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Assess the Sulphur Fractions in Soil as Affected by Soil Test Based Nutrient Application

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during Kharif, 2019 at research field of Department of soil science and agricultural chemistry, JKKVV, M. P. India. Assess the sulphur fractions in soil as affected by soil test based nutrient application. The experiment was laid out in RBD with six treatments with four replications. The treatment schedule was having Control, General Recommended Dose (120-60-40), Targeted yield of 50 q ha^{-1} (138-65-60), Targeted Yield of 60 q ha^{-1} (178-86-79), Targeted Yield of 50 q + 5 t FYM ha^{-1} (134-50-57) and Targeted Yield of 60 q + 5 t FYM ha^{-1} (174-71-76) respectively. The result of this study showed that relationship between N, P, K and FYM used in soil increased the available S, water soluble S, organic S and total S in the soil. The increase of S fractions with the application of NPK might due to synergistic effect of N-S, P-S Or K-S in the soil. The application of NPK nutrients for T.Y.60q (174-71-76) + 5 t FYM resulted maximum available S (19.94 kg ha^{-1}), water soluble S (16.96 kg ha^{-1}), heat soluble S (25.17 kg ha^{-1}), organic S (44.28 kg ha^{-1}) and total S of (112.72 kg ha^{-1}) which were significantly higher to General recommended dose for available, water soluble, heat soluble, organic, total S fraction in post-harvest soil.

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1. INTRODUCTION

Rice (*Oryza sativa*) is staple food of millions of people and provides about 700 calories/day/person for about 3000 million people living mostly in developing countries [1]. It is the grain that has shaped cultures, diets and economics of billions of people in the world ([2]. In India, more than 44 million hect Fares area is occupied by rice under three major ecosystems, rainfed uplands (16% area), irrigated medium lands (45%) and rainfed lowland (39%), with a productivity of 0.87, 2.24 and 1.55 tons per hectare, respectively [3]. In India Rice production is 105.42 MT from 43.70 M ha land with the productivity of 24.12 q ha^{-1} and in Madhya Pradesh, rice production is 4.23 MT from 2.29 M ha land with the productivity of 18.47 q ha^{-1} (Anonymous, 2018). To sustain high yield, soil must have adequate supply of nutrients. Due to continuous intensive cultivation and high nutrients uptake, the nutrient supplying capacity of soil is becoming a limited factor. This declining factor of productivity is largely due to imbalanced fertilization along with increased fertilizer cost. Therefore, there is the need to maintain the soil fertility and obtain maximum yield.

Sulphur as a soil nutrient is involved in amino acid and protein synthesis, enzymatic and metabolic activities in plants, which account for approximately 90% of organic sulphur in plant. About 90% of plant sulphur present in amino acid (methionine & cysteine) and a variety of metabolites (thiamine, pyrophosphate, glucosinolates, glutathione and phytochelatins), play a pivotal role in building blocks of protein, formation of chlorophyll, activation of enzymes etc. [4]. Furthermore, deficient supply of S in soil causing lower uptake of nitrate hence retard the activity of nitrate reductase as well as N metabolism in plants [5,6]. Sulphur deficiencies are primarily due to high crop uptake and lesser application of S containing fertilizers [7]. Soil treated with Sulphur powder improved seedling height in upland rice nursery ([8]. Singh [9] obtained favorable effect of Sulphur @ 60 kg ha^{-1} on plant height under Indian conditions. Application of Sulphur through gypsum increased number of leaf rice in Sulphur deficient soil (Suchdev, 1982). Yadav [10] and Chandel [11] also had taller plants and increased shoot number per meter square to the application of 45 kg Sulphur ha^{-1}.

2. MATERIALS AND METHODS

The field experiment was conducted in Kharif season of 2019 at the JNKVV research field, Department of Soil Science and Agricultural Chemistry, AICRP on STCR, Jabalpur (M.P.). The experimental site is situated in the South-Eastern part of Madhya Pradesh at 23° 13´ North latitude, 79° 57´ East longitudes and at an elevation of 393 meter above mean sea level. The experiment was laid out in randomized block design (RBD) six treatment and four replications viz: Control, General Recommended Dose (GRD), Targeted yield of 50 q ha^{-1}, Targeted Yield of 60 q ha^{-1}, Targeted Yield of 50 q + 5 t FYM ha^{-1} and Targeted Yield of 60 q + 5 t FYM ha^{-1}, respectively. The soil in the experimental field belongs to Vertisol, Kheri series of fine montmorillonitic hyperthermic family of Typic Haplusterts popularly known as medium deep black soil. Recommended doses of nitrogen, phosphorus and potassium were applied through urea, single super phosphate and muriate of potash and FYM. Soil samples were collected from 0-15 cm and 15-30 cm soil depths at initial, and at harvest stages of rice crop. The soil samples were air dried, grounded by wooden pestle and mortar and then passed through 2 mm stainless steel sieve and stored in polythene bags at room temperature for determination of sulfur fractions.

