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Nutrient Index of Available S in Soils of Howrah and South Dinajpur Districts of West Bengal, India

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A B S T R A C T

Nutrient index of available S in soils of two districts, namely, Howrah and South Dinajpur of West Bengal falling in the soil order Inceptisols collecting 237 soil samples from Howrah and 256 soil samples from South Dinajpur district. Soil samples were collected according to grid sampling pattern maintaining approximately 4.0 km grid for Howrah and 3.7 km grid for South Dinajpur district using global positioning system (GARMIN GPS Version *etrex*) covering 13 blocks of Howrah and 8 blocks of South Dinajpur district. Soil pH of the Howrah and South Dinajpur district ranged from 3.0to 8.30 with a mean value of 5.75 and 3.7 to 7.0 with a mean value of 5.21.The organic carbon content in soils of Howrah and South Dinajpur district ranged from 0.18 to 1.21% with a mean value of 0.55% and 0.37 to 1.32% with a mean value of 0.84%. Available S content in soils of Howrah and South Dinajpur district ranged from 1.09 to 78.70 mg kg^{-1} with a mean value of 18.12 mg kg^{-1} and2.03 to 43.39 mg kg^{-1} with a mean value of 10.52 mg kg^{-1}.Nutrient index value (NIV) of available soil S of these two districts was 1.38 and 1.10. Results revealed that available soil S status of Howrah and South Dinajpur is medium and low.

Introduction

Intensive cropping system with high yielding varieties for boosting food production caused marked depletion of inherent nutrient reserves in soil. Consequently along with deficiency of N, P and K, the deficiency of secondary and micronutrients are frequently reported. Among the secondary nutrients a good response to sulphur fertilizers has been reported by many authors (Narendranath, 2005; Jena *et al.*, 2006). Total sulphur content of Indian soils was between 19 and 3836 mg kg^{-1} and it varies in amounts depending upon its content in the primary minerals, organic compounds and in the soil solution (Renuka devi *et al.*, 2002). In India, the some scientists have been reported that about 40% soils were low, 35% in medium and 25% in high category in sulphur (Motsara, 2002). Mukhopadhyay and Mukhopadhyay (1980) studied twelve selected soil series or five

major soil zones of West Bengal and showed that $CaCl_2$ extractable S varied between 0.6 mg kg^{-1} (1.2 kg S ha^{-1}) to 217.2 mg kg^{-1} (434.4 kg S ha^{-1}). Dolui and Pramanik (2001) studied the vertical distribution of sulphur in the three profiles of Alfisols of West Bengal and showed that $CaCl_2$ extractable sulphur decreased with the increasing depth. Sarkar (1996) studied the vertical distribution of different forms of sulphur in ten established soil series of West Bengal belong to the Inceptisols order and reported that different form of sulphur including $CaCl_2$ extractable sulphur. They showed a decreasing trend of available S with increasing the depth of the profile. About 70% soils were found to be sulphur deficient in the investigated series. Three soil series which were non deficient in sulphur were located in rainfed, coastal saline zone. Basak *et al.,* (2002) determine the nutrient index for sulphur of individual mouzas of Amedanga block; they reported that the sulphur status of the block was low. Sulphur deficient areas in block widespread. In Tamil Nadu sulphur deficiency between 7-40 per cent has been reported and mostly red soils coming under Alfisols, low level laterite soils and alluvial soils with low organic status are found to have more sulphur deficiency than any other soils (Sankaran, 1989).

A preliminary investigation carried out in Tamil Nadu has shown that the occurrence of sulphur deficiency was more than 40 per cent in Madurai, Villupuram, Thiruvannamalai and Thiruvallur districts, between 20-40 per cent in Coimbatore, Erode, Trichy and Dindugal districts, less than 20 per cent in Thanjavur, Tuticorin, Kanyakumari, Ramnad and Nilgris (Arunageetha, 2001; Maragatham, 2001). **S**ahrawat *et al.,* (2007) studied on widespread deficiencies of sulphur, boron and zinc in dryland soils of the Indian semi-arid tropics. They reported that out of 1926 field samples soil sulphur status ranged from 0.23 to 98.0 mg kg^{-1} with a mean value of 5.6 mg kg^{-1}. Singh *et al.,* (2012) reported that the available sulphur status of chiraigaon block of Varanasi district (U.P.) ranges from 6.0 -16.6 mg kg^{-1} with a mean value 9.5 mg kg^{-1} i.e. low. 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 alluvial soils under rice-rice cropping system was lacking. With this background the present study was undertaken to delineate sulphur deficient areas in Howrah and South Dinajpur district of West Bengal.

