**Assess the Sulphur fractions in soil as affected by soil test based nutrient application**

**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.

**Key words-** Fractions, Rice, Sulphur.

## 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 (Singh et al. 2017). It is the grain that has shaped cultures, diets and economics of billions of people in the world (Farooq et al. 2009). In India, more than 44 million hectFares 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 (Tiwari et al. 2013).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. (Tewari et al. 2010). 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 (Prosser et al. 2001; Abdallah et al. 2010). Sulphur deficiencies are primarily due to high crop uptake and lesser application of S containing fertilizers (Messick 2003). Soil treated with Sulphur powder improved seedling height in upland rice nursery (Kim 1991). Singh (1993) 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 (2000) and Chandel (2002) also had taller plants and increased shoot number per meter square to the application of 45 kg Sulphur $ha^{-1}$.

**Material 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.

**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 (1984). 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.

**Result 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. (2007), Rahman et al. (2007), Kumar et al. (2011), Ram et al. (2014), Shivay et al. (2014), Sharma and Subehia (2014), Sarker et al. (2015), Chesti et al. (2015) and Warjri et al. (2017). Sharma et al. (2014), 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. (2000), Patel et al. (2011), Dutta et al. (2013), Upinder (2014) and Sharma et al. (2014) in their studies. The increase of organic S with NPK and FYM were also reported by Tripathi et al. (2000), Gosh et al. (2002), Jat and Yadav (2006), Rai et al. (2009), Sharma et al. (2014), Saren et al. (2016). The increase of total S with application of NPK fertilizers with FYM were also reported by Bhatnagar et al. (2003), Rai et al. (2009), Dutta et al. (2013) and Saren et al. (2016).

**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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## 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 $N-P_2O_5-K_2O\ ha^{-1}$) | 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** |