

Fertility status of cultivated soils in Patan district of North Gujarat

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ABSTRACT

An investigation was carried out to study the fertility status of cultivated soils in Patan district of north Gujarat. The soils of Patan district are neutral to alkaline in reaction (pH 7.10 to 9.30) having electrical conductivity value varied from 0.103 to 9.230 dSm⁻¹. The data on nutrient status showed that soils are low in organic carbon, medium to high in available phosphorus, high status of potash and adequate amount of sulphur. Among the DTPA extractable micronutrients, high to very high amount of manganese and copper, whereas marginal to adequate amount of iron and zinc supply. The availability of potash, sulphur and DTPA extractable micronutrient cations were significantly and positively correlated with organic carbon content of soils.

Key words : Fertility, soil properties, micronutrients

At present the exploitive agriculture with sustained efforts to increase crop yield has not only depleted our soils of their nutrient serve, but also resulted in the emergence of a number of new nutrient deficiency in the soils. Optimum use of fertilizers contributes significantly in bringing about an increase in agricultural production. Amount of fertilizers required for same crop varies from soil to soil and even from field to field. Maintenance of fertility of soils is immense concern to obtain harness higher yields (Gupta 2000). Now a day, due to change in cropping pattern and diversification of crops, it is necessary to know fertility status of soils. In the current concept of sustainable agriculture, there is need to understand the characteristics and inherent fertility of the soils for enhancing its productivity. Knowledge about the fertility status of the soils is of prime importance for the optimum use of land. Proper understanding of nutrients availability in soils and extent of their deficiencies is prerequisite for efficient management of fertilizers to sustain the crop productivity. Scantly information is available regarding fertility status of soils and their relationship with soil properties of Patan district. Therefore, the attempt was made to study the fertility status in soils of Patan district of north Gujarat

MATERIALS AND METHODS

The study area is located (Patan district) is located in the north region of Gujarat at 23.55° to 24.41° N Latitude and 71.31° to 72.20° E longitude. The district has semi-arid climate and received average rainfall of 550 mm. The main crops grown include castor, cotton, mustard, cumin, wheat etc. Three hundred sixteen (316) surface (0-15 cm) soil samples of farmers' field were collected from seven talukas (Siddhpur, Patan, Chanasma, Harij, Sami, Radhanpur and Santalpur) of Patan district by following the random sampling techniques. The soil samples, after air drying were ground with wooden mortar and pestle and passed through 2.0 mm sieve. The soil reaction (pH) and electrical conductivity (EC) were determined as per the procedure described by Jackson (1973). The soil organic carbon (OC) was estimated by wet digestion method of Walkley and Black (1934). The available P was extracted by employing Olsen extractant (0.5 M NaHCO₃) as described by Olsen *et al.*, (1954) and the available K was extracted by using neutral normal ammonium acetate and the content was determined by aspirating the extract in to flame photometer (Jackson, 1973). The available sulphur in the soil was extracted by 0.15 % CaCl₂ · 2H₂O solution as described by Williams and Steinbergs (1959) and the content of DTPA Extractable micronutrients viz.,

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Iron (Fe), Manganese (Mn), Zinc (Zn) and Copper (Cu) in soil was estimated using 1: 2 soil to extractants ratio (Lindsay and Norvell, 1978). Simple correlations were worked among different chemical properties of soil by standard statistical methods (Panse and Sukhatme, 1967). The nutrient index (NI) values for available nutrients were calculated utilizing the formula suggested by Parkar *et al.* (1951).

$$NI = [(N_l \times 1) + (N_m \times 2) + (N_h \times 3)] / N_t$$

Where, N_l , N_m and N_h are the number of soils 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 chemical properties of soil revealed that the soils of Patan district are neutral to alkaline in reaction with the pH ranging from 7.10 to 9.30 (Table 1). The highest value of pH was found in Siddhpur taluka (9.30). As

far as electrical conductivity is concerned, the overall value of EC in soils of Patan district ranged from 0.103 to 9.230 dSm⁻¹ with a mean value of 1.139 dSm⁻¹. The higher EC range was observed in Radhanpur taluka whereas lowest rang was observed in Siddhpur taluka. Similar results were found by Thakor *et al.* (2014a) in North Gujarat.

