Perpendicular Distribution of Macro Nutrients and Micronutrients of Ghatpipariya Village of Dhanora Block in Seoni district, Madhya Pradesh, India

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Abstract: A study was undertaken to evaluate the nutrient fame of soils of Ghatpipariya in Seoni district, Madhya Pradesh, India during the year 2018-19. A total of 5 Series Soil samples were collected from different physiography-Soil relationship namely Plateau, Escarpment, Pediments and Alluvial Plain and analyzed for pH, electrical conductivity, organic carbon, available nitrogen, available P2O5 and available K2O, and available micronutrients (Zn, Mn, Fe & Cu) using standard analytical methods. Based of fertility ratings, pH of soils was neutral to moderately alkaline. Electrical conductivity of all the soils ranged from 0.07 to 0.26 dSm^{-1}which are within the acceptable limit and the soils have no salinity hazard at present. Organic carbon content in soils ranged from 0.17 to 1.92 per cent in different horizons . Soils of Ghatpipariya -2 series have high organic carbon content, whereas, soils of Ghatpipariya -4, Ghatpipariya -5 series have low organic carbon content. The calcium carbone varied from 1.45 to 5.3 %. Cation exchange capacity of soils range from 39.1 to 62.6 $cmol(p^{+})kg^{-1}$. Higher CEC values were observed in soils of Ghatpipariya -4 and Ghatpipariya -5. Based on the fertility parameters the soils are low in available N, low to very high in available P and medium to very high in available K. similarly available micronutrients *viz*. Fe, Mn and Cu were high in all the soils, while, deficiency of available Zn was observed in the soils of Ghatpipariya -1, Ghatpipariya -2, Ghatpipariya -3, Ghatpipariya -4 and Ghatpipariya -5. Based on soil characterization and fertility analysis the information generated will help in sustainable development and to enhance the crop productivity.

Keywords: Soil fertility, Macro-nutrients, Micro-nutrients, Ghatpipariya

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1. Introduction

Agriculture is the most important sector, accounting for around 15% of national GDP and so serving as the backbone of the Indian economy. For their daily lives, fifty percent of the Indian population is entirely or largely reliant on agriculture and related activities (Amutha, 2013). (Sharma et. al., 2013) Soil, land, and water are the three basic elements that are vital for human life and agricultural development to be sustainable ((Das et al., 2009), (Chakraborty et al 2009). To maintain healthy food, water, and environment for the present and future, researchers, administrators, and farmers must manage (Zhuo, et.al., 2021). Soil and water resources in a sustainable manner (Das, 1998; Kanwar, 2000). Soil, as a fundamental component of the universe, plays a critical function not only in the production of food, fodder, and fibre, but also in the preservation of environmental quality. (Prava,et. al., 2019), (Xiang Yu et. al., 2020). For ages, Asian farmers have followed a cultural system that ensures a consistent output as well as the required degree of soil fertility. During the 1960s, India began cultivating high-yielding cultivars and increasing the use of chemical fertilisers, insecticides, and herbicides, among other things, in order to make the country self-sufficient in food grain production. (Debroy et al., 2020)

Though increased output assured the country's food security, extensive cultivation of high yielding cultivars and fertiliser use resulted in a decline in the use of organic manures, crop residues, and nutritional imbalance in the soils. (Lisnawati Y and Siregar C.A. 2019) The primary cause of the shortage is a lack of secondary and micronutrients, whereas the secondary cause is soil conditions that limit nutrient availability (Sharma & Chaudhary, 2007). As a result, determining the soil fertility state is necessary for the long-term usage of land to boost crop yield. Farmers are now using more chemical fertilisers and herbicides in order to enhance yields, as well as implementing continuous cropping with no fallow periods (Kumar et al., 2021), (Zhang & Zhang, 2007). The loss of soil organic matter (SOM) and stored nutrients as a result of intensive agriculture has been directly linked to productivity decline (Juo & Manu, 1996).

