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Fertility status of cultivated soils in Gandhinagar district of Gujarat

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ABSTRACT

An investigation was carried out to study the fertility status of cultivated soils in Gandhinagar district of Gujarat. The soils of Gandhinagar district are neutral to alkaline in reaction (pH 6.80 to 8.95) having electrical conductivity value varied from 0.094 to 1.897 dSm^{-1}. The data on nutrient status showed that soils are low in organic carbon, medium in available phosphorus, medium to high status of potash and high status of sulphur. Among the DTPA extractable micronutrients, high to very high amount of manganese and copper, whereas marginal status of iron and zinc in soils. The availability of potash, sulphur and DTPA extractable micronutrients (Zn and Cu) were significantly and positively correlated with organic carbon content of soils.

Key word: 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 Gandhinagar district. Therefore, the attempt was made to study the fertility status in soils of Gandhinagar district of Gujarat

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MATERIALS AND METHODS

The study area is located (Gandhinagar district) is located in the Gujarat at 23.01º to 23.56º N Latitude and N 72.33º to E 73.73º E longitude. The district has semi-arid climate and received average rainfall of 667 mm. The main crops grown include castor, cotton, tobacco, rice, pearlmillet, potato, vegetables, mustard, cumin, wheat etc. One hundred seventy seven (177) surface (0-15 cm) soil samples of farmers' field were collected from four talukas (Mansa, Kalol, Gandhinagar, and Dehgam) of Gandhinagar 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 $NaHCO_3$) 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 aspiring the extract in to flame photometer (Jackson, 1973). The available sulphur in the soil was extracted by 0.15 % $CaCl_2$. $2H_2O$ solution as described by Williums and Steinbergs (1959) and the content of DTPA

Extractable micronutrients *viz.*, 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 out 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).

$$NI = [(N_l x1) + (N_m x2) + (N_h x3)] / N_t$$

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 Gandhinagar district are neutral to alkaline in reaction with the pH ranging from 6.80 to 8.95 (Table 1). The highest value of pH was found in Kalol taluka (8.95). As far as electrical conductivity is concerned, the overall value of EC in soils of Gandhinagar district ranged from 0.094 to 1.897 dSm^{-1} with a mean value of 0.522 dSm^{-1}. The higher EC range was observed in kalol taluka. Similar results were found by Thakor *et al.* (2014a) in north Gujarat.

The organic carbon content of soil ranged from 0.123 to 0.765 with a mean value of 0.370 % which indicates poor fertility of soil in Gandhinagar 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 0.123 per cent was recorded in soil samples collected from Gandhinagar taluka, whereas the highest value of 0.765 per cent was obtained in Dehgam taluka (Table 1). The mean value of organic carbon content in soil for Mansa, Kalol, Gandhinagar, and Dehgam talukas were 0.406, 0.421, 0.425 and 0.416 per cent, respectively. The lower value of organic carbon in north Gujarat was also reported by Thakor *et. al.* (2014a)

The available P_2O_5 content of soil samples of Gandhinagar district varied between 16.98 to 86.59 kg /ha. The overall mean value of available phosphorus (39.10 kg P_2O_5/ha) also indicate that the soil of Gandhinagar district was medium in available phosphorus status. Similar results were also reported by Thakor *et. al.* (2014a) in 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 114 to 648 kg/ha with a mean value of 319 kg/ha. (Table 1). High amount of available K in this soil attributed to the prevalence of potassium rich mineral like illite and feldspar. This clearly shows that the soil of Gandhinagar district is medium to well supplied with available potassium. The results are conformity with Hasan (2002).

The available sulphur in soils of Gandhinagar district ranged from 5.42 to 75.25 mg/kg with a mean value of 24.32 mg/kg (Table 1). Considering the 10 mg/kg as critical limit for available sulphur, the soils of Gandhinagar 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 3.34 to 24.08 with a mean value of 6.91 mg/kg (Table 2). The highest mean value was found in Dehgam taluka (7.62 mg/kg) and lowest mean value was found in Mansa taluka (6.38 mg/kg). The DTPA-extractable Zn content in soil ranged from 0.16 to 1.76 mg/kg with a mean value of 0.63 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 3.28 to 23.70 mg/kg with a mean value of 12.93 mg/kg. The average available Cu content of soil ranged from 0.36 to 1.90 with a mean value of 0.96 mg/kg. The higher overall mean values of available Mn and Cu indicates sufficient availability of Mn and Cu in the soils of Gandhinagar 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 Gandhinagar district is presented in Table 3. The available K_2O, S and DTPA-Zn of the soil were found to be correlated positively and significantly with electrical conductivity. Similar relationship was also reported by Chatopadhyay *et al.* (1996). Soil available potassium, sulphur and

micronutrient (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). Soil available phosphorus showed significant and positive correlation with available K_2O and DTPA 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 Gandhinagar district. The nutrient index value for available phosphorus was ranged from 1.87 to 2.07 indicating marginal to adequate status of phosphorus in soil. The nutrient index values for available potassium ranged from 2.14 to 2.77 indicating adequate to very high status of potassium in soils of Gandhinagar district. The nutrient index value for available sulphur was ranged from 2.11 to 2.40 indicating adequate to high status of sulphur in soil. The nutrient index for Fe ranged from 1.77 to 1.98 indicating marginal status of Fe in soils. The nutrient index for Zn ranged from 1.63 to 1.86 indicating low to marginal status of zinc in soils. The higher nutrient index values were noticed in all the talukas for Mn (2.49 to 2.72) and Cu (2.96 to 3.00) indicating high to very high status of Mn and Cu in soils of Gandhinagar district

