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

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Abstract

A study was undertaken to delineate the status of available major nutrients in soils of Mehsana district of Gujarat. Total 371 representative surface soil samples were collected from cultivated farmer's field of 10 talukas of Mehsana district during April-2016. Results revealed that soils of Mehsana district are slightly neutral to moderately alkaline in reaction (pH - 7.67) with low soluble salt (EC - 0.37 dS/m) content. The soils of Mehsana district were low in organic carbon (0.41 per cent) and available nitrogen (224.80 kg/ha), medium in available phosphorus (44.38 kg/ha) and high in available potassium status (413.89 kg/ha). Overall, soils of Mehsana district had nutrient index values of 1.32, 2.06 and 2.78 for available N, P₂O₅ and K₂O which indicates very low, adequate and very high fertility status, respectively.

Keywords: Available N, P₂O₅, K₂O, Nutrient index

Introduction

The basic objective of the soil-testing programme is to give farmers a service leading to better and more economic use of fertilizers and better soil management practices for increasing agricultural production. High crop yields cannot be obtained without applying sufficient fertilizers to overcome existing deficiencies. Nitrogen is one of the most important major nutrient as well as expensive input in agricultural production, which is closely associated with growth and development of plants. It is found in amino acid, proteins, nucleic acids and chlorophyll. Phosphorus play a pivotal structure and regulatory role at the nexus of photosynthesis, root development, energy conservation, transformations, carbon metabolism, redox reactions, enzyme activation/ inactivation, signaling and nucleic acid synthesis. Potassium is well known for its ability to improve crop quality and its role in combating a variety of climatic and biological stress. Nitrogen, Phosphorus and Potassium are the spine of major nutrients and no other nutrient can alter the requirement of these essential nutrients.

Materials and Methods

To delineate the available major nutrients (N, P, K) status and chemical properties (EC, pH, OC) of the soils of Mehsana district, total 371 representative surface soil samples from depth of 0-15 cm were collected from farmers' fields during summer season using multistage stratified random sampling method (Singh *et al.*, 1982)^[8]. The soil samples were air dried in shade. The soil samples, after air drying were ground with wooden mortar and pestle and passed through 2.0 mm sieve. The prepared samples were stored in polyethylene lined cloth bags with proper labels. The soil samples were brought to laboratory for further analysis. The soil reaction (pH) and electrical conductivity (EC) were determined as per the procedure described by Jackson (1973)^[1]. The soil organic carbon (OC) was estimated by wet digestion method of Walkley and Black (1934). The Available N was determined by alkaline potassium permanganate method suggested by Subbiah and Asija (1956)^[12]. The available P₂O₅ was extracted by employing Olsen extractant (0.5 M NaHCO₃) as described by Olsen *et al.*, (1954)^[3] and the available K₂O was extracted by using neutral normal ammonium acetate and the content was determined by aspirating the extract in to flame photometer (Jackson, 1973)^[1]. Nutrient index was calculated utilizing the following formula suggested by Parker *et al.* (1951):

$$\text{Nutrient Index} = \frac{(N_1 \times 1) + (N_m \times 2) + (N_h \times 3)}{N_t}$$

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Where, N_l , 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_t is the total number of samples. The nutrient index value are rated in various categories viz., very low (< 1.33), low (1.33- 1.66), marginal (1.66 to 2.00), adequate (2.00- 2.33), high (2.33- 2.66) and very high (> 2.66) as rating given by Stalin *et al.* (2010).

Results and Discussion

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

Electrical Conductivity (EC_{2.5})

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

Name of Taluka	No. of Soil Samples	EC _{2.5} (dS/m)		pH _{2.5}	
		Range value	Mean value	Range value	Mean value
Mehsana	47	0.14- 2.10	0.48	7.25- 8.48	7.92
Vadnagar	36	0.10- 1.70	0.30	6.53- 8.18	7.50
Visnagar	40	0.11- 1.62	0.32	6.71- 8.31	7.71
Kadi	40	0.13- 1.90	0.45	7.28- 8.38	7.90
Vijapur	40	0.07- 0.59	0.18	6.38- 8.24	7.44
Kheralu	40	0.09- 0.78	0.30	6.79- 8.49	7.68
Becharaji	40	0.09- 1.81	0.44	6.75- 8.25	7.66
Unjha	32	0.15- 1.73	0.63	6.68- 8.24	7.69
Satlasana	31	0.10- 2.40	0.30	6.23- 7.86	7.25
Jotana	25	0.08- 0.98	0.29	7.19- 8.41	7.89
District	371	0.07- 2.40	0.37	6.23- 8.49	7.67