Knowledge of vertical distribution of plant nutrients in soils is useful, as roots of most of the crops go beyond the surface layers and draw part of their nutrient requirement from the sub surface layers. (Ingle et al., 2018, 2019) Soil profile characteristics as conditioned by different processes and factors of soil formation have great influence on soil fertility and crop productivity. Detailed and scientific study of soil profiles is immensely essential for understanding the prevailing soil forming (soil genesis) factors and processes, without a knowledge of which soil characteristics cannot be clearly interpreted (Vedadri and Naidu, 2018), (Medhe et al., 2012). The crop productivity cannot be boosted further without judicious use of macro and micro nutrient fertilizers to overcome the existing deficiencies. Hence, a clear cut understanding of vertical distribution of plant nutrients in soil is highly necessary to suggest appropriate fertilizer schedule for different crops to obtain optimum yield. Variations in physiography greatly influence the availability and distribution of plant nutrients, both in surface as well as subsurface soils (Dorji et al., 2014). (Ramamurthy et al., 2009), (Singh and Misra, 2012, Ingle et al., 2019 Kuchanwar et al., 2021, Kuchanwar et al., 2022).

The Seoni district of Madhya Pradesh is experiencing frequent erratic rainfall with continuous depletion of vegetative cover and increase in soil erosion with low crop productivity. The information on detailed characterization of soils, soil fertility, particularly, in soils of Ghatpipariya village of Seoni district of Madhya Pradesh. The information will be of immense use for maintain the soil health for sustained agricultural production. Therefore, the present investigation has been planned to characterize and fertility of soils of Ghatpipariya village in Seoni district of Madhya Pradesh for sustained agricultural production.

2. Materials and Methods

The Ghatpipariya villages on basaltic terrain, lies between 22° 32' 47" to 22° 34' 22" N latitudes and 79° 44' 51" to 79° 46' 49"E longitudes in Dhanora block, Seoni district, Madhya Pradesh and covers an area about 480 ha. The villages are was separated into five major Landform units *viz.* plateau (P), Alluvial Plain (A), escarpments (E), isolated mounds (M) and pediments (D). The particular area varies from 503 to 564 m above from MSL (mean sea level) accompanying with very gently sloping (1-3%) to strongly sloping (15-25%) lands.

The area under the study has a very typical sub-tropical climate with an average rai fall of 1100 mm with dominant in ustic soil moisture regime and hyperthermic soil temperature regime. The vegetation in this area includes evergreen as well as deciduous plant species including khair (Acacia catechu), babul (Acacia arabica), shivan (Gmelina arborea), behra (Terminalia bellirica), tendu (Diospyros melanoxylon), palas (Butea monosperma), neem (Azardirachta indica) and teak (Tectona grandis), etc.While the herbaceous crops include kural (Heteropogon contortus), kundu (Schema pilosum), and dub (Impara cuplinatrica). The kharif crop was dominant in this observed are including the commercial crops of pigeon pea (Cajanus cajan), ground nut (Arachis hypogea L), maize (Zea mays) cotton (Gossypium spp.), and soybean (Glycine max), similarly the main rabi crops were chickpea (Cicer arentium) and wheat (Triticum spp.). Mango (**Mangifera indica)** and Guava (Psidium guajava) were the foremost fruit crop in the Villages level.

A total of Five Profile samples were collected covering the area of 480 ha the soil samples were further processed for physic-chemical observation. To determine organic carbon, the soil sample was sieved through a hundred mesh sieve (0.5 mm) (Walkley and Black, 1934).. Soil pH was measured with a 1:25 soil water ratio. Soil available nitrogen (KMnO4-N), phosphorus (Olsen-P), and potassium (NH4OAc-K) were assessed as per the methodology given by Subiah and Asija , Olsen et al. (1954) and 1 N ammonium acetate, respectively. To determine CEC for calcareous soil and Non-calcareous soil, 1N sodium acetate (pH 8.2) and 1N sodium acetate (pH 7.0) were used, respectively, by saturating the soil overnight. While Available micronutrient cations (Fe, Mn, Cu, and Zn) were extracted by DTPA-CaCl2 extractant at pH 7.3. (Lindsay and Norvell 1978).

3. Results and Discussion

3.1. Chemical properties of study area

The data pertaining Table 1.indicate that the soils of the Villages are neutral to moderately alkaline with pH values ranging from 6.5 to 7.9 Based on pH values, the soils of the area have been grouped as neutral. (Ghatpipariya -2, Ghatpipariya -3), slightly alkaline and (Ghatpipariya -1 Ghatpipariya - 4 and Ghatpipariya -5), moderately alkaline. Higher pH value in soils may be due to basalt as parent material, which is alkaline in nature (Chinchmalatpure *et al.* 2000) 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 0.07 to 0.26dSm^{-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 0.17 to 1.92 per cent in different horizons. Soils of Ghatpipariya -2 have higher organic carbon content, whereas, soils of Ghatpipariya -4 and Ghatpipariya -5 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) Nayak *et al.* (2001) Rao *et al.* (2008) whereas the Calcium carbonate in the soils varied from

1.45 to 5.3 per cent (Table 1). The distribution of calcium carbonate in soil profile invariably shows an increasing pattern with increasing soil depth, which indicates the process of leaching down of calcium and subsequent precipitation at lower depth due to high pH level. The results are in a present with that Pal *et al*. (1999) and Challa *et al.* (2000).

