The Pharma Innovation Journal 2022; SP-11(9): 398-401

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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(9): 398-401

www.thepharmajournal.com
Received: 08-06-2022
Accepted: 13-07-2022

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Sulphur status and their fractions in the soils of South Saurashtra agro-climatic zone

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Abstract
An attempt has been made in the present study to evaluate the sulphur status of soils of South Saurashtra Agro-climatic Zone of Gujarat state by collecting two hundred seventy surface soil samples (10 soil samples from each taluka) from cultivated fields. The soil samples were analyzed for different forms of sulphur viz., total sulphur, organic sulphur, non-sulphate sulphur, available sulphur, sulphate sulphur and water soluble sulphur. In South Saurashtra Agro-climatic Zone, the water soluble sulphur ranged from 2.14 to 80.92 mg kg^{-1} with mean value of 21.39 mg kg^{-1}. The overall range of sulphate sulphur was recorded as 0.506 to 68.62 mg kg^{-1} with mean value of 18.18 mg kg^{-1}. Mean value of available sulphur was observed 25.77 mg kg^{-1} and it was ranged from 2.21 to 103.2 mg kg^{-1}. The overall range of non-sulphate sulphur was 2.33 - 63.29 mg kg^{-1} with mean value of 25.37 mg kg^{-1}. On the basis of overall data, organic sulphur ranged from 82.85 to 3180 mg $kg^{-1}$with mean value of 649.7 mg kg^{-1}. The overall range of total sulphur was 128.4 – 3216 mg kg^{-1} with mean value of 693.3 mg kg^{-1}.

Keywords: Available sulphur, total sulphur, organic sulphur, non-sulphate sulphur, sulphate sulphur, Water soluble sulphur, South Saurashtra

1. Introduction
The rising need for food due to the country's growing population has driven farmers to employ contemporary agricultural techniques. Intensive cropping, development of high yielding varieties, use of high analysis chemical fertilizers, especially sulphur-free fertilizers and other modern agro-technologies all contributed to the depletion of secondary and micronutrients. Among the secondary nutrients, the deficiency of sulphur with increasing frequency from different parts of India has been reported.

Sulphur is one of the most important element for plant growth and development. After nitrogen, phosphorus and potassium, it is presently considered the fourth most important nutrient for plants. It is similar to N in terms of plant functions and P in terms of plant uptake. When crops have access to the optimum amount of sulphur, they can generate high yields of high-quality products (Anon., 1992) [1]. The use of sulphur resulted in higher output and better quality.

Sulphur is also a constituent of vitamins like thiamine, biotin, glutathione and co-enzyme-A. It is involved in the action of proteolytic enzymes as well as oxidation-reduction activities in the plant-animal system. It is present in cell protoplasm as a constituent of proteins and hence plays a critical role in cell metabolic processes.

Despite the abundance of sulphur in the earth's crust, soil sulphur levels are frequently inadequate. Sulphur is mostly found in the organic component of surface soils, and the natural supply varies from low to adequate depending on the amount of organic matter available (Oke, 1967) [15]. Rainwater, irrigation water, atmosphere, fertilizers, manures, pesticides and fungicides are all used to supplement native sulphate. Sulphur is commonly lost from soils through leaching, volatilization and crop removal. Total S, organic S, non-sulphate S, available-S, sulphate S and water-soluble S are the six types of sulphur found in soil.

2. Materials and Methods
The present investigation was undertaken by conducting soil survey of South Saurashtra Agro-climatic Zone of Gujarat state and analysis at the Department of Soil Science and Agricultural Chemistry, College of Agriculture, Junagadh Agricultural University, Junagadh. Different soil fractions of sulphur viz, total sulphur, organic sulphur, sulphate sulphur, water soluble sulphur, heat soluble sulphur and non-sulphate sulphur were analysed.

