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Effect of sources and levels of sulphur on physico-chemical properties and available nutrient status of Niger (*Guizotia abyssinica*) growing soil

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Abstract
A field experiment was conducted on "Effect of sources and levels of sulphur on physic-chemical properties and available nutrient status of Niger (*Guizotia abyssinica*) growing soil during the year 2015-16 at College of Agriculture, Latur. The experiment was laid out in randomized block design with twelve treatments and three replications.

The results of field study indicated that the organic carbon and available nutrients of Niger growing soil were significantly influenced by application of different sources (ammonium sulphate, elemental sulphur and gypsum) and levels (10, 20 and 30 kg ha^{-1}) of sulphur.

The significantly highest organic carbon (0.95 g kg^{-1}) content, available N (156.53 kg ha^{-1}), P (28.44 kg ha^{-1}), K (537.62 kg ha^{-1}) and S (23.92 kg ha^{-1}) were recorded than the other treatments with RDF+ S 30 kg ha^{-1} through ammonium sulphate (T_6) followed by the application of RDF+ S 30kg ha^{-1} through gypsum (T_{12}). The soil pH, EC, calcium carbonate after harvest of Niger were decreased as compare to initial value but the organic carbon, available N, P, K and S content were increased in soil samples collected after harvest of Niger than the initial soil sample.

Keywords: Sources of sulphur, organic carbon, available N, P, K, S and Niger

Introduction
Oilseeds is the second largest agricultural commodity after cereals sharing 13 per cent of the country's gross cropped area and accounting for nearly 6 per cent of gross national production and 10 per cent of the value of all agricultural commodities.

Niger (*Guizotia abyssinica* Cass.) is one of the important oilseed crops of India belonging to family compositae. Though it is considered as a minor oilseed crop both at global and national level, still it has considerable importance in rain fed condition, especially on hill slopes and coarse textured soils. It is very important oilseed crop in terms of oil content, quality and potentiality. The important feature of this crop is that it gives reasonable seed yield even under poor growing condition.

Besides the importance of application of major nutrients (N: P: K) in crop production, the role of sulphur application particularly in oil seeds production has been highly emphasized in Indian agriculture. Sulphur is increasingly being recognized as the fourth major plant nutrient, after nitrogen, phosphorus and potassium. Sulphur is well known for its role in synthesis of three essential S containing amino acids *viz*., cystine, cysteine and methionine. It is required for the formation of chlorophyll, vitamins, glucosides, ferradoxins and certain disulphide linkages besides activation of proteolytic enzymes and ATP-sulphurylase. Sulphur is associated with the metabolism of carbohydrates and oils, formation of flavour imparting compounds in crucifers and marketing quality of several crops.

Material and methods
The field experiment was conducted at College of Agriculture, Latur during *kharif* season, 2015-16. The experiment was laid out in randomized block design with twelve treatments and three replications. Twelve treatments consisting of 3 levels of sulphur (10, 20 and 30 kg ha^{-1}), and 3 sources of sulphur (Ammonium sulphate, Elemental sulphur and Gypsum), another with single super phosphate (SSP) were tested. Treatments are T_1-Control, T_2-RDF (through straight fertilizers) Urea/SSP, T_3-RDF (through DAP and Urea), T_4-RDF+S 10 kg ha^{-1} through ammonium sulphate, T_5-RDF+S 20 kg ha^{-1} through ammonium sulphate, T_6-RDF+S 30 kg ha^{-1} through ammonium sulphate, T_7-RDF+S 10 kg ha^{-1} through elemental sulphur, T_8-RDF+S 20 kg ha^{-1} through elemental sulphur, T_9-RDF+S 30 kg ha^{-1} through elemental sulphur,

T_{10}-RDF+S 10 kg ha^{-1} through gypsum, T_{11}-RDF+S 20 kg ha^{-1} through gypsum and T_{12}-RDF+S 30 kg ha^{-1} through gypsum. The recommended dose of fertilizer was 40:20:0 kg ha^{-1} N, P_2O_5 and K_2O, respectively.

After harvest of crop, soil samples were collected randomly at 0-15 cm depth from each plot, dried in shade and prepared for its chemical analysis *viz*; pH, EC, organic carbon, $CaCO_3$, available N, P, K and S by standard methods. Appropriate standard errors (SEI) were work out.

