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Status of available major nutrients in soils of Sabarkantha district of Gujarat

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Abstract

A study was carried out for evaluating soil fertility with respect to available N, P, K and S status of soils in Sabarkantha district of Gujarat. The soil samples (0-15 cm depth) were collected from 8 talukas of Sabarkantha district of Gujarat. Results revealed that soils are slightly neutral to mildly alkaline in reaction with low soluble salt content. The content of organic carbon and available N were classified in low category. The status of available P and S was medium while status of available K was high. Based on overall nutrient index of soils of Sabarkantha district, available N was classified in low; available P and S in adequate; available K in high fertility status.

Keywords: Soil fertility, Major-nutrients, Soil reaction, Nutrient index

1. Introduction

Soil fertility has a direct relation with the crop yields, provided other factors are in optimum level. Soil fertility must be periodically estimated as there is continuous removal of nutrients by the crop intensively grown in every crop season. In order to achieve higher productivity and profitability, every farmer should realize that fertility levels must be measured as there measurement can then be used to manage soil fertility. Balanced nutrient use ensures high precaution level and helps to maintain the soil health. Fertilizing the soils to bring all the deficient elements at high levels as to provide sufficient ionic activity in soil solution for crop uptake is one of the most important consideration for maximization of the crop yield. Such type of information at broad villages level were lacking in Sabarkantha district of Gujarat. Therefore, study to understanding the status of major nutrients and nutrient index in soils of Sabarkantha district of Gujarat.

2. Material and Methods

Sabarkantha district covers an area of 3879.72 sq. km. and it is situated in Northern part of Gujarat state lying between 23.03° to 24.23°N latitude and 72.43° to 72.39°E longitude situated at 127 meter above mean sea level. Eight taluka namely Himmatnagar, Idar, Prantij, Talod, Khedbrahma, Vadali, Vijaynagar and Poshina were selected for study. Total 320 representative surface soil samples (fourty soil samples from each taluka) were collected from farmers' fields during April-2016 using multistage stratified random sampling. Soil samples were air dried, ground carefully with a porcelain mortar and pestle to break soil lumps and passed through 2 mm sieve. Soil pH was measured by glass electrode pH meter in 1:2.5 soil water suspension described by Jackson (1973) [2]. The electrical conductivity measured by conductometric method was described by Jackson (1973) [2]. Organic carbon was estimated by Walkley and Black's (1934) [11] rapid titration method. Available nitrogen in soil was determined by alkaline potassium permanganate method as described by Subbiah and Asija (1956) [10]. Available phosphorus was estimated by the ascorbic acid method as described by Olsen *et al.*, (1954) [4] in which 2g soil sample was extracted with 0.5 M sodium bicarbonate at pH 8.5 and available potassium was extracted from the 5 g soil with the help of suitable extractant neutral normal ammonium acetate using flame photometer Jackson (1973) [2] while available S was determined as per the methods described by Williams and Stainbergs (1959) [12]. Nutrient index was calculated utilizing the following formula suggested by Parker *et al.* (1951): Nutrient Index (NI) = $[(N_i \times 1) + (N_m \times 2) + (N_h \times 3)] / N_t$
Where, N_i , N_m and N_h are the number of samples falling in low, medium and high categories for nutrient status and are given weightage of 1, 2 and 3, respectively.

N_i is the total no. of sample. The nutrient index are rated into various categories viz., very low, low, marginal, adequate, high, and very high as rating given by Stalin *et al.* (2010) [9].

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

Electrical conductivity (EC)

The electrical conductivity varied from 0.03 to 1.31 dSm⁻¹ with a mean value of 0.43 dSm⁻¹ at 25°C of the Sabarkantha district (table 2). Considering the soils having <1.0 dS m⁻¹ as normal, 1.0-2.0 dS m⁻¹ as tending to become saline, 2.0-3.0 dS m⁻¹ as saline and >3.0 dS m⁻¹ as highly saline in EC contents, the data revealed that the lowest mean value of 0.34 dS/m was observed in the soils of Khedbrahma taluka and the highest mean value of 0.51 dS/m was registered in the soils of Idar taluka. The data presented in table 2 revealed that 95.3 per cent soil samples have EC value less than 1.0 dS m⁻¹ i.e. soluble salts under safe limit. Only 4.7 per cent soil samples falls under slightly saline status. Similar results were also obtained for soils of Mandvi talukas of Kuchch district of Gujarat (Patel *et al.*, 2012) [6]. The low EC of soil might be due to proper management of soil and thereby leaching of salt takes place from surface to sub-subsurface.

