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# Sulphur status of an Alfisol under continuous cropping and fertilization schedule*

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Sulphur is becoming a limiting nutrient particularly in light-textured soils. Sulphur deficiency is increasing in many soils due to increased use of the sulphur-free fertilizers, decreased use of sulphur-containing pesticides and increase in crop intensity and use of high-yielding crop cultivars. In view of this, a study was undertaken to assess the sulphur status of an Alfisol under continuous fertilization and manuring in intensive cropping system of maize (*Zea mays* L.)–finger millet [*Eleusine coracana* (L.) Gaertn.].

The long-term fertilizer experiment was laid out in 1986 on a laterite soil of sandy clay loam texture, classified as isohypothermic typic kandiustalfs. Initially soil was slightly acidic (*p*H 6.05), medium in available N and P and low in available K. The initial available sulphur content ($CaCl_2$-extractable) was medium (10.17 ppm).

The experiment comprised 11 treatments, viz $T_1$, 50% NPK; $T_2$, 100% NPK; $T_3$, 150% NPK; $T_4$, 100% NPK with hand-weeding; $T_5$, 100% NPK +lime; $T_6$,100% NP (–K); $T_7$,100% N (–PK); $T_8$,100% NPK + 15 tonnes/ha FYM; $T_9$,100% NPK (S-free); $T_{10}$, 100% NPK + 15 tonnes/ha FYM + lime (as per lime requirement); and $T_{11}$, control. The recommended doses of fertilizer (NPK) used for maize were 100, 75 and 100 kg /ha and for finger millet 100, 50 and 50 kg/ha during the past 12 years. The N, P and K were applied through urea, single superphosphate and muriate of potash respectively, except treatment $T_9$ [100% NPK (–S)] where P was applied through diammonium phosphate (DAP).

The soil samples were collected from each plot at 0–15 cm and 15–30 cm depth after harvest of maize during March 1998. The *p*H of the soils varied from 4.60 in $T_7$ to 6.31 in $T_{11}$ at 0–15 cm depth and 5.12 in $T_3$ to 6.59 in $T_{10}$ at 15–30 cm depth. The electrical conductivity of the soil varied from 0.07 in $T_{11}$ to 0.176 dS/m in $T_{10}$ at 0–15cm depth and 0.069 in $T_{11}$ to 0.14 dS/m in $T_3$ at 15–30 cm depth. The organic carbon content of the soil ranged from 0.44 in $T_{11}$ to 1.00% in $T_{10}$ and 0.37 in $T_{11}$ to 0.48% in $T_8$ at 0–15cm and 15–30 cm depth respectively.

The soil samples were analysed for different forms of sulphur, viz soluble sulphate (Williams and Steinbergs 1959), soluble + adsorbed sulphate (Fox *et al.* 1964) and total sulphur (Tabatabai 1982). Organic sulphur was determined by subtracting soluble and adsorbed sulphate forms from the total sulphur assuming that amount of reduced inorganic sulphur compounds was negligible in well-drained soils (Freney 1961). Further, adsorbed sulphate was determined by subtracting soluble sulphate extracted with 0.15% $CaCl_2$ extractant from sulphate extracted by monocalcium phosphate containing 500 ppm P solution. Soil *p*H (soil:water ratio, 1:2.5), electrical conductivity (soil water suspension) and soil organic carbon (Walkley and Black 1934) were also determined.

Soluble–sulphate sulphur ($SO_4$ – S) content of the soil increased significantly under all the treatments at both soil depths except in $T_1$ (50% NPK), $T_7$ (100% N) and $T_9$ [100% NPK (–S)] compared with the control (Table 1). This fraction of sulphur constituted about 3.75% of the total sulphur in the surface soil. The increase in soluble sulphate–sulphur content of the fertilized plots could be ascribed to continuous application of different amount of sulphur-containing P fertilizer (SSP) and farmyard manure (FYM). Hence the treatments with 150% of recommended NPK fertilizers containing S and 100% of recommended NPK containing S in conjuction with FYM recorded higher soluble sulphate–sulphur than the rest. On the other hand, plots receiving 100% NPK (sulphur free), 100% N alone and the control recorded lower soluble sulphate–sulphur. These findings are in agreement with those of Sharma and Omanwar (1990) and Santhy and Channal (1997). Relatively high concentration of soluble sulphate–sulphur was observed in the plots amended with lime. This could be attributed to increase in soil *p*H above 6.0, leading to desorption of sulphate–sulphur and consequent increase in soluble sulphate–sulphur concentration in the soil solution (Curtin and Syers 1990). Soluble sulphate–sulphur generally

