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Vertical Distribution of Macro Nutrients and Micronutrients of Ridhora Watershed in Nagpur district, Maharashtra, India

***Ommala D. Kuchanwar*[1]*, V.V. Gabhane*[1] *and Sagar N. Ingle*[2*]**
[1]*Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, (Maharashtra), India.*
[2]*School of Agricultural Sciences G.H. Raisoni University Saikheda, (Madhya Pradesh), India.*

(Corresponding author: Sagar N. Ingle)*
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ABSTRACT: Soil fertility is one of the important factors controlling yields of the crops. 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 agriculture production. 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. The existing have a look at undertaken to evaluate the nutrient fame of soils of Ridhora watershed in Nagpur district, Maharashtra during the year 2010-11. The nutrient status in soil profile of Ridhora watershed area. Based totally of fertility ratings, pH of soils turned into neutral to alkaline. Electric conductivity became ordinary (<1.0 dS/m). Soil organic carbon was low to high, with extra than 70% of examine area falling in the medium to high class. Whereas the soil were low to high 126.38 to 367.78 kg ha^{-1}) available N, medium to very high in available P(10.56 to 33.74 kg ha^{-1}), medium to very high in available K (159.20 to 634.40 kg). The DTPA extractant of available micronutrient Fe, Mn, Cu and Zn, ranges from 2.08 to 17.92 mgkg^{-1}, 7.57 to 13.69 mgkg^{-1}, 0.34 to 3.59 mgkg^{-1} and 0.14 to 0.83 mgkg^{-1} soils, respectively. Available micronutrient had been deficient to enough in to be had Fe and Zn whereas enough in to be had Cu and Mn, in floor and subsurface layer of soil profile. In widespread decreasing trend of those macro and micronutrient content material down the profile changed into determined in all soils.

Keywords: Available (N, P, K,) and micronutrient Fe micronutrient Fe, Mn, Cu and Zn, Mn, Cu and Zn.

INTRODUCTION

Soil properties change in time and space continuously (Rogerio *et al.*, 2006). According to (Du Feng *et al.* 2008), heterogeneity can occur at large scale (region) or at small scale (community), even in the same type of soil or in the same community. Indian agriculture is predominantly rainfall dependent and rainfed farming contributes 45% to the total food grain production. Among the total cultivated area of 141 million hectare (M ha), 61% (86 M ha) is under rainfed farming (Srinivasarao *et al.*, 2015; Vasu *et al.*, 2016; Ingle *et al.*, 2019) while agriculture is the mainstay of the majority of the population and major driver of the national economy.

Agricultural production rely heavily on natural resources for centuries (Ingle *et al.*, 2018, 2019) However, population growth and other factors are depleting the country's natural resources and thus pose a serious threat to sustainable agriculture and food security (Medhe *et al.*, 2012). Continuous planting and inappropriate conversion of nutrients released from harvested material or losses due to erosion and immersion have been major causes of reduced soil fertility. Soil fertility varies during the growing season from year to year due to changes in the amount and availability of mineral nutrients through the application of fertilizers, manure, compost, and lime in addition to immersion (Singh and Misra, 2012; Ingle *et al.*, 2019; Kuchanwar *et al*., 2021). Intensively cultivated soils are being depleted with available nutrients especially secondary and micronutrients. In both agriculturally advanced irrigated ecosystems and less-endowed rainfed regions, nutrient replenishment through fertilizers and manures remain far below crop removal, thus causing the mining of nutrient reserves over years.

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. 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 highly 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; Ingle *et al.,* 2019 and Kuchanwar *et al.,* 2021). 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 topography greatly influence the availability and distribution of plant nutrients, both in surface as well as subsurface soils (Dorji *et al*., 2014).

Soil tests are commonly used to assess the sufficiency or deficiency of essential plant nutrients. Although soil tests provide information about a soil's ability to supply plant available nutrients, it is an indirect measurement Therefore, this study was initiated with the objectives of identifying nutrient limitations through soil analysis and wheat nutrient status. The results of the study serve in making suggestions on improving fertilization and soil management to achieve sustainable crop production on Vertisols (Ramamurthy *et al.,* 2009; Ingle *et al.,* 2019; Kuchanwar *et al.,* 2021).

