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# Sulphur Status of Soils and Crops in a Submontane Tract of Northwestern India

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## ABSTRACT

This paper reports sulphur status of wheat and maize crops and the soils representing alluvial fans and choe (seasonal rivulets) beds in submontane tract of northwestern India. Nearly 77% of the soils (n=302) of the investigated area are deficient in sulphur because of low organic matter and clay contents of these soils. This is reflected from the significant values of correlations of S with organic carbon (0.33*) and clay content (0.64*). The concentration of S in leaves of maize ranged from 0.1 to 3.2 g $kg^{-1}$ with a mean value of 1.0 g $kg^{-1}$ and that in wheat plants from 1.0 to 3.7 g $kg^{-1}$ with a mean value of 1.9 g $kg^{-1}$. Considering 0.2% (2 g $kg^{-1}$) S as the critical level of sufficiency, 90 and 57% samples in maize and wheat, respectively were deficient in S. The data revealed a hunger of S in maize and wheat grown in the fields under study and indicated a need for proper S fertilization of crops to realize better yields.

**Key Words**: Sulphur status; Soils; Maize; Wheat

## INTRODUCTION

Sulphur deficiency has become a major constraint in crop production in coarse textured soils (Takkar *et al.,* 1989). Introduction of high yielding crop varieties, intensive and multiple cropping and the decreased use of farmyard manures seem to have lead to a wide occurrence of S deficiency and diverted the attention of the researchers towards this hitherto neglected element. Sulphur deficiency has been reported from over 70 countries worldwide including India (Tandon, 1991). It has become a major constraint not only in the present production programme but even for low levels of production in areas as diverse as USA, Nigeria, Australia and New Zealand, if the incoming S is in the range of 1 to 4 kg $ha^{-1}$ (Fox & Hue, 1986). It is, therefore, imperative to identify the areas with respect to the sufficiency or deficiency of this element under different situations in relation to soils, climate, crop species and cropping systems. Information on the S status of sandy soils under maize-wheat cropping system was lacking. Therefore, the present investigation was undertaken to assess the available S status of soils and that of maize and wheat crops in a sandy tract of submontaneous region of the Indian Punjab.

## MATERIALS AND METHODS

Three hundred two fields under maize-wheat cropping system were selected in four villages belonging to Bhunga block of Hoshiarpur district of the Punjab state. Surface (0-15 cm) samples from all fields and profile (0-15, 15-30, 30-60 and 60-90 cm) soil samples from 30 fields were collected. The samples were analyzed for available S (0.15% $CaCl_2$ extractable), pH, EC (1:2 Soil-water suspension), organic carbon, calcium carbonate (acid dissolution) and texture (pippete method) by the standard methods (Page *et al*., 1982). Leaf samples of wheat (flag leaf), at head emergence stage, from all the 302 sites and those of maize, at pretasseling (entirely fully developed leaf below whorl) stage, from 103 sites, were also collected and analysed for total S by the turbidimetric method of Chesnin and Yien (1950).

The investigated soils (Typic Ustipsamments) were neutral to alkaline in reaction (pH 7.1-8.4) and soluble salts content of these soils was quite low (0.06-0.35 $dSm^{-1}$). Seventy five per cent of soil samples were low in organic carbon (0.07-0.67%) and calcium carbonate content ranged from 0.0 to 1.25% (Table I). As determined from the relative proportions of sand, silt and clay, a majority (90%)

**Table I. Physico-chemical characteristics of the soils**

| Sites (No. of samples) | pH (1:2) | EC ($dSm^{-1}$) | OC (%) | $CaCO_3$ (%) | Per cent | | |
|---|---|---|---|---|---|---|---|
| | | | | | Sand | Silt | Clay |
| Bhatolian (120) | 7.1-8.4 | 0.07-0.30 | 0.07-0.67 | 0.0-1.25 | 47.2-94.5 | 3.1-39.0 | 2.5-12.5 |
| | (7.4) | (0.17) | (0.35) | (0.47) | (73.6) | (19.6) | (5.9) |
| Kahlwan | 7.2-7.9 | 0.06-0.30 | 0.07-0.49 | 0.0-0.8 | 67.5-93.5 | 4.0-18.5 | 2.0-12.5 |
| (61) | (7.5) | (0.16) | (0.24) | (0.29) | (82.5) | (10.6) | (6.3) |
| Phanwra | 7.2-8.2 | 0.07-0.35 | 0.15-0.61 | 0.0-0.7 | 62.0-93.2 | 4.0-27.0 | 2.5-15.0 |
| (79) | (7.7) | (0.15) | (0.36) | (0.23) | (80.6) | (11.9) | (6.8) |
| Fatehpur | 7.1-8.1 | 0.07-0.30 | 0.12-0.53 | 0.0-0.7 | 67.2-92.1 | 5.0-23.0 | 2.5-9.0 |
| (42) | (7.9) | (0.13) | (0.28) | (0.17) | (80.8) | (13.8) | (4.9) |
| Overall | 7.1.8.4 | 0.06-0.35 | 0.07-0.67 | 0.0-1.25 | 47.2-94.5 | 3.1-39.0 | 2.0-15.0 |
| (302) | (7.5) | (0.16) | (0.32) | (0.33) | (78.2) | (14.8) | (6.3) |

Figures in the ( ) are the average values

of the investigated soils were loamy sand in texture except at few sites where the texture was either loam (4%) or silt loam (6%).