2.1 Statistical Analysis

The data pertaining to each character of the rice crop were tabulated and analyzed statistically by applying the standard technique. Analysis of variance (ANOVA) for randomized block design was worked out and the significance of treatments were tested to draw valid conclusions for soil as described by Gomez and Gomez [12]. The differences of treatments mean were tested by 'F' test of significance based on null hypothesis. Critical differences were worked out at 5 percent level of probability where 'F' test was significant. If the variance ratios (F-test) were found significant at 5% level of significance, the standard error of mean (SE m) and critical differences (CD) were calculated accordingly.

3. RESULTS AND DISCUSSION

The data presented in (Table 1) indicated that the application of NPK nutrients for T.Y.50 q (138-65-60), T.Y. 60 q (178-86-79), T.Y.50q+5 t

FYM (134-50-57) and T.Y.60q+5 t FYM (174-71-76) significantly increased available nitrogen in soil over control, but the treatments were found at par amongst themselves. The maximum available N 176kg ha^{-1} was observed with T.Y.60q+5 tFYM (174-71-76). The data presented in (Table 1) indicated that the application of general recommended dose (GRD) of NPK (120-60-40), T.Y.50 q (138-65-60), T.Y. 60 q (178-86-79), T.Y.50q+5 t FYM (134-50-57) and T.Y.60q+5 tFYM (174-71-76) significantly increased the post-harvest available P in soilover control. However, the application of T.Y.60q (178-86-79) was found to be significantly higher to GRD but it was found at par with T.Y.50 q (138-65-60) and T.Y.50q+5 t FYM (134-50-57) for available P in soil. The application of T.Y.50q+5 t FYM(134-50-57) was also found significantly superior to GRD and T.Y.50 q (138-65-60) but it was found at par withT.Y.60 q (178-86-79) andT.Y.60q+5 t FYM (174-71-76). However, the application of nutrients for T.Y.60q+5 t FYM (174-71-76) was found to be significant over GRD, T.Y.50 q (138-65-60), T.Y. 60 q (178-86-79). The maximum available P 30.5kg ha^{-1} was observed at T.Y.60q (174-71-79) +5 t FYM in post-harvestsoil.The data presented in table 1 clearly indicated that the application of NPK for T.Y.50 q (138-65-60), T.Y. 60 q (178-86-79), T.Y.50q+5 t FYM (134-50-57) and T.Y.60q+5 t FYM (174-71-76) significantly increased post-harvest soil available K over control, but GRD was found not significant over control. However, the application of nutrients for T.Y.60q+5 t FYM (174-71-76) was found significantly superior to GRD, but the other treatments had no significant difference amongst them. The maximum available K in soil 267 kg ha^{-1} was observed with the nutrient application for T.Y.60q+5 t FYM (174-71-76).

The data presented in (Table 2) indicated that the application of NPK nutrients for T.Y.50 q (138-65-60), T.Y. 60 q (178-86-79), T.Y. 50 q + 5 t FYM (134-50-57) and T.Y.60q+5 t FYM (174-71-76) significantly increased the available, water soluble, heat soluble, organic and total S in post-harvest soil samples over control except for heat soluble and organic S at T.Y.50 q (138-65- 60). However, the application of NPK nutrients for T.Y.60q (174-71-76)+5 t FYM resulted in maximum available S (19.94 kg ha^{-1}), water soluble S (16.96 kg ha^{-1}), heat soluble S (25.17 kg ha^{-1}), organic S (44.28 kg ha^{-1}) and total S of (112.72 kg ha^{-1})which were found to be significantly superior to GRD for available, water soluble, heat soluble, organic and total S fraction in post-harvest soil samples but it was found at par with T.Y.50 q (138-65-60), T.Y. 60 q (178-86-79) and T.Y.50q+5 t FYM (134-50-57) for water soluble S, heat soluble S, organic S and total S. The available S with the NPK nutrients application for T.Y.60q+5 t FYM (174-71-76) was found significant over T.Y.50 q (138-65-60). While the application of nutrients for T.Y. 60 q (178-86-79) was also found significant over GRD for heat soluble S fractions in soil.