Materials and Methods

In order to delineate S in soils of Howrah and South Dinajpur districts of West Bengal falling in the soil order Inceptisols collecting 237 soil samples from Howrah and 256 soil samples from South Dinajpur district was calculated and presented in this section. Soil samples were collected according to grid sampling pattern maintaining approximately 4.0 km grid for Howrah and 3.7 km grid for South Dinajpur district using global positioning system (GARMIN GPS Version *etrex*) covering 13 blocks of Howrah and 8 blocks of South Dinajpur district (Fig. 1 & 2).

Immediately after collection soil samples were dried, grounded, screened through 2mm nylon sieve and stored in plastic container. Then soil samples were analyzed for basic chemical properties viz. soil pH and organic carbon as well as o.15% $CaCl_2$ extractable S by turbidimetric method (Williams and Steinberg, 1959) for inter-relationship study. Soil samples were categorized as deficient, low, medium and high on the basis of their availability in soils (Singh, 2009). Nutrient index value (Ramamurthy and Bajaj 1969) for soil samples of each district was calculated from the proportion of soils under low (deficient plus low), medium and high

available nutrient categories and is represented below:

Nutrient Index			
	Low	**Medium**	**High**
Ramamoorthy and Bajaj (1969)	<1.7	1.71 to2.33	>2.33

Formula how to calculate Nutrient index value

$$\text{Nutrient index value} = \frac{Nl*1+Nm*2+Nh*3}{Nl+Nm+Nh}$$

Where,

N_l = Nutrient low in category
N_m = Nutrient medium in category
N_h = Nutrient high in category

Results and Discussion

Soil chemical properties

Soil pH

The prominent soil in the Howrah district falls under the new alluvial and old alluvial agro-climatic zone of West Bengal. Results showed that soil pH ranged from 3.0to 8.30 with a mean value of 5.75. From 237 soil samples nearly 42.6% of soil samples were in the pH range of below 5.5 (acidic), 42.6% recorded a pH range of 5.5-6.5 (slightly acidic), 13.5% recorded a pH range of 6.5-7.5 (Neutral) and 1.2% was in the range of 7.5-8.5 (slightly alkaline). Results also showed that the highest soil pH was found in Domjur block and the lowest in Amta1 block. The data indicate that the soil pH is acidic to slightly acidic in reaction, but soils in the South Dinajpur district falls under the old alluvium and lateritic agro-climatic zone. Soil pH of South Dinajpur ranged from 3.7 to 7.0 with a mean value of 5.21. Nearly 81.6% of soil samples were in the pH range of below 5.5 (acidic), 16.58% recorded a pH range of 5.5-6.5 (slightly acidic) and a little number of samples (about 1.5%) in the pH range 6.5-7.5 (Neutral) from 256 soil samples. Therefore, results revealed that almost soil samples were acidic in reaction which might be related to the loss of basic cation from soils owing to heavy precipitation. Similarly, Mandal *et al.*, 1979 reported that in West Bengal out of total net cropped area of about 7.5 million hectares, there are about 2.0 million hectares having soils of pH less than 6.0 (Table 1 and 2).

Soil organic carbon

Organic carbon content in soils of Howrah district ranged from 0.18 to 1.21% with a mean value of 0.55%. Results revealed that 41.7% soil samples were in low category (<0.75%), 47.2% soil samples were in medium category (0.75-1.50%) and 10.9% was categorized as high (>1.50%). On an average, organic carbon content showed mostly a range of low to medium which might be due to follow of intensive cultivation in this district year after year. Organic carbon content in soils of South Dinajpur district ranged from 0.37 to 1.32% with a mean value of 0.84%. Results also revealed that 3.9% soil samples were in low category (<0.75%), 36.3% soil samples were in medium category (0.75-1.50%) and 59.7% was categorized as high (>1.50%). The data indicate that the soil organic carbon content is medium to high in reaction. Similarly, Singh and Sanyal (2001) reported that the organic carbon content in Kalimpong soil and Matimahal soil of West Bengal was 18.9 g kg^{-1} and 2.3 gkg^{-1}, respectively