*Short note

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Table1 Effect of permanent fertilizer use schedule and cropping sequence on different forms of sulphur status of the soil after harvest of maize crop (1997–98) at 2 soil depths

| | Forms of sulphur (ppm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Soluble $SO_4$-S | | Adsorbed $SO_4$-S | | Organic S | | Total S | |
| | 0–15cm | 15–30 cm | 0–15 cm | 15–30 cm | 0–15 cm | 15–30 cm | 0–15 cm | 15–30 cm |
| $T_1$, 50% NPK | 13.2 | 6.1 | 15.3 | 35.9 | 447.2 | 177.2 | 475.7 | 219.4 |
| $T_2$, 100% NPK | 25.3 | 10.4 | 13.4 | 43.3 | 550.9 | 216.5 | 589.6 | 270.3 |
| $T_3$, 150% NPK | 32.2 | 15.6 | 19.7 | 47.2 | 652.2 | 323.9 | 704.1 | 386.7 |
| $T_4$, $T_2$ + hand-weeding | 19 | 14.6 | 17.1 | 41.2 | 588.1 | 228.2 | 624.3 | 284.2 |
| $T_5$, $T_2$ + lime | 27.2 | 14 | 4.3 | 27.2 | 576.3 | 210.6 | 607.9 | 251.9 |
| $T_6$, 100% NP | 18.7 | 13.4 | 20 | 47.8 | 539.8 | 196.3 | 578.6 | 257.5 |
| $T_7$, 100% N | 9 | 3.4 | 1.4 | 18.1 | 238 | 186.1 | 248.5 | 207.6 |
| $T_8$, $T_2$ + FYM | 22.5 | 15.3 | 19.3 | 30.3 | 638.2 | 239.3 | 679.9 | 284.9 |
| $T_9$, $T_2$ (S-free) | 8.6 | 3.7 | 1.5 | 16.6 | 223.3 | 148.2 | 233.4 | 168.5 |
| $T_{10}$, $T_5$ + FYM | 34 | 14.7 | 2.9 | 33.1 | 602.6 | 213.3 | 639.6 | 261.1 |
| $T_{11}$, Control | 10.3 | 6.6 | 0.2 | 14.1 | 215.7 | 182.7 | 226.2 | 203.3 |
| SEm ± | 1.6 | 1.2 | 1.5 | 1.9 | 9.9 | 12.5 | 9.8 | 6.6 |
| CD ($P$=0.05) | 4.6 | 3.4 | 4.6 | 5.5 | 28.8 | 36.2 | 28.4 | 19 |

FYM, Farmyard manure

decreased with the increase in depth of the soil. Higher concentration of this fraction in the surface soil may be attributed to greater plant and microbial activities, resulting in the accumulation of soluble sulphate–sulphur (Tripathi and Singh 1992).

The amount of adsorbed sulphate–sulphur in long-term fertilizer experiment plots varied from 0.20 to 20 ppm and 14.1 to 47.8 ppm at 0–15 cm and 15–30 cm soil depth (Table 1) respectively. This fraction of sulphur constituted 1.85 and 11.4% of the total sulphur in the surface and sub-surface soil samples respectively. The low adsorbed sulphate–sulphur content of the surface soil could be attributed to displacement of adsorbed sulphate with organic anions and phosphate. Adsorbed $SO_4$ – S content of the soil was also affected by continuous use of sulphur-bearing fertilizers, as the plots treated with higher level of S-bearing NPK fertilizer showed higher adsorbed $SO_4$ – S content in the soil than the other treatment. Those plots treated with S-free fertilizer ($T_9$), 100% N ($T_7$) and control ($T_{11}$) had significantly low $SO_4$–S content in the soil. Unlike soluble $SO_4$–S, the adsorbed $SO_4$–S content of the soil increased with the increase in soil depth. This could be attributed to increased sulphate–sulphur adsorption capacity of the soil due to accumulation of the eluviated clay in the sub-surface soil (Pasricha and Fox 1993).

