International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(3): 3218-3223

Received: 22-03-2019
Accepted: 24-04-2019

Sahebagouda
Department of Soil Science and Agricultural Chemistry College of Agriculture, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India

T Chikkaramappa
Department of Soil Science and Agricultural Chemistry College of Agriculture, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India

PK Basavaraja
Department of Soil Science and Agricultural Chemistry College of Agriculture, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India

Correspondence
Sahebagouda
Department of Soil Science and Agricultural Chemistry College of Agriculture, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India

Effect of varied levels of sulphur and sources of organic on yield, nutrient content and uptake by soybean crop (*Glycine max*. (L.)) in *Alfisols* of Karnataka

Sahebagouda, T Chikkaramappa and PK Basavaraja

Abstract
A field experiment was conducted in farmer field at Palanahalli village, Magadi taluk, Ramanagara distinct to study the "Effect of Varied Levels of Sulphur and Sources of Organic on Nutrient Content and Uptake by Soybean Crop [*Glycine max.* (L.)] in *Alfisols* of Karnataka". The experiment was laid out in RCBD with seventeen treatments and replicated thrice. The experimental results revealed that application of 100% RDF+ poultry manure at 6 t ha^{-1} + sulphur at 40 kg ha^{-1} through gypsum (T_9) recorded significantly higher seed yield (26.90 q ha^{-1}), haulm yield (44.15 q ha^{-1}) and total uptake of major nutrients such as nitrogen (129.41kg ha^{-1}), phosphorus (17.58 kg ha^{-1}), potassium (75.47 kg ha^{-1}), sulphur (32.41 kg ha^{-1}) and micronutrients. Similarly, higher major nutrient contents such as nitrogen (2.71% and 1.25%), phosphorus (0.44% and 0.13%), potassium (1.23% and 0.96%), sulphur (0.86% and 0.21%) both seed and haulm respectively were recorded in the same treatment followed by application of 100% RDF + poultry manure @ 6 t ha^{-1} + 20 kg ha^{-1}sulphur through gypsum. Higher yield, nutrient content and uptake this treatment may be due to effective utilization of NPK nutrients by the crop through inorganic fertilizers and organic manure (poultry manure) due to its easy solubility and better uptake of major and micronutrients nutrients.

Keywords: Sulphur, organic, soybean, yield, nutrient, content, uptake and *Alfisols*

Introduction
Sulphur (S), one of the most important nutrients for all plants and animals is considered as the fourth major nutrient after nitrogen, phosphorous and potassium for agricultural crop production. Sulphur is a structural constituent of organic compounds some of which are uniquely synthesized by plants providing human and animals with essential amino acids (methionine cystine and cysteine). It is involved in chlorophyll formation, activation of enzymes and is a part of vitamins biotin and thiamine (B_1) (Hegde and Sudhakara babu, (2007) [7]. There are many other sulphur containing compounds in plants which are not essential, but may be involved in defense mechanisms against herbivores, pest and pathogens, or contribute to the special taste and odour of food plants. Sulphur improves oil and protein contents, flour quality for milling and baking, quality of tobacco and nutritive value of forages, etc. Role of sulphur in Indian agriculture is now gaining importance because of the recognition of its role in increasing crop production, not only of oil seeds, pulses, legumes and forages but also of many cereals (Singh *et al*., 2000) [20]. Sulphur deficiency in crops is gradually becoming widespread due to continuous use of sulphur free fertilizers, high yielding crop varieties, intensive multiple cropping systems coupled with higher productivity.

The transformation from traditional internal input-based agriculture to the present day external input-based agriculture has caused wide spread deficiency of sulphur. With the adoption of intensive farming, the farmers have shifted from using organic to inorganic high analysis sulphur free fertilizers leading to more widespread and intense sulphur deficiencies in Indian soils.

Supply of nutrients through bulky organics such as poultry manure, vermicompost and FYM along with chemical fertilizers can help to maintain the soil nutrient reserves for attaining higher crop yields. The development of the poultry industry in Karnataka have provided considerable quantities of organic waste, poultry litter, which have potential for use in agriculture. Application of this organic waste on agriculture soils could be good nutrient

recycling route on one hand and solves the problem of its disposal on the other hand and provide a cheap yet valuable resource, allowing them to reduce their dependence on synthetic
fertilizers. Integrated nutrient management by conjunctive use of chemical fertilizers with organic manures is the need of the day for sustaining agricultural production.

To sustain productivity, integrated nutrient management must be followed and for this, the study of interaction of different nutrients with organic manure becomes essential. So far, there have been many studies on interaction of major element like nitrogen and phosphorus with the different organic manures but the information on interaction between sulphur and organic manure is scanty. It is considered that the presence of organic material improves the transformation of elemental sulphur as well as availability of native and applied sulphur.

In Karnataka, few studies have indicated deficiencies of sulphur particularly in intensively cultivated sandy loam soils and responses of crops like sunflower, groundnut and safflower etc. Never the less, the studies on soybean are very meager.