Available S status and Nutrient Index Value of soil

Results of available S content in soils of Howrah showed that it ranged from 1.09 to 78.70 mg kg^{-1} with a mean value of 18.12 mg kg^{-1} (Table 3). Results showed that the

(33.7%) soil samples were in deficient category (<10 mg kg^{-1}), 35.02% soil samples were in low category (10.0-20.0 mg kg^{-1}) and 24.05% soil samples were in medium category (20.0-40.0 mg kg^{-1}), only a very few samples 7.1% were in the category of high (>40.0 mg kg^{-1}). Nutrient index value (NIV) of available soil S of this district was also calculated (NIV=1.38) which further revealed that available soil S status of Howrah is medium (Table 3 and Fig. 3). The medium S status of Howrah might be related to the intensive cultivation.

Table.1 Block wise pH and organic carbon content (%) in soil samples of Howrah district of West Bengal

Name of the block	pH			OC (%)		
	Range	Mean	SD(±)	Range	Mean	SD(±)
Shyampur 1	4.2-7.7	5.76	1.11	0.31-0.73	0.54	0.15
Shyampur 2	5.1-7.4	5.95	0.63	0.38-0.83	0.59	0.13
Sankrail	5.1-8.3	6.15	0.83	0.24-0.77	0.47	0.17
Domjur	6.0-7.4	6.55	0.44	0.34-0.77	0.54	0.14
Jagatballavpur	4.2-6.8	5.75	0.64	0.31-0.69	0.52	0.09
Panchla	4.3-7.4	5.18	0.75	0.31-0.78	0.50	0.16
Uluberia I	4.4-7.8	6.07	0.73	0.27-0.92	0.60	0.18
Uluberia 2	5.1-7.0	5.92	0.54	0.23-0.81	0.48	0.17
Bagnan 1	5.0-7.4	5.90	0.77	0.39-0.86	0.62	0.17
Bagnan 2	4.1-7.2	5.77	0.89	0.30-0.88	0.57	0.15
Amta 1	4.3-6.4	5.06	0.55	0.33-1.21	0.76	0.25
Amta 2	3.0-7.0	5.29	0.93	0.21-1.02	0.53	0.18
Udaynaranpur	3.4-6.5	5.44	0.98	0.18-1.21	0.47	0.25

Table.2 Block wise pH and organic carbon content (%) in soil samples of South Dinajpur district of West Bengal

Name of the block	pH			OC (%)		
	Range	Mean	SD(±)	Range	Mean	SD(±)
Tapan	3.7-6.2	5.23	0.42	0.39 -1.05	0.87	0.14
Balurghat	4.0-6.0	5.14	0.47	0.48-0.99	0.87	0.13
Gangarampur	4.2-6.5	5.28	0.53	0.51-1.50	0.9	0.23
Kushmandi	4.5-6.3	5.24	0.35	0.45-1.08	0.80	0.14
Hili	4.3-5.9	5.08	0.36	0.51-1.35	0.90	0.19
Kumarganj	4.1-6.3	4.98	0.44	0.37-1.32	0.83	0.23
Harirampur	4.4-7.0	5.56	0.66	0.45-1.17	0.80	0.17
Banshihari	4.2-6.1	5.17	0.40	0.39-1.14	0.80	0.16

Table.3 Block wise available S content (mg kg^{-1}) of soil samples as well as NIV of S in Howrah district of West Bengal

Name of the block	No. of samples analyzed	Range (mg kg^{-1})	Mean (mg kg^{-1})	SD (±)	Per cent samples deficient	No. of samples falling in the			NIV
						Low + Deficient	Medium	High	
Shyampur 1	17	5.39-78.62	26.8	20.06	23.52	8	5	4	1.76
Shyampur 2	17	5.34-72.53	27.91	18.96	11.76	8	5	4	1.76
Sankrail	14	11.88-52.88	23.13	12.40	0	6	6	2	1.71
Domjur	18	3.21-48.83	17.03	13.48	44.44	11	6	1	1.44
Jagatballavpur	17	2.84-43.65	18.26	13.80	41.18	11	4	2	1.47
Panchla	15	1.09-20.97	11.22	5.66	40	14	1	0	1.07
Uluberia I	28	3.58-63.38	20.62	13.65	28.57	18	9	1	1.39
Uluberia 2	17	5.12-38.61	18.16	9.67	23.53	9	8	0	1.47
Bagnan 1	8	3.02-42.21	21.57	13.08	12.5	4	3	1	1.63
Bagnan 2	16	5.12-23.29	15.16	5.16	12.5	13	3	0	1.19
Amta 1	12	1.72-21.07	10.18	7.26	58.33	10	2	0	1.17
Amta 2	35	1.81-27.74	10.61	6.76	54.29	32	3	0	1.09
Udaynaranpur	23	2.27-78.70	14.87	17.69	52.17	19	2	2	1.26