Soil reaction (pH)

A study on soil pH presented in table 1 revealed that the soils of farmer's field were slightly neutral to mildly alkaline in

soil reaction and pH ranged from 6.30 to 9.12 with an average value 7.67 in Sabarkantha district. Considering the soils having <6.0 as acid, 6.1-6.5 as slightly acid, 6.6-7.3 as neutral, 7.4-7.8 as mildly alkaline and >7.9 as moderately to strongly alkaline in pH contents. The lowest mean pH value of 7.35 was recorded in a soil samples collected from Vijaynagar taluka and the highest mean value of 8.10 was recorded in the samples collected from Himmatnagar taluka. Out of 320 soil samples, 0.31, 29.69, 31.56, 31.56 and 6.25 per cent soil samples have slightly acid, neutral, mildly alkaline, moderately alkaline and strongly alkaline reaction, respectively (table 2). Similar results were also obtained for Tonk district of Rajasthan (Meena *et al.*, 2006) [3]. The relative high pH in these soil might be due to the presence of high degree of base saturation.

Table 1: Talukawise range and mean values of EC and pH in soils of Sabarkantha district

Name of Taluka	EC _{2.5} (dS/m)		pH _{2.5}	
	Range values	Mean values	Range values	Mean values
Himmatnagar	0.09-1.23	0.47	6.79-9.12	8.10
Idar	0.07-1.19	0.51	6.68-8.32	7.47
Prantij	0.07-1.31	0.41	6.60-8.80	7.80
Talod	0.03-1.29	0.42	6.80-9.10	8.00
Khedbrahma	0.10-0.82	0.34	6.80-8.20	7.47
Vadali	0.06-1.15	0.40	6.80-8.32	7.58
Vijaynagar	0.08-1.09	0.43	6.30-8.37	7.35
Poshina	0.09-1.07	0.43	6.60-8.70	7.61
District	0.03-1.31	0.43	6.30-9.12	7.67

Table 2: Per cent distribution of soil samples according to categories for EC and pH in different talukas of Sabarkantha district

Name of Taluka	EC _{2.5}		pH _{2.5}					
	Normal	Slightly saline	Slightly acid	Neutral	Mildly alkaline	Moderately alkaline	Strongly alkaline	Very strongly alkaline
Himmatnagar	92.5	7.5	0	5	27.5	47.5	17.5	2.5
Idar	92.5	7.5	0	42.5	30	27.5	0	0
Prantij	92.5	7.5	0	20	27.5	47.5	5	0
Talod	95.0	5.0	0	12.5	25	35	25	2.5
Khedbrahma	100	0	0	40	42.5	17.5	0	0
Vadali	97.5	2.5	0	37.5	25	37.5	0	0
Vijaynagar	97.5	2.5	2.5	47.5	35	15	0	0
Poshina	97.5	2.5	0	32.5	40	25	2.5	0
District	95.3	4.7	0.31	29.69	31.56	31.56	6.25	0.63

Organic carbon (OC)

Data presented in table 4 revealed that most of the soils were having low status of organic carbon. It ranged from 0.06 to 0.95 per cent with a mean value of 0.43 per cent in soils of Sabarkantha. The lowest mean OC value of 0.39 per cent was recorded in a soil samples collected from Talod taluka and the highest mean value of 0.47 per cent was recorded in samples collected from Khedbrahma taluka. In general, 68.4 per cent samples were deficient and 27.8 per cent medium. Such low values for organic carbon status of soils are expected because

of the arid climate, less use of organic manure and negligible replacement of organic matter. Similar results were obtained for soils of Tonk district of Rajasthan (Meena *et al.*, 2006) [3].

Table 3: Limits for the soil test values used for rating the soil

Parameters	Low	Medium	High
Organic carbon (%)	<0.50	0.50-0.75	>0.75
Available N(Kg ha ⁻¹)	<250	250-500	>500
Available P (Kg ha ⁻¹)	<28	28-56	>56
Available K(Kg ha ⁻¹)	<140	140-280	>280

Table 4: Talukawise range, mean value and per cent distribution of organic carbon content in soils of Sabarkantha district

Name of Taluka	Range value (%)	Mean value (%)	Per cent distribution of organic carbon		
			Low	Medium	High
Himmatnagar	0.14-0.92	0.43	67.5	25	7.5
Idar	0.17-0.72	0.40	77.5	22.5	0
Prantij	0.14-0.87	0.42	75	17.5	7.5
Talod	0.14-0.77	0.39	77.5	20	2.5
Khedbrahma	0.18-0.95	0.47	57.5	37.5	5
Vadali	0.06-0.75	0.42	62.5	35	2.5
Vijaynagar	0.17-0.89	0.44	65	30	5
Poshina	0.15-0.71	0.43	65	35	0
District	0.06-0.95	0.43	68.4	27.8	3.8