Ten surface soil samples were collected from Junagadh, Bhesan, Keshod, Malia, Manavadar, Mangrol, Mendarda, Vanthali and Visavadar talukas of Junagadh district, Gir-Gadhada, Kodinar, Sutrapada, Talala, Una and Veraval talukas of Gir Somnath district, Bagasara, Jafrabad and Rajula talukas of Amreli district, Ghogha, Mahuva and Talaja talukas of Bhavnagar district, Porbandar, Kutiyana and Ranavav talukas of Porbandar district, Dhoraji, Upleta and Jetpur talukas of Rajkot district of South Saurashtra Agro-climatic Zone of Gujarat. Total 270 surface (0-15 cm) soil samples were collected during summer season of 2021.

All the soil samples collected were analysed for different forms of sulphur by using standard methods. Total sulphur was determined by using method given by Chaudhary and Cornfield (1966) [6] while organic sulphur was determined by using method given by Bardsley and Lancaster (1965) [4]. Sulphate sulphur, water soluble sulphur and heat soluble sulphur was determined by using method given by Williams and Steinbergs (1959) [22]. The non-sulphate sulphur is estimated by difference between the total sulphur and sum of organic and sulphate sulphur.

3. Results and Discussion

3.1 Status of water soluble sulphur in South Saurashtra Agro-climatic Zone

The overall range of water soluble sulphur in South Saurashtra Agro-climatic Zone was 2.14 - 80.92 mg kg^{-1} with a mean value of 21.39 mg kg^{-1} (Table - 1). The highest mean value 26.34 mg kg^{-1} of water soluble sulphur was recorded in Bhavnagar district whereas, the lowest value of 14.65 mg kg^{-1} was recorded in the soil sample collected from Rajkot district (Fig. 1).

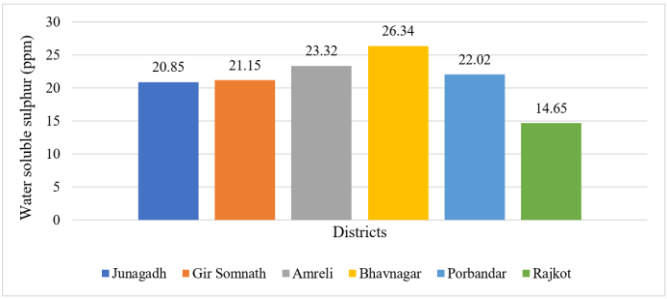

Fig 1: District wise distribution of water soluble sulphur (ppm) on mean value basis

The results are similar to those found by Karwasara *et al.* (1986) [11], who found that water soluble sulphur content in Hisar soils ranged from 14.0 to 85.6 ppm with an average of 31.1 ppm. The amount of water soluble sulphur ranges from 1.4 to 230.6 ppm, with a mean value of 28.7 ppm, according to Balanagoudar and Satyanarayana (1990) [3] in Vertisols and Alfisols of northern Karnataka, while, Kour *et al.* (2010) [12] discovered a wide range of water-soluble sulphur (12 to 66.5 mg kg^{-1}), with a mean of 32.1 mg kg^{-1} in midhill soils of North India.

3.2 Status of sulphate sulphur in South Saurashtra Agro-climatic Zone

In the South Saurashtra Agro-climatic Zone, the overall range of sulphate sulphur was 0.51 - 68.62 mg kg^{-1}, with a mean value of 18.18 mg kg^{-1} (Table - 1). The highest sulphate sulphur value of 23.63 mg kg^{-1} was found in Bhavnagar, while the lowest of 11.85 mg kg^{-1} was found in the soil sample collected from Rajkot district (Fig. 2).

