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Status of available Sulphur and micronutrients in soils of Patan district of Gujarat

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Abstract
In order to assess available sulphur and micronutrients (Fe, Mn, Zn and Cu) in soils of Patan district of Gujarat, three hundred and sixty surface soil samples (0-15cm) were randomly collected from 9 talukas (Siddhpur, Saraswati, Patan, Chanasma, Harij, Shankhesvar, Sami, Radhanpur, and Santalpur) of Patan district. All the collected soil samples were analyzed for available sulphur and DTPA-extractable micronutrients (Fe, Mn, Zn and Cu) as per standard procedures. The available sulphur content in soils of Patan district varied from 2.15 to 92.68 mg kg^{-1} with a mean value of 28.99 mg.kg^{-1}. Out of 360 soil samples of the district, 21.94, 32.50 and 45.56 per cent were found under low, medium and high categories for available sulphur, respectively. The soils of Patan district have overall nutrient index of 2.24 indicating adequate status for available sulphur. The DTPA-extractable Fe in soils of Patan district ranged from 3.34 to 22.80 mg kg^{-1} with an average value of 6.99 mg kg^{-1}. As far as DTPA-extractable Mn is concerned, it varied from 3.46 to 37.10 mg kg^{-1} with a mean value of 12.63 mg kg^{-1}. The DTPA-extractable Zn content in soils of Patan district varied from as low as 0.10 to as high as 2.18 mg kg^{-1} with a mean value of 0.75 mg kg^{-1}. The content of DTPA-extractable Cu in soils of Patan district varied from 0.14 to 2.76 mg kg^{-1} with a mean value of 0.82 mg kg^{-1}. The correlation study showed that the soil pH had highly significant and negative correlation with DTPA-extractable Mn and Zn (-0.209^{**} and -0.260^{**}, respectively). The highly positive significant correlation of DTPA-extractable Mn, Zn and Cu with organic carbon content of the soil (0.294^{**}, 0.312^{**} and 0.167^{**}, respectively) was obtained.

Keywords: Sulphur, micronutrients, Patan, nutrient index

Introduction

Soil is dynamic natural body composed of mineral, organic matter and living organism in which plant grows. Soil is medium for plant growth, which supplies moisture, air, nutrient and supports plant life. Soil is a vital natural resource. Life supporting system of a country and the socio-economic development of its people depends upon proper use of soil. To meet the requirements of food, fiber, fuel, fruits for the increasing population, farm land development are often extended even to the areas unsuitable for agriculture with the shrinking of land for agriculture. Success in agriculture depends on the land quality and soil characteristics. At this juncture, our efforts for increasing productivity should aim at the optimum utilization of natural resources *viz*., water and climate without impairing the environment. In this context, the need for both basic and applied researches are to be focused on the intensively cultivated area to generate scientific information or utilize it to generate appropriate technology for sustainable agricultural production with improvement of soil productivity and soil quality.

Sulphur is recognized as fourth important plant nutrient after N, P and K and is gaining considerable importance in quality crop production in context of Indian agriculture, particularly when there is more and more use of non-sulphur containing fertilizers as well as insufficient use of organic manures. A few years ago, sulphur was considered as a nutrient of academic interest. But today its importance to Indian agriculture is being increasingly recognized (Tandon, 1991) [21]. In India, the total removal of S by growing crops is estimated to be 1.8 million tonnes per year and the addition of S through fertilizers is 0.8 million tonnes resulting in an annual deficit of 1.0 million tonnes. Further, in intensive cropping systems, removal of S ranges from 30 to 70 kg per hectare per annum. Thus, the annual S deficit could reach 1.3 million tonnes of S by 2010 unless extra ordinary corrective measures are taken to bridge the gap (Gupta, 2006) [5]. Sulphur is known for its role in the formation of amino acids *viz*., cystine, cysteine and methionine; oil content in oilseeds and nutritive quality of forages. Sulphur is associated with synthesis of certain vitamins, metabolism of carbohydrates, proteins and oils; formation of flavour imparting compounds in crucifers and marketing quality of the produce of several crops. It is also a constituent of glutathione, a compound supposed to play a part in plant respiration. Further, sulphur plays a vital role in chlorophyll formation and the building blocks for the proteins.