Results and discussion

Effect on chemical properties of soil

The results regarding chemical properties of soil *viz;* pH, EC, organic carbon and calcium carbonate as influenced by sulphur levels and sources after harvest of Niger are presented in table 1.

Table 1: Chemical properties of soil as influenced by various treatments at harvest of Niger crop

Treatments	pH	EC (dS m-1)	Organic carbon (g kg^{-1})	$CaCO_3$ (g kg^{-1})
T_1- Control	7.76	0.22	0.57	43.50
T_2- RDF(through straight fertilizers)Urea/SSP	7.75	0.16	0.87	37.63
T_3- RDF(through DAP and Urea)	7.90	0.17	0.77	39.80
T_4-RDF+S 10kg ha -1through ammonium sulphate	7.83	0.16	0.81	38.11
T_5- RDF+S 20kg ha-1 through ammonium sulphate	6.72	0.18	0.88	32.73
T_6-RDF+S 30 kg ha-1 through ammonium sulphate	6.58	0.22	0.95	30.37
T_7- RDF+ S 10 kg ha-1 through elemental sulphur	7.18	0.13	0.77	34.21
T_8- RDF+ S 20 kg ha-1 through elemental sulphur	7.28	0.15	0.83	33.20
T_9-RDF+ S 30 kg/ha through elemental sulphur	7.59	0.12	0.92	37.62
T_{10} –RDF+ S 10kg ha-1 through gypsum	7.60	0.14	0.78	36.12
T_{11}- RDF+ S 20kg ha-1 through gypsum	7.81	0.11	0.85	35.91
T_{12}- RDF+ S 30kg ha-1 through gypsum	7.87	0.09	0.94	34.73
S.E.±	0.13	0.01	0.01	0.80
C.D at 5 %	NS	NS	0.05	NS
Initial values	7.95	0.24	0.67	44.1

Soil pH

pH of soil was not affected significantly due to various treatments of sulphur. The lower pH (6.58) was recorded with the treatment T_6 (RDF+ S 10 kg ha^{-1} through elemental sulphur) while, higher pH (7.90) noted with treatment T_3 (RDF through DAP and Urea). Further the data revealed that the pH of soil after harvest of crop was decreased as compared to initial pH value (7.95) in Niger growing soil. Laximinarayan and Patiram (2005) [5] showed that the pH of soil decreased slightly with the addition of organic manures over the initial values that might be attributed to the formation of organic acids during decomposition of organic matter. Similarly, beneficial effect of S seems to be in lowering soil pH and improving physical condition of soil (Choudhary and Das, 1996) [3].

Electrical conductivity (EC)

The data revealed that the difference in soil EC value due to different treatments was not reach to level of significance. Minimum (0.09 dSm^{-1}) and maximum (0.22 dSm^{-1}) EC values were recorded with treatment T_{12} (RDF+ S 30kg ha-1 through gypsum) and T_1 (control), respectively. Further data revealed that EC of initial soil sample (0.24 dSm^{-1}) was higher as compared to the samples collected after harvest of crop.

The decrease in EC of post-harvest soil sample might be due to leaching of salts due to rains and utilization of nutrients by crop. Similar results were also observed by Mann *et al.* (2006) [7].

Organic carbon

Results indicated that the effect of sources and levels of sulphur on organic carbon was influenced significantly. Organic carbon content in soil was increased significantly with application of treatments T_6 (RDF+ S 30 kg ha^{-1} through ammonium sulphate) which was found significantly superior (0.95 g kg^{-1}) over rest of the treatments and remained at par with all the treatments. The lower organic carbon content (0.57 g kg^{-1}) was recorded at control (T_1). Further, it was observed from the result that the organic carbon content was increased in soil samples collected after harvest of Niger than the initial soil samples (0.67 g kg^{-1}).

Increase in organic carbon in post-harvest soil samples might be due to addition of plant residues and organic matter in soil. Similar findings were also reported by Jenkinson and Johnson (1977) [4]. This increase in organic carbon in post-harvest soil samples might be due to addition of organic manure which stimulated the growth and activity of microorganisms and also better root growth. Similar findings were also reported by Varalakshmi *et al.* (2005) [7].

Calcium carbonate

The difference in calcium carbonate value due to different treatments was not reach to the significant level. Minimum (30.37g kg^{-1}) and maximum (43.50 g kg^{-1}) calcium carbonate values were recorded with treatment T_6 (RDF+ S 30 kg ha^{-1} through ammonium sulphate) and T_1 (control), respectively. Further, it was observed from the data that calcium carbonate was decreased in soil samples collected after harvest of niger as compared to initial soil samples (44.1g kg^{-1}).