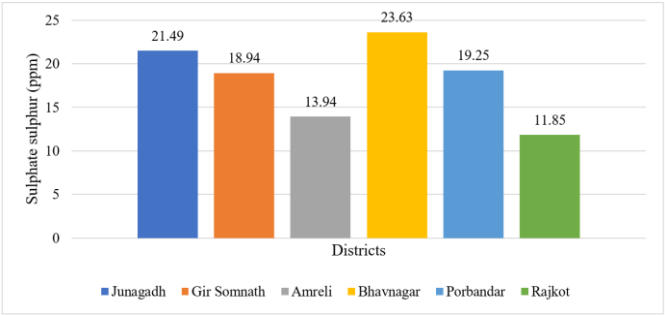

Fig 2: District wise distribution of sulphate sulphur (ppm) on mean value basis

The results are similar to those reported by Arora *et al.* (1988) [2], who found that the $CaCl_2$ extractable sulphate sulphur ranged from 5.1 to 46.0 ppm in major Punjab soil series. In some parts of Western Uttar Pradesh, Sharma *et al.* (2000) [18] found that the ranges of calcium chloride extractable (sulphate) sulphur were 10.1 to 47.5, 3.7 to 56.2 and 3.7 to 47.5 mg kg^{-1} in Alfisols, Inceptisols and Mollisols, respectively, sulphate sulphur concentrations ranged from 4.1 to 39.95 g kg^{-1} in Jaipur district (Rajasthan), according to Jat and Yadav (2006) [9].

3.3 Status of heat soluble or available sulphur in South Saurashtra Agro-climatic Zone

Heat soluble sulphur ranged from 2.21 to 103.2 mg kg^{-1} in the South Saurashtra Agro-climatic Zone, with a mean value of 25.77 mg kg^{-1} (Table - 1). The highest value of heat soluble sulphur was found in Bhavnagar district soils, with a mean of 35.15 mg kg^{-1} and the lowest value of 17.43 mg kg^{-1} was found in Junagadh district soils (Fig. 3).

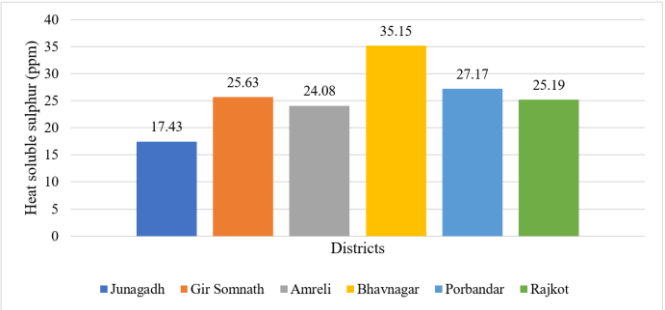

Fig 3: District wise distribution of heat soluble sulphur or available sulphur (ppm) on mean value basis

Whatever the outcomes of available sulphur came, it was comparable to those obtained by findings of Gupta and Submaria (1997) [8] in the soils of Jammu area of Jammu and Kashmir, Jetpara *et al.* (2009) [10] studied available sulphur over a cycle of ten years in the soils of Saurashtra region of Gujarat during the year 1990 and 2000, Patel *et al.* (2011) [17] in soil of Banaskantha district of Gujarat and Sutaria *et al.* (2016) [20] observation as available S ranged from 3.6 to 141.8 mg kg^{-1} in soils of Rajkot district, Gujarat were also giving the result comparable to research findings.

3.4 Status of non-sulphate sulphur in South Saurashtra Agro-climatic Zone

The overall range of non-sulphate sulphur in South Saurashtra Agro-climatic Zone was 2.33 - 63.29 mg kg^{-1} with mean value

of 25.37 mg kg^{-1} (Table - 1). The highest value of non-sulphate sulphur was recorded in Gir-Somnath with a mean of 28.20 mg kg^{-1} whereas, lowest value of 22.73 mg kg^{-1} was recorded in the soil sample collected from Junagadh soils (Fig. 4).

