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Soil fertility status of macro-nutrients and micro-nutrients in Bareli watershed of Seoni district, Madhya Pradesh, India

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Abstract
A detailed soil survey was undertaken in Bareli watershed in Madhya Pradesh state of India with the aim of evaluating the fertility status of soils. A total of 5 Series Soil samples were collected and analyzed for pH, electrical conductivity, organic carbon, available nitrogen, P2O5 and K2O, and available micronutrients (Zn, Mn, Fe & Cu) using standard analytical methods. Based of fertility ratings, pH of soils was neutral to alkaline. Electrical conductivity was normal (<1.0 dS/m). Soil organic carbon was low to high, with more than 70% of study area falling in the medium to high category. Available macronutrient status (N, P, K,) were moderately low to high. The availability of micronutrients was highly variable. Zinc (Zn) was to low (defficient) while iron (Fe), manganese (Mn) and copper (Cu) were high and sufficient to excess were observed as the most important soil fertility constraints that could affect sustainable crop production in the study area. The situation therefore demands the adoption of appropriate management practices in order to boost the fertility status. These practices may include such practices as site specific nutrient management, increased use of organic nutrient sources, sustainable land use and cropping systems, and appropriate agronomic practices.

Keywords: Soil fertility, macro-nutrients, micro-nutrients, Bareli, Madhya Pradesh, India

Introduction

As human population continues to increase, human disturbance on the earth's ecosystem to produce food and fiber will place greater demand on soils to supply essential nutrients. Continuous cropping for enhanced yield removes substantial amounts of nutrients from soil. Imbalanced and inadequate use of chemical fertilizers, improper irrigation and various cultural practices also deplete the soil quality rapidly (Medhe *et al.* 2012) [7].

Soil fertility fluctuates throughout the growing season each year due to alteration in the quantity and availability of mineral nutrients by the addition of fertilizers, manure, compost, mulch, and lime in addition to leaching. (Singh and Misra, 2012). Hence it is necessary to assess the fertility status of soil with the consideration of available nutrients in soils and to recommend the specific nutrients for the proper management of soil. Information on soil fertility status in crop field is very important and useful for fertilizer requirement and also to the specific management of the crop and soil. The availability of nitrogen, phosphorus and potassium (NPK), whether in soils or plants is among most of the nutrient studied for precision agriculture (Malek *et al.* 2007) [6]. Soil testing plays an important role in the use of fertilizers and other agricultural inputs. Soil test summaries and soil fertility are vital necessity as reference materials for scientific management of soil. This information will also help to adopt effective strategy on fertilizer use and cropping pattern vary widely in their soils and their potentials, behaviour and response to management and soil based fertilizer recommendations should be preferred to achieve precision in farming and to maximise crop production, maintain soil health and minimise fertilizer misapplication (Ramamurthy *et al.* 2009) [12].

Materials and Methods

The Bareli watershed in basaltic terrain, lies between 22° 29' 39" to 22° 32' 10" N latitudes and 79° 46' 44" to 79° 49' 50"E longitudes, and covers an area of 1795.35 ha in Dhanora block, Seoni district, Madhya Pradesh. Physiographic ally, Bareli watershed was divided into three major physiographic units *viz.* plateau (P), escarpments (E), hills and ridges (H), isolated mounds (M) and pediments (D). The elevation of the area ranges from 520 to 620 m above mean sea level (MSL). The area is associated with level to nearly level sloping (0-1%) to moderately steep to steeply sloping (15-25%) lands. The climate is mainly dry sub-tropical with mean annual temperature of 28.4 °C and mean annual rainfall of 1100 mm. The area qualifies for ustic soil moisture regime and hyperthermic soil temperature regime respectively. The natural vegetation comprises of teak (*Tectona grandis*), babul (*Acacia spp*.), palas (*Butea frandosa*), charoli (*Buchanania lanzan*), ber (*Ziziphus jujuba*) etc. The major crops are paddy (*Glycine max*), pigeonpea (*Cajanus cajan*), maize (*Zea mays*) and safflower (*Carthamus tinctorius*) in *kharif* and wheat (*Triticum aestivum*) and gram (*Cicer arietinum*) in *rabi* under irrigation or stored moisture. Mango and Guava are the main fruit crops of the area.