2. Material and Methods

A field experiment was conducted during *Kharif* 2016 in farmer field palanahalli village Magadi taluk, Ramanagara district to study the Effect of Varied Levels of Sulphur and Sources of Organic on Yield, Nutrient Content and Uptake by Soybean Crop [*Glycine max.* (L.)] in *Alfisols* of Karnataka. Soybean (var. MAUS 2) was raised as test crop. A composite soil sample was collected from experimental site before the start of experiment and was analysed for physical and chemical properties (Table 1).

The experiment consists of seventeen treatments with varying S doses and organic sources were tested in RCBD with 3 replications. 100 per cent recommended dose of fertilizer for soybean crop is 25: 60: 25 kg N, P_2O_5, K_2O and 50 per cent of recommended dose (12.5:60:12.5 kg N, P_2O_5 and K_2O ha^{-1}) which were applied according to the treatment details. The nutrients *i.e.* nitrogen, phosphorus, potassium and Sulphur were applied through urea and DAP, DAP, muriate of potash and gypsum respectively were applied at the time of sowing. Farm yard manure, Poultry manure, Vermicompost were applied two weeks before sowing as per the treatments. The present study was carried under the following treatments, *i.e*. Control (T_1), 50% RDF + poultry manure @ 3 t ha^{-1} + 20 kg ha^{-1} sulphur through gypsum (T_2), 50% RDF + poultry manure @ 3 t ha^{-1} + 40 kg ha^{-1} sulphur through gypsum, (T_3), 50% RDF + poultry manure @ 6 t ha^{-1} + 20 kg ha^{-1} sulphur through gypsum, (T_4), 50% RDF + poultry manure @ 6 t ha^{-1} + 40 kg ha^{-1} sulphur through gypsum (T_5), 100% RDF + poultry manure @ 3 t ha^{-1} + 20 kg ha^{-1} sulphur through gypsum (T_6), 100% RDF + poultry manure @ 3 t ha^{-1} + 40 kg ha^{-1} sulphur through gypsum (T_7), 100% RDF + poultry manure @ 6 t ha^{-1} + 20 kg ha^{-1} sulphur through gypsum (T_8), 100% RDF + poultry manure @ 6 t ha^{-1} + 40 kg ha^{-1} sulphur through gypsum (T_9), 50% RDF + vermicompost @ 3 t ha^{-1} + 20 kg ha^{-1} sulphur through gypsum (T_{10}), 50% RDF + vermicompost @ 3 t ha^{-1} + 40 kg ha^{-1} sulphur through gypsum (T_{11}), 50% RDF + vermicompost @ 6 t ha^{-1} + 20 kg ha^{-1} sulphur through gypsum (T_{12}), 50% RDF + vermicompost @ 6 t ha^{-1} + 40 kg ha^{-1} sulphur through gypsum (T_{13}), 100% RDF + vermicompost @ 3 t ha^{-1} + 20 kg ha^{-1} sulphur through gypsum (T_{14}), 100% RDF + vermicompost @ 3 t ha^{-1} + 40 kg ha^{-1} sulphur through gypsum (T_{15}), 100% RDF + vermicompost @ 6 t ha^{-1} + 20 kg ha^{-1} sulphur through gypsum (T_{16}) and 100% RDF + vermicompost @ 6 t ha^{-1} + 40 kg ha^{-1} sulphur through gypsum (T_{17}). Plant samples were collected at harvest of the crop (from five plants) randomly from each plot, oven dried, digested using digestion mixture (Perchloric acid: sulphuric acid= 9:4) for nutrients except nitrogen and Nitrogen content in plant samples was determined by digesting the samples in concentrated sulphuric acid with digestion mixture (K_2SO_4 + $CuSO_4$ + Se) and distilled in an alkaline medium (Piper, 1966) [15]. After harvest of soybean, grain and stover samples were analysed for N, P, K, Ca, Mg, S, Fe, Zn, Mn, B and Cu Using the content of nutrients, uptake of major, secondary and micronutrients by soybean were calculated using the formula.

$$\text{Nutrient uptake} = \frac{\text{Nutrient content (\%)} \times \text{dry matter yield (kg ha}^{-1})}{100}$$

Statistical analysis and interpretation of data

The analyses and interpretation of the data was done using the Fisher's method of analysis and variance technique as given by Panse and Sukhatme (1967) [14]. The level of significance used in 'F' and't' test was 5 per cent probability and wherever 'F' test was found significant, the 't' test was performed to estimate critical differences among various treatments.

3. Results and Discussion

3.1 Effect on seed, haulm and pod yield:

The data on seed and haulm yields of soybean are significantly differed among the various treatment combinations. The results are presented in Table 2.

