soils (Singh et al., 1993 ; Singh et al., 1995). These soils are unable to fulfill the requirement of sulphur needs of vegetable crops for achieving crop productivity. At present, as per estimate, Jharkhand state is providing 9.6 lakh tones of vegetables from an area of 80100 hectares. The requirement is around 19 lakh tones of vegetable per annum in the state (Sarkar, 2003). Thus, the vegetable production is to be doubled with optimum use of plant nutrients. Vegetables are extensively grown by the farmers in acidic upland soils of Jharkhand. Not much information is available at present to S nutrition in vegetable crops. Therefore, the present investigation was under taken to study the effect of sulphur on yields, S uptake and S use efficiency by cowpea and french bean grown at farmer's field of Ranchi district.

Surendra Singh
Department of Soil Science and Agricultural Chemistry,
Institute of Agricultural Sciences
Banaras Hindu University,
Varanasi -221005 (U.P.)

Sixteen field experiments were conducted at farmer's field covering four villages viz; Pithoria and Madanpur in Kanke block and Ulihatu and Jhariadih in Namkum block on cowpea (Pusa Barsati) and french bean (Birsa Priya) in Ranchi district of Jharkhand during *Kharif* seasons of 2005 to 2006. The treatments consisted of: two sources of S (Sulfer' 95 and gypsum) and three S levels (20, 40, 60 kg ha^{-1}) including a control (Recommended dose of NPK fertilizers) symbolized as: T_1- RDF (NPK), T_2- RDF+Gy 20 kg S ha^{-1}, T_3- RDF+Gy 40 kg S ha^{-1} T_4-RDF+Gy 60 kg S ha^{-1}, T_5- RDF+Sulfer'95 20 kg S ha^{-1}, T_6- RDF+Sulfer'95 40 kg S ha^{-1} and T_7-RDF+Sulfer'95 60 kg S ha^{-1}. Basal application of phosphogypsum and sulfer'95 was made and mixed uniformly in soil at sowing time. To neutralize soil acidity, powdered lime @ 300 kg ha^{-1} was applied in the open furrows and was mixed in soil. Recommended dose of 50 kg N, 80 kg P_2O_5 and 80 kg K_2O were applied and mixed with soil for each cowpea and frenchbean. Soils of the farmers field were coarse in texture (67.6% sand, 11.2%silt and 20.0 %clay) with varying pH (4.9 to 6.3) , low in organic carbon content (2.1 to 4.2 g kg^{-1}) and low in 0.15 per cent calcium chloride extractable S (6.1 to 14.4 kg ha^{-1}). Nitrogen, phosphorus and potassium were applied through S- free fertilizers viz; urea, triple super phosphate and muriate of potash, respectively. All the agronomic practices were adopted for raising these two vegetable crops in good condition at farmer's field. Green pod yields of three cumulative picking were recorded for both crops. Samples of cowpea and french bean pod were dried in oven at 65 ^{oC} , digested in diacid mixture of $HClO_4$ and HNO_3 in the ratio of 4:10 for total analysis. The S content in plant extract was determined turbidimetricaly (Chesnin and Yien, 1951). The S use efficiency (SUE) and apparent S recovery (ASR) were calculated as:

Table 1: Effect of S source and levels on Cowpea and French bean pod yields at farmers field of Ranchi district

Treatments	Pod yield (q ha^{-1})							
	Cowpea				French bean			
	2004	2005	Mean	SUE (kg pod kg^{-1} S)	2004	2005	Mean	SUE (kg pod kg^{-1} S)
T_1 -RDF(NPK)	42.4	60.6	51.5	-	58.5	60.1	59.3	-
T_2 -RDF + Gy 20 kg S ha^{-1}	47.7	69.3	58.5	35.0	70.2	76.7	73.5	71.0
T_3 -RDF + Gy 40 kg S ha^{-1}	58.6	84.2	71.4	49.8	98.4	83.8	91.1	79.5
T_4 -RDF + Gy 60 kg S ha^{-1}	55.7	81.1	68.4	28.2	82.9	80.9	81.9	37.7
T_5 -RDF + Sul 20 kg S ha^{-1}	49.2	78.3	63.8	61.5	79.2	91.3	85.3	80.0
T_6 -RDF + Sul 40 kg S ha^{-1}	61.5	95.8	78.7	68.0	111.7	98.4	105.1	89.5
T_7-RDF + Sul 60 kg S ha^{-1}	55.2	87.0	71.1	32.7	95.4	91.5	93.5	40.3
CD (P=0.05)	4.2	5.1	-		8.3	3.4	-	

RDF = Recommended dose of fertilizers; Gy = Gypsum ; Sul = Sulfer, 95

$$\text{SUE (kg pod kg -1 applied S)} = \frac{\text{(Pod yield with sulphur – Pod yield without sulphur)}}{\text{Amount of S applied}}$$

$$\text{\% ASR} = \frac{\text{(S uptake by crop in S treated plot- S uptake by crop in RDF plot)}}{\text{Amount of S applied}} \times 100$$

