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

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Abstract
A study was undertaken to assess the status of available major nutrients in soils of Banaskantha district of Gujarat. About Forty representative surface (0-15 cm) soil samples were collected from farmer's field of each taluka. The soil samples were analysed for pH, EC, organic carbon, available N, P_2O_5, and K_2O. Soils of Banaskantha district are moderately alkaline in reaction ($pH_{2.5}$ 7.84) with low soluble salt content (EC 0.35 dS/m).The organic carbon status of soils of Banaskantha district was low (0.30 %). The available N, P_2O_5 and K_2O content in these soils ranged from 47.00 to 376.3, 15.6 to 95.8 and 107.5 to 873.6 kg/ha with a mean value of 228.4, 45.8 and 288.4 kg/ha, respectively. On the basis of nutrient index value, soils of Banaskantha district were very low in available nitrogen, marginal in available phosphorus and high in available potassium status. Highly significant and positive correlation was observed between organic carbon with available nitrogen (r = 0.710**). Available P_2O_5 (r = 0.126**) showed highly significant and positive correlation with available K_2O.

Keywords: Available N, P_2O_5, K_2O, EC, pH, organic carbon, nutrient index, correlation

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. 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 plays an important role in plant metabolism by virtue of being an essential constituent of structural component of the cell and many metabolically active compounds. Phosphorus is facilitating plant nutrient as it is involved in a wide range of plant processes, from permitting division to development of a good root system ensuring timely and uniform ripening of crop. Potassium is well known for its ability to improve crop quality and its role in combating a variety of climatic and biological stress. Potassium has been, thus rightly called by many other names such as a root booster, stalk strengthener, food former, an enzyme activator, a breathing regulator, water stretcher, sugar and starch transporter, protein builder, wilt reducer and disease retardant.

Materials and Methods
To assess the available nitrogen, phosphorus and potassium in soils of Banaskantha district, total 556 representative surface soil samples were collected from farmer's fields of each taluka of Banaskantha district during 2016. One representative surface sample was collected from field upto a depth of 0 to 15 cm by zig-zag method. About forty soil samples were collected from 14 talukas of Banaskantha district during April-2016. 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. Soil $pH_{2.5}$ was measured in 1:2.5 soil: water suspension by using glass electrode electric pH-meter (Jackson, 1973) [3]. The standard analytical methods followed for estimating organic carbon, available nitrogen, phosphorus and potassium are given as follow:

Standard analytical methods for estimating pH, EC, organic carbon and available major nutrients

S. No	Parameter	Method	Reference
1	pH (1: 2.5)	Potentiometric method	Jackson (1973) [3]
2	EC (1: 2.5)	Conductometric method	Jackson (1973) [3]
3	Organic carbon	Walkley and Black titration method	Jackson (1973) [3]
4	Available N	Alkaline potassium permanganate method	Subbiah and Asija (1956)
5	Available P_2O_5	Extraction : 0.5 M $NaHCO_3$ (pH 8.5) Colorimetric method	Olsen *et al.* (1954) [5]
6	Available K_2O	Extraction : 1 N NH_4OAc (pH 7.0) Flame photometric method	Jackson (1973) [3]

Correlation Coefficient (r) between organic carbon and available major nutrients (N, P_2O_5 and K_2O) were worked out using standard procedure (Panse and Sukhatme, 1967) [6]. Nutrient index was calculated utilizing the following formula suggested by Parker *et al.* (1951) [7]:

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

Where, N_l, N_m and N_h are the number of 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 no. of sample. The nutrient index values are rated into various categories *viz.*,very low, low, marginal, adequate, high, and very high as rating given by (Stalin *et al.*, 2010) [14].

Results and Discussion

Soil reaction ($pH_{2.5}$)

In general, soils of this district are neutral to moderately alkaline in reaction. The pH values of soils for the entire district ranged from 7.0 to 8.85 with a mean value of 7.84 (Table 1). The lowest mean pH value of 7.48 was recorded in a soil samples collected from Danta taluka and the highest mean value of 8.05 was recorded in the soil samples collected from Tharad taluka. Similar results were obtained for soils of Tonk district of Rajasthan (Meena *et al.*, 2006) [4].

