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Assessment of Soil Fertility Status of Different Villages of Depalpur Block of Indore District, Madhya Pradesh, India

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ABSTRACT

Soil is a vital natural resource that sustains life on earth. The main factor affecting crop production potential is soil fertility, which is one of several factors. The purpose of this study was to evaluate the ability of the soils in the Depalpur block of Indore district of Madhya Pradesh to produce better crop yield potential. The random sampling technique was used to gather forty soil samples from 0-15 cm depth from six different villages (Pitawali, Mendakwas, Palsoda, Chittoda, Kadoda and Kai) using GPS and bring them to the laboratory for soil physico-chemical properties analysis using standard methods. The collected soil samples were air dried, sieved and analyzed for different fertility parameters viz., bulk density, particle density, porosity percentage, water holding capacity, soil pH, electrical conductivity, organic carbon, available nitrogen, available phosphorus, available potassium, exchangeable calcium, exchangeable magnesium and sulfur. The findings indicated that the soils of studied areas were alkaline in nature, free from salinity hazards, rich in organic carbon, high in phosphorus, potassium, exchangeable calcium and magnesium, low in available nitrogen and medium in sulfur content. The findings of this research could help in crop nutrient management, fertilizer recommendation and decision-making for increasing agricultural output and farmer profitability.

Keywords Soil fertility, Physico-chemical properties, Depalpur block, GPS.

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INTRODUCTION

More than 70% of India's population is dependent on agriculture, either directly or indirectly, as agriculture is the primary and basic occupation and the backbone of the Indian economy (Ramamurthy and Bajaj 1969). Soil is an essential component of effective agriculture because it serves as a nutrient bin for several macro and micronutrients that are essential for crop growth and development. Soil fertility is the inherent capacity of soil to provide essential nutrients for crop production and yield improvement. It is a complex and dynamic natural property (Tisdale *et al*. 1993). Soil fertility refers to the interactions of soil's physical, chemical and biological properties and it is directly related to agricultural production (Rakesh *et al*. 2012). Soil fertility varies from year to year due to changes in the amount applied and the availability of mineral nutrients caused by the addition of fertilizers, manure, compost, mulch and lime, as well as leaching. Chemical fertilizer overuse is a significant danger to a sustainable agricultural production system. The fertility of the agricultural soil of Depalpur block can reveal a lot about its productivity potential. Soil fertility testing of Depalpur block helps the farmer to get an idea about the properties of their soil and based on testing results, we can make fertilizer recommendations which will help in minimizing the fertilizer input without any yield loss (Yadav *et al*. 2018). Farmers may adjust fertility by regulating the plant's nutritional condition, which is an advantageous move (Nafiu *et al*. 2012). Sustainable agriculture practises can be achieved only through the estimation of the soil fertility of that area. Soil testing is one of the most frequently used techniques in the world for evaluating soil fertility (Gehlot *et al*. 2019). The assessment of the soil fertility status of various villages in Assam's Lahowal Block, Dibrugarh, for better crop production (Barooah *et al*. 2020). Evaluation of soil fertility is essential to provide nutrients for optimum crop growth (Nafiu *et al*. 2012). Soil testing is perhaps the most regularly used method for determining soil fertility (Havlin *et al*. 2010) for increasing agricultural production through fertility management (Goovaerts 1998). A suspicious evaluation of a soil's fertility before planting the crop aids in the implementation of suitable measures to balance deficiencies and ensure the best possible crop yield. Any farming system's productivity is dependent on an appropriate supply of plant nutrients. Because the data on soil fertility in Depalpur town is currently limited, there is a need to acquire such data in order to improve and maintain soil fertility.

MATERIAL AND METHODS

Study area description

This study was conducted at Depalpur a town in Indore district with a total area of 797 km^2, out of which 9.10 km^2 belongs to the urban area while the remaining 787.50 km^2 under the rural area. It is one of the four blocks (Hatod, Indore, Depalpur and Mhow) of the Indore district situated at an altitude of 1748 feet above sea level and 22.85°N latitude and 75.55°E longitude. Depalpur is small part of the Malwa plateau and has a sub-tropical and semi-arid climate with lows of 4°C and 21°C and highs of 29°C and 43°C in the winter and summer seasons, respectively. The month of January is the coldest and the temperature reaches its highest point in the month of May. The area receives the majority of the annual rainfall, which falls between the months of mid-June and mid-September with an average annual rainfall of 952.2 millimeters. Soils found in the area are medium black, shallow black and mixed red. The main crops of the town are soybean and wheat.

