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EVALUATIONS OF SOIL FERTILITY STATUS OF AVAILABLE MAJOR NUTRIENTS AND MICRO NUTRIENTS IN VERTISOL OF INDORE DISTRICT OF MADHYA PRADESH INDIA

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ABSTRACT

Soil fertility is an important factor, which determines the growth of plant. In general soil chemical fertility and in particular lack of nutrient inputs is a major factor in soil degradation (Hartemink *et al.,* 2010). The available nitrogen was measured by Jain and Singh 2014 from Madhya Pradesh, India its value ranges from 172 ±2.1 to 193.3 $kgha^{-1}$ for red, and brown soil and 197±4.9 to 215±21 $kgha^{-1}$ for black soil, 183±19 $kgha^{-1}$ nitrogen investigate in yellow soil (Jain and Singh, 2014). Phosphorus is also part of every living cell in plant. It is one of the most important micronutrient essential for plant growth. Phosphorus is most often limiting nutrients remains present in plant nuclei and act as a energy storage. It helps in transfer of energy (Jain *et al.,* 2014). Adequate phosphorus availability for plants stimulates early plant growth and hastens maturity. The soil with minimum leaching is known to contain high amount of phosphorus as compared to the soil with maximum leaching (Ashraf *et al.,* 2012). Potassium is not an integral part of any major plant component but it plays a key role in a vast array of physiological process vital to plant growth from protein synthesis to maintenance of plant water balance (Sumithra *et al.,* 2013).

Soil characterization in relation to evaluation of fertility status of the soils of an area or region is an important aspect in context of sustainable agricultural production. Nitrogen, phosphorus, potassium and sulphur are important soil elements that control its fertility and yields of the crops. The use of plant nutrients in a balanced manner is the prime factor for efficient fertilizer program. Balanced nutrient use ensures high production level and helps to maintain the soil health. Because of imbalanced and inadequate fertilizer use coupled with low efficiency of other inputs, the response (production) efficiency of chemical fertilizer nutrients has declined tremendously under intensive agriculture in recent years. Variation in nutrient supply is natural phenomenon and some of them may be sufficient where others deficient. The stagnation in crop productivity cannot be boosted without judicious use of macro and micronutrient fertilizers to overcome existing deficiencies/imbalances. Soil fertility is determined by the presence or absence of nutrients i.e. macro and micronutrients. Soil fertility is the inherent ability of soils to supply nutrient elements to plants. Soil fertility is related to the amount of available nutrients. Some measure it by the yield capacity, and others look it to be a function of organic matter or even soil texture. In brief, soil fertility refers to the availability status of essential macro and micro nutrients in the soil (Tisdale et.al., 1993).

Keyword: Soil Fertility status, Vertisol, Nutrient content

Introduction

Soil-test based fertility management is an effective tool for increasing productivity of agricultural soils that have high degree of spatial variability resulting from the combined effects of physical, chemical or biological processes (Goovaerts, 1998). However, major constraints impede wide scale adoption of soil testing in most developing countries. In India, these include the prevalence of small holding system of farming as well as lack of infrastructural facilities for extensive soil testing (Sen *et al.*, 2008). However, major constraints impede wide scale adoption of soil testing in most developing countries. In India, these include the prevalence of small holding systems of farming as well as lack of infrastructural facilities for extensive soil testing. Under this context, Geographic Information System (GIS)-based soil fertility mapping has appeared as a promising alternative. Soil testing provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximizing crop yields. Soil testing program is beneficial to formulated specific fertilizer recommendation. This knowledge will create awareness among the farmers about economic productivity.