MATERIALS AND METHOD

The Ridhora watershed in Nagpur district of Maharashtra located among 21°10′ to 21°14′N Lattitude and 78033′ to 78°38′E longitude. The whole vicinity is 2482.59 ha.. The examine region is covered by using the Survey of India Toposheet No.55K/12. Geologically the location mainly occupied by means of the Deccan basalts accompanied with the aid of limestone, clay, sandstone and conglomerate of cretaceous duration. The watershed vicinity changed into divided into six predominant landform gadgets, viz., top pediment, plateau, lower valley, top valley, remoted mound, and escarpment. The imply elevation of vicinity varies from 420 to 540 m above suggest sea degree (MSL) associated with gently sloping (3-8%) to fairly steeply sloping (15-30%) slope. The climate of the vicinity is subtropical; dry sub-humid with ustic soil moisture regime and hyperthemic soil temperature regime. The average rainfall is 1051.5mm that is received usually from south-west monsoon. The herbal plants accommodates dry deciduous combined bushes, and grasses. The bushes are teak (*Tectona grandis*), khair (*Acacia catechu*), neem (*Azardirachta indica*), tendu (*Diospyros melanoxylon*), behra (*Terminalia bellirica*), babul (*Acacia arabica*), shivan (*Gmelina arborea*), palas (*Butea monosperma*), and many others and the grasses are dub (Impara cuplinatrica), kural (*Heteropogon contortus*), kundu (*Schema pilosum*) and many others. A huge percentage of cultivated land is mainly beneath kharif plants such as cotton (*Gossypium* spp.), soybean (*Glycine max*), pigeon pea (*Cajanus cajan*), ground nut (*Arachis hypogea* L.), and maize (*Zea mays*) even as the main rabi crops are wheat (*Triticum* spp.), chickpea (*Cicer arentium*), vegetables and Mandarin (*Citrus reticulate*) is the main fruit crop in the watershed.

The place of 2482.59 ha Horizon clever samples have been amassed. The samples had been 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 turned into measured with 1:2 soil water ratio. Soil to be had nitrogen (N) was estimated by way of the technique of Subbiah and Asija (1956); to be had phosphorus (P) with the aid of Olsen *et al.* (1954) for neutral and alkaline soils (pH > 6.5) Soil available potassium changed into extracted by way of 1 N ammonium acetate (pH 7.0). The CEC of calcareous soil turned into determined by using in a single day saturating the soils with 1N sodium acetate (pH 8.2), while, for non-calcareous soil 1N sodium acetate (pH 7.0). Available micronutrient cations (Fe, Mn, Cu and Zn) have been extracted through DTPA-$CaCl_2$ extractant at (pH 7.3) (Lindsay and Norvell 1978).

RESULTS AND DISCUSSION

A. Physico-chemical properties of study area

Data relating to Table 1 shows that the surface area of water is neutral to alkaline with pH values ranging from 7.10 to 8.43. Based on pH values, local soil is collected as neutral (Kokarda-1, Kokarda-2, Mendhepather, Ridhora-1, Ridhora-2, Kacharisawanga-2, Subkund-1 and Bariwari-1), moderately neutral and (Kacharisawanga-1, Kacharisawanga-3, Bhiwari-2 and Subkund- 2), strong alkaline. The high pH value in the soil may be due to the accumulation of calcium carbonate and dissolved salts being washed down from the surface and basalt as the parent material, which is naturally alkaline (Chinchmalatpure *et al*., 2000), a similar effect was reported by Bante *et al.,* (2012).

higher pH in soil lower elevation may be due to more accumulation of bases removed from upper elevation. The relative value of pH of this soil might be due to high degree of base saturation (Mali and Raut 2001; Ingle *et al*., 2018, 2019; Kuchanwar *et al*., 2021).

The EC of soils is usually low and ranges from 0.13 to $0.43 dSm^{-1}$ which might be in acceptable limit and the soils have no salinity hazard at present. The low EC cost have been located on this soil can be because of leaching of salt from the surface layer of soil.

Organic carbon content in soils ranged from 2.99 to 13.81 gkg^{-1} in extraordinary horizons. Soils of Kokarda-1, Kokarda-2, Mendhepather, Ridhora-1, Ridhora-2, Kacharisawanga-3 and Bhiwari-1 have better natural carbon content material, whereas, soils of Kacharisawanga-1, Kacharisawanga-2, Subkund-1 Subkund-2 and Bhiwari-2 have decreased natural 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 various authors (Sarkar *et al.*, 2001; Nayak *et al.* 2001; Rao *et al.* 2008; Ingle *et al.*, 2018, 2019; Kuchanwar *et al.*, 2021).