Soil sampling and analysis

A total of 40 surface soil samples were collected from the undisturbed land of six different villages in the Depalpur block. It is sampled randomly from a depth of 0–15 cm (plough layer) in a 'V' shape with the help of a spade from 40 different sites of different geomorphologic locations represented in Table 1. The soil samples were mixed systematically and about one kilogram of composite samples was collected in polythene bags from the farmer's field for analysis. The collected soil samples were air dried, crushed, powdered and grinded with a wooden roller before sieving with a 2.0 mm sieve and before being transported to the laboratory. Finally, a 500g soil sample was preserved in a labelled polythene bag for further laboratory study. The methods used to analyze various fertility parameters are given in Table 2. The present study was carried out in the years 2020–21 in the laboratory of the Department of Soil Science and

Table 1. Description of soil sampling sites.

Sl.No.	Name of village	Land type
1	Pitawali	Fallow land
2	Mendakwas	Fallow land
3	Palsoda	Fallow land
4	Chittoda	Fallow land
5	Kadoda	Fallow land
6	Kai	Fallow land

Table 2. Methodology used for physico-chemical analysis of soil.

Sl.No.	Parameters	Method	Reference
Physical properties			
1	Bulk density (g/cm^3)	Pycnometer	Black (1965)
2	Particle density (g/cm^3)	Pycnometer	Black (1965)
3	Water holding capacity	Keen box	Piper (1966)
Chemical properties			
1	Soil pH	Glass electrode pH meter	Jackson (1973)
2	Electrical conductivity (dSm^{-1})	Electrical conductivity meter	Jackson (1973)
3	Organic carbon (%)	Wet oxidation method	Walkley and Black (1934)
Primary macronutrients			
1	Available nitrogen	Alkaline potassium permanganate	Subbiah and Asija (1956)
2	Available phosphorus	Olsen's method	Olsen *et al.* (1954)
3	Available potassium	Flame photometer	Schollenberger and Simon (1945)
Secondary nutrients			
1	Calcium	Versanate titration	Jackson (1973)
2	Magnesium	Versanate titration	Jackson (1973)
3	Sulfur	Spectrophotometer	Chesnin and Yien (1950)

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Statistical analysis

Correlation coefficients were taken into consideration to examine the link between various soil parameters and micronutrient levels in soils and plants.

$$r = \sqrt{\frac{sp\ (xy)}{ss(x),\ ss(y)}}$$

Where:
r = Correlation coefficient
SP (xy) = Sum product of x, y variables
SS (x) = Sum of square of x variable
SS (y) = Sum of square of y variable

RESULTS AND DISCUSSION

The results of collected soil samples for various physico-chemical parameters, primary macronutrients and secondary macronutrients were shown in Table 3. The soil reaction (pH) is one of the most important parameters in which the soils of Depalpur town were found alkaline (>7.3) in nature as the pH of soil samples varied from 7.4 to 8.9 with an average value of 8.21. Similar results were seen in Gwalior city of Madhya Pradesh (Wani *et al*. 2014) and Varanasi of Uttar Pradesh (Chaurasia *et al*. 2014) respectively. The soils of the study area have no salinity hazard. 100 % of the soil samples of Depalpur tehshil were in the permissible range (<0.7), suitable for all types of crops as the electrical conductivity (EC) of soil samples varied from 0.12 to 0.47 dS m^{-1} with an average value of 0.18 dS m^{-1}. Similar results were observed in soils from the Narayanpur block of Uttar Pradesh's Mirzapur district (Bharteey *et al*. 2017).