Table 1 Chemical characteristics and nutrient status of soils of Gandhinagar district

Taluka	No. of Samples	$pH_{2.5}$	$EC_{2.5}$ (dSm^{-1})	Organic Carbon (%)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)	Available Sulphur (mg/kg)
Mansa	40	7.45-8.75 (8.10)	0.108-1.125 (0.454)	0.265-0.565 (0.406)	22.97-86.59 (37.34)	114-618 (313)	7.41-45.92 (24.64)
Kalol	47	7.00-8.95 (8.29)	0.263-1.897 (0.737)	0.195-0.571 (0.421)	20.78-48.09 (33.94)	195-648 (396)	6.29-51.10 (27.26)
Gandhinagar	47	7.20-8.75 (7.90)	0.266-1.325 (0.525)	0.123-0.493 (0.425)	18.01-80.90 (41.39)	126-640 (315)	7.23-58.87 (20.19)
Dehgam	43	6.80-8.70 (7.47)	0.094-1.562 (0.347)	0.129-0.765 (0.416)	16.98-70.75 (43.5)	118-632 (247)	5.42-75.25 (25.31)
District...	177	6.80-8.95 (7.95)	0.094-1.897 (0.522)	0.123-0.765 (0.37)	16.98-86.59 (39.1)	114-648 (319)	5.42-75.25 (24.32)

Note: Value in parenthesis shows mean

Table 2: Micronutrient status of soils of Gandhinagar district

Taluka	No. of Samples	DTPA –extractable micronutrient (mg/kg)			
		Fe	Mn	Zn	Cu
Mansa	40	4.42-11.10 (6.38)	4.82-23.70 (13.69)	0.30-1.14 (0.59)	0.38-1.26 (0.81)
Kalol	47	3.34-20.20 (6.79)	3.28-20.84 (11.83)	0.28-1.30 (0.63)	0.50-1.90 (0.98)
Gandhinagar	47	3.44-14.10 (6.84)	4.94-21.70 (12.72)	0.36-1.12 (0.58)	0.36-1.34 (0.91)
Dehgam	43	3.88-24.08 (7.62)	4.38-21.62 (13.64)	0.16-1.76 (0.74)	0.46-1.72 (1.15)
District...	177	3.34-24.08 (6.91)	3.28-23.70 (12.93)	0.16-1.76 (0.63)	0.36-1.90 (0.96)

Note: Value in parenthesis shows mean

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

Soil Properties	EC_{25}	pH_{25}	Org. Carbon (%)	Ava. P_2O_5 (kg/ha)	Ava. K_2O (kg/ha)	Ava. S (mg/kg)	DTPA –extractable micronutrient (mg/kg)		
							Fe	Mn	Zn
pH_{25}	0.341**								
Org. Carbon(%)	0.131	0.077							
Avail. P_2O_5 (kg/ha)	0.039	-0.116	0.033						
Avail. K_2O (kg/ha)	0.267**	0.166*	0.171*	0.209**					
Avail. S (mg/kg)	0.350**	-0.020	0.317**	-0.037	0.135				
Fe (mg/kg)	0.020	-0.001	0.001	0.115	0.088	-0.001			
Mn (mg/kg)	0.031	-0.283**	0.069	-0.009	0.046	0.059	-0.184*		
Zn (mg/kg)	0.177*	0.018	0.221**	0.201**	0.168*	0.156*	0.338**	0.142	
Cu (mg/kg)	0.105	-0.199**	0.175*	0.132	0.098	0.233**	0.275**	0.142	0.250**

Table 4: Nutrient index values of available nutrients in soils of Gandhinagar district

Taluka	Available P_2O_5	Available K_2O	Available S	DTPA Extractable Micronutrients			
				Fe	Mn	Zn	Cu
Mansa	1.98	2.43	2.40	1.85	2.68	1.63	2.98
Kalol	1.87	2.77	2.40	1.79	2.49	1.77	3.00
Gandhinagar	1.87	2.40	2.11	1.98	2.64	1.64	2.96
Dehgam	2.07	2.14	2.33	1.77	2.72	1.86	3.00
District	1.94	2.44	2.31	1.82	2.63	1.76	2.98

CONCLUSION

The results of study indicate that soils of Gandhinagar district are neutral to alkaline in reaction with low in organic carbon. The soils of Gandhinagar district are low to medium in available P_2O_5 ; high in available K_2O and sulphur content. With respect to DTPA Mn and Cu, these soils 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 Gandhinagar district.

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