Soil Reaction (pH_{2.5})

In general, the soils of this district are slightly neutral to moderately alkaline in reaction. The pH values of the soils for the entire district were ranging from 6.23 to 8.49 with a mean value of 7.67 (Table 1). The lowest mean pH value of 7.25 was recorded in soils of Satlasana taluka and the highest mean value of 7.92 was recorded in the soils of Mehsana taluka. Out of 371 total soil samples, 1.35, 23.45, 42.59 and 32.61 per

The electrical conductivity of soil was varied widely ranged from 0.07 to 2.40 dS/m with a mean value of 0.37 dS/m (Table 1). The data revealed that the lowest mean values of 0.18 dS/m was observed in the soils of Vijapur taluka and the highest mean value of 0.63 dS/m was registered in the soils of Unjha taluka. The data presented in table 2 revealed that 93.80 per cent soil samples have EC value less than 1.0 i.e. soluble salt under safe limit. Only 5.66 and 0.54 per cent soil sample falls under slightly saline and saline status, respectively. None of the soil sample falls under highly saline status. Similar results were also obtained for soils of Mandvi taluka of Kutch district of Gujarat (Patel *et al.*, 2012). The low EC of soil might be due to proper management of soil and thereby leaching of salt take place from surface to sub-surface.

cent soil samples have slightly acidic, neutral, mildly alkaline and moderately alkaline reaction, respectively (Table 2). Similar results were also obtained for soils of Patan district of Gujarat (Patel *et al.*, 2016) and for soils of Gandhinagar district of Gujarat (Patel *et al.*, 2017). The relative high pH in these soils might be due to presence of high degree of base saturation.

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

Name of Taluka	Electrical Conductivity (EC _{2.5})				Soil Reaction (pH _{2.5})			
	Normal	Slightly Saline	Saline	Highly Saline	Slightly Acidic	Neutral	Mildly Alkaline	Moderately Alkaline
	<1.0 dS/m	1.0-2.0 dS/m	2.0-3.0 dS/m	>3.0 dS/m	6.1-6.5	6.6-7.3	7.4-7.8	7.9-8.4
Mehsana	89.36	8.51	2.13	0.00	0.00	2.13	44.68	53.19
Vadnagar	94.44	5.56	0.00	0.00	0.00	41.67	36.11	22.22
Visnagar	97.50	2.50	0.00	0.00	0.00	15.00	52.50	32.50
Kadi	92.50	7.50	0.00	0.00	0.00	5.00	42.50	52.50
Vijapur	100.00	0.00	0.00	0.00	5.00	37.50	40.00	17.50
Kheralu	100.00	0.00	0.00	0.00	0.00	30.00	35.00	35.00
Becharaji	90.00	10.00	0.00	0.00	0.00	32.50	37.50	30.00
Unjha	78.13	21.88	0.00	0.00	0.00	18.75	53.13	28.13
Satlasana	96.77	0.00	3.23	0.00	9.68	48.39	41.94	0.00
Jotana	100.00	0.00	0.00	0.00	0.00	8.00	44.00	48.00
District	93.80	5.66	0.54	0.00	1.35	23.45	42.59	32.61

Organic Carbon

Data presented in table 3 revealed that most of the soils were having low status of organic carbon. It ranged from 0.20 to 0.72 per cent with a mean value of 0.41 per cent. The lowest mean organic carbon value of 0.39 per cent was recorded in soils of Vadnagar, Kadi and Jotana talukas and the highest mean organic carbon value of 0.48 per cent was recorded in the soils of Visnagar taluka. In general, 80.05 per cent soil samples were low in organic carbon status and only 19.95 per

cent medium in organic carbon status (Table 3). The results are strongly supported by the findings of Singh and Mishra (2012) [9] in soils of Chiraigaon block of Varanasi (U.P.). Such low values for organic carbon status of soils are expected because of the rapid decomposition and mineralization of organic matter in semi-arid climatic conditions and particularly negligible replacement of organic matter.