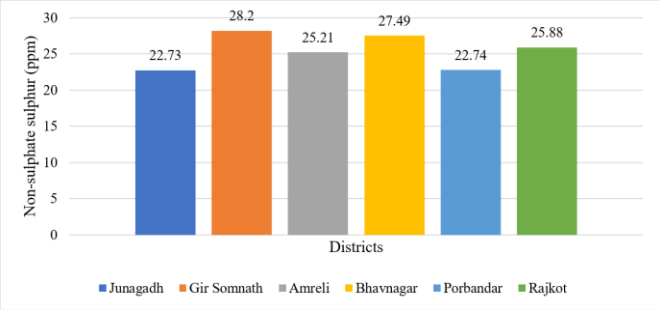

Fig 4: District wise distribution of non-sulphate sulphur (ppm) on mean value basis

The result obtained is similar to that obtained by Dolui and Nayek (1981) [7] that non-sulphate sulphur ranged from 13 to 70 mg kg^{-1} (averaged 29.14 mg kg^{-1}) in some red and lateritic soil profiles of West Bengal, Singh (2015) [19] found non-sulphate sulphur concentrations ranging from 25 to 105 mg kg^{-1}, with an average of 60 mg kg^{-1} in soils of Agra, Uttar Pradesh, Sutaria *et al.* (2016) [20] found range of non- sulphate sulphur as 3.6 to 157.1 mg kg^{-1} soil (mean 31.2 mg kg^{-1}) in the soils of Rajkot, Gujarat.

3.5 Status of organic sulphur in South Saurashtra Agro-climatic Zone

Organic sulphur levels in the South Saurashtra Agro-climatic Zone ranged from 82.85 to 3180 mg kg^{-1}, with a mean of 649.7 mg kg^{-1} (Table - 1). The highest amount of organic sulphur was found in Bhavnagar, at 833.9 mg kg^{-1}, while, the lowest value was found in a soil sample from Rajkot soils, at 314.7 mg kg^{-1} (Fig. 5).

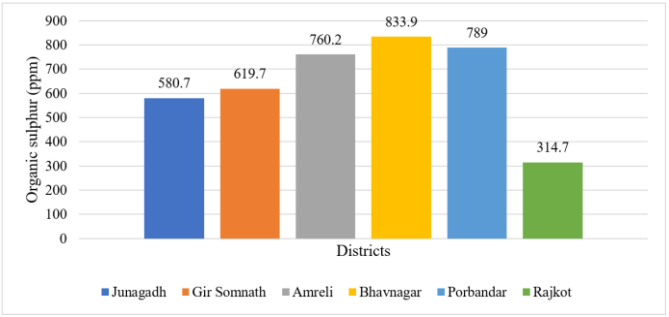

Fig 5: District wise distribution of organic sulphur (ppm) on mean value basis

The organic sulphur results agreed with those reported by Trivedi *et al.* (2000) [21] in soil profiles of Madhya Pradesh, Jat and Yadav (2006) [9] findings in soils of Jaipur district (Rajasthan) and Pareek (2007) [16] findings in soils of Pantnagar, Uttarakhand.

3.6 Status of total sulphur in South Saurashtra Agro-climatic Zone

The overall range of total sulphur in South Saurashtra Agro-climatic Zone was 128.4 – 3216 mg kg^{-1} with mean value of 693.3 mg kg^{-1} (Table - 1). The highest value of total sulphur was recorded in Bhavnagar with a mean of 885 mg kg^{-1} whereas, lowest value of 352.4 mg kg^{-1} was recorded in the soil sample collected from Rajkot soils (Fig. 6).