The organic carbon content of soil ranged from 0.039 to 2.388 with a mean value of 0.366 % which indicates poor fertility of soil in Patan district. This could be ascribed due to rapid decomposition and mineralization organic matter in semi arid climatic conditions. The lowest value of organic carbon content of 0.039 per cent was recorded in soil samples collected from Sami taluka, whereas the highest value of 2.388 per cent was obtained in Chansma taluka (Table 1). The mean value of organic carbon content in soil for Siddhpur, Patan, Chansma, Harij, Sami, Radhanpur and Santalpur talukas were 0.355, 0.360, 0.540, 0.336, 0.300, 0.486 and 0.235 per cent, respectively. The lower value of organic carbon in north Gujarat was also reported by Thakor *et al.* (2014a)

The available P₂O₅ content of soil samples of Patan district varied between 9.99 to 138.82 kg/ha. The overall mean value of available phosphorus (52.42 kg P₂O₅/ha)

Table 1: Chemical characteristics and nutrient status of soils of Patan district

Sr. No.	Taluka	No. of Samples	pH _{2.5}	EC _{2.5} (dSm ⁻¹)	Organic Carbon (%)	Available P ₂ O ₅ (kg/ha)	Available K ₂ O (kg/ha)	Available Sulphur (mg/kg)
1.	Siddhpur	41	7.10-9.30 (8.13)	0.132-1.350 (0.397)	0.117-1.025 (0.355)	9.99-120.85 (55.25)	123.51-616.22 (257.88)	6.30-49.99 (20.51)
2.	Patan	54	7.10-8.70 (7.75)	0.180-3.500 (0.790)	0.117-0.766 (0.360)	15.98-101.87 (37.53)	105.91-678.05 (300.21)	5.18-79.60 (24.69)
3.	Chansma	42	7.20-8.80 (7.86)	0.103-2.500 (0.617)	0.182-2.388 (0.540)	11.99-126.94 (45.89)	213.70-873.60 (460.33)	4.81-57.76 (26.40)
4.	Harij	42	7.20-8.60 (7.94)	0.241-4.480 (1.213)	0.065-0.779 (0.336)	21.97-138.82 (66.92)	170.69-744.71 (431.73)	5.92-74.79 (25.34)
5.	Sami	56	7.40-8.75 (8.04)	0.167-7.310 (1.287)	0.039-0.948 (0.300)	17.98-103.87 (53.79)	177.41-940.80 (523.79)	2.22-70.32 (36.85)
6.	Radhanpur	36	7.15-8.80 (8.18)	0.332-9.230 (2.782)	0.182-1.181 (0.486)	19.98-106.86 (56.87)	185.88-825.22 (468.80)	4.81-94.78 (38.47)
7.	Santalpur	45	7.10-8.85 (7.88)	0.209-7.410 (1.153)	0.117-0.584 (0.235)	20.97-95.88 (55.04)	124.99-768.77 (369.73)	7.41-98.12 (30.51)
	District	316	7.10-9.30 (7.96)	0.103-9.230 (1.139)	0.039-2.388 (0.366)	9.99-138.82 (52.42)	105.91-940.80 (402.21)	2.22-170.32 (29.03)

