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Evaluation of Soil Fertility Status in Different Villages of Bhikangaon and Gogaon Block of Khargone District, Madhya Pradesh

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ABSTRACT

The study was conducted on Assessment of Soil Fertility of Different Villages of Bhikangaon and Gogaon Block of Khargone District, Madhya Pradesh. Khargone district lie between North latitudes 22° 47' and 22° 35' and East longitudes 75° 19' and 76° 14'. For this study soil samples are collected from 0-15cm depth of different field lands in Bhikangaon and Gogaon Block. In this study the results are going to show that BD, PD, Porosity and water holding capacity of soils are 1.21-1.59, 2.41-2.81 g/cm-3, 39.44-59.16 and 34.24-67.85%. in soil fertility organic carbon and primary nutrients plays a major role. The results obtained in this analysis are organic carbon ranged from 0.03-1.94% while primary nutrients are of N, P, K – 158.65-394.3 kg/ha ,11.43-38 kg/ha and 110.8-593 kg/ha. The current study is expected to help the farmers of Gogaon Block in guiding techniques required for long-term soil fertility management and creating future agricultural research strategies on the farm.

Keywords Soil fertility, Physico-chemical properties, Soil quality, Soil health.

INTRODUCTION

As we well known that how fast the population in India was increasing from 1950's to til now. So, because of that we have seen the shortage of food-grains to sustain the entire population. After the independence, the Government of India want to prepare India self-dependent in view of food grain for their entire population. With the view of these India introduced the Green Revolution in mid of 1960's to overcome from the traditional method of agriculture and to introduce the new high-yielding varieties of seeds and new methods for cropping. Through this we introduced the high yielding varieties that requires the new techniques and assets also like using of fertilizers, advanced machinery, pesticides and increased the use of irrigation. Because of all this India shifted from Grain deficient nation to self-sufficient of food to entire population and also reduced the imports and started exporting grains to other nations through this economic sector of India also get boosted (Singh *et*

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al. 2018). Among the Indian states, the state which is most benefited from the green revolution in India is Punjab where food grains production increased from 5.37 million tones in 1965-66 to 32 million tones in 1995-96 accounted for 21 % of total food grains produced in India (Singh *et al*. 2016). As we well known that soil is a very precious material for growing of crops and for us to live on this earth. Soil is applied solely to those superficial horizons of Rocks, that have been more or less modified naturally by the interaction of water, air and various kinds of organisms, either living or dead; this being reflected in a certain manner in composition, structure and color of such formations. Where conditions are absent there are no natural soils, but either artificial mixtures or rocks. So, we can say that formation of single layer of soil it takes so many processes with long period of time. But now-days because of increased production of food grains we play' s wrong with soil also like, we are using fertilizers, pesticides, which are fully chemicals through this we produces more but we loss the nature of soil, that producing the crop naturally. Soil health refers to a soil's ability to act as a living system with ecological and land use boundaries in order to maintain plant and animal productivity, improve water and air quality, and promote plant and animal health. Healthy soil maintains a diverse community of soil weed pests, forms beneficial symbiotic relationships with plant roots, recycles vital plant nutrients, improves soil structure with positive ramifications for soil water and nutrient holding capacity, and improves crop output. An ecosystem perspective might be added to this definition: A healthy soil does not harm the environment and, by preserving or increasing its carbon content, helps to mitigate climate change (Sharma *et al*. 2021).