Available macronutrients status of soils**Available N status**

The available N content in soils of Sabarkantha district ranged from 47.04 to 470.40 kg ha⁻¹ with a mean value of 218.30 kg ha⁻¹ (table 5). The highest mean value of available N was found in Vadali (232.06 kg ha⁻¹) taluka and lowest mean value of available nitrogen was found in Poshina (183.06 kg ha⁻¹) taluka. Out of 320 soil samples, 65.9 per cent, were found as low available N, whereas 34.1 per cent were medium in available N content in soils of Sabarkantha district (table 6). Nutrient index values ranged from 1.18 to 1.55 with a mean value of 1.34. The overall fertility rating for available N was low (table 7). Similar results were also reported for soils of Gir Somnath district (Polara and Chauhan, 2015) [7]. Such lower values for available N might be due to lower content of organic carbon and little addition of organic matter as well as less use of organic manures in the arid tract.

Available P status

The available phosphorus content in soils of Sabarkantha district varied from 7.66 to 118.88 kg ha⁻¹ with a mean value of 50.03 kg ha⁻¹ (table 5). The highest mean value of available P₂O₅ was found in Vadali (55.57 kg ha⁻¹) taluka followed by Vijaynagar (52.81 kg ha⁻¹) and Khedbrahma (52.18 kg ha⁻¹) taluka. The lowest mean value of available P₂O₅ was found in Poshina (46.56 kg ha⁻¹) taluka. Out of 320 soil samples, Nearly 49.7 per cent soil samples was observed under medium status in available phosphorus (table 6). The medium content of available phosphorus in these soils might be due to regular application of phosphatic fertilizers to realise higher yields of oil seeds, which are the principal crops of the area. Nutrient index values ranged from 1.98 to 2.35 with a mean value of 2.18. The overall fertility rating for available P was adequate (table 7). Similar results were also obtained for soils of Gir Somnath district (Hadiyal *et al.*, 2016) [1].

Table 5: Talukawise range and mean values for available N, P₂O₅, K₂O and S in soils of Sabarkantha district

Name of Taluka	Available N (kg ha ⁻¹)	Available P ₂ O ₅ (kg ha ⁻¹)	Available K ₂ O (kg ha ⁻¹)	Available S (kg ha ⁻¹)
Himmatnagar	78.40-470.40 (228.54)	7.66-118.79 (47.25)	161.28-981.12 (437.14)	7.50-22.94 (15.01)
Idar	78.40-360.64 (212.07)	13.52-91.75 (48.93)	147.84-913.92 (321.55)	6.98-22.37 (14.67)
Prantij	94.08-360.64 (214.42)	16.59-95.79 (47.86)	134.40-954.24 (348.77)	5.38-23.92 (14.71)
Talod	109.76-329.28 (220.70)	19.39-116.89 (49.05)	134.40-967.98 (379.01)	5.14-22.62 (16.15)
Khedbrahma	62.72-470.40 (223.83)	15.84-118.59 (52.18)	161.28-994.56 (390.43)	4.55-39.64 (15.40)
Vadali	78.40-376.32 (232.06)	19.54-105.30 (55.57)	188.16-981.12 (411.26)	7.29-25.79 (17.58)
Vijaynagar	62.72-392.00 (231.67)	12.92-108.23 (52.81)	120.96-860.16 (304.75)	6.73-24.50 (14.91)
Poshina	47.04-282.24 (183.06)	18.39-118.88 (46.56)	120.96-779.52 (382.37)	6.25-19.76 (13.58)
District	47.04-470.40 (218.30)	7.66-118.88 (50.03)	120.96-994.56 (371.91)	4.55-39.64 (15.25)

Note: Value in parenthesis indicates mean value

Table 6: Per cent distribution of soil samples according to low, medium and high categories for available major nutrients in different talukas of Sabarkantha district

Name of Taluka	Available N			Available P ₂ O ₅			Available K ₂ O			Available S		
	L	M	H	L	M	H	L	M	H	L	M	H
Himmatnagar	62.5	37.5	0.0	17.5	57.5	25.0	0.0	22.5	77.5	10.0	77.5	12.5
Idar	70.0	30.0	0.0	17.5	47.5	35.0	0.0	50.0	50.0	10.0	77.5	12.5
Prantij	75.0	25.0	0.0	17.5	45.0	37.5	2.5	45.0	52.5	17.5	70.0	12.5
Talod	67.5	32.5	0.0	15.0	57.5	27.5	2.5	37.5	60.0	7.5	77.5	15.0
Khedbrahma	62.5	37.5	0.0	12.5	40.0	47.5	0.0	40.0	60.0	17.5	70.0	12.5
Vadali	62.5	37.5	0.0	12.5	45.0	42.5	0.0	15.0	85.0	2.5	67.5	30.0
Vijaynagar	45.0	55.0	0.0	15.0	47.5	37.5	7.5	47.5	45.0	5.0	90.0	5.0
Poshina	82.5	17.5	0.0	22.5	57.5	20.0	2.5	15.0	82.5	12.5	87.5	0.0
District	65.9	34.1	0.0	16.3	49.7	34.1	1.9	34.1	64.1	10.3	77.2	12.5