Electrical Conductivity ($EC_{2.5}$)

Overall, EC in the soils of Banaskantha district varied widely ranging from 0.04 to 3.38 with a mean value of 0.35 dS/m (Table 1). The lowest (0.04 dS/m) EC value was recorded in the soil sample collected from Palanpur taluka, whereas the highest value of (3.38 dS/m) was recorded in Deesa taluka. Meena *et al.*, (2006) [4] also reported almost similar range of EC in soils of Tonk district of Rajasthan, (Savalia and Gundalia, 2009) in soils of southern Saurashtra region of Gujarat.

Organic carbon

In general, soils of Banaskantha district are low in organic carbon status. Overall organic carbon content in soils ranged from 0.01 to 0.78 per cent having a mean value of 0.30 per cent (Table 1). 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) [4].

Available nitrogen

Overall, available nitrogen status for the Banaskantha district was low and it ranged from 47.0 to 376.3 kg/ha with a mean value of 228.4 kg/ha (Table 1). 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. Similar results were also reported for soils of Gir Somnath district (Polara and Chauhan, 2015) [11].

Available phosphorus

The available P_2O_5 was medium in most of talukas. The available P_2O_5 status of soils varied from 15.6.to 95.8 kg/ha with a mean value of 45.8 kg/ha, which was in medium categories (Table 1). 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. Patel *et al.*, (2017) [8] observed similar results for soils of Gandhinagar district of Gujarat.

Available potassium

Overall, available potassium status for the Banaskantha district was high and varied from 107.5 to 873.6 K_2O kg/ha with an average of 288.4 kg/ha (Table 1). 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. Similar results were also obtained for soils of Gandhinagar district of Gujarat (Patel *et al.*, 2017) [8].

Nutrient index values of available major nutrients

The nutrient index values for available major nutrients are presented in Table 2. Overall, soils of Banaskantha district had nutrient index values of 1.13, 1.98 and 2.53 for available N, P_2O_5 and K_2O, respectively. Based on overall nutrient index values of soils in Banaskantha district and the criteria suggested by Stalin *et al.* (2010) [14], soils of Banaskantha district have very low fertility class for available N, marginal fertility class for available P_2O_5 and high fertility class in respect of available K_2O. Similar results were reported for available nitrogen in soils of Amreli district of Gujarat (Polara and Kabaria, 2006) [10], for available phosphorus in soils of Patan district of Gujarat (Annual report, 2013) [2] and for available potassium in soils of Bhavnagar district of Gujarat (Rajput and Polara, 2012) [12].

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

The correlation coefficient (r) values indicated highly significant and positive relationship between organic carbon content and available nitrogen (r = 0.710**). Available P_2O_5 also showed significant and positive correlation (r = 0.043) with organic carbon. Similar results were obtained for soils of Tonk district of Rajasthan (Meena *et al.*, 2006) [4] and for soils of Senapati district of Manipur (Athokpam *et al.*, 2013). Soil available P_2O_5 showed negative correlation with soil pH (r = -0.043) and EC (r = -0.021). Soil available P_2O_5 showed significant positive correlation (r = 0.126**) with soil available K_2O. Similar results were obtained for soils of Patan district of Gujarat (Patel *et al.*, 2016) [9] and for soils of Gandhinagar district of Gujarat (Patel *et al.*, 2017) [8].

Table 1: Talukawise range and mean values for EC, pH, organic carbon, available N, P_2O_5 and K_2O in soils of Banaskantha district