Application of 100% RDF + PM at 6 t ha^{-1} + sulphur 40 kg ha^{-1}through gypsum (T_9) proved significantly superior and produced highest seed yield (26.90 q ha^{-1}), haulm yield (44.15 q ha^{-1}) and pod yield (30.30 q ha^{-1}) compared to other treatments. But, it was on par with treatment which received 100% RDF + PM at 6 t ha^{-1} + sulphur at 40 kg ha^{-1} through gypsum (T_8). Significantly lower the seed and haulm yield was obtained in control (RDF + FYM). It might be due to the higher availability of nutrients and increased nitrogen from organic manure (poultry manure) along with inorganic fertilizers which has profound influence in mobilizing the nutrients from the unavailable forms of nutrients mainly due to the improved the physical, chemical and biological properties of the soil. Similarly, reported by conformity with Tiwari (2007) [25], The sulphur fertilization played a vital role in improving the three major aspects of yield determination i.e. formation of vegetative structure there by photosynthesis strong sink strength through development of reproductive structure and production of assimilates to fill economically important sink. Thus cumulative influence of S application maintained balance source – sink relationship and ultimately resulted in increased seed yield. The results are in close conformity with the findings of Ganeshmurthy (1996) [4] and Hussain *et al.* (2011)

3.2 Effect on major nutrient content

Effect of varied levels of sulphur and sources of organics on content of nutrients at harvest of soybean: Concentration of nitrogen, phosphorus and potassium in seed and haulm of soybean was significantly influenced due to the application varied levels of sulphur and different organic sources and the results were presented in Table 3.

Significantly higher nitrogen concentration of 2.71 per cent and 1.29 per cent were recorded at harvest in seed and haulm respectively with the application of (T_9) 100% RDF + poultry manure at 6 t ha^{-1} + sulphur at 40 kg ha^{-1} through gypsum. It was on par with the application of (T_8) 100% RDF + poultry manure at 6 t ha^{-1} + sulphur at 20 kg ha^{-1} through gypsum with nitrogen content 2.55 per cent and 0.90 per cent in haulm at harvest respectively. Where, T_7 was on par with the T_{17} and T_{16} related to the nitrogen content in seed and haulm at harvest. However, lower nitrogen concentration of 1.63 and 1.08 per cent was recorded at harvest in seed and haulm respectively in the control treatment compare to other treatments. Increase in nitrogen content in grain and haulm at harvest may be due to the more uptake of nitrogen during crop growth period. The inorganic nitrogen applied through chemical fertilizers has influenced in better availability for the crop and organic manure (poultry manure) enhances mineralization and released soil nitrogen and also helps in uptake of nitrogen by seed and haulm. These results are in conformity with the findings of Nwachukwu and Ikeadigh (2012) [12].

Application of (T_9) 100% RDF + poultry manure at 6 t ha^{-1} + sulphur at 40 kg ha^{-1} through gypsum was recorded significantly higher phosphorus content of 0.44 and 0.13 per cent at harvest in seed and haulm respectively. It was on par with the (T_8) 100% RDF + poultry manure at 6 t ha^{-1} + sulphur at 20 kg ha^{-1} through gypsum. Where, T_6 was on par with the T_{17} and T_{16} related to the phosphorus content in seed and haulm at harvest. However, lower phosphorus content was recorded in the (T_1) control. Where, highest P content was recorded in application of (T_9) 100% RDF + poultry manure at 6 t ha^{-1} + sulphur at 40 kg ha^{-1} through gypsum. It might be due application of sulphur along with organic manure (poultry manure) may be due to more accumulation and uptake of phosphorus. The results are in conformity with the findings of Karki *et al.* (2005) [10].

Significantly higher potassium content of 1.23 and 0.96 per cent was recorded at harvest in the grain and haulm respectively by the application of (T_9)100% RDF + poultry manure at 6 t ha^{-1} + sulphur at 40 kg ha^{-1} through gypsum, it was on par with the (T_8) 100% RDF + poultry manure at 6 t ha^{-1} + sulphur at 20 kg ha^{-1} through gypsum with the potassium content of 1.18 percent in seed and 0.13 percent in haulm at harvest. Where, T_6 was on par with the T_{17}, T_{16} and T_5, however lower potassium content was noticed in the control (application of NPK and FYM) compare to the treated plots. The higher potassium content in seed and haulm at harvest this might be due to synergetic effect of sulphur on potassium uptake. Potassium uptake will result in higher dry matter production, growth and yield parameters and nutrient content in plants. Results of the present study are in conformity with the findings of Patel *et al.*, (1985) [13] in soybean. And also higher accumulation and uptake of potassium in the seed and in haulm. These results are in conformity with the findings of Komal Singh *et al.* (2002) [11].

Sulphur content was significantly higher at harvest in seeds (0.86%) and haulm (0.21%) by Application of 100% RDF + PM at 6 t ha^{-1} + sulphur 40 kg ha^{-1} through gypsum (T_9). It was on par with the treatment T_8 which received 100% RDF + PM at 6 t ha^{-1} + sulphur 20 kg ha^{-1} through gypsum 0.83 0.19 per cent in seed and haulm respectively followed by T_6 and T_{17} treatments. However, lowest sulphur content was recorded in (T_1) control treatment (RDF + FYM) compared to other treatments. It might be due to application of poultry manure and increased sulphur level resulted in more accumulation and uptake of sulphur by plants. Similar results were found by Ganeshmurthy (1996) [4]. Between the two levels of sulphur tested, better growth, seed yield, quality character, sulphur uptake and highest accumulation of sulphur in all the plant parts of soybean were observed with 40 kg^{-1} S than 20 kg ha^{-1} S through gypsum. Similar beneficial effect was also reported by Ramamoorthy *et al.* (1996) [16].