Nutrient Index Value: Low <1.34, Medium 1.34-2.33, High >2.33, SD: Standard Deviation

Table.4 Block wise available S content (mg kg^{-1}) of soil samples as well as NIV of S in South Dinajpur district of West Bengal

Name of the block	No. of samples analyzed	Range (mg $kg^{-1)}$	Mean (mg kg^{-1})	SD (±)	Per cent samples deficient	No. of samples falling in the			NIV
						Low+ Deficient	Medium	High	
Tapan	39	2.70-26.00	9.15	5.32	64.10	38	1	0	1.03
Balurghat	30	4.05-26.68	12.27	5.74	33.33	25	5	0	1.17
Gangarampur	29	2.53-43.39	16.01	10.05	27.59	21	7	1	1.31
Kushmandi	26	2.70-40.01	9.74	8.21	65.38	24	1	1	1.12
Hili	32	3.38-41.70	11.42	7.41	46.88	29	2	1	1.13
Kumarganj	32	3.38-22.79	8.50	5.21	65.63	31	1	0	1.03
Harirampur	34	2.19-23.64	9.78	5.44	52.94	32	2	0	1.06
Banshihari	34	2.03-19.08	7.30	3.76	79.41	34	0	0	1.00

Nutrient Index Value: Low <1.34, Medium 1.34-2.33, High >2.33, SD: Standard Deviation

Fig.1 Location map of study area

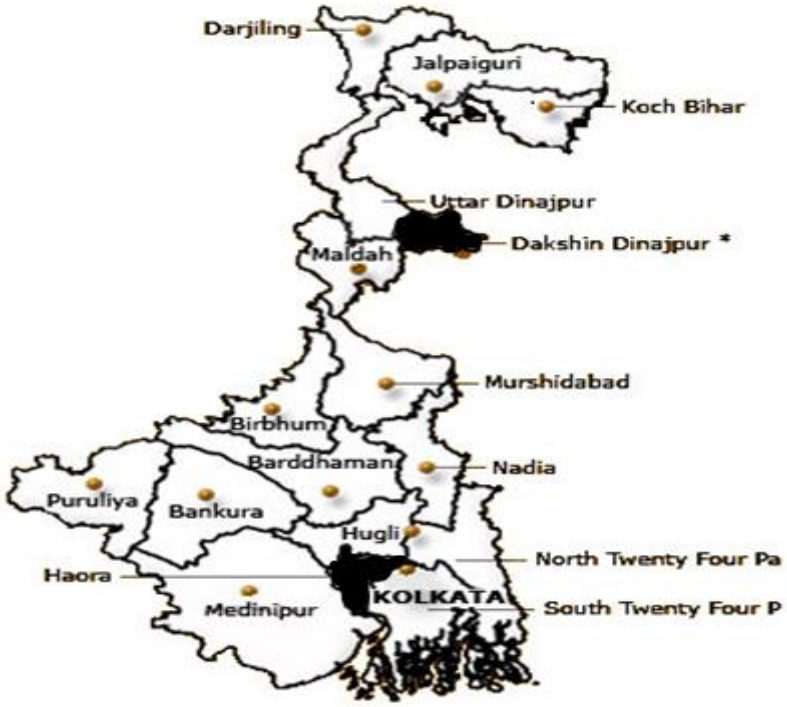


Fig.2 Block wise map location of collected soil samples from Howrah and South Dinajpur district of West Bengal