On the basis of available evidence, one can also add that sulphur lowers the HCN content of certain crops, promotes nodulation in legumes, produces heavier grain of oilseeds and improves the quality of sugarcane juice. In the absence of sufficient sulphur, several essential enzymatic activities and physiological functions are inhibited. When sulphur is in insufficient amount, both quantity and quality of the crops are adversely affected. Thus, maintenance of optimal level of sulphur in the soil in relation to other nutrients is essential for maximum crop production and as well as its quality.

Deficiency of sulphur in soil makes the plant weak, stunted, pale green to pale yellow in colour with weak stem and plant do not attain maturity in time which would result in great economic loss. Sulphur deficiency is known to reduce crops yield upto 35 per cent. (Pal and Singh, 1992) [13]. The deficiency of sulphur has been reported by several workers for most of the crops all over the world (Chapman, 1975 and Tandon, 1986) [26]. Sulphur deficiency may occur in any type of soil but there is more possibility of sulphur deficiency in light textured soil with poor organic matter content. However, major reasons for sulphur deficiency could be lack of balanced fertilizer use of N, P and K, increasing depletion of soil sulphur through higher yields, higher cropping intensity and removal of sulphur through leaching and soil erosion (Jayalalitha and Narayanan, 1995) [9].

Micronutrients are important for maintaining soil health and also increasing productivity of crops (Rattan *et al*. 2009) [20]. Deficiency of micronutrients during the last three decades has grown in both, magnitude and extent. This has become a major constraint to production and productivity of rice, wheat and pulses. Plants grow in micronutrient deficient soils exhibit similar reductions in productivity as those grown in macronutrient deficient soils. Higher removal of micronutrients from the soil as a consequence of adoption of high yielding varieties (HYVs) and intensive cropping together with shift towards high analysis NPK fertilizers and scarce or limited use of organic manure has caused decline in the level of micronutrients in the soil to below normal at which productivity of crops cannot be sustained. The improper nutrient application has led to emergence of multi-nutrient deficiencies in the Indian soils (Sharma, 2008) [21]. The micronutrients essential for plants also indispensible for human being, Zn and Fe are the most important nutrients and nearly half of the Indian soils are deficient in Zn and 15% in Fe. Available zinc in Gujarat soils ranges between 0.25 to 2.58 mg kg^{-1}. As nearly 24% soils of Gujarat state are Zn deficient and 58% soils of North Gujarat found deficient to medium in available zinc status (Dangarwala *et. al*., 1983) [4]. Scanty information is available on status of available sulphur and micronutrients in soils of Patan district. In view of this, an attempt was made in present investigation, to workout the systematic and comprehensive information on sulphur and micronutrients status and its relationship with important physio-chemical properties (EC, pH and organic carbon) of soil by collecting large number of soil samples (40) from every talukas of Patan district.

Materials and Methods

Geographically, Patan district lies between 23.55° to 24.41° North (latitude) and 71.31° to 72.20° East (longitude) situated and bounded by Arabic sea in the west. The area covered by the district is 5667.72 Sq.km. For administrative convenience, the district has been divided into 9 Taluka and 510 Gram panchayats with 521 villages. Patan district also has various rivers like Banas, Saraswati and Rupen with sandy and sandy-loam soil, which is perfect for crop cultivation. Patan district is subdivided into three agro-ecological situations *viz*., Alluvial sandy soil with low rainfall, Saline soil with low rainfall, Salt affected soil. According to climate, topography, soil characteristics and cropping pattern, Patan district falls under North Gujarat Agro-climatic Zone-IV.

The climate of this region is sub-tropical monsoon type and falls under arid and semi-arid region. In general monsoon commences in July and retreats by the middle of September. Most of the precipitation is received from south-west monsoon concentrating in the month of July and August. The average rainfall varies from 550 mm to 650 mm. The temperature varies from 7°C to 45°C. The December and January are the coldest months while April and May are the hottest month of the year. The summer is very hot where in temperature ranges from 42-46°C. The average wind velocity varies from 4.0 to 12 km/hr. In the Patan district nearly 90 per cent of soil are loamy. The alluvial soil is found in the taluka of Santalpur and Radhanpur. The type of soil is saline and can yield crops only under optimum rainfall conditions. Medium black and saline soils are in patches in the low-lying portions of Sami and Harij talukas. This type of soil is suitable for cultivation of wheat and cotton. The soils of Patan District are neutral to alkaline in pH, normal to medium in electric conductivity, low in organic carbon, nitrogen, medium in phosphorus and medium to high in potash contents. So, overall, the soil fertility indices are good from the point of view of agriculture.