The area of 1795 ha Horizon wise samples were collected. The samples were labelled, air dried and sieved through 2 mm sieve for analysis of soil fertility parameters. The samples were sieved through 100 mesh sieve (0.5 mm) for determining organic carbon (OC) (Walkley and Black, 1934). Soil pH was measured with 1:2 soil water ratio. Soil available nitrogen (N) was estimated by the method of Subbiah and Asija (1956); available phosphorus (P) by Olsen *et al.* (1954) for neutral and alkaline soils (pH>6.5) Soil available potassium (K) was extracted by 1 N ammonium acetate (pH 7.0). The CEC of calcareous soil was determined by overnight saturating the soils with 1*N* sodium acetate (pH 8.2), whereas, for non-calcareous soil 1*N* sodium acetate (pH 7.0). Available micronutrient cations (Fe, Mn, Cu and Zn) were extracted by DTPA-$CaCl_2$extractant at pH 7.3 (Lindsay and Norvell 1978) [5]

3. Results and Discussion

Physico-chemical properties of study area

The data pertaining Table 1.indicate that the soils of the watershed are neutral to alkaline with pH values ranging from 6.36 to 7.28. Based on pH values, the soils of the area have been grouped as neutral. (Diwara, Bareli-2), slightly acidic and (Diwartola Bareli-1 and Bareli-3), moderately alkaline. Higher pH value in soils may be due to basalt as parent material, which is alkaline in nature (Chinchmalatpure *et al.* 2000) [1], higher content of calcium carbonate and accumulation of soluble salts due to washing from upper elevation (Arnold and Venkateshwarlu, 1982).

The EC of soils is generally low and ranges from 0.13 to 0.4 3dSm^{-1} which are within the acceptable limit and the soils have no salinity hazard at present. The low EC value were observed in this soil may be due to leaching of salt from the surface layer of soil.

Organic carbon content in soils ranged from 0.31 to 0.96 per cent in different horizons. Soils of Diwara and Bareli-2 have higher organic carbon content, whereas, soils of Diwartola, Bareli-1 and Bareli-3 have lower organic content. In general, the organic carbon content decreased gradually with increase in depth, which is mainly due to the accumulation of plant residues on the soil surface and less movement down the profile due to rapid rate of mineralization at higher temperature and adequate soil moisture level. Similar results were observed by Sarkar *et al.* (2001) [14], Nayak *et al.* (2001) [8] Rao *et al.* (2008) [13].

Nutrient Status and Soil fertility

Available Macronutrient

Soil fertility status exhibit the status of different soil with regard to amount of nutrient essential for plant growth. The available soil nitrogen content of the surface soils ranges from 139 to 435 kg ha^{-1} and found low in soils of Bareli-1. Available N status was observed low at rooting depth (upto 45 cm) in all the which might be due to rapid decomposition of inorganic matter and low nitrogen supplying power of then soils. Available N content was maximum in surface horizon and found decreasing with increasing depth which might be due confinement of falling of plant residues and debris and rhizosphere of plant with decreasing content of organic carbon with depth. Similar results were reported by Sharma and Bali (2000) [15] and Todmal *et al.* (2008) [19]. Verma *et al.* (2013) [20].

The available phosphorus content of the surface soils varied from 18.5 to 37.6 kg ha^{-1}. The soils of Diwartola and Bareli-3 are high, whereas, soils of Diwara, Bareli-1 and Bareli-2 are moderately high in available P. The declined trend of phosphorus with depth may due to higher fixation of available P by clay.The reasons for highest p observed in surface soil due to confinement of crop cultivation to the rhizospere and supplementing of depleted phosphorous through external sources i.e. fertilizer Similar findings were reported by Todmal *et al.* (2008) [19]. Gajare *et al.* (2014) and Verma *et al.* (2013) [20].

The available potassium content of the surface soils varied from 195.1 to 481.6 kg ha^{-1}. The soils of Diwara, Diwartola and Bareli-1 are very high and soils of Bareli-2 and Bareli-3 are medium to moderately high in available K. The potassium content also increased with the clay content. This may be attributed to the K-rich minerals occurring in the soil (Pal, 1985) and the relative immobility of this element on account of fixation by clay. Most of the surface soils had higher available potassium content which might be due to more intense weathering of potash bearing minerals, generation of leaf litter from different crops in cropping systems, release of labile K from organic residues, application of K fertilizers and upward translocation of K from lower depth with capillary rise of ground water (Hirekurbar *et al.* 2000 and Patil *et al.* 2008) [3, 9].

Available Micronutrient

The DTPA extractable Fe ranges from 6.2 to 15.2 mg kg^{-1} and found to be much higher than the critical level of 4.5 mg kg^{-1} (Lindsey and Norvell, 1978) [5] in all the soils. The high Fe content was due to presence of mineral like feldspar, haematite, magnetite and limonite which together constitute bulk of rock in this soil Pharande *et al.* (1996) [10] and Abrahim *et al.* (2011).