Materials and Methods

The study was carried out in 5 villages namely Setkhedi, Ramukhedi, Khudel khurd, Bisenkheda and Buranakhedi falling under Indore blocks. Selection of the village was based on its soil type, farming situation and crops grown. Soil samples (0-15 cm) at random were collected during 2015-16 with the help of soil augur. Processed soil samples were analysed for nutrient availability by following standard analytical techniques. Total 349 soil samples covering all soil types. These samples were analyzed for pH, EC, OC, available N, P, K and S of soil and Available micronutrients Fe, Mn, Cu, Zn and B. Available Nitrogen

was determined by alkaline permanganate method (Subbiah and Asija, 1956). The electrical conductivity (dSm^{-1}) and pH analysis soil suspension used for pH determination was allowed to settle down and conductivity of supernatant liquid was determined by using conductivity meter (Jackson, 1967). The results are expressed in dSm^{-1}at 25°C. Organic carbon content in soil was determined by Walkley and Black's rapid titration method (1934). Available phosphorus was determined by using Olsen's extractant (0.5 N sodium bicarbonate solution of pH 8.5, Olsen *et al.,* 1954). Available potassium was determined by flame photometer as described by Jackson (1967). Available micronutrients Fe, Mn, Cu, & Zn, estimated by DTPA extractable method (Lindsay & Norvell, 1978). The simple correlation analysis of data was computed in relation to available nutrient contents with physico-chemical properties of the soils under study. Overall this physico-chemical study of soil is based on various parameters like pH, electrical conductivity, soil organic matter, available nitrogen, phosphorus and potassium.

Result and Discussion

Soil Fertility Status under Different Cropping Sequences

Table 1 : Sampling location and cropping sequence of selected sites

S. N	Village	GPS location	Major cropping system prevailed in the village
1	Setkhedi	$76^0$03'21.40 E $22^0$43'23.44 N	Soybean-Wheat, Soybean-Potato-wheat Soybean-Chickpea
2	Ramukhedi	$76^0$03'19.90 E $22^0$43'36.60 N	Soybean-Wheat, Soybean-Potato-wheat Soybean-Chickpea
3	Khudel Khurd	$76^0$02'43.80 E $22^0$43'23.30 N	Soybean-Wheat, Soybean-Potato-wheat Soybean-onion Soybean-Chickpea
4	Bisenkheda	75-59'25.40 E 22-04'27.80 N	Soybean-Wheat, Soybean-Potato-wheat Soybean-onion Soybean-Chickpea
5	Buranakhedi	$76^0$00'51.85 E $22^0$45'46.63 N	Soybean-Wheat, Soybean-Potato-wheat Soybean-Garlic Soybean-Chickpea

Physico-chemical characteristics of soils:

Soil reaction (pH):

The soil samples of all the 5 villages viz. villages Setkhedi, Ramukhedi, Khudel khurd, Bisenkeda, Buranakhedi were determined for pH (Table 2) and in total sample 72.1,36.4,65.2,63.9 and 54.2 percent of sample were found under neutral category and 27.9, 63.6, 34.8, 35.8 and 42.2 percent samples were found under the slightly alkaline category respectively with average of 8.06,8.08,8.11,8.09 and 8.04 and range of 7.55-8.45, 7.60-8.50, 7.60-8.51, 7.38- 8.43 and 7.50-8.43 respectively. Shivanna and Nagendrappa (2014) reported that the pH of the soil samples ranged from 7.07 to 7.87 and was on slightly alkaline side but within the limit of 6.5-8.5 which is optimum for crops. Jibhakate *et al.* (2009) were also found similar result in soils of kotal tahsil in Nagpur district of Maharashtra, in which pH ranges from 7.1 to 8.1 as reported by.

The total soluble salt contents expressed as electrical conductivity (EC) having the entire sample under the normal category (<0.8 ds/m-1). The EC of the soil varied from 0.11 to 0.78 dS m^{-1} with the mean value of 0.31 to 0.39 dS m^{-1} at 25°C in all the five villages (Table 3). The normal EC may be ascribed to leaching of salt to lower horizons. Similar result was also found in soils of Akaltara block of Janjgir district of Chhattisgarh as described by Kunal *et al.*, (2013).

The data presented in Table 4 revealed that organic carbon (OC) status of majority of samples ranged between low to medium. The majority soil sample of Setkhedi village (90.7%) were found to under low OC content. The average OC in the Setkhedi village is 0.42%. The soil samples of the village Bisenkheda also have lowest OC in the soil with mean value of the 0.47 percent of organic carbon. The village Khudel khurd have the highest soil sample in medium category in organic carbon content in soil followed by Burnakhedi. The mean organic carbon content in Khudelkhurd and Buranakhedi is 0.55 and 0.51 percent respectively. The organic carbon content of both the villages ranges from 0.20 to 0.92 percent of samples. Observations in the line with the present findings have been reported in Nazif *et al.,* (2006) showed that majority of the soil sites were medium amount of organic matter. Low status of organic carbon in some soils of the area is indicating that adequate nitrogen fertilization through organic manure, FYN etc are required. Similar findings were reported by Lathwal (2006) in district Kurukshetra, Sharma *et al.,* (2008) in soils of Amritsar District.