Jenkinson and Johnson (1977) [4] found that sunflower crop decreases the calcium carbonate content in the soil because of addition of organic matter of soil. The application of sulphur @ 40 kg ha1showed slight decrease in pH and EC and increase in organic carbon (Yadav *et al*., 2010) [8].

Effect on available N, P, K and S in soil

Available nutrient contents *viz;* N, P, K and S were analyzed from soil samples collected from different plots after harvest of Niger crop are presented in table 2.

The available N, P, K and S in soil were affected significantly due to sulphur application. It is evident from the results, the maximum available N (156.53kg ha^{-1}) noted with application of treatment T_6 (RDF+S 30kg ha^{-1} through ammonium sulphate) followed by treatments T_5, T_9 and T_{12}. While, minimum available N (104.53 kg ha^{-1}) was noted with control (T_1). Available P (28.44 kg ha^{-1}) was recorded higher with

treatment T_6 (RDF+S 30kg ha^{-1} through ammonium sulphate) and remains at par with treatments T_2, T_5, T_8, T_9, T_{11} and T_{12}. However, lower content of available P (22.77 kg ha^{-1}) was recorded with treatment T_1 (control). Available K was found highest (537.62kg ha^{-1}) with treatment T_6 (RDF+S 30 kg ha^{-1} through ammonium sulphate) and it was at par with treatments T_2, T_4, T_5, T_8, T_9, T_{10}, T_{11} and T_{12}. Whereas, it was found lowest (421.00 kg ha^{-1}) with control (T_1). Available S was recorded maximum (23.92 kg ha^{-1}) with treatment T_6 (RDF+S 30 kg ha^{-1} through ammonium sulphate) followed by treatments T_9 and T_{12}. While, minimum (17.88 kg ha^{-1}) content was recorded with treatments T_1 (control). Further, data revealed that the N, P, K and S in soil after harvest of Niger was increased than the initial soil samples.

Bharose *et al*. (2014) [1] concluded that available N, P, K and S of soil was found significant at different levels of sulphur. Similarly, Chaurasia *et al.* (2009) [2] revealed that 40 kg S/ha gave significantly available N, P2O5, K2O and S. On the other hand, Yadav *et al*. (2010) [8] observed that the application of sulphur @ 40 kg ha1showed increase in available nitrogen, phosphorous, potassium and sulphur.

Table 2: Available nitrogen, phosphorus, potassium and sulphur as influenced by various treatments at harvest of Niger

Treatments	**Available Nutrients (kg ha^{-1})**			
	N	**P**	**K**	**S**
T_1- Control	104.53	22.77	421.00	17.88
T_2- RDF(through straight fertilizers)Urea/SSP	130.53	27.58	500.33	21.86
T_3- RDF(through DAP and Urea)	108.71	23.82	423.72	18.23
T_4-RDF+S 10kg ha -1through ammonium sulphate	121.25	27.24	481.19	21.00
T_5-RDF+S 20kg ha-1 through ammonium sulphate	133.02	27.55	510.11	22.48
T_6-RDF+S 30kg ha-1 through ammonium sulphate	156.53	28.44	537.62	23.92
T_7- RDF+ S 10 kg ha-1 through elemental sulphur	108.71	25.52	424.33	19.22
T_8- RDF+ S 20 kg ha-1 through elemental sulphur	125.44	27.56	487.40	21.81
T_9-RDF+ S 30 kg/ha through elemental sulphur	137.98	27.76	521.36	22.91
T_{10} –RDF+ S 10kg ha-1 through gypsum	112.89	26.11	467.00	19.33
T_{11}- RDF+ S 20kg ha-1 through gypsum	129.80	27.58	498.27	21.86
T_{12}- RDF+ S 30kg ha-1 through gypsum	142.93	28.08	527.60	23.74
S.E.±	8.53	0.37	27.00	0.358
C.D at 5 %	24.80	1.08	79.08	1.041
Initial values	115.01	21.04	420.00	15.45

Conclusion

Considering the overall response of Niger to sources and levels of sulphur during kharif season, it is concluded that organic carbon, available nutrients *viz*; N, P, K and S after harvest of Niger were increased with application of T_6 (RDF+ S 30 kg ha^{-1} through ammonium sulphate).

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