Data presented in Table 2 showed that the application of NPK nutrients T.Y. 60 q (178-86-79), T.Y.50q+5 t FYM (134-50-57) and T.Y.60q+5 t FYM (174-71-76) significantly increased the available, water soluble, heat soluble, organic and total S in soil over control except heat soluble and organic S at T.Y. 50 q (138-65-60). However, the application of NPK nutrients for T.Y.60q+5 t FYM (174-71-76) resulted the maximum available S (19.94 kg ha^{-1}), water soluble S (16.96 kg ha^{-1}), heat soluble S (25.17 kg ha^{-1}), organic S (44.28 kg ha^{-1}) and total S (112.72 kg ha^{-1}), which were significantly higher to GRD for available, water soluble, heat soluble, organic and total S in soil. This increase of S fractions with increased level of NPK application might be due to synergistic effect of N-S, P-S and K-S in soil. Similar results were obtained by Sachidanand et al. [13], Rahman et al. [14], Kumar et al. [15], Ram et al. [16], Shivay et al. [17], Sharma and Subehia [18], Sarker et al. [19], Chesti et al. [20] and Warjri et al. [21]. Sharma et al. [22], reported higher water-soluble sulphur content in 100% NPK application. The increase of heat soluble S with increased levels of NPK + FYM was also similarly reported by Rashid et al. [23], Patel et al. [24], Dutta et al. [25], Upinder [26] and Sharma et al. [22] in their studies. The increase of organic S with NPK and FYM were also reported by Tripathi et al. [27], Gosh et al. [28], Jat and Yadav [29], Rai et al. [30], Sharma et al. [22], Saren et al. [31]. The increase of total S with application of NPK fertilizers with FYM were also reported by Bhatnagar et al. [32], Rai et al. [30], Dutta et al. [25] and Saren et al. [31].

4. CONCLUSION

On the basis of the present research work, it is concluded that Application of NPK For T.Y.50 q (138-65-60), T.Y. 60 q (178-86-79) and T.Y.60q+5 t FYM (174-71-76) significantly increased available, water soluble, heat soluble, organic and total sulphur over control except heat soluble, organic S at T.Y.50 q (138-65-60).

However, the application of NPK for T.Y.60q+5 t FYM (174-71-76) was found significantly superior to T.Y.50 q (138-65-60) and GRD for available, water soluble, heat soluble and organic S. The presence of S fractions was in order of total S > organic S > heat soluble S > Available S > water soluble S. While the application NPK for T.Y.60q+5 t FYM (174-71-76) was found significant over T.Y.50 q (138-65-60) and GRD for available, water soluble, heat soluble, organic S.