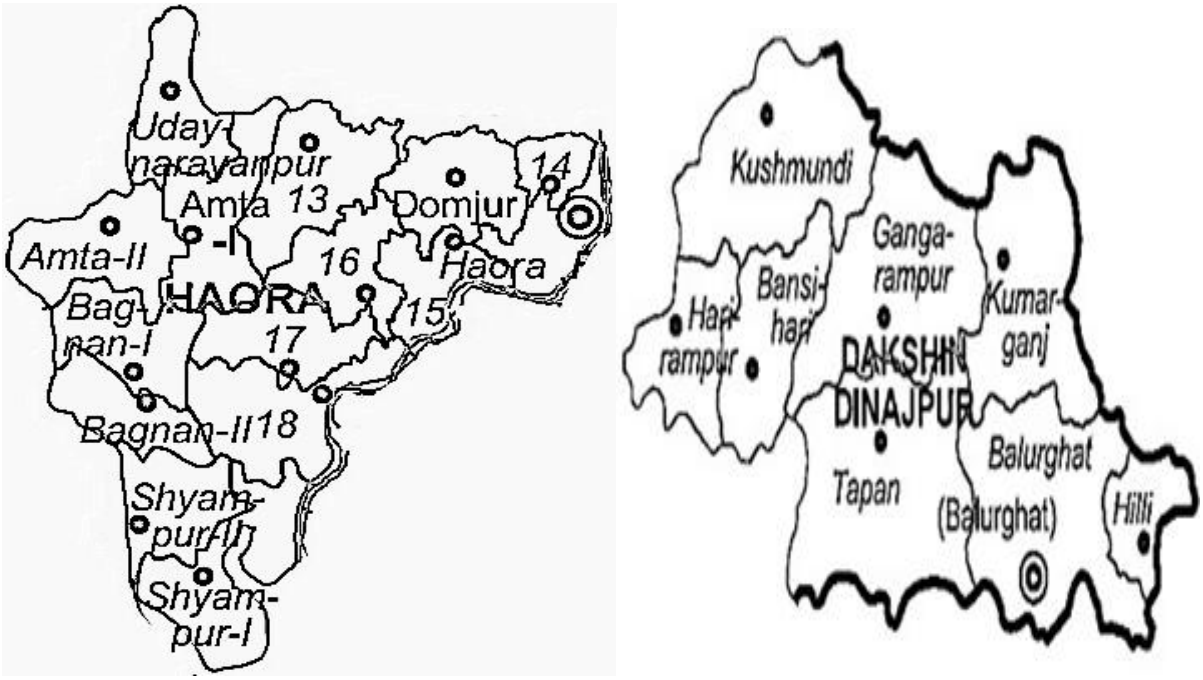


Fig.3 Graphical representation of the deficient, low, medium and high content of available S (mg kg^{-1}) in soil samples of Howrah and South Dinajpur district