Effect of S application through gypsum and sulfer'95 on pod yields of cowpea and french bean are presented in table 1. Pod yields of cowpea and french bean increased significantly up to application of 40 kg S ha^{-1} from the applied both S sources. The crop yields were reduced at higher level of applied S (60 kg ha^{-1}). Application of 40 kg S ha^{-1} from sulfer'95 produced an additional mean pod yield of 27.2 q ha^{-1} in cowpea and 45.8 q ha^{-1} in french bean over the recommended dose of NPK fertilizers. Sulfer'95 has resulted in better performance for obtaining higher crop productivity as compared to gypsum. The sulphur use efficiency by the crop showed an increasing trend up to 40 kg S ha^{-1} and thereafter decreased at 60 kg ha^{-1} of S application. Crop response in term of kg pod kg^{-1} S ranged from 35.0 to 68.0 in cowpea and 71 to 89.5 in french bean. Sulphur requirement of legume vegetable is quite higher as compared to non legume vegetable. Hence, such spectacular increase in pod yield of cowpea and french bean may be expected with application of sulphur in S deficient acidic upland soils of Ranchi. Liming also increased the soil pH to neutrality and restricted the adsorption of sulphate which helped in enhancing availability of S to crop. Similar results in an increase of pod yield of cowpea and frenchbean has also been reported (Singh et al., 2000 ; Poonkodi and Poomurugesan, 2003).

Data on S uptake and apparent S recovery are presented in table 2. Sulphur uptake by cowpea and french bean was found to be higher with Sulfer'95 as compared to applied gypsum. The total mean S uptake was found to be higher at applied 40 kg S ha^{-1} of S over the recommended dose of NPK fertilizers. Mean total S

Table 2: Effect of S source and levels on S uptake by Cowpea and Frenchbean at farmers field of Ranchi district

Treatments	S uptake (kg ha^{-1})							
	Cowpea				French bean			
	2004	2005	Mean	Apparent S recovery % (ASR)	2004	2005	Mean	Apparent S recovery % (ASR)
T_1 -RDF(NPK)	13.8	17.3	15.6	-	14.4	14.9	14.7	-
T_2 -RDF + Gy 20 kg S ha^{-1}	15.2	22.9	19.0	17.0	19.7	21.9	20.8	30.5
T_3 -RDF + Gy 40 kg S ha^{-1}	21.7	33.3	27.1	28.9	32.5	26.6	29.1	36.0
T_4 -RDF + Gy 60 kg S ha^{-1}	20.9	36.2	28.6	21.6	27.0	27.9	27.5	21.3
T_5 -RDF + Sul 20 kg S ha^{-1}	16.7	27.4	20.2	23.0	23.8	25.6	24.7	50.0
T_6 -RDF + Sul 40 kg S ha^{-1}	27.7	38.6	33.1	43.8	34.9	36.8	35.9	53.0
T_7-RDF + Sul 60 kg S ha^{-1}	22.0	33.2	27.6	20.0	30.5	28.5	29.5	24.7
CD (P=0.05)	1.9	3.2	-		4.1	3.1	-	

RDF = Recommended dose of NPK fertilizers; Gy = Gypsum ; Sul = Sulfer, 95

uptake at 20 to 60 kg S ha^{-1} level through added Sulfer'95 and gypsum increased from 19.0 to 33.1 kg ha^{-1} in cowpea and 20.8 to 35.9 kg ha^{-1} in french bean. Apparent S recovery of added S ranged from 17.0 to 43.8 per cent in cow pea and 24.7.0 to 53.0 per cent in french bean. The greater recovery of S with smaller rates of added S in both the crop was obtained. However, apparent S recovery with 60 kg S ha^{-1} was lower as compared to 40 kg ha^{-1} of S application. The higher S uptake by crop may be attributed to the increased availability of the micronized $SO_4^=$ -S particles in the soil solution through added Sulfer'95 as S source and consequently better utilization by plant roots. Comparatively lower S uptake by crop through added gypsum may probably due to less availability of $SO_4^=$ -S in soil solution for crop use because of leaching loss in acidic upland coarse textured soils.

The results of the experiments conducted at farmer's field of Ranchi reveal that cowpea and french bean are more responsive to sulpur up to 40 kg ha^{-1} application. There is declined in pod yields of both the crop with 60 kg ha^{-1} of S application. Therefore the optimum sulphur requirement of these two important vegetable crops is 40 kg S ha^{-1}. Higher S use efficiency through Sulfer'95 in S deficient soils could be due to its higher supply rates due controlled release behavior of sulphur available to growing crop. On the other hand, comparatively lower S use efficiency of gypsum to crop may probably be due to lower sulphur supply rate and leaching loss of sulphate ion in these coarse textured acidic upland soils.

References

Chesnin L, Yien CH (1951) Turbidimetric determination of available sulphate. Proc Soil Sci Soc Am 15: 149 -151

Poonkodi P, Poomurugesan AV (2003) Influence of sulphur of growth and yield of cowpea (*Vigna unguiculata L*). Advances in plant sciences 16 : 653-655

Sarkar AK (2003) Sulphur fertilization in vegetables crop through sulfer' 95 in red and lateritic soils of Jharkhand. Consolidated project report, Sulphur Works Inc Canada

Singh S, Singh SK, Singh KP, Kumar R (1995) Status and forms of sulphur in upland and lowland soils of Santhal Parganas region of Bihar. J Indian Soc Soil Science 43 : 682-684

Singh Surendra, Sarkar AK, Singh KP (2000) Sulphur research in soils and crops of Bihar plateau SSAC (BAU) bull No, 1/ 2000 p: 30-31