While The dominance of calcium and magnesium content on the exchange complex was observed in the soils of the village. The exchangeable cations were found in the order Ca^{2+}>Mg^{2+}>Na^{+}>K^{+} indicating the presence of calcium bearing minerals in parent rocks. Similar results were reported by Sarkar *et al*. (2001) and Maji *et al*. (2005).

The exchangeable calcium content of the soils ranges from 20 to 34.5 cmol(p^+)kg^{-1}.The exchangeable calcium content was higher in soils of Ghatpipariya -4 and Ghatpipariya -5. Exchangeable magnesium content of the surface soils ranges from 16.8 to 21.5 cmol (p^+)kg^{-1}. Exchangeable sodium ranges from 0.57 to 0.58 cmol(p)kg^{-1} Exchangeable potassium ranges from 0.15 to 0.21 cmol (p^+)kg^{-1}. Accordingly Cation exchange capacity of soils range from 39.1 to 62.6 cmol(p^+)kg^{-1}. Higher CEC was observed in soils of Ghatpipariya -4 and Ghatpipariya -5 compared to Ghatpipariya -1, Ghatpipariya -2 and Ghatpipariya -3. Pal and Deshpande (1987) stated that higher CEC values in black soils were due to smectite type of clay mineralogy.

3.2. Nutrient Status and Soil fertility

3.3. Available Macronutrient

Soil fertility status exhibit the status of different soil with regard to amount of nutrient essential for plant growth. The data pertaining Table 1. The available soil nitrogen content of the surface soils ranges from 107 to 390 kg ha^{-1} and and found low in soils of Ghatpipariya -1, Ghatpipariya -2 and Ghatpipariya -3 and medium in soils of Ghatpipariya -4 and Ghatpipariya -5. The available nitrogen was higher in surface soils as compared to subsoil layers. This might be due to the higher content of organic carbon in surface soils. Similar results were reported by Sharma and Bali (2000) and Todmal et al., (2008).

The available phosphorus content of the surface soils varied from 7.9 to 34.3 kg ha^{-1}. indicate that soils of Ghatpipariya -1 is low, moderately high in soils of Ghatpipariya -2 and Ghatpipariya -5 and high in soils of Ghatpipariya -3 and Ghatpipariya -4. The phosphorus content is seen to be increasing with reduction in slope and elevation. Higher phosphorus content in soils of pediment and valley may be attributed to higher clay content in these soils and the declined trend of phosphorus with depth may due to higher fixation of available P by clay. Similar findings were reported by Todmal et al.(2008).

The available potassium content of the surface soils varied from 342.4 492.8 kg ha^{-1}. The soils of soils of Ghatpipariya -1, Ghatpipariya -2, Ghatpipariya -3, Ghatpipariya -4 and Ghatpipariya -5 are very 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).

3.4.Available Micronutrient

The data pertaining Table 1. The DTPA extractable Fe ranges from 11.1 to 33.6 mg kg^{-1} and found to be much higher than the critical level of 4.5 mg kg^{-1} (Lindsey and Norvell, 1978) 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) and Abrahim *et al.* (2011).The DTPA extractable Mn content varies from 10.1 to 43.1 mg kg^{-1} and found to be much higher than the critical level of 3.0 mg kg^{-1} (Takkar *et al.* 1989 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) Cu content of the soils varies from 2.3 to 6.4 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). Zn content of the soils varies from 0.15 to 0.59 mg kg^{-1}. The soils of Ghatpipariya -1, Ghatpipariya -2, Ghatpipariya -3, Ghatpipariya -4 and Ghatpipariya -5 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) 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).

4. Conclusion

In the current study, the soil test report values are used to classify several significant soil features like village wise soil fertility indices of available Nitrogen (N), Available Phosphorus (P), Available Potassium (K), Organic Carbon (OC) along with Micronutrient like Fe, Mn, Zn, Cu as well as the parameter Soil Reaction (pH), CEC and CaCO3. The classification and prediction of the village wise soil parameters aids in reducing wasteful expenditure on fertilizer inputs, increase profitability, save the time of chemical soil analysis experts, improves soil health and environmental quality.