Table 3: Talukawise range, mean value and per cent distribution of organic carbon content in soils of Mehsana district

Name of Taluka	No. of Soil Samples	Range value (%)	Mean Value (%)	Per cent distribution of organic carbon		
				Low <0.50 (%)	Medium 0.50-0.75 (%)	High >0.75 (%)
Mehsana	47	0.21- 0.72	0.42	76.60	23.40	0.00
Vadnagar	36	0.20- 0.56	0.39	83.33	16.67	0.00
Visnagar	40	0.33- 0.68	0.48	62.50	37.50	0.00
Kadi	40	0.20- 0.66	0.39	75.00	25.00	0.00
Vijapur	40	0.23- 0.59	0.40	90.00	10.00	0.00
Kheralu	40	0.21- 0.57	0.41	87.50	12.50	0.00
Becharaji	40	0.26- 0.65	0.42	85.00	15.00	0.00
Unjha	32	0.24- 0.62	0.40	78.13	21.88	0.00
Satlasana	31	0.23- 0.65	0.41	83.87	16.13	0.00
Jotana	25	0.20- 0.57	0.39	80.00	20.00	0.00
District	371	0.20- 0.72	0.41	80.05	19.95	0.00

Available nitrogen

The overall, available N status for the targeted district was low and it range from 94.08 to 344.96 kg/ha with a mean value of 224.80 kg/ha (Table 4). The highest mean value of available nitrogen was found in Unjha taluka (245.49 kg/ha) and lowest mean value of available nitrogen was found in soils of Becharaji taluka (209.72 kg/ha). Out of 371 total soil samples, 68.19 per cent were found to be low in available nitrogen status, whereas 31.81 per cent were medium in

available nitrogen content (Table 5). The nutrient index value ranged from 1.18 to 1.53 with a mean value of 1.32 which indicated very low status of available nitrogen in soils of Mehsana district (Table 6). Similar results were also reported for soils of Chambal region of Madhya Pradesh (Singh *et al.*, 2014) [10]. Such lower values for available N might be due to lower content of organic carbon and poor addition of organic matter as well as less use of organic manures in the semi-arid area.

Table 4: Talukawise range and mean value for available N, P₂O₅ and K₂O content in soils of Mehsana district

Name of Taluka	No. of Soil Samples	Available N (kg/ha)	Available P ₂ O ₅ (kg/ha)	Available K ₂ O (kg/ha)
Mehsana	47	125.44- 297.92 (218.52)	13.05- 97.63 (36.88)	188.16- 994.56 (382.04)
Vadnagar	36	141.12- 282.24 (224.75)	13.74- 90.04 (47.60)	188.16- 873.60 (386.03)
Visnagar	40	141.12- 344.96 (225.79)	14.86- 99.83 (50.26)	188.16- 792.96 (352.13)
Kadi	40	94.08-329.28 (210.90)	20.10- 73.47 (47.85)	188.16- 940.80 (466.03)
Vijapur	40	109.76-297.92 (219.91)	20.91- 83.25 (51.33)	215.04- 913.92 (409.92)
Kheralu	40	172.48- 297.92 (232.06)	12.19- 91.07 (43.74)	147.84- 954.24 (416.30)
Becharaji	40	156.80- 313.60 (209.72)	13.59- 75.89 (39.55)	188.16- 967.68 (465.36)
Unjha	32	203.84- 297.92 (245.49)	11.79- 97.86 (36.62)	174.72- 833.28 (440.58)
Satlasana	31	156.80- 313.60 (240.76)	20.55- 71.59 (44.16)	241.92- 860.16 (447.42)
Jotana	25	188.16- 297.92 (231.44)	19.64- 74.55 (47.03)	174.72- 846.72 (373.63)
District	371	94.08- 344.96 (224.80)	11.79- 99.83 (44.38)	147.84- 994.56 (413.89)

Note: Values in parenthesis indicates mean value

Table 5: Per cent distribution of soil samples according to low, medium and high categories for macronutrients in different talukas of Mehsana district

Name of Taluka	No. of Soil Samples	Available N			Available P ₂ O ₅			Available K ₂ O		
		Low	Medium	High	Low	Medium	High	Low	Medium	High
		< 250 (kg/ha)	250-500 (kg/ha)	> 500 (kg/ha)	< 28 (kg/ha)	28-56 (kg/ha)	> 56 (kg/ha)	< 140 (kg/ha)	140-280 (kg/ha)	> 280 (kg/ha)
Mehsana	47	70.21	29.79	0	31.91	59.57	8.51	0	38.30	61.70
Vadnagar	36	69.44	30.56	0	13.89	63.89	22.22	0	25.00	75.00
Visnagar	40	60.00	40.00	0	20.00	32.50	47.50	0	25.00	75.00
Kadi	40	80.00	20.00	0	2.50	70.00	27.50	0	15.00	85.00
Vijapur	40	72.50	27.50	0	2.50	62.50	35.00	0	17.50	82.50
Kheralu	40	67.50	32.50	0	15.00	65.00	20.00	0	12.50	87.50
Becharaji	40	82.50	17.50	0	22.50	65.00	12.50	0	17.50	82.50
Unjha	32	46.88	53.13	0	40.63	50.00	9.38	0	21.88	78.13
Satlasana	31	51.61	48.39	0	6.45	74.19	19.35	0	6.45	93.55
Jotana	25	76.00	24.00	0	8.00	68.00	24.00	0	40.00	60.00
District	371	68.19	31.81	0	16.71	60.65	22.64	0	21.83	78.17