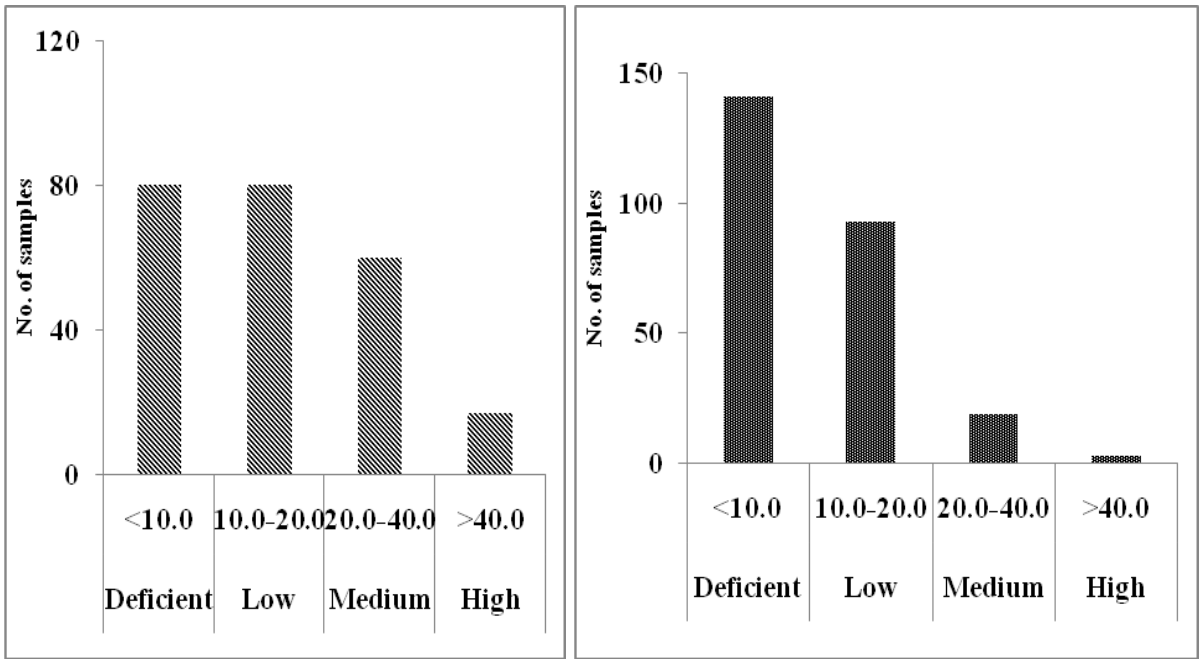
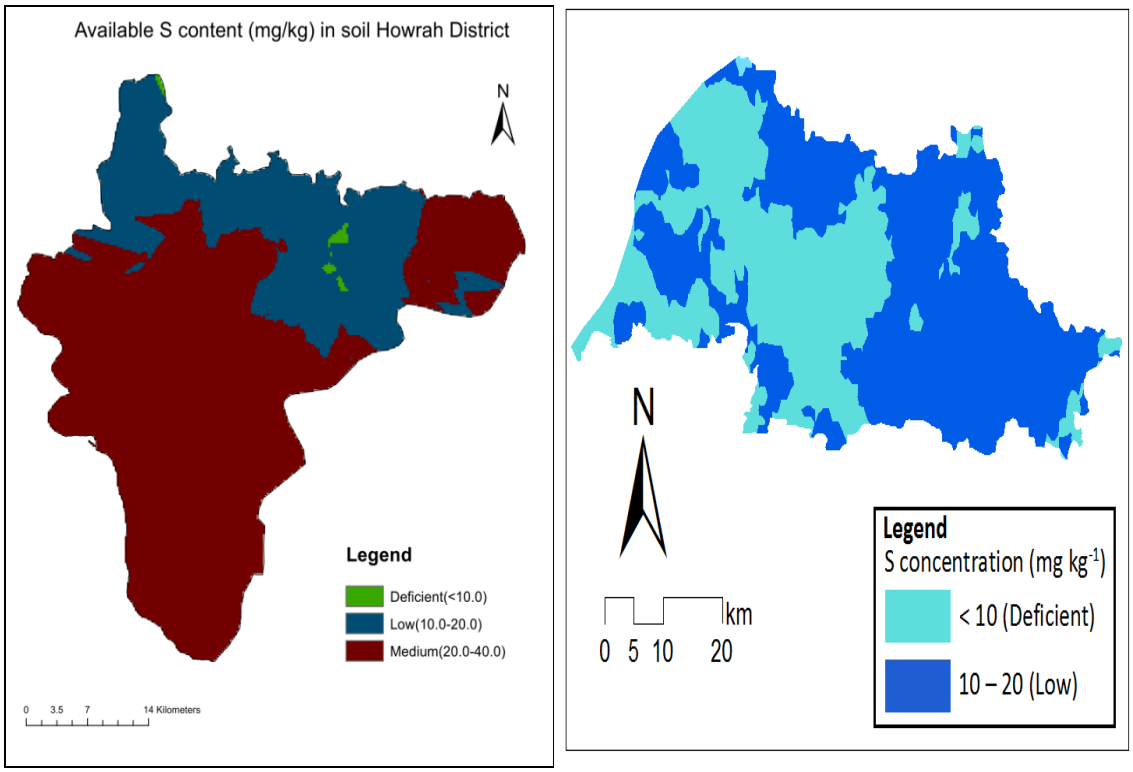


Fig.4 GPS-GIS based S delineation map of the Howrah and South Dinajpur district



Results of available S content in soils of South Dinajpur district showed that it ranged from 2.03 to 43.39 mg kg^{-1} with a mean value of 10.52 mg kg^{-1} (Table 4). Here also results showed that most of the soil samples are in deficient (55.08%), low (36.3%) category and medium (7.4%) and only a very few samples (1.1%) are high in S. NIV calculation (NIV =1.10) also revealed that available S status of South Dinajpur district was in low category (Table 4 and Fig. 3).

Soil fertility status

GPS-GIS based S delineation map of the Howrah and South Dinajpur district has been drawn that showed the soil of Howarh district was medium in Sulphur (Fig. 4) and deficient to low in South dinajpur district (Fig. 4).

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