Calcium carbonate in the soils varied from 0 to 20.17 per cent (Table 1). Data reveal that calcium carbonate is absent in soils *i.e.* (Kokarda-1, Kokarda-2, Mendhepather, Ridhora-1, Subkund-1 and Bhiwari-1 whereas it was high in the soils of valleys. (Kacharisawanga-2, Ridhora-2, Subkund-2 and Bhiwari-2) this could be because of the leaching of calcium salts from upslope and its deposition down the slope. The high amounts of calcium might react with CO_2 and H_2O under high temperature conditions to form $CaHCO_3$, which on dessication may result in precipitation of $CaCO_3$. The distribution of calcium carbonate in soil profiles invariably shows an increasing pattern with increase in soil depth, which indicates the process of leaching down of calcium and subsequent precipitation at lower depth due to high pH level. Similar results were observed by Buddy *et al.* 1999; Challa *et al.* 2000; Ingle *et al.*, 2019; Kuchanwar *et al.*, 2021. In surface soils the calcium carbonate was found in powdered form while in lower layers it was in the form of nodules plus powder. In floor soils the calcium carbonate was observed in powdered shape whilst in lower layers it turned into in the shape of nodules plus powder.

Table 1: Chemical properties of soils.

Horizon	Depth (cm)	pH (1:2.5)	Organic carbon (g kg^{-1})	Cation Exchange Capacity (CEC)	Calcium carbonate $CaCO_3$ (%)
Kokarda-1	***Fine loamy mixed, hyperthermic Typic Ustorthents***				
Ap	0 -20	7.22	9.44	24.94	0.00
Kacharisawanga-1	***Very fine clayey, smectitic, hyperthermic Typic Ustorthents***				
Ap	0 - 23	8.27	6.54	66.25	5.05
Kokarda-2	***Fine clayey,smectitic, hyperthermic Typic Ustorthents***				
A	0 - 10	7.32	13.81	35.69	0.00
Mendhe pathar	***Fine loamy mixed, hyperthermic Typic Ustorthents***				
A	0 - 10	7.42	7.14	25.83	0.00
Ridhora-1	***Fine loamy mixed, hyperthermic Typic Ustorthents***				
A	0 - 8	7.10	9.81	27.09	0.00
Subkund-1	***Fine loamy mixed, hyperthermic Typic Uatorthents***				
A	0 - 12	7.34	2.99	40.00	4.94
Kacharisawanga-2	***Fine loamy mixed, hyperthermic (calcareous) Typic Ustorthents***				
Ap	0 - 12	7.37	4.58	38.15	2.88
Bw1	12 - 30	7.51	3.36	36.65	3.79
Bhiwari-1	***Fine loamy mixed, hyperthermic Typic Ustorthents***				
Ap	0 - 13	7.36	9.34	28.73	0.00
Bw1	13 - 30	7.50	8.09	31.42	0.00
Kacharisawanga-3	***Very fine clayey, smectitic, hyperthermic (calcareous) Vertic Haplustepts***				
Ap	0 - 18	7.29	8.39	47.31	8.63
Bw1	18 - 23	8.07	8.16	47.62	11.57
Bw2	53 - 79	8.36	6.24	47.75	13.19
Bw3	79 - 120	8.29	4.80	49.46	25.78
Bhiwari-2	***Very fine clayey, smectitic, hyperthermic(calcareous) Typic Haplustepts***				
Ap	0 -13	7.73	5.84	60.05	3.06
Bw1	13 -42	8.18	5.11	60.37	4.73
Bw2	42 -75	8.43	4.65	60.33	6.25
Ridhora-2	***Very fine clayey, smectitic, hyperthermic(calcareous) Typic Haplusterts***				
Ap	0 -27	7.38	7.50	61.88	5.60
Bw1k	27 -50	7.55	7.13	61.01	10.84
Bss1	50 - 67	7.45	6.57	61.50	7.41
Bss2	67 -94	7.60	6.20	64.13	7.04
Bw2	94 -130	7.90	5.57	60.58	6.68
Subkund-2	***Very fine clayey, smectitic, hyperthermic (calcareous) Typic Haplustepts***				
Ap	0-17	8.03	7.54	61.23	8.31
Aw1	17- 38	8.18	5.05	62.61	9.58
Aw2k	38 -75	8.28	4.80	61.29	20.17

