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Assessment of available Macronutrient Status and their Correlation Studies with Important Soil Properties in Soils of Narmada District

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ABSTRACT: Soil survey information is the key to understanding the soil resource. The information assembled in a soil survey can be used to predict or estimate the potentials and limitations of the soils' behavior under different uses. Soil surveys also provide insight into the kind and intensity of land management that will be needed. Surface soil samples (0-22.5 cm) were collected from 125 locations from five *talukas* of Narmada district using GPS. The soil samples were analyzed for available macronutrients. Available N, P_2O_5, K_2O and S content varied from 45.27 to 225.71 kg ha^{-1}, 2.01 to 66.35 kg ha^{-1}, 207.21 to 518.63 kg ha^{-1} and 1.26 to 25.5 mg kg^{-1}, respectively. Out of 125 samples 100 per cent samples were deficient in N, 72.8 per cent samples were deficient in P_2O_5, and 40.8 per cent samples were deficient in available S. whereas, 76.8 per cent samples were high in K_2O. Available N (0.552**), available P_2O_5 (0.245), available K_2O (0.242**) and available S (0.343**) showed significantly positive correlation with soil organic carbon and available N (-0.291**) significantly negative correlation with soil pH.**

Keywords: Macronutrients, GPS, correlation, soil organic carbon and narmada.

INTRODUCTION

Efficient management and maintenance of soil health/quality is the key to accomplish sustained high productivity, food security and environmental safety (Tripathi *et al.*, 2006). Characterization, classification and evaluation of soils for different land uses are the first milestone to develop sustainable and eco-friendly land use model. Soil survey information is the key to understanding the soil resource. Soil survey is an inventory of the properties of the soil (such as texture, internal drainage, parent material, depth to groundwater, topography, degree of erosion, stoniness, pH, and salinity) and their spatial distribution over a landscape. With the advent of Green revolution, intensive cultivation with high yielding varieties and high analysis fertilizers triggered the crop productivity for decades. Macronutrient specifically nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) had played a crucial role in plant growth and development.

Keeping in view the above said context, the present study was carried out with an objective to assess the spatial distribution of available macronutrients (N, P, K and S) in surface soil and their relationship with soil chemical properties (pH, EC, SOC and $CaCO_3$). In this occasion, a study on GPS based soil testing was done to evaluate the macronutrient status in soils of Narmada district of Gujarat, India.

MATERIALS AND METHODS

A. Study area

The study area is situated between parallels of 21°23′ to 22°05′ North Latitude and 73°17′ to 73°59′East Longitude in Narmada district of Gujarat. It falls under semi arid to tropic agro climatic zone with varied landscape. The soils found in Narmada district are predominantly black cotton soil. Plain area has mainly heavy black soils and hilly area has light texture soil.

B. Collection of soil samples

A total of 125 representative GPS- referenced surface (0-22.5 cm) soil samples were randomly collected from farmers field covering five *talukas* (Tikalwada, Garudeshwar, Nandod, Dediyapada and Sagbara) of

Narmada district during summer 2020 following zig-zag method of sampling. Surface (0-22.5 cm) soil samples brought to the laboratory was processed as per standard procedure and then stored with proper labeling in clean polythene bags for analysis.

Physico-chemical parameters like $pH_{2.5}$ and $EC_{2.5}$ were determined as per standard methods described by Jackson (1979). Soil organic carbon was determined by rapid titration method (Walkly and Black, 1934). The simple correlation among physio chemical properties and available macronutrients were work out as per standard method given by Panse and Sukhatme (1967). The standard analytical methods followed for estimating available nitrogen, phosphorus, potassium and sulphur are given as follow:

Sr. No.	Parameter	Method	Reference
1.	Available N	Alkaline $KMnO_4$ method	Subbiah and Asija (1956)
2.	Available P_2O_5	Extraction with 0.5 M $NaHCO_3$ (pH 8.5) and estimated by spectrometer	Olsen *et al.* (1954)
3.	Available K_2O	Extraction with 1 N NH_4OAc (pH 7) and estimated by flame photometer	Jackson (1979)
4.	Available S	Turbidometric (extraction with 0.15% $CaCl_2$)	Williams and Steinbergs (1959)

RESULTS AND DISCUSSION

The soils of Narmada district are medium acidic to moderately alkaline (pH 5.7 to 8.17) with mean value of 7.23 and values of electrical conductivity varied from 0.04 to 0.74 dS m^{-1}. The organic carbon content in soils varied from 0.27 to 2.83 per cent with mean value of 0.86 per cent (Table 1).