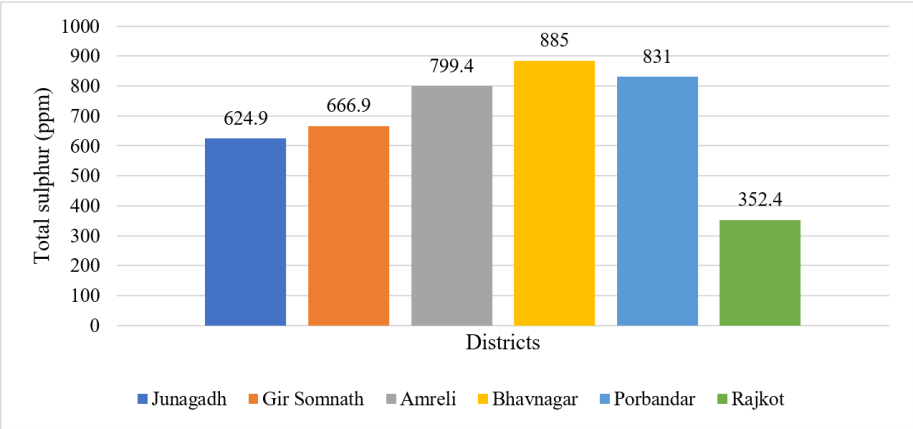

Fig 6: District wise distribution of total sulphur (ppm) on mean value basis

The data obtained for total sulphur during analysis was in line to that obtained by Lande *et al.* (1977) [13] who found that total sulphur in saline soils ranged from 425.74 to 1057.74 ppm. Bhatnagar *et al.* (2003) [5] reported that the total sulphur in surface soil of Vertisols ranged from 798 to 987 mg kg $^{-1}$ with mean value of 892 mg kg^{-1} and total S content in soils of the Osmanabad district of Maharashtra varied between 300-2500 mg kg^{-1} with a mean value of 1654.38 mg kg^{-1} in Vertisols, according to Narale *et al.* (2017) [14].

Table 1: Range and mean of different forms of sulphur (mg kg^{-1}) in different districts of South Saurashtra Agro-climatic Zone

Name of districts	HSS	SS	WSS	OS	TS	NSS
Junagadh	2.21 - 81.80 (17.43)	3.25 - 68.62 (21.49)	2.38 - 71.02 (20.85)	108.1 – 3180 (580.7)	136.5 - 3216 (624.9)	2.33 - 55.96 (22.73)
Gir Somnath	5.59 - 73.80 (25.63)	1.23 - 57.71 (18.94)	3.37 - 80.92 (21.15)	105.6 - 2305 (619.7)	148.5 - 2386 (666.9)	5.64 - 63.29 (28.20)
Amreli	10.06 - 53.22 (24.08)	4.21 - 32.75 (13.94)	6.93 - 44.03 (23.32)	155.2 – 3016 (760.2)	182.2 - 3050 (799.4)	13.82 - 36.35 (25.21)
Bhavnagar	14.54 - 83.12 (35.15)	6.42 - 62.87 (23.63)	4.38 - 70.95 (26.34)	203.4 – 2518 (833.9)	280.8 - 2547 (885)	4.29 - 47.94 (27.49)
Porbandar	3.85 - 103.2 (27.17)	0.51 - 64.71 (19.25)	3.04 - 61.80 (22.02)	240 – 2356 (789)	264 - 2434 (831)	11.28 - 41.69 (22.74)
Rajkot	5.34 - 57.02 (25.19)	2.20 - 27.42 (11.85)	2.14 - 34.25 (14.65)	82.85 - 991.5 (314.7)	128.4 - 1015 (352.4)	11.78 - 61.97 (25.88)
Overall	2.21 - 103.2 (25.77)	0.51 - 68.62 (18.18)	2.14 - 80.92 (21.39)	82.85 - 3180 (649.7)	128.4 – 3216 (693.3)	2.33 - 63.29 (25.37)

Note: Values in parenthesis are mean values

4. Conclusion

The soils of South Saurashtra Agro-climatic Zone are calcareous in nature and alkaline in reaction. As per data obtained, it can be concluded that decreasing order for reading of different fractions of sulphur in South Saurashtra Agro-climatic Zone is TS > OS > AS > NSS > WSS > SS. Organic sulphur contributed maximum to total sulphur.