To assess the available sulphur and micronutrients (Fe, Mn, Zn, Cu) in soils of Patan district, total 360 representative surface soil samples from depth of 0-15 cm were collected from farmers' fields during summer season using multistage stratified random sampling method covering 9 talukas (Siddhpur, Saraswati, Patan, Chanasma, Harij, Shankhesvar, Sami, Radhanpur, and Santalpur) of district. The forty soil samples were collected from each talukas of Patan district. The soil samples were drawn with the help of stainless steel implement to avoid micronutrients contamination. The collected soil samples were analyzed for available sulphur, micronutrients and various chemical properties viz., soil reaction (pH), electrical conductivity (EC), organic carbon (OC). The standard analytical methods followed for the estimated of available sulphur, micronutrients and chemical properties of soil are as under:

Parameter	Method	References
pH (1: 2.5)	Potentiometric method	Jackson (1973)
EC (1: 2.5)	Conductometric method	Jackson (1973)
Organic carbon	Walkley and Black titration method	Jackson (1973)
Available sulphur	i. Extraction: 0.15% $CaCl_2$	Williams and Steinbergs, (1959)
	ii. Estimation: Turbidimetric	Chesnin and Yein, (1951)
DTPA-extractable Fe, Zn, Mn and Cu	i..Estimation: 0.005*M* DTPA (pH 7.3)	Lindsay and Norvell, (1978)
	ii. Estimation: Atomic Absorption Spectrophotometric	

Result and Discussion

Range and mean values of available sulphur and DTPA-extractable micronutrients in soils of Patan district

Available sulphur

The results presented in Table 1 revealed that available sulphur content in soils of Patan district varied from 2.15 to 92.68 mg kg^{-1} with a mean value of 28.99 mg kg^{-1}. The lowest value of available sulphur in soil was recorded in Sami taluka, whereas the highest value was found in Santalpur taluka. Comparatively higher mean value of available sulphur was recorded in Radhanpur (39.97 mg kg^{-1}), Shankhesvar (36.32 mg kg^{-1}) and Sami (35.03 mg kg^{-1}) taluka as compared to the other talukas (Table 1) The value of available sulphur in Siddhpur, Patan and Saraswati taluka were lower than other talukas of the district. Such low status of sulphur in soils might be due to wide gap between addition and removal of sulphur by the crop leading to sulphur mining from the soil. Similar results were also obtained for soils of Kachchh district of Gujarat (Anon., 2011) [1], in soils Patan district of Gujarat (Patel *et al.*, 2016) [15], for soils of Gandhinagar district of Gujarat (Patel *et al.*, 2017) [14].

DTPA-extractable Fe

The DTPA-extractable Fe content in soils of Patan district is given in Table 1. The DTPA-extractable Fe content in soils of Patan district were ranged from 3.34 to 22.80 mg kg^{-1} with a mean value of 6.99 mg kg^{-1}. The results also revealed that the minimum value (3.34 mg kg^{-1}) of DTPA-extractable Fe was found in Radhanpur taluka, whereas the maximum value (22.80 mg kg^{-1}) was found in Shankhesvar taluka. Among different talukas, Radhanpur taluka contained the highest mean value of DTPA-extractable Fe (7.63 mg kg^{-1}), while Saraswati taluka had the lowest mean value of 6.29 mg kg^{-1} DTPA-extractable Fe (Table 1). The mean value of DTPA-extractable Fe is in conformity with the findings of Meena *et al.* (2006) [12] and Polara and Kabariya (2006) [16]. Hundal *et al.* (2005) [7] also reported the available Fe in Inceptisol, Entisol, Aridisol and Alfisol of Punjab in the similar range from 2.80-23.1 mg kg^{-1}. The results are also accordance with the findings of Sood *et al.* (2009) [22] and Talukdar *et al.* (2009) [25].

DTPA-extractable Mn

The data presented in Table 1 revealed that DTPA-extractable Mn content in soils of Patan district varied from 3.46 to 37.10 mg kg^{-1} with a mean value of 12.63 mg kg^{-1}. The results further revealed that soils of Chanasma taluka possess the highest mean value of DTPA-extractable Mn (15.83 mg kg^{-1}) followed by that of Harij (14.63 mg kg^{-1}) and Siddhpur (13.86 mg kg^{-1}) talukas. Whereas, soils of Shankhesvar taluka contain the lowest mean value of 10.25 mg kg^{-1} DTPA-extractable manganese. The mean values of DTPA-extractable Mn obtained in present study are comparable with those reported by (Srinivasan and Poongothai, 2013) [23].