Note: Value in parenthesis shows mean

Table 2 Micronutrient status of soils of Patan district

Sr. No.	Taluka	No. of Samples	DTPA - extractable micronutrients (mg/kg)			
			Fe	Mn	Zn	Cu
1.	Siddhpur	41	4.22-14.22 (6.61)	5.20-28.76 (13.17)	0.22-1.28 (0.73)	0.34-1.70 (0.70)
2.	Patan	54	4.26-12.86 (6.23)	3.60-25.48 (11.71)	0.14-1.48 (0.60)	0.22-2.14 (0.71)
3.	Chanasma	42	3.48-8.84 (6.29)	6.38-38.08 (15.66)	0.46-1.86 (0.90)	0.22-1.16 (0.68)
4.	Harij	42	4.84-16.04 (7.13)	4.36-24.14 (14.69)	0.40-1.38 (0.82)	0.34-1.90 (0.85)
5.	Sami	56	4.12-23.92 (6.99)	4.18-24.36 (10.19)	0.30-2.10 (0.71)	0.28-2.76 (0.88)
6.	Radhanpur	36	3.54 -13.60 (7.52)	4.94-20.58 (13.03)	0.34-1.40 (0.69)	0.16-2.58 (0.95)
7.	Santalpur	45	3.66 -14.80 (7.39)	3.92-17.94 (10.85)	0.38-1.32 (0.64)	0.18-2.18 (0.84)
	District	316	3.48-23.92 (6.77)	3.60-38.08 (12.51)	0.14-2.10 (0.71)	0.10-2.76 (0.86)

Note: Value in parenthesis shows mean

Table 3 Correlation coefficient (r) between different chemical properties of soil

Soil Properties	EC _{2.5}	pH _{2.5}	Org. Carbon (%)	Ava. P ₂ O ₅ (kg/ha)	Ava. K ₂ O (kg/ha)	Ava. S (mg/kg)	DTPA -extractable micronutrients (mg/kg)		
							Fe	Mn	Zn
pH _{2.5}	-0.101								
Org. Carbon(%)	0.185**	-0.045							
Avail. P ₂ O ₅ (kg/ha)	0.98**	0.011	0.053						
Avail. K ₂ O (kg/ha)	0.226**	0.016	0.209**	0.141*					
Avail. S (mg/kg)	0.580**	-0.137*	0.130*	0.097	0.200**				
Fe (mg/kg)	0.109	-0.075	0.200**	0.173**	0.334**	0.079			
Mn (mg/kg)	0.157**	-0.360**	0.343**	0.218**	0.170**	0.132*	0.110		
Zn (mg/kg)	0.142*	-0.102	0.388**	0.139*	0.279**	0.136*	0.213**	0.326**	
Cu (mg/kg)	0.257**	-0.076	0.288**	0.037	0.586**	0.197**	0.555**	0.182**	0.397**

Table 4 Nutrient index values of available nutrients in soils of Patan district

Taluka	Available P ₂ O ₅	Available K ₂ O	Available S	DTPA Extractable Micronutrients			
				Fe	Mn	Zn	Cu
Siddhpur	2.22	2.27	2.24	1.88	2.68	1.95	2.85
Patan	1.78	2.48	2.19	1.85	2.52	1.80	2.67
Chansama	2.00	2.93	2.29	1.79	2.74	2.17	2.86
Harij	2.43	2.86	2.31	1.90	2.67	1.98	2.74
Sami	2.29	2.84	2.29	1.87	2.37	1.82	2.89
Radhanpur	2.33	2.72	2.31	2.22	2.69	1.86	2.83
Santalpur	2.29	2.62	2.24	2.16	2.62	1.80	2.82
District	2.18	2.67	2.27	1.91	2.58	1.86	2.87

also indicate that the soil of Patan district was medium in available phosphorus status. Similar results were also reported by Thakor *et al.* (2014a) in north Gujarat. The farmers are using only Dia Ammonium Phosphate (DAP) as a source of nutrients in adequate quantity. As a result, available P_2O_5 in medium range. The average available K_2O content of soil varied from 105.91 to 940.80 kg/ha with a mean value of 402.21 kg/ha. (Table 1). Adequate (medium to high) available K in this soil attributed to the prevalence of potassium rich mineral like illite and feldspar. This clearly shows that the soils of Patan district is medium to well supplied with available potassium. These results are conformity with Hasan (2002).