The data depicted in the Table 5 shows that due to lower organic carbon content nitrogen deficiency found in majority of the soil sample of the different villages. The village Setkhedi, Ramukhedi, Khudel khurd, Bisenkeda and Burnakedi have the 97.7%, 77.3%, 82.6%, 96.7% and 93.2% percent of soil sample shows the deficiency of the nitrogen and comes under low category. The nitrogen content in all the villages varies from 80kg/ha to 320 kg/ha. The average nitrogen content in Setkhedi,Ramukhedi, Khudel khurd, Bisenkeda and Burnakedi is 171.6, 190.2, 210.4, 188.7, and 200.6 kg/ha respectively. The average nitrogen content in Kuhdel kurd is higher i.e. 210.4 kg/ha and lowest in Setkhedi i.e. 171.6 kg/ha.

The data (Table 6) revealed that mean values of available phosphorus were 12.50 to 15.86 kg/ha in soil samples of all the villages. Similar results were reported by Pathak (2010) who concluded that available phosphorus range from medium to high category in India. The majority soil sample found under medium category. The village Setkhedi and Khudel kurd have the 20.9 and 13.0 percent of soil sample under the low category. In the village Ramukedi and Khudel kurd 13.6 and 4.3 percent of soil sample is found rich in the phosphorus,

The data presented in the Table 7 shows that majority of the soil sample for potassium comes under the medium to high category. The village Setkhedi, Ramukhedi, Khudel khurd, Bisenkeda and Burnakedi have the 74.4%,72.7%, 73.9%, 65.1% and 80.1% percent of soil sample shows more than 400 kg/ha potassium and comes under higher category. The potassium content in all the villages varies from 257 kg/ha to 873 kg/ha. The average potassium content in Setkhedi, Ramukhedi, Khudel khurd, Bisenkeda and

Burnakedi is 452, 481, 450, 420 and 465 kg/ha respectively. The average potassium content in Ramukhedi is higher i.e. 481 kg/ha and lowest in Bisenkheda i.e. 420 kg/ha. No soil sample comes under low category in all the villages,

The data presented in the Table 8 shows that majority of the soil sample for sulphur comes under the low to medium. The village Setkhedi, Ramukhedi, Khudel khurd, Bisenkeda and Burnakedi have the 60.5%,31.8%, 52.2%, 43.1% and 37.8% percent of soil sample shows low content of sulphur in soil. The sulphur content in all the villages varies from 6.28 ppm to 16.82 ppm. The average sulphur content in soil in all the village varies from 9.87 to 10.74 ppm. No soil sample comes under higher category in all the villages,

The data give in the Table 9 shows that zinc deficiency gradually increasing in the area. Presently 11.6, 9.1, 8.7, 10.2 and 5.9 percent of the soil sample for zinc showing the deficiency. Although majority of the sample comes under the sufficient or medium category. The village Setkhedi, Ramukhedi, Khudel khurd, Bisenkheda and Burnakhedi have the 88.4%, 90.9%, 82.6%, 89.8% and 94.1% percent of soil sample shows sufficient content of zinc in soil. The Zinc content in all the villages varies from 0.12 to 1.54 ppm. The average zinc content in soil in all the village varies from 0.70 to 0.93 ppm. 8.7 percent soil samples comes under higher category in village Khudel Khurd,

The data give in the Table 10 shows that there is no any deficiency in the area. Most of the sample comes under medium to high category. Presently 25.6, 27.3, 13.0, 4.8 and 7.97 percent of the soil sample showing the higher iron content. Although majority of the sample comes under the medium to high category. The village Setkhedi, Ramukhedi, Khudel khurd, Bisenkheda and Burnakhedi have the 25.6%, 27.3%, 13.0%, 4.8% and 7.97% percent of soil sample shows high content of iron in soil . The Iron content in all the villages varies from 5.25 to 16.78 ppm. The average iron content in soil in the entire village varies from 7.35 to 8.98 ppm. In village Bisenkheda and Khudel Khurd have 95.2 and 87.0 percent soil samples respectively comes under medium category,

The data give in the Table 11 shows that soil of the all the villages having the higher content of the manganese in the soil. No deficiency of manganese is found in the soil sample of the villages. The average content of manganese is ranges from 6.17 to 6.94 ppm and it ranges from the 5.11 to 9.32 ppm in the soil.