Apart from water and air, soil quality is one of the three components of environmental quality. Water and air quality are primarily determined by the amount of pollution they contain, which has a direct impact on human and animal consumption and health, as well as natural ecosystems. Soil quality, on the other hand, is typically defined as "the capacity of a soil to function within ecosystem and land-use constraints to sustain biological productivity, maintain environmental quality, and promote plant and animal health" rather than "the degree of soil pollution" (Goovaerts 1998). As a result, any soil fertility management system must take into account all aspects of soil-plant connections as well as environmental contamination). The capacity of the soil system to supply nutrients can be defined as soil fertility evaluation (Singh 2018). It aids in the adoption of appropriate solutions for overcoming various constraints while also ensuring optimal crop output. As fertilizers are one of the first inputs, a well-balanced scheduling for optimizing fertilizer amounts to extract optimum remunerative returns must be given significant consideration. These nutrients are required for plants to complete their life cycle, metabolic processes, and chemical processes that occur within living organisms such as photosynthesis. These components are required for the plant to develop and reproduce. Because carbon, oxygen, and hydrogen are available through air and water, they are classified as non-mineral elements. The macro and micro nutrients are separated into two categories. Macronutrients are those that are required in significant amounts and include (C, H, O, N, P, K, Ca, Mg and S). Some are available through the atmosphere and water, while the others are divided into - Plant growth is impossible without the primary nutrients N, P and K, which are required in considerable quantities. Ca, mg and s are secondary nutrients that are required in moderate amounts. Micronutrient deficiencies are more common in highly leached sands, organic soils and extremely alkaline soils because they are required in lesser amounts (Singh *et al*. 2017). When micronutrients are present in large levels, they can be toxic or damaging to plant growth. There are a few aspects that do not match the exact definition of essential but are nonetheless crucial. These elements are either required by some plant species but not all, or are extremely advantageous to plant growth. Furthermore, variability in soil fertility status at the block level was illustrated and described. An effort has also been made to correlate soil nutrient content with main soil parameter.

MATERIALS AND METHODS

Description of the study area

It is land locked in the country's central region, bordered on the northwest by Rajasthan, on the north by Uttar Pradesh, on the east by Chhattisgarh, on the

Table 1. Description of sampling sites.

Sl.No.	Name of village	Land type
1	Shakargaom	Cultivated maize
2	Khudgaom	Cultivated cotton
3	Badgaom	Cultivated chilli
4	Rehgaon	Cultivated soyabean
5	Jatapur	Cultivated maize
6	Machalgaon	Cultivated cotton

south by Maharashtra and on the west by Gujarat. Madhya Pradesh is the second most populous state in the country. The state is mostly agricultural. The state's rural population is approximately 73 % is reliant on agriculture, either directly or indirectly. Madhya Pradesh covers 30.75 million hectares and is divided into 45 districts and nine revenue divisions. There are 313 development blocks in the state, which serve as units for development operations. Forests cover 8.49 million hectares in the state, accounting for 27.2 % of the state's geographical area, while cultivated land accounts for around 49 %. The state's largest perennial rivers, including the Mahi, Narmada, Tapti, Chambal, Betwa, Sone, Wainganga, Ken and Pench, originate in Madhya Pradesh and flow to seven neighboring states. Madhya Pradesh's terrain is characterized by plains that run north to south, interrupted by mountainous areas. Winter (November through February), summer (March through May) and monsoon season (June through August) are the three main seasons of the state (September). The typical winter temperature is between 10° and 27° C (50° and 81°F). Summers are hot, with an average temperature of 29° C (85° F) and high temperatures of 48° C (118° F) at times. Temperatures range from 19° to 30° C (66° to 86°) during the monsoon season. Madhya Pradesh receives roughly 1200 mm (almost 50 in) of annual rainfall, with 90 % of it falling during the monsoon season. Bhopal is the state's capital. Khargone district lie between North latitudes 22° 47' and 22° 35'and East longitudes 75° 19' and 76° 14'. The climate is hot summer and general dryness except during the S-W monsoon season. The rainfall of about 835 mm. During the S-W monsoon season the relative humidity generally Exceeds 85 % and the rest of Year is driver. Because of varied geomorphic units, Presence of fluvial unity shows - the occurrences of alluvium in flood Plains of N-W Part of district. Basaltic uplands forming lower belt that extends from W-E in southern part of district. Soils of this region we seen here is black and alluvial type is more. Description of sampling sites in Table1.