3.3 Effect on major nutrients uptake:

The data on the uptake of major nutrients by soybean at harvest as influenced by application of various organic manures in combination with inorganic fertilizers and results are presented in the Table 4.

Significantly higher seed, haulm and total uptake of nitrogen with129.41 kg ha^{-1} by soybean was recorded due to 100% RDF + PM at 6 t ha^{-1} + sulphur 40 kg ha^{-1} through gypsum application (T_9). It was on par with the treatment T_8 which received 100% RDF + PM at 6 t ha^{-1} + sulphur 20 at kg ha^{-1} through gypsum (113.90 kg ha^{-1}). However, significantly lower nitrogen uptake by soybean was recorded in the treatment T_1 receiving 100% RDF + FYM (45.15 kg ha^{-1}). Nitrogen uptake had shown significant increase under application of 100% RDF + PM at 6 t ha^{-1} + sulphur 40 kg ha^{-1} through gypsum might be due to beneficial effect of combined use of fertilizers and poultry manure. Poultry manure improved the physico-chemical and biological properties, availability of macro and micronutrients and better microbial activity in the root zone of plant to support vegetative growth. Similar findings were also reported by Tripathy and Bastia (2012) [26] and also due to application of sulphur at 40 kg ha^{-1} due to the increase in sulphur levels increased the uptake of nitrogen in seed and haulm at harvest. It might be due to nitrogen and sulphur are required for formation of protein. In order to maintain the balance of N and S in plants, uptake of one nutrient will certainly effect the uptake of another one. The similar results were reported by Singh *et al*. (1988) [21].

Application of 100% RDF + PM at 6 t ha^{-1} + sulphur 40 kg ha^{-1} through gypsum (T_9) recorded significantly higher seed, haulm and total uptake of phosphorus by soybean (42.38 kg ha^{-1}). It was on par with the treatment T_8 which received 100% RDF + PM at 6 t ha^{-1} + sulphur 20 kg ha^{-1} through gypsum (37.08 kg ha^{-1}). However, lowest sulphur content (12.94 kg ha^{-1}) was recorded in (T_1) control treatment (RDF + FYM) compared to other treatments. The higher uptake of phosphorus recorded may be due to the higher phosphorus content in the stover and grain. The phosphorus content in the fertilizers facilitated better absorption of phosphorus by the maize crop. The effect of p uptake by the organics (FYM) is attributed to the release of P during mineralization hence higher uptake by maize was recorded, high potassium levels (125%) decreased the phosphorus uptake due to antagonistic effects. The results are in conformity with the findings of Abida Akram *et al.* (2007)

Significantly higher seed, haulm and total uptake of phosphorus by soybean was recorded in the treatment T_9 which received 100% RDF + PM at 6 t ha^{-1} + sulphur at 40 kg ha^{-1} through gypsum (17.58 kg ha^{-1}). It was on par with T_8 which received 100% RDF + PM at 6 t ha^{-1} + sulphur at 20 kg ha^{-1} through gypsum (15.39 kg ha^{-1}). However, significantly lower uptake by seed was noticed in treatment T_1 which receiving 100% RDF + FYM (4.82 kg ha^{-1}). Higher phosphorus uptake was due to higher P application through inorganic fertilizer and organic source (PM), this has contributed surplus P in the soil. The higher mineralization of organic source in addition to inorganic application had provided more available nutrients for plants uptake in addition to fixation that normally takes place. Poultry manure application reduced the loss of nutrients through leaching and made available to plant which created a balancing effect on supply of nitrogen, phosphorus and potassium. These results are in support with the findings of (Vijayapriya *et al*. 2005) [27] and also the application of 40 kg S ha-1 might have increased the uptake of P by soybean which might be due to their mutually competitive effect on the adsorption sites on the colloidal surfaces and resulted in increase in their concentration in soil solution (Reddy and Reddy, 2001) [17]. Similar results have been reported by Bansal (1991) [3], Sharma and Gupta (1992) [23].

Total uptake of potassium by soybean showed significantly differed due different treatments. The highest total uptake of 75.47 kg ha^{-1} was recorded in 100% RDF + PM at 6 t ha^{-1} + sulphur at 40 kg ha^{-1} through gypsum applied plot (T_9) and it was on par with the treatment T_8 which received 100% RDF + PM at 6 t ha^{-1} + sulphur at 20 kg ha^{-1} through gypsum (65.95 kg ha^{-1}). However, significantly lower potassium uptake by soybean was noticed in the treatment T_1 receiving 100% RDF + FYM (23.58 kg ha^{-1}). It might be due to direct addition of nutrients through poultry manure and it might have improved availability of native soil nutrients and their uptake by soybean crop. The results of this investigation are agree with the findings of Gopal Reddy. (1997) [6] and also due to synergetic effect of sulphur on potassium uptake. Potassium uptake will result in higher dry matter production, growth parameters and yield and yield parameters. Results of the present study are in conformity with the findings of Patel *et al*., (1985) [13] in soybean.