Where, L=Low, M=Medium, H=High fertility class

Available K status

Overall, available potassium status for the Sabarkantha district was high and varied from 120.96 to 994.56 available K kg ha⁻¹ with an average of 371.91 kg ha⁻¹ (table 5). The highest mean value for available K₂O was found in Himmatnagar (437.14 kg ha⁻¹) taluka and lowest mean value of available K₂O was found in Vijaynagar (304.37 kg ha⁻¹) taluka. Out of 320 soil samples, 34.1 per cent had medium available potassium content, whereas 64.1 per cent samples had high in available potassium content of the study area (table 6). Nutrient index values ranged from 2.38 to 2.85 with

a mean value of 2.62. The overall fertility rating for available K was high (table 7). Similar results were also observed for the soils of Tonk district of Rajasthan (Meena *et al.*, 2006) [3]. The high available potassium content in these soils might be attributed to the prevalence of potassium rich minerals like illite, feldspar, muscovite and high potassic fertilizers use.

Available S status

The available S content in soils of Sabarkantha district ranged from 4.55 to 39.64 mg kg⁻¹ with a mean value of 15.25 mg kg⁻¹ (table 5). On the basis of mean values, soils of Vadali taluka

have the highest amount of available sulphur (17.58 mg kg⁻¹) followed by Talod (16.15 mg kg⁻¹) and Khedbrahma (15.40 mg kg⁻¹) talukas while the soils of Poshina taluka have the lowest mean value (13.58 mg kg⁻¹) of available sulphur. Out of 320 soil samples, nearly 77.2 per cent soil samples were observed under medium status in available S (table 6). The medium status of sulphur in soils of Sabarkantha district might be due to use of S-bearing fertilizers such as ammonium sulphate and magnesium sulphate by the cultivators and cultivation of S loving oil seed crop. Nutrient index values ranged from 1.88 to 2.28 with a mean value of 2.02. The overall fertility rating for available S was adequate (table 7). Singh *et al.* (2009) [8] reported similar results for soils of Udham Singh Nagar district of Uttarakhand.

Correlation coefficient (r) among different properties of soils of Sabarkantha district

The data of correlation values indicated highly significant positive relations between organic carbon with available N (r

= 0.501**), available P (r = 0.158**) and also with available S (r = 0.284**). The major nutrient availability was increase with increase of organic carbon (table 8). Similar results were recorded for soils of Tonk district of Rajasthan (Meena *et al.*, 2006) [3].

Conclusion

The soil analytical data of Sabarkantha district clearly indicates that soils are slightly neutral to mildly alkaline in reaction with low soluble salt content. The content of organic carbon and available N were classified in low category. The status of available P and S was medium while status of available K was high. Based on overall nutrient index in soils of Sabarkantha district, available N was classified in low; available P and S in adequate where as available K in high fertility status.

Table 7: Talukawise nutrient index and fertility status of available major nutrients in soils of Sabarkantha district

Name of Taluka	Nutrient values				Fertility status			
	N	P ₂ O ₅	K ₂ O	S	N	P ₂ O ₅	K ₂ O	S
Himmatnagar	1.38	2.08	2.78	2.03	Low	Adequate	Very High	Adequate
Idar	1.30	2.18	2.50	2.03	Very low	Adequate	High	Adequate
Prantij	1.25	2.20	2.50	1.95	Very Low	Adequate	High	Marginal
Talod	1.33	2.13	2.58	2.08	Low	Adequate	High	Adequate
Khedbrahma	1.38	2.35	2.60	1.95	Low	High	High	Marginal
Vadali	1.38	2.30	2.85	2.28	Low	Adequate	Very high	Adequate
Vijaynagar	1.55	2.23	2.38	2.00	Low	Adequate	High	Adequate
Poshina	1.18	1.98	2.80	1.88	Very Low	Marginal	Very high	Marginal
District	1.34	2.18	2.62	2.02	Low	Adequate	High	Adequate

Table 8: Correlation co-efficient (r values) between chemical properties and available major nutrients

Chemical properties	Available N	Available P	Available K	Available S
EC	0.039	-0.023	-0.039	0.062
pH	-0.026	-0.017	-0.001	0.013
OC	0.501**	0.158**	0.087	0.284**

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