Soil sampling and laboratory analysis

Soil sampling and laboratory analysis total forty surface soil samples (0-15 cm) were collected randomly from 6 different sites by making V- shape notch at depth of 15 cm. At first remove both stones and surface litter in sampling spot itself, collect five-six representative samples in zig-zag pattern to ensure homogeneity. On an average 2 to 3 kg of sample were collected and thoroughly mix together and reduce

Table 2. Procedure used for physical and chemical analysis of soil.

Properties	Method applied	Reference
Physical properties		
Bulk density (Mg kg^{-1})	Pycnometer	Black *et al*. (1965)
Particle density (Mg kg^{-1})	Pycnometer	Black *et al*.(1965)
Water holding capacity	Keen box	Piper (1966)
Chemical properties		
pH	Glass electrode pH meter	Jackson (1973)
EC (dSm^{-1})	Electrical conductivity meter	Jackson (1973)
Organic carbon (%)	Wet oxidation method	Walkey and Black (1934)
Available nitrogen	Alkaline Potassium permanganate	Subbiah and Asija (1956)
Available phosphorus	Modified Olsen's method	Olsen *et al*.(1954)
Available potassium	Extractable K2O Ammonium acetate	Schollenberger and Simon (1945)
Exchangeable calcium and magnesium	EDTA titration method	Jackson (1973)
Available sulfur	Turbidimetric method	Chesnin and Yien (19500
Cationic Micronutrient	DTPA solution by Atomic Absorption	Lindsay and Norvell (1978)
Zn, Fe, Cu and Mn (mg/kg)	Spectrophotometer	

up to 1 kg by quartering into a composite sample. The collected soil samples were kept in shade for air drying, at normal room temperature, after complete drying take to laboratory for further processing. Dried samples were crushed with the help of wooden roller. Later, samples were sieved by using 2 mm mesh sieve. After sieving samples were stored in plastic bags with labelling on it like collection of data and time were specified. Labelled samples were finally analyzed for physico-chemical properties (Tables 1, 2).

Statistical analysis

The relationship between different soil characteristics and micronutrient contents in soils and plants were determined using correlation coefficients:

$$r = \sqrt{\frac{SP\,(x,\,y)}{SS(x),\,SS(y)}}$$

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

Physico-chemical properties

pH in soil samples varied from 7.1 to 8.8 with a mean of 8.18. The results concluded that 100 % of the samples are alkaline in nature. Nagaraja *et al.* (2014) observed similar findings in Karnataka India, respectively. The Electrical Conductivity of the analyzed soil samples ranged from 0.11- 0.35 dSm^{-1} with a mean value of 0.20 dSm^{-1}. According to the results it is found that 100 % of the soil samples were in permissible range, suitable for all type of crops as salinity was not a concern in these soils. Bhatt *et al.* (2019) found similar results in soils from the Uttarakhand.

Bulk density in soil samples varied from 1.21-1.59 g cm^{-3} with a mean value of 1.37 g cm^{-3}. The sample no. 14 and 24 of the Jatapur and Andad village founded lowest bulk density, this may be because of the presence of high organic carbon content and sample no. 4 and 17 of khudgoan and Badiya village founded high bulk density, this may be due to presence of low organic carbon content. The partical density of soil samples ranged from 2.41-2.81 g cm^{-3} with an average value of 2.609 g cm^{-3}. Sample no. of 16 of Badiya village reported lowest particle density and sample no: 19 of Sahjela village reported highest particle density and coefficient of variation of particle density were ±0.18 and 5.37 % respectively. Similar results were observed by Sharma *et al.* (2010).

Table 3. Soil physico-chemical parameters of different villages of Bhikangaon and Gogaon block.