The seed, haulm and total uptake of sulphur by soybean crop significantly differed due to different treatments. The highest total sulphur uptake 32.41 kg ha^{-1} was recorded in 100% RDF + PM at 6 t ha^{-1} + sulphur at 40 kg ha^{-1} through gypsum applied plot (T_9) compare to all other treatments. It might be due to application of poultry manure and increased sulphur level resulted in increased uptake of sulphur by plants. Similar results were found by Ganeshmurthy (1996) [4]. Between the two levels of sulphur tested, better growth, seed yield, quality character, sulphur uptake and highest accumulation of sulphur in all the plant parts of soybean were observed with 40 kg^{-1} S than 20 kg ha^{-1} S through gypsum. Similar beneficial effect was also reported by Ramamoorthy *et al.* (1996) [16].

3.4 Effect on micronutrients uptake

Total uptake of iron, manganese, zinc, copper and boron by soybean crop differed significantly due to application of varied levels of sulphur and organic sources and results were presented in the Table 5.

Significantly higher seed, haulm and total uptake of iron, manganese zinc, copper and boron (1199.80, 198.18, 209.21, 113.82 and 131.01g ha^{-1} respectively) by soybean was recorded in treatment where 100% RDF + PM at 6 t ha^{-1} + sulphur at 40 kg ha^{-1}through gypsum (T_9) compare to all other treatments. Application of sulphur increased the nutrient uptake which resulted in higher dry matter production, yield and yield components, and there is synergestic relationship between sulphur and organic manures on nutrient uptake of zinc and iron. The increase in zinc and iron uptake may be due to the interaction effect of sulphur, zinc and iron which are synergestic. These results are supported by the findings of Sharma *et al.* (1990) [22] in mustard and also it might be due to microbial decomposition of organic manures with simultaneous release of organic acid might have favoured the availability of micronutrients in soil and their uptake by soybean. Faster rate of decomposition of organic manures as resulted in of narrowing of C:N ratio with the combined application of both organic and inorganic sources of nutrients. These results are in support with the findings of Sakal *et al.* (1993) [18, 19]

Addition of organic manures to soil besides increasing the availability of micronutrients in soil, also have the complexing properties of these manure with micronutrients might have prevent the precipitation, fixation, leaching and kept them in soluble form which might have resulted in higher uptake of these micronutrients by soybean crop. Similar results were reported by Ghosh *et al.* (1999) [5].

Table 1: Physico-chemical properties of soil of the experimental site**.**

Sl. No	Parameter	Values	Methods followed
1	Mechanical composition		International pipette method (Piper, 1966) [16]
	Sand (%)	65.72	
	Silt (%)	20.54	
	Clay (%)	13.74	
2	Textural class	Sandy loam	
3	BD (g cm-3)	1.35	Core sampler method
4	MWHC (%)	22.73	Keen's cup method
5	pH	7.38	Potentiometric method
6	EC (dSm^{-1})	0.39	Conductometry (Jackson 1973)
7	OC (g kg^{-1})	8.51	Walkley and Black wet oxidation method (1934)
8	CEC (c mol (p+) kg^{-1})	15.68	Ammonium acetate method
9	Avail. N (kg ha^{-1})	240.50	Alkaline potassium permanganate method (subbaiah and asija, 1956)
10	Avail. P_2O_5 (kg ha^{-1})	28.23	Olson, method (Jackson, 1954)
11	Avail. K_2O (kg ha^{-1})	165.34	Flame photometry (Jackson 1973)
12	Exch. Ca (meq $100g^{-1}$)	4.37	Versanate method
13	Exch. Mg (meq $100g^{-1}$)	1.87	Versanate method
14	Avail. S (mg kg^{-1})	8.17	Turbidometry method
15	DTPA Boron (mg kg^{-1})	0.21	Hot water soluble method
16	DTPA Zn (mg kg^{-1})	1.51	DTPA extractable
17	DTPA Fe (mg kg^{-1})	17.79	DTPA extractable
18	DTPA Cu (mg kg^{-1})	0.96	DTPA extractable
19	DTPA Mn (mg kg^{-1})	9.13	DTPA extractable

Table 2: Pod, seed and haulm yields of soybean at harvest as influenced by combined application of varied levels of sulphur and sources of organics

Treatments	Pod yield (q ha^{-1})	Seed yield (q ha^{-1})	Haulm yield (q ha^{-1})
T_{1}	14.67	13.64	21.22
T_{2}	19.89	19.01	32.15
T_{3}	22.23	19.38	32.67
T_{4}	22.87	20.42	34.08
T_{5}	23.17	20.80	34.82
T_{6}	25.75	23.07	38.08
T_{7}	26.65	23.44	39.19
T_{8}	27.85	24.47	41.20
T_{9}	30.30	26.90	44.15
T_{10}	18.05	16.79	28.17
T_{11}	18.33	17.03	29.01
T_{12}	19.29	17.73	30.33
T_{13}	19.81	18.11	30.85
T_{14}	22.33	20.07	33.05
T_{15}	22.83	20.41	33.67
T_{16}	24.67	22.81	35.75
T_{17}	25.73	23.05	36.15
Sem ±	1.41	0.89	1.22
CD @ 5%	4.06	2.56	3.59

RDF: Recommended dose of fertilizer (25:60:25 kg NPK ha^{-1}), PM: Poultry Manure, VC: Vermicompost,
FYM: Farm yard manure (6.25 t ha^{-1}), S: Sulphur

Table 3: Effect of varied levels of sulphur and sources of organics on N, P and K concentration in the seed and haulm of soybean at harvest.