The soils of Depalpur block were found rich in organic carbon content, ranging from 0.00 to 1.99 % with an average value of 0.69. 95% of the soil samples were in a category of medium-high organic carbon content according to the limits proposed (Muhr *et al*.1965). Alike findings were observed in the soils of the Mid Himalayan region of Himachal Pradesh (Annepu *et al*. 2017). The bulk density, particle density, porosity percentage and water holding capacity of soil samples ranged from 1.24-1.57 g/cm^3, 2.12-2.81 g/cm^3 and 36.02 to 55.16 % and 38.24 to 62.85 % with a mean value of 1.40 g/cm^3, 2.59 g/cm^3, 46.03 % and 55.51 %, respectively (Dipanjali *et al*. 2019).

Status of primary macronutrients

The nitrogen status in soils of the Depalpur block was reported as low, ranging from 159.65 to 398.30 kg/ha with a mean of 211.90 kg/ha. In the nitrogen

Table 3. Soil physico-chemical parameters of different villages of Depalpur block.

Soil characteristics	Range	Mean	SD	CV
pH	7.4-8.9	8.21	0.34	4.09
EC	0.12-0.47	0.21	0.06	26.54
Organic carbon (%)	0.69-1.99	0.69	0.47	67.89
Bulk density (g cm^{-3})	1.24-1.57	1.40	0.09	6.40
Particle density (g cm^{-3})	2.12-2.81	2.59	0.13	5.06
Porosity (%)	36.02-55.16	46.03	4.46	9.68
WHC (%)	38.24-62.85	55.51	4.14	7.46

Table 4. Nutrient rating of the soil test values. Source: Ramamoorthy and Bajaj 1969.

Parameters	Low	Medium	High
Organic carbon (%)	<0.5	0.5-0.75	>0.75
Available N(kg/ha)	<280	280-560	>560
Available P (kg/ha)	<12.5	12.5-25	>25
Available K (kg/ha)	<135	135-335	>335
Available S (kg/ha)	<10	10-20	>20
	Deficient	Sufficient	
Magnesium(Meq/100g)	<1.5	>1.5	-
Calcium (Meq/100g)	<1.0	>1.0	-

content limits defined by Muhr *et al*. (1965), 80% of soil samples were classified as low (280 kg/ha), 20% as medium (280-560 kg/ha) and none as high (> 560 kg/ha) (Table 4). Similar findings were observed in Ralyawan Village Madhya Pradesh by Patidar *et al*. (2017) and in Alirajpur district of Madhya Pradesh by Rajendiran *et al*. (2018), respectively.

Status of secondary macronutrients

A sufficient (>1.5 Meq/100g) amount of exchangeable calcium was present in the soils of Depalpur block, ranging from 10 to 52 Meq/100g with a mean of 37.65 Meq/100g. Soils in the study area had sufficient exchangeable magnesium content (> 1.0 Meq/100g) and ranged "between" 22.80 and 132.00 Meq/100g, with a mean value of 89.26 Meq/100g. The available sulfur content in soil samples varies from 9.50 to 20.50 mg/kg with an average value of 14.22 mg/kg in Table 5. According to the ranges (Singh, 2018), 95% of the samples were in the medium range (10-20 mg/kg) of sulfur content, while 2.5% of the samples were in both the low (10 mg/kg) and high range (> 20 mg/kg) of sulfur content.

Soil nutrient index

The nutrient index (NI) value is a measurement of the soil's ability to provide nutrients to plants (Singh *et al*. 2016). The nutrient index is calculated by using the given formula by Muhr *et al*. (1965):

Table 5. Status of available macronutrients viz., N, P, K, Ca, Mg, S in soils of Depalpur block.

Soil characteristics	Range	Mean	SD	CV(%)
N (kg/ha)	159.65 - 398.3	211.90	61.14	28.25
P (kg/ha)	15.43 - 34.85	22.85	5.33	23.32
K (kg/ha)	280 - 1008	460.29	119.13	25.88
Ca (Meq/100g)	10.0 – 52.0	37.65	9.16	24.33
Mg (Meq/100g)	22.8 - 132	89.26	27.37	30.66
S (mg/kg)	9.5 - 20.5	14.22	2.42	17.02

$$NI = [(1x\ NL) + (2x\ NM) + (3x\ NH)]/NT$$

Where,

NL: Number of samples falling under low category
NM: Number of samples falling under medium category
NH: Number of samples falling under high category
NT: The total number of soil samples

The nutrient index value of less than 1.5 is rated as low, 1.5 to 2.5 is rated as medium and more than 2.5 is rated as high fertility status as suggested (Ramamurthy and Bajaj 1969). The Nitrogen, Phosphorus, Potassium and Sulfur index calculated value is given in the Table 6.