The DTPA extractable Mn content varies from 11.18 to 42.83 mg kg^{-1} and found to be much higher than the critical level of 3.0 mg kg^{-1} (Takkar *et al.* 1989) [18] in all the soils. Mn deficiency usually does not occur in black soils because a sizeable portion of Mn is bound with manganese oxide which may be readily available (Singh, 1988) [16].

Cu content of the soils varies from 2.36 to 8.56 mg kg^{-1} and decreased with depth. The Cu content is higher than the critical value of 0.2 mg kg^{-1} (Katyal and Randhawa, 1983) in all the soils. The copper content could be attributed to difference geology, physiography and degree of weathering in these soil similar result were observed in Kirmani *et al.* (2011) [4]

Zn content of the soils varies from 0.29 to 0.52 mg kg^{-1}. The soils of Diwara, Diwartola, Bareli-1, Bareli-2 and Bareli-3 showed zinc deficiency against critical level of 0.6 mg kg $^{-1}$ (Katyal and Randhawa, 1983; Sharma *et al.* 1996) and need to be supplemented. The high deficiency status of Zn might be due to the formation of Zn-phosphates following large applications of P fertilizer as well as the formation of complexes between Zn and organic matter in soils with high pH and high organic matter content or because of large applications of organic manures and crop residues (Kavitha and Sujatha, 2015). Hence, their solubility and mobility may decrease resulting in reduced availability. According to Singh *et al.* (2016) [17], zinc uptake by plants decreases with increased soil pH. Uptake of zinc also is adversely affected by high levels of available phosphorus in soils (Pulakeshi *et al.* 2012) [11].

Table 1: Soil physico-chemical properties and available nutrient status of the study area

Horizon	Depth (cm)	pH (1:2.5)	EC (dSm^{-1})	OC (%)	CEC (cmol (p+) kg^{-1})	$CaCO_3$ (%)	N	P	K	Fe	Mn	Cu	Zn
							(Kg ha^{-1})			(mg kg^{-1})			
Diwartola Series (very gently sloping plateau): *Clayey, smectitic, hyperthermic, Lithic Haplustepts*													
Ap	0-20	7.06	0.19	0.84	51.5	2.16	376	37.6	436.5	10.9	21.34	4.26	0.52
Bw	20-36	7.18	0.17	0.38	50.6	3.11	170	31.2	195.1	7.6	20.46	4.03	0.39
Diwara Series (moderately steeply sloping escarpment): *Clayey, smectitic, hyperthermic, Lithic Ustorthents*													
Ap	0-10	6.61	0.31	0.93	42.6	2.12	417	27.3	448	15.2	21.03	6.20	0.49
AC	10-20	6.84	0.31	0.76	44.4	3.30	340	18.5	358.4	11.2	18.46	5.08	0.44
Bareli-1 Series (very gently sloping pediment): Fine, smectitic, hyperthermic Vertic Haplustepts													
Ap	0-13	7.16	0.43	0.96	47.5	1.10	279	37.2	481.6	12.3	20.15	4.03	0.45
Bw	13.-32	7.2	0.33	0.37	50.6	2.08	166	20.6	459.2	7.4	15.50	3.10	0.37
Bss	32-50	7.28	0.36	0.31	55.7	2.20	139	27.3	347.2	6.2	27.98	2.38	0.38
Bareli-2 Series (gently sloping pediment): Clayey-skeletal, smectitic, hyperthermic Lithic Ustorthents													
Ap	0-15	6.36	0.13	1.38	51.1	1.06	435	22.0	213.5	13.4	42.83	8.56	0.41
Bareli-3 Series (moderately sloping pediment): Clayey-skeletal, smectitic, hyperthermic Typic Ustorthents													
Ap	0-15	6.98	0.17	0.68	46.7	1.96	305	39.4	268.8	13.6	12.34	2.46	0.35
AC	15-32	7.12	0.17	0.46	50.2	2.12	206	26.8	246.4	9.2	11.18	2.36	0.29

Conclusion

The study has revealed that the pH of soils were neutral to alkaline. Electrical conductivity was normal (<1.0 dS/m). Soil organic carbon was low to high, with more than 60% of study area falling in the medium to high category. Available macronutrient status (N, P, K) were moderately low to high. The availability of micronutrients was highly variable. Zinc (Zn) was very low (deficient), iron (Fe) was to much higher, while manganese (Mn) and copper (Cu) were very high across the critical level. The situation therefore demands the adoption of appropriate management practices in order to boost the fertility status. These practices may include such practices as site specific nutrient management, increased use of organic nutrient sources, sustainable land use and cropping systems, and appropriate agronomic practices.