Soil parameters	Rane	Mean	SD±	CV (%)
Bulk density (Mg/m^3)	1.21-1.59	1.37	0.09	7
Particle density (Mg/m^3)	2.41-2.81	2.609	0.10	4
Water holding capacity (%)	34.24-67.85	55.50	5.34	9
Porosity (%)	39.44-59.16	46.88	3.96	8
pH	7.1-8.8	8.18	0.52	6
EC (dSm^{-1})	0.11-0.35	0.20	0.05	28
Organic carbon (%)	0.03-1.94	0.77	0.65	50

Status of macronutrients

The perusal data presented in Table 4 revealed, the nitrogen content in soil samples ranged from 158.65-394.3 kg ha^{-1} with a mean value of 226.4 kg ha^{-1}. 80 % of soil samples were found low in nitrogen content, 20 % of soil samples showed medium levels of nitrogen and none of soil sample showed high level of nitrogen content. Thus, the low status of available nitrogen was observed in studied area. Limits suggested "(Ramamoorthy and Bajaj 1969), in (Table 4 - 6).

The phosphorus content in analyzed soil samples ranged from 11.43-38 kg ha^{-1} with a mean value of

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/100 g)	<1.0	>1.0	

22.76 kg ha^{-1}. The value of SD and CV of phosphorus were 7.43 and 32 % respectively. Out of total soil samples 61.50 % of the samples were found in medium phosphorus range and 38.5 % of the samples were found in high phosphorus range. The results showed that soils of Bhikangaon and Gogaon block are rich in phosphorus content this may be due to high phosphorus mineral content (Apatite) or due to use of phosphatic fertilizers. Similar results observed in Singh (2019). The potassium content in analyzed soil samples ranged from 110.8-593 kg ha^{-1} with a mean value of 418.8 kg ha^{-1}. The SD and CV of potassium were 102.25 and 24 % respectively. Out of total soil samples 7.90 % of the samples were found in medium potassium range while 92.10 % of soil samples were found in high potassium range. Similar results were observed in Rajendiran *et al*. (2020). The results concluded that soils of studied area were high in potassium content; this might be due to the presence of most of the mica (biotite and muscovite) in finer clay fractions of soils.

Calcium content in soil samples ranged from 10.4- 52.3 Meq $100g^{-1}$ with an average value of 37.57 Meq $100g^{-1}$. The SD and CV value of calcium were 9.92± and 26 % respectively. 100 % of the soil samples were sufficient in calcium whereas 0.00 % of the samples were deficient in calcium Magnesium content in soil samples ranged from 24.80 to 138 Meq $100g^{-1}$ with an average value of 86.7 Meq $100g^{-1}$. The SD and CV value of calcium were 31.4± and 36 % respectively. 100 % of the soil samples were sufficient in magnesium whereas 0 % of the samples were deficient in magnesium. Similar results were observed in Sharma *et al*. (2021). Sulfur content in soil samples ranged from 9.50 to 34.5 mg kg^{-1} with an average value of 14.55 mg kg^{-1}. The SD and CV value of sulfur were 3.02± and 20 % respectively. Similar results were observed by Patidar *et al*. (2017). Out of total soil samples, 94 % of samples found in medium range of sulfur content whereas 6 % samples in both low and high range of sulfur content.

Table 5. Status of available macronutrients viz., Ca, Mg, S in soils of Kovur block.

Soil parameters	Range	Mean	SD±	CV (%)
Ca (Meq $100g^{-1}$)	10.4-52.3	37.57	9.92	26
Mg (Meq $100g^{-1}$)	24.80-138	86.70	31.4	36
S (mg/kg)	9.50 -34.5	14.55	3.02	20

Micronutrients (Fe, Cu, Mn and Zn)

The DTPA-iron content in the soil samples ranged from 0.21-6.1 mg kg^{-1} with an average value of 1.37 mg kg^{-1}. It was found that 86.6 % of soil samples are in low concentration of iron. The DTPA- manganese content in soil samples ranged from 0.12-4.7 mg kg^{-1} with a mean value of 1.37 mg kg^{-1}. The values of standard deviation and coefficient of variation were 1.07 ± and 7.8 % respectively. It was found that 96.6 % of samples were deficient in Mn content (as per critical limit suggested by Lindsay and Norvell (1978).