5. References

1. Anonymous. The importance of sulphur for crop production. FIA Jr. 1992, 127-130.
2. Arora BR, Ghai VK, Hundal HS. Distribution of sulphur in benchmark soils of Punjab. Journal of Indian Society of Soil Science. 1988;36(2):367-368.
3. Balanagoudar SR, Satyanarayana T. Depth distribution of different forms of sulphur in Vertisols and Alfisols. Journal of Indian Society of Soil Science. 1990;38(4):634-640.
4. Bardsley CE, Lancaster JD. Sulphur in "Method of soil Analysis" Part II, Ed. by C. C. Black, Acad. Press, Inc., New York, 1965, 1102-1116.
5. Bhatnagar RK, Bansal KN, Trivedi SK. Distribution of sulphur in some profiles of Shivpuri District of Madhya Pradesh. Journal of Indian Society of Soil Science. 2003;51(1):74-76.
6. Chaudhary IA, Cornfield AH. The determination for total sulphur in soils and plant materials. Analyst. 1966;9(1085):586-589.
7. Dolui AK, Nayek AK. Distribution of different forms of sulphur in some red and lateritic soil profiles of West Bengal. Indian Agriculturist. 1981;25(3):185-189.
8. Gupta JP, Submaria NM. Analytical sampling of soils of Jammu region of J and K for sulphur content. Research and Development Reporter. 1997;14(1-2):26-29.
9. Jat JR, Yadav BL. Different forms of sulphur and their relationship with properties of Entisols of Jaipur district (Rajasthan) under mustard cultivation. Journal of Indian Society of Soil Science. 2006;54(2):208-212.
10. Jetpara PI, Sakarvadia HL, Parmar KB. Status and depletion of sulphur in the soils of Saurashtra region of Gujarat. Asian Journal of Soil Science. 2009;4(1):156-157.
11. Karwasara SPS, Bharti A, Khera AP. Sulphur status of some soils of Haryana. Journal of Indian Society of Soil Science. 1986;34(3):617-618.
12. Kour S, Arora S, Jalali VK, Mondal AK. Soil sulphur forms in relation to physical and chemical properties of midhill soils of North India. Communications in Soil Science and Plant Analysis. 2010;41(3):277-289.
13. Lande MG, Varade SB, Badhe NN. Sulphur status and relationship with physicochemical properties of Marathwada soils. Journal of Maharashtra Agricultural University. 1977;2(3):195-201.
14. Narale SH, Pawar YS, Gourkhede PH. Evaluation of different fractions of N and S in soils of Tuljapur tahsil of Osmanabad district. International Journal of Tropical Agriculture. 2017;35(3):0254-8755.
15. Oke OL. Sulphur status of some Nigerian soils. Journal of Indian Society of Soil Science. 1967;15:207-208.
16. Pareek N. Soil mineralizable sulphur: A sulphur availability index. Journal of Indian Society of Soil Science. 2007;55(3):289-293.
17. Patel JM, Patel MV, Jadav NJ, Patel VR. Sulphur fraction and relationship with soil properties in Banaskantha district, Gujarat. Agropedology. 2011;21(2):35-40.
18. Sharma YK, Gangwar MS, Srivastava PC. Sulphur fractions and carbon, nitrogen and sulphur relationships in Alfisols, Inceptisols and Mollisols in some parts of western UP. Journal of Indian Society of Soil Science. 2000;48(3):477-486.
19. Singh S. Forms of sulphur in relation to soil properties under pearl millet cultivation in soils of Agra, Uttar Pradesh. Annals of Plant and Soil Research. 2015;17(4):362-365.
20. Sutaria GS, Vora VD, Talpada MM, Hirpara DS, Vekaria PD, Akbari KN. Studies on sulphur fractions in soils of Rajkot district, Gujarat. International Journal of Agricultural Science and Research. 2016;6(1):61-68.
21. Trivedi S, Bansal KN, Tomar RAS, Verma RS. Vertical distribution of forms of sulphur in some profiles of Morena and Bhind districts of Madhya Pradesh, Journal of Indian Society of Soil Science. 2000;48(2):238-241.
22. Williams CH, Steinbergs A. Soil sulphur fractions as chemical indices of available sulphur in some Australian soils. Australian Journal of Agricultural Research. 1959;10(3):340-352.