B. Nutrient Status and Soil fertility

(i) Available macronutrient. Soil fertility indicates the different soil conditions in terms of the number of nutrients that are important for plant growth. The available Soil nitrogen found in the surface soils ranges from 126.38 to 367.78 kg ha^{-1} and is found below the soil of Bhiwari-2. The N condition found is found to be low in root depth (up to 45 cm) in all probability due to the rapid decomposition of inanimate matter and the low nitrogen content it provides to the soil at that time. The N content available was very high on the horizon and was found to decrease with increasing depth which may be due to the blockage of plant residues and debris and the plant rhizosphere with reduced carbon content in depth. Similar results were reported by Sharma and Bali 2000; Todmal *et al.*, 2008; Verma *et al.*, 2013; Ingle *et al.*, 2018, 2019.

The available phosphorus content of the surface soils numerous from 10.56 to 33.74 kg ha^{-1}. The soils of Subkund-1 and Subkund-2 are excessive, while, soils of Kokarda-1, Kokarda-2, Mendhepather, Ridhora-1, Ridhora-2, Kacharisawanga-1, Kacharisawanga-2, Kacharisawanga-three Bhiwari-1 and Bhiwari-2 are reasonably medium in to be had P. The declined fashion of phosphorus with depth may additionally due to better fixation of to be had P by way of clay. The motives for highest p determined in surface soil because of confinement of crop cultivation to the rhizospere and supplementing of depleted phosphorous via outside assets *i.e*. fertilizer. Similar findings have been stated by Todmal *et al.* 2008; Gajare *et al*., 2014; Verma *et al*., 2013; Ingle *et al.*, 2018.

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The available potassium content material of the floor soils various from 159.20 to 634.40 kg ha^{-1}. The soils of Kokarda-1, Kokarda-2, Mendhepather, Ridhora-1, Ridhora-2, Kacharisawanga-1, Kacharisawanga-2, Kacharisawanga-3 Bhiwari-1 and Subkund-2 are very high and soils of Bhiwari-2 and Subkund-1 are medium to fairly high in available K. The potassium content also increased with the clay content material. This may be attributed to the k-wealthy minerals taking place in the soil (Buddy, 1985) and the relative immobility of this detail attributable to fixation by using 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; Patil *et al.*, 2008; Ingle *et al.*, 2018, 2019; Kuchanwar *et al.*, 2021).

Table 2: Fertility Properties of soil.