DTPA-extractable Zn

The data given in Table 1 showed that DTPA-extractable Zn content in soils of Patan district varied between 0.10 and 2.18 mg kg^{-1} with a mean value of 0.75 mg kg^{-1}. The lowest value of DTPA-extractable Zn content (0.10 mg kg^{-1}) was obtained in soil sample collected from Patan taluka, whereas the highest value (2.18 mg kg^{-1}) was recorded in soil samples collected from Sami taluka. The low value of Zn in soils might be due to fact that in well drained and aerated soils, zinc exists in oxidized state and their availability becomes very low. The similar mean value of DTPA-extractable Zn obtained in present study are also comparable with a mean of DTPA-extractable Zn as reported by (Singh *et al.*, 2014) and (Anon., 2011) [1] for soils of Banaskantha district Gujarat. Talukawise mean value of DTPA-extractable Zn (Table 1) further revealed that the lowest mean value of 0.66 mg kg^{-1} was obtained in Patan taluka, whereas the highest mean value of 0.95 mg kg^{-1} was recorded in Chanasma taluka.

DTPA-extractable Cu

The DTPA-extractable Cu content in soils of Patan district is given in Table 1. The DTPA-extractable Cu content in soils of Patan district varied from as low as 0.14 to as high as 2.76 mg kg^{-1} with a mean value of 0.82 mg kg^{-1}. The soils of Radhanpur taluka had highest mean value of 0.98 mg kg^{-1} followed by Sami (0.90 mg kg^{-1}), Shankhesvar (0.89 mg kg^{-1}) and Santalpur (0.89 mg kg^{-1}) talukas (Table 1). The lowest mean value of 0.67 mg kg^{-1} was obtained in Chanasma taluka. The results revealed that the minimum value (0.14 mg kg^{-1}) of DTPA-extractable Cu was found in Radhanpur taluka, whereas the maximum value (2.76 mg kg^{-1}) was found in Shankhesvar taluka. Similar findings were also reported by Polara *et al.* (2006) [17] and Patel *et al.* (2017) [14].

Nutrient index and fertility status in soils of Patan district

Available sulphur

The nutrient index as well as sulphur status for the soils of Patan district is presented in Table 2. Nutrient index of Patan district ranged from 2.13-2.30 which indicating adequate sulphur status of soil. The highest nutrient index for sulphur of 2.30 was noticed in Shankhesvar and Radhanpur talukas followed by Siddhpur (2.28) and Harij (2.28). Whereas, the lowest nutrient index of 2.13 was found in soils of Saraswati taluka. Overall, the soils of Patan district had nutrient index of 2.24 for available sulphur. Based on the nutrient index of soils and criteria suggested by Ramamurthy and Bajaj (1969) [19] and Stalin *et al.* (2010) [24], the soils of Patan district were registered adequate with respect to available sulphur status. Similar results are also reported by Patel *et al.* (2016) [15] for the soils of Patan district of Gujarat.

DTPA-extractable Fe

The nutrient index and fertility status of DTPA-extractable Fe for the soils of Patan district is given in Table 2. Nutrient index for Fe of Patan district ranged from 1.78 to 2.20 indicating marginal to adequate Fe status of soil. Among different talukas, the highest nutrient index of 2.20 was found in Radhanpur taluka followed by Santalpur (2.13) which fall in the adequate fertility status of DTPA-extractable Fe. Whereas, all the other seven taluka had nutrient index less than 2.00 which indicates the marginal fertility status of DTPA-extractable iron. Overall, the soils of Patan district had nutrient index of 1.93 for DTPA-extractable Fe. Based on the nutrient index of soils and criteria suggested by Ramamurthy and Bajaj (1969) [19] and Stalin *et al.* (2010) [24], the soils of Patan district registered marginal status of DTPA-extractable-iron. The results are in conformity with the findings of Patel *et al.* (2016) [15] for the soils of Patan district of Gujarat.