Correlation between physico-chemical properties of soils of depalpur town

The pH of the soil was found to be positively and significantly related to phosphorus (r = 0.750**). The EC of soil was positive and had a non-significant relationship with OC (r = 0.11), Nitrogen (r = 0.014) and Potassium (r = 0.276). Soil organic carbon was positively and strongly related to nitrogen (r = 0.927**) and positively related to potassium (r = 359*).The bulk density of the soil was negative, highly significant related to porosity (r =-0.757**), water holding capacity (r = -0.498**), organic carbon (r =-0.847**) and nitrogen (r =-0.773*) of the soil. Particle density was discovered to be a positive and highly significant co-relationship with porosity (r = 0.643**). Nitrogen in Depalpur block soils was positive, with a strong significant relationship to po-

Table 6. Nutrient index values of Depalpur block.

Sl.No.	Available nutrient	Nutrient index values	Category
1	Nitrogen	1.20	Low
2	Phosphorus	2.37	High
3	Potassium	2.92	High
4	Sulfur	2.00	Medium
5	Organic carbon	2.42	High

Table 7. Correlation between soil physico-chemical properties of Depalpur town of Indore district in Madhya Pradesh. ** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level.

	BD	PD	Porosity	WHC	pH	EC	OC	N	P	K	Ca	Mg	S
BD	1												
PD	0.009	1											
Porosity	-0.757**	0.643**	1										
WHC	-0.498**	-0.113	0.307	1									
pH	0.199	0.006	-0.138	-0.089	1								
EC	0.043	-0.077	-0.082	0.003	0.028	1							
OC	-0.847**	0.138	0.733**	0.518**	-0.222	0.011	1						
N	-0.773**	0.133	0.679**	0.506**	-0.249	0.014	0.927**	1					
P	-0.113	0.087	0.157	0.069	0.750**	-0.064	0.123	0.139	1				
K	-0.303	-0.268	0.061	0.090	-0.106	0.276	0.359*	0.423**	-0.180	1			
Ca	-0.132	-0.197	-0.024	-0.077	0.285	0.120	0.005	0-.065	0.280	-0.212	1		
Mg	0.236	-0.073	-0.243	-0.111	-0.060	0.044	-0.192	-0.225	-0.278	0.062	-0.214	1	
S	-0.186	0.024	0.167	-0.232	-0.072	-0.035	0.252	0.334*	0.060	0.140	-0.095	0.072	1

tassium (r = 0.423**) and a significant relationship to sulphur (r = 0.334*). The phosphorus level of soil was positively but non-significantly co-related with calcium (r = 0.280) and sulphur (r = 0.060). Soil potassium had a positive and non-significant relationship with magnesium (r = 0.62) and sulphur (r = 0.140). The exchangeable calcium of soil was negatively and non-significantly related to magnesium (r = -0.214) and sulphur (r = -0.095), whereas the magnesium of soil was positively and non-significantly related to sulphur (r = 0.072) of soil. The correlation between the soil fertility parameters is given in Table 7. This result was similar to the spatial distribution of macro and secondary nutrients in the soils of the Varanasi district (Singh *et al*. 2016).

CONCLUSION

Soil testing is a low-cost method of estimating the soil fertility and capacity of soils to support crop growth. Growers can take judicial decisions to minimize risk and maximize profitability. From the above results, it was concluded that the soils of Depalpur town were alkaline in nature and there was no crop salinity hazard. Using the soil nutrient index of the study region, it was observed that the soils of the Depalpur block were low in available nitrogen, medium in sulfur and high in potassium. Phosphorus and organic carbon status were found to be medium to high in the soils of the studied area. Deficient nutrients can be supplemented to prevent crops from suffering from deficiencies and to optimize the efficiency of other nutrients. Integrated nutrient management holds the key to sustainable soil fertility management.

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