Available nitrogen varied from 45.27 to 225.71 kg ha^{-1} with mean value 120.76 kg N ha^{-1} (Table 1). When categorized, 100 per cent samples were found low in available N status in soil (Table 2).

The low level of available nitrogen may be ascribed to several factors like higher ammonia volatilization losses, reduced nitrification and reduction in activity of nitrogen fixing microbes (Kumar *et al.*, 2017). Correlation studies indicate that available N was positively and significantly correlated with SOC, available P_2O_5, K_2O and available S and negatively and significantly correlated with pH (Table 3). Positive and significant correlation between available N and SOC was observed by Ramana *et al.* (2015); Vijaykumar and Haroon (2013); Thombe *et al*. (2020).

Table 1: Macronutrient (N, P_2O_5, K_2O and S) status and other soil properties in different *talukas* of Narmada district.

Taluka	$pH_{(1:2.5)}$	$EC_{(1:2.5)}$ dS m^{-1}	SOC (%)	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})	Available S (mg kg^{-1})
Tilakwada	7.44-8.12 (7.78)	0.11-0.35 (0.21)	0.4-1.03 (0.75)	62.72-172.48 (116.45)	6.03-66.35 (29.27)	260.87-495.19 (370.51)	2.52-24.49 (11.77)
Garudeshwar	6.49-8.04 (7.42)	0.08-0.47 (0.27)	0.46-1.8 (0.88)	77.26-152.4 (116.14)	2.01-43.23 (21.56)	217.6-498.4 (377.2)	2.5-25.2 (12.0)
Nandod	6.78-8.17 (7.53)	0.11-0.74 (0.25)	0.4-1.62 (0.79)	45.27-133.26 (97.92)	2.01-59.31 (20.28)	207.21-471.88 (326.32)	3.28-20.95 (10.52)
Dediyapada	6.34-7.93 (7.18)	0.04-0.51 (0.24)	0.27-1.08 (0.63)	92.82-225.71 (131.86)	2.01-39.21 (16.28)	216.83-518.63 (321.97)	1.26-21.46 (11.18)
Sagbara	5.7-7.05 (6.24)	0.05-0.27 (0.13)	0.73-2.83 (1.27)	62.72-209.48 (141.44)	2.01-30.16 (12.24)	237.83-428.51 (333.56)	3.78-25.5 (12.43)
Overall	5.7-8.17 (7.23)	0.04-0.74 (0.22)	0.27-2.83 (0.86)	45.27-225.71 (120.76)	2.01-66.35 (19.92)	207.21-518.63 (345.93)	1.26-25.5 (11.58)
SD	0.63	0.11	0.37	34.06	13.57	74.13	5.61

Available P_2O_5 varied from 2.01 to 66.35 kg ha^{-1} with a mean value 19.92 kg ha^{-1} indicated these soils deficient in available P_2O_5 (Table 1). When categorized, these soils were found to deficient in 72.8 per cent samples, 24.80 per cent were in medium and 2.4 per cent were high in available P_2O_5 content (Table 2). This wide variation in available P_2O_5 content was might be due to variation in soil properties *viz.*, pH, texture and agronomic practices. Correlation study shows that available P_2O_5 was positively and significantly correlated with pH, SOC, available N, K_2O and available S (Table 3). Positive and significant correlation between available P_2O_5 and SOC was observed by Tsozue *et al*. (2016); Thombe *et al*. (2020); Singh *et al*. (2021). The lowest and highest values of available K_2O content in soil were 207.21 kg ha^{-1} and 518.63 kg ha^{-1}, respectively, with the mean value 345.93 kg ha^{-1} indicated that these soils have sufficient

available K_2O (Table 1). When categorized 125 soil samples, 23.2 per cent samples were medium and 76.8 per cent were high in available K_2O (Table 2). Correlation study indicates that available K_2O was positively and significantly correlated with SOC, available N, P_2O_5 and available S (Table 3). Positive and significant relationship of K_2O was obtained by Vijaykumar and Haroon (2013) with SOC, available N and available S.