DTPA-extractable Mn

The nutrient index as well as fertility status of DTPA-extractable Mn for the soils of Patan district is presented in Table 2. Nutrient index for Mn of Patan district ranged from 2.35-2.73 indicating high to very high Mn status of soil. The highest nutrient index of 2.73 was noticed in Chanasma taluka followed by Siddhpur (2.70) and Radhanpur (2.68) which indicates the very high fertility status of DTPA-extractable Mn in given talukas. Whereas, the lowest nutrient index of 2.35 was found in soils of Shankhesvar taluka which indicates the high fertility status of DTPA-extractable Mn. On whole, the soils of Patan district had nutrient index of 2.57 for DTPA-extractable Mn. Based on the nutrient index of soils and criteria suggested by Ramamurthy and Bajaj (1969) [19] and Stalin *et al.* (2010) [24], the soils of Patan district bust high status of DTPA-extractable Mn. The results confirmed the finding as reported by Rajput and Polara (2012) [18] for the soils of Bhavnagar district of Gujarat and Patel *et al.* (2016) [15] for the soils of Patan district of Gujarat and Patel *et al.* (2017) [14] for the soils of Gandhinagar district of Gujarat.

DTPA-extractable Zn

The nutrient index as well as fertility status of DTPA-extractable Zn for the soils of Patan district is given in Table 2. Nutrient index for Zn of Patan district varied from 1.78-2.20 indicating marginal to adequate Zn status of soil. Among different talukas, the highest nutrient index of 2.20 was noticed in Chanasma taluka which indicate the adequates fertility status of DTPA-extractable Zn. Whereas, the nutrient index of all the other eight talukas were found less than 2.00 (1.78 to 1.98) indicating the marginal fertility status of DTPA-extractable Zn. Overall, the soils of Patan district had nutrient index of 1.91 for DTPA-extractable Zn. Based on the nutrient index of soils and criteria suggested by Ramamurthy and Bajaj (1969) [19] and Stalin *et al.* (2010) [24], the soils of Patan district were found marginal with respect to DTPA-extractable Zn status. The results are in conformity with findings of Patel *et al.* (2016) [15] for the soils of Patan district of Gujarat and Patel *et al.* (2017) for the soils of Gandhinagar district of Gujarat.

DTPA-extractable Cu

The nutrient index as well as fertility status of DTPA-extractable Cu for the soils of Patan district is presented in Table 2. Nutrient index for Cu of Patan district ranged from 2.65-2.90 indicating high to very high Cu status of soil. Among different talukas, the lowest nutrient index of 2.65 was found in soils of Saraswati taluka which indicates the high fertility status of DTPA-extractable Cu. Whereas, all the other eight talukas had nutrient index ranged from 2.68 (Patan) to 2.90 (Shankhesvar) which indicates very high fertility status of DTPA-extractable Cu. On whole, the soils of Patan district had nutrient index of 2.77 for DTPA-extractable Cu. Based on the nutrient index of soils and criteria suggested by Ramamurthy and Bajaj (1969) [19] and Stalin *et al.* (2010) [24], the soils of Patan district were found very high with respect to DTPA-extractable Cu status. Similar results were also reported by Hadiyal *et al.* (2016) [16], Patel *et al.* (2016) [15] and Patel *et al*. (2017) [14] for the soils of Gir Somnath, Patan and Gandhinagar district of Gujarat, respectively.

Correlation co-efficient (r) between soil properties (EC, pH and OC) and available sulphur and DTPA-extractable micronutrients

The data on simple correlation (r) studies between soil properties (EC, pH and OC) with available sulphur and DTPA-extractable micronutrients presented in Table 3. The data regarding correlation revealed that the electrical conductivity (EC) was significantly negatively correlated with manganese (-0.098^{**}). Similar kind of relationship of DTPA-extractable Mn with EC was also reported by Singh and Kumar (2012). The correlation value (Table 3) showed that the soil pH had highly significant negative correlation with DTPA-extractable Mn and Zn ($-0.209^{**}$and -0.260^{**}, respectively). This indicates that with increase in pH of the soil, the availability of micronutrients and available sulphur decreased which might be due to alkaline nature of the soil. Similar relationship between pH and DTPA-extractable micronutrients was also reported by Patel *et al.* (2016) [15]. The highly significant and positive correlation of DTPA-extractable Mn, Zn and Cu with organic carbon content of the soil (0.294^{**}, 0.312^{**} and 0.167^{**}, respectively) was obtained. This indicates that the availability of these nutrients increased with increase in organic matter content of soil because organic matter acts as chelating agent. This also suggests that the importance of organic matter in promoting the availability of these micronutrients in the soil. The correlation study also showed that organic carbon had significant positive correlation with available sulphur (0.118^{**}). This might be due to the fact that with increase in organic matter content in soil, the clay-humus complex becomes more active thereby providing more exchange sites and access to sulphur. Similar kinds of relationship between DTPA-extractable Fe and Cu with organic carbon were also reported by Kumar and Babel (2011) [10], Patel *et al.* (2016) [15] and Patel *et al.* (2017) [14].