FUTURE SCOPE

Present exploration needs to be further verified and similar types of experiments should be conducted to study the release patterns of sulphur and their interaction with other nutrients in soils.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Singh SP. Productivity and uptake of wheat as influenced by integrated nutrient management. Annals of Plant and Soil Research. 2017;19(1):12-16.
2. Farooq M, Wahid A, Kobayashi, DN, Fujita S and Basara MA. Plant drought stress: Effects, mechanisms and management. Agronomy for Sustainable Development. 2009;29:185-212.
3. Tiwari RK, Jha A, Tripathi SK, Khan IM and Rao SK. Rice based cropping system and climate change. JNKVV. Res. J. 2013;47:239-247.
4. Tewari RK, Kumar P and Sharma PN. Morphology and oxidative physiology of sulphur deficient mulberry plants. Environmental and Experimental Botany. 2010;68:301-308.
5. Prosser IM, Purves JV, Saker LR and Clarkson DT. Rapid disruption of nitrogen metabolism and nitrate transport in spinach plants deprived of sulphate. Journal of Experimental Botany. 2001;52:113-121.
6. Abdallah M, Dubousset L, Meuriot F, Etienne P, Avice JC, Ourry A. Effect of mineral sulphur availability on nitrogen and sulphur uptake and remobilization during the vegetative growth of Brassica napus L. Journal of Experimental Botany. 2010;61(10):2635-2646.
7. Messick DL. S Fertilizers: A Global Perspective. Proceedings of TSI-FAI-IFI Workshop on S in Balanced Fertilization. 2003;1-7.
8. Kim HD. Response of Sulphur in rice – A Review. Res. Repor. Rural Dev. Admi. Rice. 1991;33:25-31.
9. Singh M. Response of Sulphur in Rice – A Review. Oryaza. 1993;30:315-317.
10. Yadav RL, Dwivedi BS, Prasad K, Tomar OK, Shurpali NJ and Pandey PS. Yield trends and changes in soil organic-C and available NPK in a long-term rice- wheat system under integrated use of man ures and fertilizers. Field Crops Research. 2000;68:219-246.
11. Chandel RS. Effect of Sulphur application on growth and yield of rice in rice- mustard cropping sequence. Indian Journal of Agricultural Sciences. 2002;72:229- 231.
12. Gomez AA, Gomez KA. Statistical procedures for Agricultural Research. 2nd Ed. John Wiley and Sons, New York; 1984.
13. Sachidanand B, Sharma SN, Sharma RA. Organic farming practices or maintaining soil health and crop productivity enhancement. In. Int. Conf. on Sustainable Agriculture for Food Bioenergy and Livelihood Security. 2007;1:34-35.
14. Rahman MN, Sayem SM, Alam MK, Islam MS, Mondal ATMAI. Influence of sulphur on nutrient content and uptake by rice and its balance in old Brahmaputra floodplain soil. J. Soil Nature. 2007;1(3):5-10.
15. Kumar Santosh, Verma SK, Singh TK and Singh Shaymbeer. Effect of nitrogen and sulphur on growth, yield and nutrient uptake by Indian Mustard at rainfed condition. Indian Journal of Agricultural Sciences. 2011;81(2):145-9.
16. Ram Asha, Kumar Dinesh, Singh Nain, Anand Anjali. Effect of sulphur on growth, productivity and economics of aerobic rice (*Oryza sativa*). Indian Journal of Agronomy. 2014;59(3):404-409.
17. Shivay YS, Prasad Rajendra, Pal Madan. Effect of levels and Sources of Sulphur on Yield, Sulphur and nitrogen concentration

and uptake and S-use efficiency in Basmati Rice. Communication in Soil Science and Plant Analysis. 2014;45:2468-2479.

18. Sharma Upinder, Subehia SK. Effect of long-term integrated nutrient management on rice (*Oryza sativa* L.) - wheat (*Triticum aestivum* L.) productivity and soil properties in North-Western Himalaya. Journal of the Indian Society of Soil Science. 2014;62:248-254.
19. Sarker D, Mazumder S, Kundu S, Akter F, Paul SK. Effect of poultry manure incorporated with nitrogenous and sulphur fertilizer on the growth, yield, chlorophyll and nutrient contents of Rice var. BRRI dhan 33. Bangladesh Agronomy Journal. 2015;18(1):99-111.
20. Chesti MH, Kohli A, Mujtaba A, Sofi JA, Nazir Q, Tabasum Peer QJA, Dar MA, Bisati IA A. Effect of Integrated Application of Inorganic and Organic Sources on Soil Properties, Yield and Nutrient Uptake by Rice (*Oryza sativa* L.) in Intermediate Zone of Jammu and Kashmir. Journal of the Indian Society of Soil Science. 2015;63(1):88-92.
21. Wajri Rupabakor C, Gosh Kumar Goutam, Saha Dipankar. Effect of FYM, Zinc and Sulphur on yield and quality of Rice in hilly region of Meghalaya. International Journal of Plant, Animal and Environmental Sciences. 2017;7.
22. Sharma U, Subehia SK, Rana SS, Sharma SK, Negi SC. Soil sulphur fractions and their relationship with soil properties and rice (*Oryza sativa* L.) yield under long-term integrated nutrient management in an acid alfisol. Research on Crop. 2014;15(4):738-745.
23. Rashid AS, Iqbal MA, Naeem, Rafique E. Nutrient indexing of sulphur in rainfed peanut grown in Potahar Plateau of Pakistan. Journal of Indian Society Soil Science. 2000;48(1):124-129.
24. Patel JM, Patel MV, Jadav NJ, Pavaya RP. Distribution of different forms of sulphur in soils of Banaskantha districts of Gujarat. Asian Journal of Soil Science. 2011;6(1):11-16.
25. Dutta J, Sankhyan NK, Sharma SP, Sharma GD, Sharma SK. Sulphur fractions in acid soil continuously fertilized with chemical fertilizers and amendments under Maize-Wheat system. Journal of the Indian Society of Soil Science. 2013;61(3):195-201.
26. Upinder S, Subehia SK, Rana S, Sharma SK, Negi SC. Soil sulphur fractions and their relationship with soil properties and rice (*Oryza sativa* L.) yield under long term integrated nutrient management in an acid Alfisol. Research on Crops. 2014;15(4):738-745.
27. Tripathi SB, Tripathi SK. Distribution of various forms of sulphur in soils under forage production systems. Range Mgt Agro Forestry. 2000;21(1):23-27.
28. Gosh SK, Mukhopadhyay AK, Mousumi Sarkar. Status and profile distribution of forms of sulphur in some established soil series belonging to Inceptisols of West Bengal. Indian Agriculturist. 2002;46(3/4):147-152.
29. Jat JR and Yadav BL. Different forms of sulphur and their relationship with properties of Entisols of Jaipur district (Rajasthan) under mustard cultivation. J. Indian Soc. Soil Sci. 2006;54(1):208-212..
30. Rai AP, Mishra SK, Rai GK, Rai PK and Mondal AK. Forms of sulphur and their relationship with soil properties in soils of Allahabad district. Journal of Research, SKUAST-J. 2009;8(1):92-98.
31. Saren Subhasis, Barman Saurav, Mishra Antaryami, Saha Dipanker. Effect of added organic matter and sulphur on transformation of different fractions of sulphur in soil. An International Quarterly Journal of Life Sciences. 2016;11(4):2399-2403.
32. Bhatnagar RK, Bansal KN, Trivedi SK. Distribution of sulphur in some profiles of Shivpuri district of Madhya Pradesh. Journal Indian Society Soil Science. 2003;51(1):74-76.