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	seed	haulm	seed	haulm	seed	haulm
T_{1}	1.63	1.08	0.26	0.06	0.78	0.61
T_{2}	2.34	1.13	0.34	0.08	1.09	0.77
T_{3}	2.38	1.15	0.35	0.09	1.05	0.78
T_{4}	2.39	1.18	0.36	0.10	1.12	0.83
T_{5}	2.42	1.19	0.37	0.10	1.13	0.84
T_{6}	2.48	1.21	0.38	0.12	1.16	0.87
T_{7}	2.51	1.23	0.39	0.12	1.17	0.88
T_{8}	2.55	1.25	0.41	0.13	1.18	0.90
T_{9}	2.71	1.25	0.44	0.13	1.23	0.96
T_{10}	2.17	1.10	0.29	0.06	1.05	0.67
T_{11}	2.20	1.10	0.30	0.06	1.06	0.69
T_{12}	2.25	1.12	0.32	0.08	1.08	0.72
T_{13}	2.31	1.13	0.32	0.08	1.09	0.73
T_{14}	2.38	1.17	0.35	0.09	1.11	0.82
T_{15}	2.38	1.18	0.36	0.09	1.12	0.83
T_{16}	2.43	1.20	0.37	0.11	1.16	0.86
T_{17}	2.46	1.21	0.38	0.11	1.16	0.87
S.Em ±	0.08	0.01	0.03	0.02	0.03	0.02
CD @ 5%	0.24	0.04	0.08	0.04	0.08	0.06

RDF: Recommended dose of fertilizer (25:60:25 kg NPK ha^{-1}), PM: Poultry Manure, VC: Vermicompost,
FYM: Farm yard manure (6.25 t ha^{-1}), S: Sulphur

Table 4: Effect of varied levels of sulphur and sources of organics on N, P, K and S uptake by seeds and haulm of soybean at harvest

Treatments	Nitrogen (kg ha^{-1})			Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})			Sulphur (kg ha^{-1})		
	Seeds	Haulm	Total	Seeds	haulm	Total	Seeds	Haulm	Total	Seeds	Haulm	Total
T_{1}	22.23	22.92	45.15	3.55	1.27	4.82	10.64	12.94	23.58	7.23	2.76	9.99
T_{2}	44.48	36.33	80.81	6.46	2.57	9.04	20.72	24.76	45.48	14.07	5.14	19.21
T_{3}	46.12	37.57	83.69	6.78	2.94	9.72	20.35	25.48	45.83	14.54	5.23	19.76
T_{4}	48.80	40.21	89.02	7.35	3.41	10.76	22.87	28.29	51.16	15.72	5.91	21.63
T_{5}	50.34	41.44	91.77	7.70	3.48	11.18	23.50	29.25	52.75	16.22	5.92	22.14
T_{6}	57.21	46.08	103.29	8.77	4.57	13.34	26.76	33.13	59.89	18.61	6.85	25.46
T_{7}	58.83	48.20	107.04	9.14	4.83	13.98	27.42	34.49	61.91	19.22	7.05	26.28
T_{8}	62.40	51.50	113.90	10.03	5.36	15.39	28.87	37.08	65.95	20.31	7.83	28.14
T_{9}	72.90	56.51	129.41	11.84	5.74	17.58	33.09	42.38	75.47	23.13	9.27	32.41
T_{10}	36.43	30.89	67.33	4.87	1.69	6.56	17.63	18.87	36.50	10.58	4.23	14.80
T_{11}	37.47	31.91	69.38	5.11	1.74	6.85	18.05	20.02	38.07	11.07	4.35	15.42
T_{12}	39.89	33.97	73.86	5.67	2.53	8.20	19.15	21.84	40.99	12.06	4.85	16.91
T_{13}	41.83	34.86	76.69	5.80	2.47	8.26	19.74	22.52	42.26	12.68	5.04	17.72
T_{14}	47.77	38.67	86.44	7.02	2.97	10.00	22.28	27.10	49.38	15.25	5.62	20.87
T_{15}	48.58	39.73	88.31	7.35	3.03	10.38	22.86	27.95	50.81	15.72	5.72	21.44
T_{16}	55.43	42.90	98.33	8.44	3.93	12.37	26.46	30.75	57.20	18.32	6.44	24.76
T_{17}	56.70	43.74	100.44	8.76	3.98	12.74	26.74	31.45	58.19	18.44	6.51	24.95
S.Em ±	1.88	1.88	6.05	0.35	0.56	0.71	1.54	2.12	2.94	0.85	0.53	1.21
CD @ 5%	5.40	5.46	17.42	1.01	1.60	2.06	4.44	6.17	8.48	2.46	1.51	3.49

RDF: Recommended dose of fertilizer (25:60:25 kg NPK ha^{-1}), PM: Poultry Manure, VC: Vermicompost, FYM: Farm yard manure, (6.25 t ha^{-1}), S: Sulphur

Table 5: Micronutrients uptake by seed and haulm of soybean at harvest as influenced by varied levels of sulphur and sources of organics.