Name of Taluka	No. of Soil Samples	Range and Mean Value					
		OC	($EC_{2.5}$)	($pH_{2.5}$)	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Palanpur	40	0.02-0.59 (0.36)	0.04-0.46 (0.20)	7.30-8.6 (7.92)	78.4-297.9 (237.6)	18.5-91.4 (42.0)	215.0-443.5 (279.1)
Danta	40	0.02-0.78 (0.39)	0.06-0.67 (0.18)	7.00-8.00 (7.48)	141.1- 360.6 (256.4)	23.0-95.0 (48.2)	201.6-577.9 (299.2)
Vadgam	40	0.02-0.66 (0.25)	0.08-0.77 (0.25)	7.55-8.70 (7.9)	78.4-329.3 (228.9)	22.2-92.6 (48.5)	201.6-739.2 (313.9)
Amirgadh	40	0.10-0.77 (0.43)	0.07-0.85 (0.29)	7.18-8.05 (7.55)	172.5-313.6 (257.9)	26.7-95.8 (50.4)	147.8-564.5 (281.2)
Deesa	40	0.05-0.70 (0.30)	0.11-3.38 (0.48)	7.46-8.65 (7.89)	78.4-313.6 (220.3)	19.2-97.5 (49.6)	161.3-389.8 (243.3)
Dhanera	40	0.05-0.58 (0.30)	0.10-0.72 (0.30)	7.10-8.60 (7.86)	141.1-345.0 (243.4)	20.7 -77.4 (47.4)	121.0-873.6 (368.9)
Dantiwada	40	0.11-0.63 (0.31)	0.08-0.99 (0.20)	7.40-8.35 (7.72)	141.1-329.3 (223.4)	18.8-95.2 (48.3)	161.3-537.6 (280.9)
Kankrej	40	0.07-0.71 (0.40)	0.16-1.93 (0.48)	7.35-8.65 (7.89)	47.0-376.3 (223.0)	16.2-81.1 (47.2)	121.0-779.5 (412.3)
Tharad	40	0.02-0.70 (0.23)	0.09-0.77 (0.37)	7.10-8.70 (8.05)	78.4-376.3 (223.1)	19.8-65.8 (44.5)	107.5-416.6 (205.3)
Lakhani	40	0.02-0.65 (0.26)	0.09-0.77 (0.30)	7.10-8.70 (8.0)	62.7-376.3 (221.1)	25.8-91.8 (48.8)	107.5-322.6 (201.5)
Deoder	40	0.06-0.76 (0.32)	0.13-2.59 (0.44)	7.20-8.85 (7.99)	62.7-376.3 (216.4)	27.3-95.0 (46.9)	107.5-416.6 (262.1)
Vav	40	0.03-0.75 (0.23)	0.10-2.13 (0.55)	7.20-8.25 (7.84)	47.0-297.9 (212.9)	20.6-69.6 (46.9)	147.8-430.1 (247.0)
Suigam	36	0.03-0.75 (0.20)	0.10-1.99 (0.47)	7.20-8.25 (7.96)	78.4-297.9 (220.8)	21.3-70.8 (46.7)	147.8-416.6 (257.7)
Bhabhar	40	0.01-0.45 (0.24)	0.10-1.21 (0.40)	7.20-8.30 (7.83)	47.0-376.3 (212.8)	15.6-86.5 (52.5)	121.0-752.6 (386.1)
District	556	0.01-0.78 (0.30)	0.04-3.38 (0.35)	7.00- 8.85 (7.84)	47.0-376.3 (228.4)	15.6-95.8 (45.8)	107.5-873.6 (288.4)

Note: Value in parenthesis indicates mean values

Table 2: Nutrient index and fertility status of nutrient in soils of Banaskantha district

Name of Taluka	Nutrient Index			Fertility Status		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Palanpur	1.12	2.02	2.70	Very low	Adequate	Very high
Danta	1.37	2.30	2.67	Low	Adequate	Very high
Vadgam	1.15	1.97	2.80	Very low	Marginal	Very high
Amirgadh	1.35	1.90	2.62	Low	Marginal	High
Deesa	1.17	1.82	2.72	Very low	Marginal	Very high
Dhanera	1.05	1.90	2.00	Very low	Marginal	Adequate
Dantiwada	1.15	1.92	2.72	Very low	Marginal	Very high
Kankrej	1.22	1.97	2.00	Very low	Marginal	Adequate
Tharad	1.05	1.75	2.72	Very low	Marginal	Very high
Lakhani	1.02	2.12	2.77	Very low	Adequate	Very high
Deoder	1.07	2.27	2.45	Very low	Adequate	High
Vav	1.05	1.95	2.52	Very low	Marginal	High
Suigam	1.02	1.87	2.61	Very low	Marginal	High
Bhabhar	1.10	2.02	2.22	Very low	Adequate	Adequate
District	1.13	1.98	2.53	Very low	Marginal	High

Table 3: Correlation coefficient (r) among different soil properties of soils for Banaskantha district

Soil Properties	EC	pH	OC	Avaiable N	Available P_2O_5
pH	0.002				
Organic Carbon	0.085*	-0.239**			
Available N	0.048	-0.195**	0.710**		
Available P_2O_5	-0.021	-0.043	0.043	0.058	
Available K_2O	0.049	-0.026	0.066	0.026	0.126**

* Significant at the 0.05 level.
** Significant at the 0.01 level.

Conclusion

Soils of Banaskantha district of Gujarat, the content of organic carbon and available nitrogen were classified in low category. Status of available phosphorus and sulphur, was medium while status of available potassium was high. Organic carbon positively correlated with available major nutrients.

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