References

1. Chinchmalatpure AR, Brijlal R, Challa O, Sehgal J. Available micronutrient status of soils on different parent materials and landforms in a micro-watershed of Wunna catchment near Nagpur (Maharashtra). Agropedology. 2000; 10:53-58.
2. Gajare AS, Dhawan AS, Ghodke SK, Waghmare YM, Chaudhari PL. Nutrient indexing of major soybean growing soils of Latur district, J Soil. And Crop. 2014; 24(1):50-56.
3. Hirekurbar BT, Satyanarayan T, Sarangmath PA Manjunathaiah HM. Forms of potassium and their distribution in soils under cotton based cropping system in Karnataka. J Indian Soc. Soil Sci. 2000; 48(3):604-608.
4. Kirmani NA, Sofi JA, bhat MA, Bangroo SA, Shabir Bhat A. Soil micronutrient status of district Budgam, Res. J Agri. Sci. 2011; 2(1):30-32.
5. Lindsay WL, Norwell A. Development of DTPA soil test for Zn, Fe,Mn and Cu. Society of American Journal, 1978, 42:421-428.
6. Malek MY, Kamaruzaman J, Mohd HI. Soil nutrient variability mapping in Ui TM research station, Arau, Perlis Using Landsat TM7 and Geostatistical analysis, WSES Transaction on Signal Processing. Greece. 2007; 502:80-87.
7. Medhe SR, Tankankhar VG, Salve AN. Correlation of chemical properties, secondary nutrients and micronutrient anions from the soils of Chakur Tahsil of Latur district, Maharashrta. Journal of Trends in life sciences, 2012, 1(2).
8. Nayak AK, Sahu GC, Nanda SSK. Characterization and classification of soils of Central Research Station, Bhubaneswar. Agropedology. 2001; 12:1-8.
9. Patil GD, Khedkar VR, Tathe AS, Deshpande AN. Characterization and classification of soils of Agricultural College Farm, Pune. J Maharashtra agric. Univ. 2008; 33(2):143-148.
10. Pharande AL, Raskar BN, Nipunage MV. Micronutrient status of important Verisols and Alfisols soil series of Western Maharashtra. J Maharashtra Agric. Univ. 1996; 21(2):182-185.
11. Pulakeshi HBP, Patil PL, Dasog GS, Radder BM, Mansur CP. Mapping nutrients status by geographic information system (GIS) in Mantagani village under northern transition zone of Karnataka. Karnataka J Agric. Sci. 2012; 25(3):232-235.
12. Ramamurthy V, Naidu LGK, Ramesh Kumar SC, Srinivas S, Hegde Rajendra. Soil-based fertilizer recommendations for precision farming, Curr. Sci. 2009; 97:641-646.
13. Rao APV, Prasad MVS, Naidu N. Ramavatharam and G. Rama Rao. Characterization, classification and evaluation of soils on different landforms in Ramachandrapuram Mandal of Chittoor District in Andhra Pradesh for sustainable land use planning. J Indian Soc. Soil Sci. 2008; 56(1):23-33.
14. Sarkar D, Gangopadhyay SK, Velayutham M. Soil toposequence relationship and classification in lower outlier of Chhotanagpur plateau. Agropedology. 2001; 11:29-36.
15. Sharma MP, Bali SV. Long term effect of different cropping ststems on physicochemical properties and soil fertility. J Indian Soc. Soil Sci. 2000; 18(1):183-185.

16. Singh SS. Crop management under irrigated and rainfed conditions. Kalyani Publ. New Delhi, Ludhiana, 1988, 450.
17. Singh G, Sharma M, Manan J, Singh G. Assessment of Soil Fertility Status under Diferent Cropping Sequences in District Kapurthala. J Krishi Vigyan. 2016; 5(1):1-9
18. Takkar PN, Chhibba IM, Mehta SK. Twenty years of coordinated research on micronutrients in soil and plant. Bull. Indian Institute of Soil Science, Bhopal, 1989, 1-75.
19. Todmal SM, Patil BP, Tamboli BD. Characterisation and classification of soils in Agriculture College Farm, Kolhapur. J Maharashtra agric. Univ. 2008; 33(3):287-291.
20. Verma US, Jatur GK, Bhagat RK. Evaluation of soil fertility status in inceptisols of Malkharda block in Janjgir district of Chhattisgarh, Asian. J of Soil Sci. 2013; 8(1):103-109.