Table 1: Talukawise range and mean values of available sulphur and DTPA-extractable Fe, Mn, Zn & Cu content in soils of Patan district

Name of Taluka	No. of soil samples	Range (mg kg^{-1})					Mean (mg kg^{-1})				
		S	Fe	Mn	Zn	Cu	S	Fe	Mn	Zn	Cu
Siddhpur	40	5.94- 45.79	3.98-14.44	5.10-27.56	0.20-1.30	0.28-1.72	20.10	6.71	13.86	0.75	0.72
Saraswati	40	5.09 -78.86	4.14-12.74	3.46-25.56	0.14-1.44	0.22-2.12	24.65	6.29	11.84	0.67	0.73
Patan	40	5.43-70.38	4.10-13.10	3.68-25.60	0.10-1.52	0.20-2.22	23.30	6.35	11.89	0.66	0.75
Chanasma	40	4.29-56.62	3.40-8.96	5.80-37.10	0.40-1.82	0.20-1.28	25.58	6.36	15.83	0.95	0.67
Harij	40	5.09-65.24	4.70-15.96	4.10-24.38	0.34-1.42	0.26-1.94	24.76	7.39	14.63	0.77	0.88
Shankhesvar	40	2.39-72.62	3.96-22.80	3.96-24.10	0.28-2.12	0.26-2.76	36.32	7.23	10.25	0.74	0.89
Sami	40	2.15-70.92	3.98-21.86	3.98-24.46	0.28-2.18	0.24-2.72	35.03	7.52	10.93	0.76	0.90
Radhanpur	40	4.53-88.46	3.34-13.68	4.80-21.10	0.30-1.44	0.14-2.64	39.97	7.63	13.32	0.74	0.98
Santalpur	40	5.91-92.68	3.50-14.84	3.86-19.10	0.32-1.40	0.16-2.24	31.16	7.47	11.14	0.69	0.89
District	360	2.15-92.68	3.34-22.80	3.46-37.10	0.10-2.18	0.14-2.76	28.99	6.99	12.63	0.75	0.82

Table 2: Nutrient Index and fertility status of available sulphur and DTPA-extractable Fe, Mn, Zn & Cu of Patan district

Name of Taluka	Nutrient Index					Fertility status				
	S	Fe	Mn	Zn	Cu	S	Fe	Mn	Zn	Cu
Siddhpur	2.28	1.85	2.70	1.98	2.80	Adequate	Marginal	Very high	Marginal	Very high
Saraswati	2.13	1.83	2.50	1.90	2.65	Adequate	Marginal	High	Marginal	High
Patan	2.15	1.80	2.48	1.83	2.68	Adequate	Marginal	High	Marginal	Very high
Chanasma	2.25	1.78	2.73	2.20	2.88	Adequate	Marginal	Very high	Adequate	Very high
Harij	2.28	1.95	2.65	1.98	2.70	Adequate	Marginal	High	Marginal	Very high
Shankhesvar	2.30	1.90	2.35	1.85	2.90	Adequate	Marginal	High	Marginal	Very high
Sami	2.23	1.98	2.43	1.80	2.85	Adequate	Marginal	High	Marginal	Very high
Radhanpur	2.30	2.20	2.68	1.88	2.75	Adequate	Adequate	Very high	Marginal	Very high
Santalpur	2.23	2.13	2.63	1.78	2.73	Adequate	Adequate	High	Marginal	Very high
District	2.24	1.93	2.57	1.91	2.77	Adequate	Marginal	High	Marginal	Very high

Table 3: Correlation coefficient (r) of soil properties (EC, pH and OC) with available sulphur and DTPA-extractable micronutrients

Soil Properties	Available nutrients				
	S	Fe	Mn	Zn	Cu
EC	-0.011	0.113*	-0.098*	-0.030	0.013
pH	-0.112*	-0.064	-0.209**	-0.260**	-0.081
OC	0.118*	0.077	0.294**	0.312**	0.167**

* Significant at 5% level of significance ** Significant at 1% level of significance

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