The copper in the soil sample show the medium to high content in the soil sample as data shown in the Table 12. The two village setkhedi and burankhedi have the 2.3 and 0.40 percent of soil sample shows the deficiency in the soil. The village bisankheda have 65.7 percent sample in higher category. The majority of the sample shows the sufficiency of the copper content in soil. The average content of copper is ranges from 0.52 to 0.68 ppm and the range is from the 0.20 to 1.32 ppm in the soil.

The Data presented in the table 13 shows that boron content in the soil is sufficient and it is medium to high in the soil. The village Bisankeda have the 90.4 percent soil sample in medium category and Ramukhedi have the 31.8 percent soil sample in this category. The average content of boron is ranges from 1.25 to 1.63 ppm and the range is from the 0.98 to 2.17 ppm in the soil.

Table 2 : pH value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		pH <6.5	pH 6.5-8.2	pH >8.2		
1	Setkhedi	0.0	72.1	27.9	8.06±0.24	7.55-8.45
2	Ramukhedi	0.0	36.4	63.6	8.08± 0.25	7.60-8.50
3	Khudel Khurd	0.0	65.2	34.8	8.11±0.24	7.60-8.51
4	Bisenkheda	0.3	63.9	35.8	8.09±0.20	7.38-8.43
5	Buranakhedi	3.6	54.2	42.2	8.04±0.15	7.50-8.43

Table 3 : EC value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		EC <0.8 ds/m1	EC 0.8-1.6 ds/m1	EC <1.6 ds/m1		
1	Setkhedi	100	0	0	0.39±0.16	0.15-0.78
2	Ramukhedi	100	0	0	0.35±0.11	0.20-0.56
3	Khudel Khurd	100	0	0	0.33±0.16	0.11-0.65
4	Bisenkheda	100	0	0	0.35±0.15	0.11-0.78
5	Buranakhedi	100	0	0	0.31±0.10	0.13-0.68

Table 4 : Organic carbon value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		Low (<0.5%)	Medium (0.50.75%)	High (>0.75%)		
1	Setkhedi	90.7	7.0	2.3	0.42±0.11	0.28-0.92
2	Ramukhedi	50.0	45.5	4.5	0.49±0.20	0.22-0.80
3	Khudel Khurd	30.5	65.2	4.3	0.55±0.15	0.20-0.81
4	Bisenkheda	68.1	29.8	2.1	0.47±0.16	0.24-0.79
5	Buranakhedi	47.0	57.6	0.4	0.51±0.14	0.23-0.69

Table 5 : Nitrogen value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		Low (250 kg/ha)	Medium (250-400 g/ha)	High (>400 kg/ha)		
1	Setkhedi	97.7	2.3	0	171.6±30.5	320-133
2	Ramukhedi	77.3	22.7	0	190.2±58.9	278-104
3	Khudel Khurd	82.6	17.4	0	210.4±46.2	283-80
4	Bisenkheda	96.7	3.3	0	188.7±26.4	274-114
5	Buranakhedi	93.2	6.8	0	200.6±44.1	258-109

Table 6 : Phosphorus value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		Low (<10 kg/ha)	Medium (10-20 kg/ha)	High (>20 kg/ha)		
1	Setkhedi	20.9	79.1	0	12.50±2.41	8.41-16.4
2	Ramukhedi	4.5	81.8	13.6	15.86±4.16	9.88-25.23
3	Khudel Khurd	13.0	82.7	4.3	14.17±2.80	8.90-20.23
4	Bisenkheda	4.5	95.5	0	13.77±2.16	8.75-19.61
5	Buranakhedi	1.6	95.2	3.2	14.61±2.21	8.03-23.61