Available Phosphorus

The available P₂O₅ content in soils of Mehsana district varied widely from 11.79 to 99.83 kg/ha with a mean value of 44.38 kg/ha (Table 4). The highest mean value of available P₂O₅ was found in Vijapur taluka (51.33 kg/ha) followed by Visnagar (50.26 kg/ha) and Kadi (47.85 kg/ha) talukas. The lowest mean value was found in soils of Unjha taluka (36.62 kg/ha). Out of 371 soil samples, 16.71 per cent were found to

be low, 60.65 per cent were medium and remaining 22.64 per cent were high in available phosphorus content (Table 5). Nutrient index value ranged from 1.69 to 2.33 with a mean value of 2.06. The overall fertility rating was adequate (Table 6). These results are strongly supported by the findings of Patel *et al.*, (2016) for soils of Patan district of Gujarat. The medium status of available phosphorus in these soils might be due to regular application of phosphatic fertilizers to realize

higher yields of oil seeds, which are the principal crops of the area.

Available Potassium

The available potassium in soil varied from 147.84 to 994.56 kg/ha with an average value of 413.89 kg/ha (Table 4). The highest mean value for available K₂O was found in Kadi taluka (466.03 kg/ha) followed by Becharaji taluka (465.36 kg/ha) and Satlasana taluka (447.42 kg/ha). The lowest mean value of available K₂O was found in Visnagar taluka (352.13 kg/ha). Out of 371 soil samples, 78.17 per cent soil samples

were found to be high and 21.83 per cent soil samples were medium in available potassium content (Table 5). Nutrient index value ranged from 2.60 to 2.94 with a mean value of 2.78 which indicated very high fertility status of potassium in soils of Mehsana district (Table 6). The high available potassium content in these soils might be attributed to the prevalence of potassium rich minerals like feldspars and muscovite and high potassic fertilizers use. Similar results were also obtained for soils of Gandhinagar district of Gujarat (Patel *et al.*, 2017).

Table 6: Nutrient index and fertility status of nutrient in soils of Mehsana district

Name of Taluka	Nutrient Index			Fertility Status		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Mehsana	1.30	1.77	2.62	Very low	Marginal	High
Vadnagar	1.31	2.08	2.75	Very low	Adequate	Very high
Visnagar	1.40	2.28	2.75	Low	Adequate	Very high
Kadi	1.20	2.25	2.85	Very low	Adequate	Very high
Vijapur	1.28	2.33	2.83	Very low	High	Very high
Kheralu	1.33	2.05	2.88	Low	Adequate	Very high
Becharaji	1.18	1.90	2.83	Very low	Marginal	Very high
Unjha	1.53	1.69	2.78	Low	Marginal	Very high
Satlasana	1.48	2.13	2.94	Low	Adequate	Very high
Jotana	1.24	2.16	2.60	Very low	Adequate	High
District	1.32	2.06	2.78	Very low	Adequate	Very high

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

The data of correlation values indicated highly significant positive relations between organic carbon with available nitrogen ($r = 0.243^{**}$) and available P₂O₅ ($r = 0.161^{**}$)

(Table 7). The availability of these nutrients increased with an increase of organic carbon content in the soil. Similar results were also obtained for soils of Tonk district of Rajasthan (Meena *et al.*, 2006)^[2].

Table 7: Correlation coefficient (r) among different soil properties of soils for Mehsana district

Soil Properties	EC	pH	Organic Carbon	Available N	Available P ₂ O ₅
pH	-0.108*				
Organic Carbon	-0.020	-0.002			
Available N	-0.054	-0.106*	0.243**		
Available P ₂ O ₅	-0.067	-0.063	0.161**	-0.004	
Available K ₂ O	0.038	-0.042	0.044	0.045	0.148**

* Significant at the 0.05 level.

** Significant at the 0.01 level.

Conclusion

The soil survey data of Mehsana district clearly indicates that the soils are slightly neutral to moderately alkaline in reaction with low soluble salt content. The soils of Mehsana district were low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium status. On the basis of overall nutrient index, soils of Mehsana district are very low in available nitrogen, adequate in available phosphorus and very high in available potassium status.

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