## RESULTS AND DISCUSSION

Available sulphur content fluctuated between 0.5 and 0.18, 0.5 and 13.5, 2.0 and 14.0 and 0.5 and 13.5 mg $kg^{-1}$ in villages Bhatolian, Kahlwan, Phanwra and Fatehpur with the respective mean values of 7.5, 6.3, 7.9 and 5.5 mg $kg^{-1}$. Considering 10 mg $kg^{-1}$ $CaCl_2$ extractable S as critical (Kanwar & Takkar, 1964) level, 77% of soils of the area indicated S deficiency (Table II). Such a high magnitude of S deficiency could be ascribed to the low organic carbon content in 75% soil samples and low sulphate retention capacity owing to the coarse texture of 90% of the soils. Significant correlations of available S with organic carbon (0.33*) and clay content (0.64*) support this contention. In coarse-textured soils of Ludhiana (Punjab), S deficiency was reported by Kanwar (1963), and Cheema and Arora (1984), respectively to the tune of 75 and 82%. With the soil depth, the available S decreased from 6.7-8.5 mg $kg^{-1}$ in 0-15 cm to 4.7-6.4 mg $kg^{-1}$ in 30-60 cm layers and thereafter, it increased to 7.7-12.4 mg $kg^{-1}$ in 60-90 cm (Fig. 1). The pattern observed in the upper three layers seems to have resulted from recycling of S over the years by higher plants and microbial activity and subsequent organic matter accumulation in the 0-15 cm layer. The higher content in

**Table II. Available sulphur status (mg $kg^{-1}$) of surface soils**

| Villages | Available sulphur | | Frequency of S Deficiency (%) |
|---|---|---|---|
| | Range | Mean | |
| Bhatolian | 0.5-18.0 | 7.5 | 68 |
| Kahlwan | 0.5-13.5 | 6.3 | 88 |
| Phanwra | 2.0-14.0 | 7.9 | 75 |
| Fatehpur | 0.5-13.5 | 5.5 | 90 |
| Overall | 0.5-18.0 | 7.1 | 77 |

**Fig 1. Profile distribution of available sulphur**

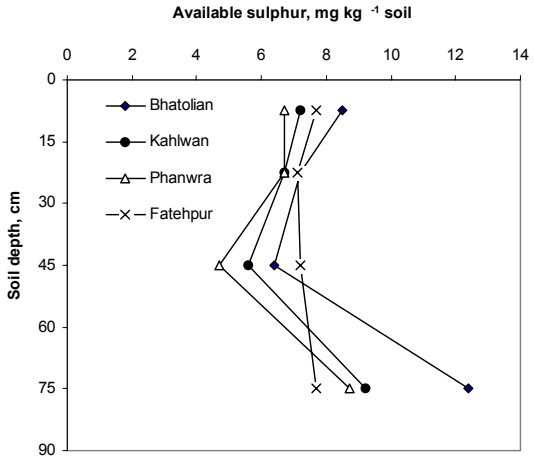


**Table III. Sulphur content (g $kg^{-1}$) of maize and wheat leaves**

| Villages | Maize | | Wheat | |
|---|---|---|---|---|
| | Range (Mean) | Deficient Samples (%) | Range (Mean) | Deficient Samples (%) |
| Bhatolian | 0.1-3.2 (1.2) | 89 | 1.0-3.3 (1.9)` | 63 |
| Kahlwan | 0.2-2.2 (1.0) | 96 | 1.1-3.7 (1.9) | 58 |
| Phanwra | 0.2-1.0 (0.4) | 94 | 1.1-3.7 (2.0) | 46 |
| Fatehpur | 0.4-2.7 (0.4) | 77 | 1.2-3.7 (2.1) | 55 |
| Overall | 0.1-3.2 (1.0) | 90 | 1.0-3.7 (1.9) | 57 |

60-90 cm layer might be the consequence of the downward movement of S from the upper layers during rains and/or irrigations as well as relatively finer texture of the soil in this layer.

The concentration of S in maize leaves ranged form 0.1 to 3.2 g $kg^{-1}$ with a mean value of 1.0 g $kg^{-1}$ (Table III). Considering 0.20% S (2 g $kg^{-1}$) as the critical limit of sufficiency (Plant Analysis Laboratory, Madison, Wisconsin, U.S.A.), 89, 96, 94 and 77% samples were deficient in S in Bhatolian, Kahlwan, Phanwra and Fatehpur, respectively with an overall deficiency of 90%. Concentration of S in wheat plants ranged from 1.0 to 3.7 g $kg^{-1}$ with average value of 1.9 g $kg^{-1}$. Though all the wheat samples had, in general, higher S content than that in maize leaves yet a majority of the former contained inadequate S. About 63, 58, 46 and 55% samples of wheat had deficient S content in villages Bhatolian, Kahlwan, Phanwra and Fatehpur, respectively with an overall deficiency of 57%. These data thus also revealed a hidden hunger of S in the wheat grown in the fields under investigation and indicate a necessity for proper S fertilization to obtain better yields. Similar results have been reported by Cheema and Arora (1984) for wheat growing in coarse textured soils of Ludhiana and by Jones (1976) for maize from Georgia. The extent of deficiency in maize (90%) was almost in proportion with that in the soil (80%); whereas, in wheat the deficiency was lower (57%) than that observed in the corresponding soils (77%). The variation in the magnitude of deficiency exhibited by the leaf and soil analysis might have emanated from the factors affecting the status of soils and crops which are not being accounted for in the critical levels used in this study. Comparatively lower percentage of deficiency indicated by wheat plants may be ascribed to the absorption of S from the deeper layers of soils (Chhibba & Sekhon, 1983), besides longer duration of this crop compared to maize.

## CONCLUSION

The results of this study indicated a high degree of S deficiency in the soils as well as crops in the investigated

area and have underlined the need for S fertilization to realize desirable crop yields.

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