Table 7 : Potassium value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		Low (250 kg/ha)	Medium (250-400 kg/ha)	High (>400 kg/ha)		
1	Setkhedi	0	25.6	74.4	452±82.5	264-630
2	Ramukhedi	0	27.3	72.7	481±127.9	263-686
3	Khudel Khurd	0	26.1	73.9	450±71.8	331-591
4	Bisenkheda	0	34.2	65.1	420±84.7	259-741
5	Buranakhedi	0	19.9	80.1	465±86.3	257-873

Table 8 : Sulphur value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		Low (10 ppm)	Medium (10-20 ppm)	High (>20 ppm)		
1	Setkhedi	60.5	39.5	0	10.13±2.27	6.28-16.82
2	Ramukhedi	31.8	68.2	0	10.74±2.18	6.42-15.32
3	Khudel Khurd	52.2	47.8	0	9.87±1.30	7.26-12.36
4	Bisenkheda	43.1	56.9	0	10.44±1.71	6.42-14.82
5	Buranakhedi	37.8	62.1	0	10.13±1.91	6.32-14.69

Table 9 : Zinc value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		Low (<0.5 ppm)	Medium (0.5-1.5 ppm)	High (>1.5 ppm)		
1	Setkhedi	11.6	88.4	0	0.70±0.19	0.15-1.0
2	Ramukhedi	9.1	90.9	0	0.72±0.24	0.12-1.19
3	Khudel Khurd	8.7	82.6	8.7	0.93±0.34	0.16-1.54
4	Bisenkheda	10.2	89.8	0	0.75±0.27	0.13-1.35
5	Buranakhedi	5.9	94.1	0	0.79±0.25	0.15-1.25

Table 10 : Iron value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		Low (<4.5 ppm)	Medium (4.5-10 ppm)	High (>10 ppm)		
1	Setkhedi	0	74.4	25.6	8.98±2.24	5.56-16.78
2	Ramukhedi	0	72.7	27.3	8.37±2.28	5.62-13.66
3	Khudel Khurd	0	87.0	13.0	8.33±1.70	5.56-12.30
4	Bisenkheda	0	95.2	4.8	8.10±1.39	5.55-12.44
5	Buranakhedi	0	32.0	7.97	7.35±1.84	5.25-12.65

Table 11 : Manganese value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		Low (<2.0 ppm)	Medium (2.0-4.0 ppm)	High (>4.0 ppm)		
1	Setkhedi	0	0	100	6.55±1.00	5.16-9.24
2	Ramukhedi	0	0	100	6.17±1.05	5.11-8.67
3	Khudel Khurd	0	0	100	6.94±0.88	5.34-8.32
4	Bisenkheda	0	0	100	6.43±0.66	5.14-8.64
5	Buranakhedi	0	0	100	6.64±0.87	5.30-9.32

Table 12 : Copper value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		Low (<0.2 ppm)	Medium (0.2-0.6 ppm)	High (>0.6 ppm)		
1	Setkhedi	2.3	39.5	58.1	0.62±0.17	0.26-0.92
2	Ramukhedi	0	59.1	40.9	0.52±0.20	0.24-0.85
3	Khudel Khurd	0	52.2	47.8	0.57±0.15	0.32-0.88
4	Bisenkheda	0	34.3	65.7	0.68±0.17	0.23-1.32
5	Buranakhedi	0.4	84.8	14.7	0.48±0.15	0.20-0.93

Table 13 : Boron value of soil samples of different villages.

S.N	Village	Per cent samples			Mean ± SD	Range
		Low (<0.5 ppm)	Medium (0.5-1.5 ppm)	High (>1.5 ppm)		
1	Setkhedi	0	44.2	55.8	1.54±0.21	1.19-1.97
2	Ramukhedi	0	31.8	68.7	1.63±0.23	1.23-1.97
3	Khudel Khurd	0	43.5	56.5	1.56±0.27	1.06-2.11
4	Bisenkheda	0	90.4	9.6	1.25±0.19	0.98-1.99
5	Buranakhedi	0	39.0	61.0	1.58±0.26	1.13-2.17

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