Treatments	Iron (g ha^{-1})			Manganese (g ha^{-1})			Zinc (g ha^{-1})			Copper (g ha^{-1})			Boron (g ha^{-1})		
	Seeds	Haulm	Total	Seeds	haulm	Total	Seeds	Haulm	Total	Seeds	Haulm	Total	Seeds	Haulm	Total
T_{1}	165.28	197.57	362.85	27.83	37.96	65.79	26.07	39.34	65.41	12.43	11.32	23.74	27.43	12.73	40.16
T_{2}	291.40	408.78	700.17	45.90	72.74	118.64	45.90	77.35	123.25	24.29	34.29	58.58	45.22	24.33	69.55
T_{3}	302.75	426.04	728.79	47.94	75.01	122.95	47.51	80.06	127.57	25.48	35.94	61.42	47.48	25.40	72.88
T_{4}	328.99	460.61	789.60	51.27	80.27	131.54	52.32	84.96	137.28	28.36	39.76	68.12	54.85	27.92	82.78
T_{5}	341.43	481.28	822.71	53.39	83.43	136.82	54.08	88.36	142.44	29.81	42.21	72.02	57.93	29.40	87.33
T_{6}	401.59	552.83	954.42	60.52	94.36	154.88	63.60	100.45	164.05	34.61	48.51	83.12	67.84	33.70	101.54
T_{7}	412.80	576.81	989.61	62.58	98.41	160.99	66.06	106.28	172.34	36.46	51.67	88.12	70.32	35.27	105.59
T_{8}	444.90	614.33	1059.23	64.62	106.20	170.82	71.14	115.35	186.49	39.60	57.75	97.35	75.04	38.60	113.65
T_{9}	523.85	675.95	1199.80	79.80	118.38	198.18	81.30	127.91	209.21	46.63	67.20	113.82	86.38	44.64	131.01
T_{10}	225.47	310.39	535.85	37.62	56.34	93.96	35.82	59.70	95.52	18.28	24.41	42.69	33.35	19.19	52.54
T_{11}	235.58	334.15	569.72	39.17	59.63	98.79	38.35	63.02	101.37	19.05	26.53	45.58	34.79	20.41	55.21
T_{12}	250.71	361.72	612.43	41.96	64.70	106.67	41.96	67.88	109.84	21.21	29.32	50.52	37.59	21.90	59.49

T_{13}	262.73	376.71	639.44	43.60	67.07	110.66	43.60	72.78	116.38	22.34	31.08	53.41	39.86	23.27	63.14
T_{14}	317.56	433.66	751.22	49.72	76.02	125.74	50.54	79.31	129.85	26.89	36.93	63.82	50.29	25.75	76.04
T_{15}	326.86	451.68	778.54	51.03	78.93	129.96	52.30	83.84	136.14	28.04	38.90	66.94	51.83	27.07	78.90
T_{16}	381.26	498.77	880.03	58.88	86.44	145.32	61.84	91.46	153.30	32.86	43.50	76.36	62.28	30.45	92.73
T_{17}	392.10	510.22	902.32	60.35	89.03	149.38	63.43	94.10	157.53	34.48	45.74	80.22	64.79	31.33	96.12
S.Em ±	27.85	20.58	25.18	1.50	3.80	4.69	1.41	6.02	1.49	2.77	4.22	6.63	4.21	2.39	6.07
CD @ 5%	80.21	59.27	72.54	4.32	10.95	13.51	4.06	17.35	4.29	7.97	12.27	19.09	12.13	6.89	17.49

RDF: Recommended dose of fertilizer (25:60:25 kg NPK ha^{-1}), PM: Poultry Manure, VC: Vermicompost, FYM: Farm yard manure, (6.25 t ha^{-1}), S: Sulphur

4. Conclusion

Total uptake of nitrogen and sulphur by soybean was significantly increased by the graded levels of sulphur and organic manures (poultry manure). However, higher seed yield, pod and haulm yield, major nutrient content and uptake of major and micronutrients was recorded due to application of 100% RDF + PM at 6 t ha^{-1} + sulphur 40 kg ha^{-1} through gypsum (T_9) and followed by 100% RDF + PM at 6 t ha^{-1} + sulphur 20 kg ha^{-1} through gypsum (T_8).