Horizon	Depth (cm)	N	P	K	Cu	Fe	Zn	Mn
		(Kg ha^{-1})			(mg kg^{-1})			
Kokarda-1 Series: ***(Very gently sloping plateau): Fine loamy mixed, hyperthermic Typic Ustorthents***								
Ap	0-20	328.58	16.53	470.40	2.35	9.82	0.51	12.83
Kacharisawanga-1 Series ***(Very gently sloping plateau) Very fine clayey, smectitic, hyperthermic Typic Ustorthents***								
Ap	0-23	190.98	12.86	365.60	1.59	5.07	0.27	9.57
Kokarda-2 Series: ***((Moderately steeply sloping escarpment) Fine clayey, smectitic, hyperthermic Typic Ustorthents***								
A	0-10	287.98	12.86	376.80	1.62	8.78	0.65	8.16
Mendhe pathar Series : ***(Steeply sloping escarpment) Fine loamy mixed, hyperthermic Typic Ustorthents***								
A	0-10	267.78	20.80	421.60	2.54	9.81	0.42	9.56
Ridhora-1 Series ***(Moderately steeply sloping pediment) Fine loamy mixed, hyperthermic Typic Ustorthents***								
A	0-8	210.07	22.17	287.20	1.36	17.92	0.79	13.97
Subkund-1 Series: ***Moderately steeply sloping pediment) Fine loamy mixed, hyperthermic Typic Ustorthents***								
A	0-12	367.78	33.74	208.00	0.68	10.78	0.43	13.69
Kacharisawanga-2 Series ***(Gently sloping isolated mound) Fine loamy mixed, hyperthermic (calcareous) Typic Ustorthents***								
Ap	0 - 12	269.38	23.06	290.40	1.64	5.99	0.31	9.86
Bw1	12 - 30	242.10	19.29	279.20	2.00	5.68	0.45	9.67
Bhiwari-1 Series: ***(Gently sloping isolated mound) Fine loamy mixed, hyperthermic Typic Ustorthents***								
Ap	0 - 13	285.38	14.24	310.40	2.48	11.36	0.34	12.61
Bw1	13 - 30	231.64	11.02	335.20	2.37	7.98	0.21	11.37
Kacharisawanga-3 Series: ***(Very gently sloping upper valley) Very fine clayey, smectitic, hyperthermic (calcareous) Vertic Haplustepts***								
Ap	0 - 18	234.47	24.01	300.80	2.26	5.86	0.31	8.76
Bw1	18 - 23	220.53	23.88	298.00	2.70	5.09	0.30	8.36
Bw2	53 - 79	183.10	21.12	283.20	2.25	4.13	0.26	7.95
Bw3	79 - 120	150.53	20.90	260.00	1.29	2.93	0.21	7.78
Bhiwari-2 Series: ***(Very gently sloping upper valley) Very fine clayey, smectitic, hyperthermic (calcareous) Typic Haplustepts***								
Ap	0 -13	167.78	27.55	201.60	3.59	12.88	0.83	8.48
Bw1	13 -42	156.13	23.42	187.20	2.06	3.16	0.23	7.90
Bw2	42 -75	126.38	12.40	159.20	1.91	3.13	0.21	7.57
Ridhora-2 Series: ***(Very gently sloping lower valley) Very fine clayey, smectitic, hyperthermic (calcareous) Typic Haplusterts***								
Ap	0 -27	283.03	14.24	634.40	0.89	4.37	0.43	11.11
Bw1k	27 -50	219.32	14.24	620.80	0.86	4.16	0.22	10.36
Bss1	50 - 67	205.68	12.24	612.00	0.79	3.87	0.14	9.12
Bss2	67 -94	201.92	11.48	593.60	0.60	3.45	0.15	9.48
Bw2	94 -130	203.40	10.56	582.40	0.34	2.90	0.14	9.23
Subkund-2 Series: ***(Very gently sloping lower valley) Very fine clayey, smectitic, hyperthermic (calcareous) Typic Haplustepts***								
Ap	0-17	242.10	30.87	455.20	0.70	4.82	0.25	8.36
Aw1	17- 38	233.08	19.75	436.80	0.67	2.85	0.19	8.32
Aw2k	38 -75	205.68	18.37	392.90	0.68	2.08	0.14	7.88

(ii) Available Micronutrient. The DTPA extractable Fe levels from 2.08 to 17.92 mg kg^{-1} and the soils of Kacharisawanga-3, Ridhora-2 and Subkund-2 found to be deficient in opposition to the critical level 4.5 while Kokarda-1, Kokarda-2, Mendhepather, Ridhora-1, Kacharisawanga-1, Kacharisawanga-2, Kacharisawanga-3 Bhiwari-1 found to be much higher than the critical level of 4.5 mg kg^{-1}. The DTPA extractable Mn content varies from 7.57 to 13.69 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 material of the soils varies from 0.34 to 3.59 mg kg^{-1} and decreased with depth. The Cu content is higher than the important fee of 0.2 mg kg^{-1} (Katyal and Randhawa, 1983) in all of the soils. The copper content could be attributed to difference geology, physiography and degree of weathering in these soil similar result had been discovered in (Kirmani *et al*., 2011, Ingle *et al.*, 2019; Kuchanwar *et al.*, 2021). Zn content of the soils varies from 0.14 to 0.83 mg kg^{-1}. The soils of Kokarda-1, Kokarda-2, Mendhepather, Ridhora-1, Ridhora-2, Kacharisawanga-1, Kacharisawanga-2, Kacharisawanga-3 Bhiwari-1 and Subkund-2 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, Ingle *et al*., 2018, 2019; Kuchanwar *et al*., 2021).

FUTURE SCOPE

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 $CaCO_3$. 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.

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Conflict of Interest. None.

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