APPENDIX

Table 1. Effect of fertility levels with and without FYM on available nutrients in soil at harvest stage and 0-15 cm depth

Treatments	Available primary nutrients (kg ha^{-1})		
	Available N	Available P	Available K
T_1: Control (0-0-0 kg N-P_2O_5-K2O ha^{-1})	126	11.5	196
T_2: GRD (120-60-40 kgN-P_2O_5-K_2O ha^{-1})	148	21.9	227
T_3: T.Y. 50 q ha^{-1} (138-65-60 kg N-P_2O_5-K_2O ha^{-1})	157	23.6	240
T_4: T.Y. 60 q ha^{-1} (178-86-79 kg N-P_2O_5-K_2O ha^{-1})	165	26.8	252
T_5: T.Y. 50 q + 5 t FYM ha^{-1} (134-50-57 kg N-P_2O_5-K_2O ha^{-1})	166	27.1	254
T_6: T.Y. 60 q + 5 t FYM ha^{-1} (174-71-76 kg N-P_2O_5-K_2O ha^{-1})	176	30.5	267
SE m ±	**7.43**	**1.11**	**11.45**
CD *(p=0.05)*	**22.9**	**3.43**	**35.3**

Table 2. Effect of fertility levels with and without FYM on available sulphur fractions in soil at harvest stage and 0-15 cm depth

Treatments	Sulphur fractions (kg ha^{-1})				
	Available S	Water soluble S	Heat soluble S	Organic S	Total S
T_1: Control (0-0-0 kg N-P_2O_5-K2O ha^{-1})	11.43	10.21	17.50	32.00	78.33
T_2: GRD (120-60-40 kg N-P_2O_5-K_2O ha^{-1})	14.42	12.38	19.17	35.14	91.26
T_3: T.Y. 50 q ha^{-1} (138-65-60 kg N-P_2O_5-K_2O ha^{-1})	15.66	13.75	21.33	37.75	97.61
T_4: T.Y. 60 q ha^{-1} (178-86-79 kg N-P_2O_5-K_2O ha^{-1})	17.22	15.40	24.56	40.16	103.37
T_5: T.Y. 50 q + 5 t FYM ha^{-1} (134-50-57 kg N-P_2O_5-K_2O ha^{-1})	17.12	14.20	22.46	38.70	98.14
T_6: T.Y. 60 q + 5 t FYM ha^{-1} (174-71-76 kg N-P_2O_5-K_2O ha^{-1})	19.94	16.96	25.17	44.28	112.72
SE m ±	**1.01**	**0.98**	**1.36**	**1.98**	**4.91**
CD *(p=0.05)*	**3.37**	**3.29**	**4.58**	**6.64**	**16.47**

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