The DTPA- Zn content in soil samples ranged from 0.04-0.89 mg kg^{-1} with a mean value of 0.37 mg kg^{-1}. The values of standard deviation and coefficient of variation were 0.21± and 5.8 % respectively. It was found that 83.3 % of samples were deficient in Zn content. The DTPA- Cu content in soil samples ranged from 0.13-3.67 mg kg^{-1} with a mean value of 0.38 mg kg^{-1}. The values of standard deviation and coefficient of variation were 0.65± and 16.9 % respectively. Similar results were observed by Singh (2019). It was found that 60 % of samples were deficient in Cu content.

Soil nutrient index

To compare the levels of soil fertility in one region with those in another, it was necessary to acquire a single value for each nutrient. The nutrient index (NI) value is an indicator of the soil's ability to supply nutrients to plants. The nutrient index approach established by ICAR -NBSS and LUP13, Ministry of Agriculture (Govt. of India), FAO, and others has been adopted and updated by a number of researchers

Table 6. Status of available micronutrients viz., Fe, Zn, Mn and Cu in soils of Kovur block.

Soil parameters	Range	Mean	SD±	CV (%)
Available Fe (mg kg^{-1})	0.21-6.1	1.6	1.7	102
Available Mn (mg kg^{-1})	0.12-4.7	1.37	1.07	7.8
Available Zn (mg kg^{-1})	0.04-0.89	0.37	0.21	5.8
Available Cu (mg kg^{-1})	0.13-3.67	0.38	0.65	16.9

Table 7. Nutrient index values of Bhikangaon and Gogaon block.

Sl.No.	Available nutrient	Nutrient index values	Category
1	Nitrogen	1.26	Low
2	Phosphorus	2.23	Medium
3	Potassium	2.76	High
4	Sulfur	2.00	Medium
5	Organic carbon	2.66	High

and national/international organizations, including ICAR -NBSS and LUP 13, Ministry of Agriculture (Govt of India), FAO and others (Parker *et al*. 1951). This index is used to evaluate soil fertility using samples from low (1.67), medium (1.67-2.33) and high (>2.33) classes. The nutrient index values for macro and micronutrients of soil samples are given in Table 7. The NI was evaluated for the soil samples analyzed using following formula:

Nutrient Index (NI) = (NL × 1 + NM × 2 + NH × 3) / NT

Where,

NL: Indicates number of samples falling in low class of nutrient status

NM: Indicates number of samples falling in medium class of nutrient status

NH: Indicates number of samples falling in high class of nutrient status

NT: Indicates total number of samples analyzed for a given area.

Correlation matrix between physico-chemical properties of soil of different villages of Khargone District, Madhya Pradesh.

The pH of the soil was found negative and highly significantly correlated with Porosity (r = -0.510 **) and Nitrogen (r = -0.469**) of the soil. The pH of the soil was found negatively significantly correlated with OC (r = -0.433*). Similarly, result was reported by Singh *et al*. (2017) in soils of lahar block, Bhind District, Rajasthan, India. The pH of soils is negatively non-significant related with Sulfur (r = - 0.092) and EC (r = -0.077) while it is positively non-significantly correlated with BD (r =0.339), potassium (r = 0.140), calcium (r =0.285) and magnesium (r =0.175). While positively strong significant is phosphorus (r = 0.519**) and positive significant is Zn (r = 0.414*) of soil. The EC of soil was positively significant related with OC (r = 0.451*), Nitrogen (r = 0.446*) of soil while it is negatively non-significant with Phosphorus (r= -0.056) and Sulfur (r = -0.054), potassium (r =0.288) and BD (r = -0.412) of soil. Similar findings were reported by Sharma *et al*. (2021). The organic carbon of soil was positively strongly significant with Nitrogen (r = 0.928**) and positively non-significant with calcium (r = 0.009) and sulfur (r =0.042) of soil, while negatively non-significant with Magnesium (r = -0.151), phosphorus (r = 0.059) and potassium (r =0.115) of soil. The primary macronutrients of soil i.e., Nitrogen in soils of Bhikangaon and Gogaon