Organic sulphur content of the soil decreased as the soil depth increased following the trend of organic matter in the soil. It was intimately related with organic carbon content of the soil, as indicated by significant correlation($r = 0.67$) between them. Like soluble and adsorbed sulphate–sulphur, organic sulphur content of all plots increased due to continuous application of sulphur-containing fertilizers and manures compared with plots treated with non-sulphur-bearing fertilizers and the control. The results conform the findings of Rattan *et al.* (1995) and Santhy and Channal (1997).

The total sulphur content of the long-term fertilizer experiment plots varied from 233.4 to 704.1 ppm at surface and from 203.3 to 386.8 ppm at subsurface soil (Table 1). Like organic sulphur, the total sulphur content also decreased with soil depth. However, significant increase in total sulphur content of surface and sub-surface soil was observed in most of the treatments compared with the control ($T_{11}$).

Thus continuous fertilization with single superphosphate and farmyard manure improves the different forms of sulphur in the soil under finger millet – maize crop sequence in Alfisols.

## SUMMARY

A study was conducted during 1998 to find out soluble, organic and total sulphur in an on-going long-term fertilization experiment. The results showed that continuous fertilization with the single superphosphate and farmyard manure improves various forms of sulphur in the soil having finger millet [*Eleusine coracana* (L.) Gaertn.]–maize (*Zea mays* L.) cropping sequence in an Alfisol.

## REFERENCES

Curtin D and Syers, J K. 1990. Extractability and adsorption of sulphate in soils. *Journal of Soil Science* 41 : 305–12.

Fox R L, Olson R A and Rhodes H F. 1964. Evaluating the sulpur status of soils by plant and soil tests. *Proceedings, Soil Science Society of America* 28 : 243–6.

Freney J R. 1961. Some observations on the nature of organic sulphur compounds in soils. *Australian Journal of Agricultural Research* 12 : 424–32.

Pasricha N S and Fox R L. 1993. Plant nutrient sulphur in the tropics

and sub-tropics. *Advances in Agronomy* **50** : 210–11.

Rattan R K, Saharan Neelm and Balloli. 1995. Soil sulphur status and crop responses to sulphur in Western Uttar Pradesh. *Fertiliser News* **40** (4) : 31–40.

Santhy P, and. Channal 1997. Organic available and total sulphur status of soil due to long term fertilization after twenty years of intensive cultivation. *Madras agricultural Journal* **84** (10) : 607–9.

Sharma D K and Omanwar P F. 1990. Heat soluble and organic sulphur levels in soils in Hapludoll as affected by continuous cropping and fertilization. *Fertiliser News* **35** (9) : 61–7.

Tabatabai M A. 1982. Chemical and microbiological properties. Sulfur. (*in*) *Methods of Soil Analysis,* Part 2, edn 2, pp 501–38. Page AL (Ed.). American Society of Agronomy Monograph No.9.

Tripathi D and Singh K. 1992. Vertical distribution of sulphur in representative soil groups of Himachal Pradesh. *Journal of Indian Society of Soil Science* **40** : 447–53.

Walkley A and Black I A. 1934. An examination of degtareff method for determining soil organic matter and a proposed modification of the chromic and titration method. *Soil Science* **34** : 29–38.

Williams C H and Steinbergs A. 1959. Soil sulphur fractions as chemical indiceses of available sulphur in some Australian soils. *Australian Journal of Agricultural Research* **10** : 340–52.