The available sulphur in soils of Patan district ranged from 2.22 to 170.32 mg/kg with a mean value of 29.03 mg/kg (Table 1). Considering the 10 mg/kg as critical limit for available sulphur, the soils of Patan district are adequate in sulphur. The higher concentration of available S in sub tropical region might be attributed to higher amount of soluble salts in these soils. Similar results were reported by Kour and Jalai (2008)

The available Fe content of soil sample varied from 3.48 to 23.92 with a mean value of 6.77 mg/kg (Table 2). The highest mean value was found in Radhanpur taluka (7.52 mg/kg) and lowest mean value was found in Patan taluka (6.23 mg/kg). The DTPA-extractable Zn content in soil ranged from 0.14 to 2.10 mg/kg with a mean value of 0.71 mg/kg (Table 2). Similar Results are also reported by Patel *et al.* (1998) and Thakor *et al.* (2014b). The medium status of Fe and Zn might be due precipitation of this nutrients under alkaline condition of soil. The average available Mn content of soil ranged from 3.60 to 38.08 mg/kg with a mean value of 12.51 mg/kg. The average available Cu content of soil ranged from 0.10 to 2.76 with a mean value of 0.86 mg/kg. The higher overall mean values of available Mn and Cu indicates sufficient availability of Mn and Cu in the soils of Patan district. Similar Results are also reported by Patel *et al.* (1998) and Thakor *et al.* (2014b)

Interrelationship among different chemical properties of soil

The correlation coefficient (r) among different chemical properties of soils in Patan district is presented in Table 3. The available P_2O_5 , K_2O , S and DTPA extractable micronutrients (Mn, Zn, Cu) of the soil were found to be correlated positively and significantly with electrical conductivity. Similar relationship was

also reported by Chatopadhyay *et al.* (1996). With the increasing of soil pH, availability of micronutrient decreased, which probably due to alkaline nature of soils. This confirmed that soil pH had negative correlation with available Fe (-0.075), available Zn (-0.102), available Mn (-0.366") and available Cu (-0.076). Soil available potassium, sulphur and micronutrients (Fe, Mn, Zn, Cu) had significant and positive correlation with organic carbon. The positive correlation between these nutrients and organic carbon content of soil indicate that the availability of nutrients increased with an increase of organic carbon in the soil. Similar relationship was also observed by Dhane and Shukla (1995) and Bhogal *et al.* (1993). Available K had a significant positive correlation with available Fe (0.334"), available Mn (0.170"), available Zn (0.279") and available Cu (0.586"). Sharam *et al.* (2008) also reported similar results in soils of Amritsar district of Punjab. Soil available phosphorus showed significant and positive correlation with available K_2O , available Fe, available Mn and available Zn.

Nutrient Index Values and fertility status

The nutrient index values (Table 4) for all the nutrients were worked out for all the talukas of Patan district. The nutrient index value for available phosphorus was ranged from 1.78 to 2.43 indicating marginal to high status of phosphorus in soil. The nutrient index value for available potassium ranged from 2.27 to 2.93 indicating adequate to very high status of potassium in soils of Patan district. The nutrient index value for available sulphur was ranged from 2.19 to 2.31 indicating adequate status of sulphur in soil. The nutrient index for Fe and Zn ranged from 1.79 to 2.22 and 1.80 to 2.17, respectively indicating marginal to adequate status of these nutrient in soils. The higher nutrient index was noticed in all the talukas for Mn (2.37 to 2.74) and Cu (2.67 to 2.85) indicating high to very high status of Mn and Cu in soils of Patan district.

CONCLUSION

The results of study indicate that soils of Patan district are neutral to alkaline in reaction with low in organic carbon. The soils of Patan district are low to medium in available P_2O_5 and sulphur whereas high in available K_2O content. With respect to DTPA Mn and Cu, the soils of Patan district were found to be sufficient but for DTPA Zn and Fe, it was medium in status. This information can be useful for the cultivated soils of Patan district.

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