Table 8. Correlation matrix between physico-chemical properties of soil of different villages of Khargone district, Madhya Pradesh. Note: '*' represents significant at 0.05 levels, '**' represents significant at 0.01 level.

	pH	E.C	B.D	P.D	porosity	WHC	OC	N
pH	1							
E.C	-0.338	1						
B.D	-0.034	-0.3127	1					
P.D	0.0156	0.2204	0.2143	1				
porosity	0.3957*	-0.1941	0.162	0.1897	1			
WHC	-0.103	-0.172	-0.004	-0.003	0.021	1		
OC	-0.098	-0.0416	0.0442	-0.187	0.147	0.034	1	
N	-0.202	0.1192	0.0978	-0.014	-0.401*	-0.206	0.1026	1
P	-0129	-0.1017	-0.059	-0.049	-0.266	0.334	0.1395	0.1639
K	0.1985	-0.0112	0.1897	-0.123	0.202	0.252	0.5059*	-0.141
Ca	-0.246	0.3136	0.1346	0.059	-0.205	0.0032	-0.0167	-0.037
Mg	0.1793	0.0056	-0.007	-0.217	0.2193	-01225	0.2143	0.2514
S	0.3282	-0.2956	0.0274	0.123	0.2396	-0.1227	-0.0338	0.0624
Cu	0.0187	-0.1472	-0.014	-0.444*	0.0696	-0.2532	0.3002	-0.069
Mn	0.0988	-0.0654	-0.202	-0.166	0.3069	0.1051	0.2959	0.2198
Fe	-0.164	0.0575	0.1405	-0.172	-0.0152	-0.009	0.2039	0.1893
Zn	-0.113	0.3238	0.0668	0.2296	0.0608	-0.009	-0.3453	-0.042

Table 8. Continued.

	P	K	Co	Mg	S	Cu	Mn	Fe	Zn
pH									
E.C									
B.D									
P.D									
porosity									
WHC									
OC									
N									
P	1								
K	0.0335	1							
Ca	0.0779	-0.009	1						
Mg	-0.273	0.2385	-0.2171	1					
S	0.00007	-0.091	0.03952	0.1447	1				
Cu	0.0716	0.1657	-0.0796	0.0191	0.06715	1			
Mn	0.3026	0.3279	-0.2897	0.2483	-0.0372	-0.0103	1		
Fe	-0.139	0.1283	-0.1509	0.1228	-0.1646	0.2127	-0.0888	1	
Zn	-0.112	0.1865	0.22063	0.0291	0.23846	-0.0827	-0.0865	-0.2947	1

block was found negative non-significant related to Potassium (r = -0.013) and significantly related with potassium (r = -0.106), calcium (r = -0.083) and magnesium (r = -0.173) of soil. It is positively non-significant related with sulfur (r = 0.260) of soil. Phosphorus of soil was positively non-significant related with Calcium (r = 0.278) and Potassium (r = 0.168) of soil whereas it is negatively non- significant with sulfur (r = -0.209) and Magnesium (r = -0.284) of soil. Potassium of soil was positively non-significant related with Magnesium (r = 0.244) and Sulfur (r = 0.083) and Calcium (r = 0.073) of soil. Similar findings were observed by Ramana *et al*. (2015) (Table 8).

CONCLUSION

The soil test results were analyzed using literature to assist farmers in analyzing and supplementing lacking nutrients. According to the foregoing findings, the soils of Bhikangaon and Gogaon block are alkaline in nature, and crop salinity is not a problem. The soils of the Bhikargaon and Gogaon block have low available nitrogen, medium sulfur and high potassium, according to the soil nutrient index of the research region. The levels of phosphorus and organic carbon in the soils of the study area were medium to high. Deficient nutrients can be supplemented to prevent deficiency in crops and to improve the efficiency of other nutrients. The key to long- term soil fertility control is integrated nutrient management.

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