Table 1 : Soil Chemical properties and available Macro and Micronutrient status of the study area.

Hori-zon	**Depth**	**pH**	**EC**	**O.C**	**$CaCO_3$**	**Exchangeable cations**				**Sum of cations**	**CEC**	**Available nutrients**						
						Ca^{++}	**Mg^{++}**	**Na^{+}**	**K^{+}**			**N**	**P**	**K**	**Fe**	**Mn**	**Cu**	**Zn**
	(cm)	**(1:2.5)**	**($dS\ m^{-1}$)**	**(%)**	**(%)**	**[cmol (p+) kg^{-1}]**						**($kg\ ha^{-1}$)**			**($mg\ kg^{-1}$)**			
Ghatpipariya - 1 Clayey, smectitic, hyperthermic Lithic Ustorthents																		
Ap	0-15	7.4	0.17	1.90	2.1	20.0	12.5	0.13	0.02	32.7	39.1	183	7.9	492.8	22.2	27.0	5.4	0.58
Ghatpipariya - 2 Fine, smectitic, hyperthermic Typic Haplustepts																		
A	0-17	6.5	0.08	1.92	2.2	25.4	21.0	0.20	0.01	46.6	49.5	156	26.8	342.4	28.6	43.1	6.4	0.54
Bw1	17-34	6.5	0.08	1.48	4.7	23.2	20.0	0.17	0.02	44.4	47.6	132	16.1	291.6	27.4	32.5	5.1	0.44
Bw2	34-51	6.7	0.07	1.42	5.3	21.7	18.3	0.14	0.02	40.2	45.1	107	11.3	223.4	23.8	27.5	3.2	0.27
Ghatpipariya - 3 Clayey, smectitic, hyperthermic Lithic Ustorthents																		

Ap	0-10	6.9	0.09	0.93	4.1	20.1	15.2	0.16	0.04	35.5	39.1	151	30.0	369.6	33.6	37.6	3.5	0.43
Ghatpipariya - 4 Fine, smectitic, hyperthermic (calcareous) Typic Haplusterts																		
Ap	0-18	7.6	0.20	0.64	2.2	25.1	16.8	0.57	0.15	42.6	45.2	390	34.3	368.8	19.4	31.1	4.5	0.39
Bw	18-38	7.7	0.17	0.61	2.8	31.1	19.7	0.46	0.18	51.4	53.4	350	26.4	346.4	18.7	28.5	4.2	0.31
Bss1	38-55	7.9	0.26	0.59	3.3	29.9	18.1	0.35	0.19	48.5	50.3	315	22.7	276.4	16.6	24.2	3.0	0.27
Bss2	55-75	7.3	0.23	0.47	5.2	30.2	18.8	0.39	0.16	49.6	51.4	270	17.7	223.1	15.4	21.5	2.7	0.21
Bss3	75-101	7.7	0.19	0.26	6.5	27.5	16.3	0.45	0.14	44.4	47.7	125	10.5	196.5	13.2	19.8	2.4	0.15
Ghatpipariya - 5 Very-fine, smectitic, hyperthermic (calcareous) Typic Haplusterts																		
Ap	0-18	6.5	0.10	0.72	1.45	31.5	21.5	0.58	0.21	53.8	57.4	384	23.3	362.8	29.7	34.1	4.7	0.59
Bw	18-42	7.8	0.07	0.62	2.20	34.5	22.3	0.47	0.15	57.4	62.6	362	21.5	340.6	25.9	29.5	4.3	0.52
Bss1	42-76	6.7	0.07	0.47	2.69	33.3	21.5	0.37	0.22	55.4	61.7	333	16.8	295.7	21.4	27.2	3.6	0.40
Bss2	76-102	7.5	0.14	0.32	3.48	32.6	22.7	0.32	0.25	55.9	59.3	274	14.8	272.9	18.5	19.8	3.1	0.31
Bss3	102-132	7.6	0.20	0.30	3.65	34.4	19.6	0.34	0.26	54.6	61.7	218	11.8	220.5	14.6	12.8	2.8	0.27
Bss4	132-150	7.6	0.08	0.17	4.25	27.5	15.4	0.38	0.26	43.5	48.8	125	8.2	152.7	11.1	10.1	2.3	0.18

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