The lowest and highest values of available S were recorded 1.26 mg kg^{-1} and 25.5 mg kg^{-1}, respectively, with the mean value 11.58 mg kg^{-1} (Table 1). Available S in surface soils was grouped under low (40.8 per cent), medium (50.4 per cent) and high (only 8.8 per cent) category (Table 2). According to Khadka *et al.* (2017), continuous removal of S by crops due intensive cropping without adding S element might be the cause of low amount of sulphur. Thus, soils having sulphur status below critical level are required to be replenished/improved to meet the demand of S in soils. Correlation study indicates that available S was positively and significantly correlated with SOC, available N, P_2O_5 and K_2O (Table 3). Positive and significant relationship of available S and SOC was reported by Vijaykumar and Haroon (2013); Thombe *et al*. (2020).

Table 2: Categorization of macro nutrients status in surface soils of Narmada district.

Taluka	Available N			Available P_2O_5			Available K_2O			Available S		
	L	M	H	L	M	H	L	M	H	L	M	H
Tilakwada	**25** (100)	**0** (0)	**0** (0)	**13** (52)	**10** (40)	**2** (8)	**0** (0)	**5** (20)	**20** (80)	**11** (44)	**12** (48)	**2** (8)
Garudeshwar	**25** (100)	**0** (0)	**0** (0)	**15** (60)	**10** (40)	**0** (0)	**0** (0)	**2** (8)	**23** (92)	**10** (40)	**11** (44)	**4** (16)
Nandod	**25** (100)	**0** (0)	**0** (0)	**20** (80)	**4** (16)	**1** (4)	**0** (0)	**7** (28)	**18** (72)	**13** (52)	**11** (44)	**1** (4)
Dediyapada	**25** (100)	**0** (0)	**0** (0)	**20** (80)	**5** (20)	**0** (0)	**0** (0)	**8** (32)	**17** (68)	**8** (32)	**16** (64)	**1** (4)
Sagbara	**25** (100)	**0** (0)	**0** (0)	**23** (92)	**2** (8)	**0** (0)	**0** (0)	**7** (28)	**18** (72)	**9** (36)	**13** (52)	**3** (12)
Overall	**125** (100)	**0** (0)	**0** (0)	**91** (72)	**31** (24.80)	**3** (2.4)	**0** (0)	**29** (23.2)	**96** (76.8)	**51** (40.8)	**63** (50.4)	**11** (8.8)

L=Low, M=Medium, H=High; and values in parenthesis ( ) indicates per cent soils.

Table 3: Simple correlation among different parameters of surface soils of Narmada district.

	pH	EC	SOC	N	P_2O_5	K_2O	S
pH	1.00						
EC	0.377**	1.00					
SOC	-0.407**	-0.187*	1.00				
N	-0.291**	-0.16	0.552**	1.00			
P_2O_5	0.292**	-0.029	0.245**	0.277**	1.00		
K_2O	0.12	0.027	0.242**	0.359**	0.264**	1.00	
S	-0.124	0.021	0.343**	0.370**	0.307**	0.179*	1.00

Note: ** and * denote significant at 1% and 5% level respectively.

CONCLUSION

All (100 per cent) soils of entire Narmada district belonged to low available N status and thus, clearly suggested that emphasis should be given for appropriate management of available N status (through application of more organic matters, bio-fertilizers in combination with regular chemical N-fertilizer) of these soils to overcome problems of low N availability to maintain soil. Similarly, soils of *talukas* (Tilakwada, Garudeshwar, Nandod, Dediyapada and Sagbara) due to their low available P_2O_5 status would need proper management of soil P through proper placement of inorganic P-fertilizers in combination with organic sources / green manuring and PSB *etc*. for proper plant nutrition and soil health. About 96 per cent soil samples belonged to high K_2O and medium available S (particularly from Dediyapada and Sagbara *talukas*) appropriate management of sulphur would be must through addition of inorganic sulphur, organic manures or sulphinated compost, bio-composts and sulphur solubilizing microbes. Besides, to this deficiency of nutrients is also emerging issue which will cause significant reduction in soil productivity. Hence, periodic assessments of soil nutrients are recommended in these areas. It requires detailed studies on soil nutrients by taking large number of soil samples and conducting field trials.

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Conflict of Interest. None.

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