5. References

1. Aulakh MS, Dev G. Interaction effect of calcium and sulphur on the growth and nutrient composition of alfalfa (*Medicago sativa*) using 35 S. Plant Soil. 1978; 50:125-133.
2. Aulakh MS, Dev G. Interaction effect of calcium and sulphur on the growth and nutrient composition of alfalfa (*Medicago sativa*) using 35 S. Plant Soil. 1978; 50:125-133.
3. Bansal KN. Effect of levels of sulphur on the yield and composition of soybean, greengram, blackgram and cowpea. Madras Agricultural Journal. 1991; 78(5-8):188-190.
4. Ganeshmurthy AN. Critical plant sulphur content and effect of application on grain and oil yield of rainfed soybean in *Vertic Ustochrepts*. J. Indian Soc. Soil Sci. 1996; 44(2):290-294.
5. Ghosh BN, Prakas V, Singh RD. Yield response and nutrient use efficiency in soybean-wheat cropping system in a long term manorial experiment. Indian J Agric Sci. 1999; 71(2):149-152.
6. Gopal Reddy B. Soil health under integrated nutrient management in maize-soybean cropping system. Ph.D. Thesis, Acharya N. G. RANGA Agric. Univ. Rajendranagar, AP, 1997.
7. Hegde DM, Sudhakara Babu SN. Correcting sulphur deficiencies in soils and crops. Indian J Fert. 2007; 3(1):65-79.
8. Hussain K, Islam M, Siddique MT, Hayat R, Mohsan S. Soybean growth and nitrogen fixation as affected by sulphur fertilization and inoculation under rainfed conditions in Pakistan. Int. J Agric. Biol. 2013; 13:951-955.
9. Jackson ML. Soil chemical analysis Prentice-Hall of India Pvt. Ltd, New Delhi, 1973, 498.
10. Karki TB, Ashok Kumar, Gautam RC. Influence of integrated nutrient management on growth, yield, content and uptake of nutrients and soil fertility status in maize (*Zea mays* L.). Indian J Agri. Sci. 2005; 75(10):682-686.
11. Komal Singh SK, Bansal, Moinuddin Effect of potassium fertilization on depletion of NPK in a long term (Fodder) Sorghum - Wheat cropping system on an Inceptisol. J Potash. Res. 2002; 18:16-22.
12. Nwachukwu OI, Ikeadigh MC. Water use efficiency and nutrient uptake of maize as affected by organic and inorganic fertilizer. Pat. 2012; 8(1):199- 208.
13. Patel PV, Mehta PM, Patel ML, Patel MG. Efficient utilization of potassic fertilizers by sorghum on vertisols. J potash Res. 1985; 1(2):129-132.
14. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR, New Delhi, India, 1967
15. Piper CS. Soil and plant Analysis, Academic press, New York, 1966, 367.
16. Ramamoorthy K, Ramaswami M, Vairavan K. Effect of sources and levels of sulphur on production of soybean [*Glycine Max* (L).]. Indian J Agron. 1996; 41(4):654-655.
17. Reddy KPC, Reddy MS. Uptake of major nutrients by soybean (*Glycine max* (L.) Merrill) at different stages of crop growth as influenced by sulphur application. Journal of Oilseeds Research. 2001; 18(2):181-184.
18. Sakal R, Sinha RB, Singh AP, Bhogal NS. Relative performance of some sulphur sources on the sulphur nutrition to groundnut in calcareous soil. Ann. Agril. Res. 1993; 14(3):329-330.
19. Sakal R, Singh AP, Singh RP, Bhagal NS. 25 years of research on micronutrient in soil and crops of Bihar. In: Annual Report, All India. Co-ordinated Scheme of Micronutrients in Soils and Plants. Rahuri Agriculture University, Pusa, Bihar, 1993.
20. Singh SP, Ram J, Singh N. Forms of sulphur in relation to soil characteristics in some soil series of Nagaland. J Maharashtra Agric. Univ., 2000; 25(1):3-8.
21. Singh VK, Singh V, Singh M. Response of Indian mustard to sulphur fertilization. The Indian J of Agril sci. 1988; 88(10):754-756.
22. Sharma UC, Gangwar MS, Shrvastava PC. Effect of zinc and sulphur on nutrient uptake and yield of mustard. J Ind. Soc. Soil Sci. 1990; 38:696-701.
23. Sharma RA, Gupta RK. Response of rainfed soybean-safflower sequence to nitrogen and sulphur fertilization in vertisols). Indian Journal of Agricultural Sciences. 1992; 62 (8):529-534.
24. Subbaiah B, Asija CL. A rapid procedure for he estimation of available nitrogen in soils. Curr. Sci. 1956; 25:270-280.
25. Tiwari. Effect of decomposed city waste under integrated nutrient management system on yield and nitrogen uptake by soybean. Adv. Pl. Sci. 2007; 20(1):295-298.
26. Tripathy S, Bastia DK. Irrigation and nutrient management for yield augmentation of summer sesame (*Sesamum indicum* L.). Journal of Crop and Weed. 2012; 8(2):53- 57.
27. Vijayapriya M, Muthukkaruppan SM, Ramachandra SMV. Effect of sulphur and rhizobium inoculation on nutrient uptake by soybean ad soil fertility. Adva in Plant Sci. 2005; 18(1):19-21.
28. Walkley, Black CA. An examination of digestion method for determining organic carbon in soil, effect of variations in digestion conditions and of inorganic soil constituents, Soil. Sci. 1934; 63:251-263.