A review article: Status of micronutrients distribution in mix red and black soil of Rewa district of Madhya Pradesh, India

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Abstract

This paper aim was to review on the title “Status of Micronutrients in Mix red and Black Soil of Rewa District of Madhya Pradesh, India”. The work summarized that Delineation work was undertaken to evaluate the status of available micronutrients in mixed red and black soils of Rewa district, Madhya Pradesh. For this, 204 surface soil samples (0-15 cm) were collected from Rewa district using GPS. The Rewa district is spread between Longitudes -242159.9N to 244840.9N and Latitude- 810921.8E to 820202.2 E. The pH of the soil varied from 5.5 to 8.1 in Rewa district. Thus, the soil samples of Rewa district were found to be slightly acidic to alkaline in reaction. Electrical conductivity of the soil varied from 0.10 to 0.88 dSm⁻¹ in Rewa district. Soils were found to be low in soluble salts. Organic carbon content in soils was found to vary from 2.10 to 11.0 gkg⁻¹ in Rewa district. On an average the soils were medium in respect of organic carbon content, similarly, the average content of CaCO₃ was found to be 2.83 in Rewa district, indicating non-calcareous soils. In the entire Rewa district, the average Zn, Cu, Fe, Mn, and B contents were observed as 0.69, 1.17, 20.87, 14.41, and 1.34 mg kg⁻¹, respectively. None of the soil samples were classified as deficient in available Cu, Mn and B content in Rewa districts whereas, available Zn, and Fe deficiency in soil were observed in 55.88% and 2.0 % Samples in Rewa district.

Keywords: Micronutrients, zinc, iron, boron, copper

Introduction

Out of seventeen essential plant nutrients required for plant growth, seven are required in much smaller quantities hence they are termed as micronutrients, these are manganese, copper, zinc, molybdenum, boron, iron and chlorine. The micronutrients are equally essential for the growth, development and reproduction of plant as major nutrients. Requirement of micronutrient by various crops increased with the adoption of high yielding varieties and intensive cropping together with a shift towards high analysis NPK fertilizers, which caused the decrease in level of micronutrient in soil. Deficiency of micronutrient may be due to low total content of elements caused by soil factors reducing their availability to plants. Zinc is involved in the biosynthesis of a plant hormones like indol acetic acid which is a component of variety of enzymes such as carbonate anhydrase, dehydrogenase etc. Zinc play a role in nucleic acid and protein synthesis and helps in the utilization of phosphorus and nitrogen as well as in seed formation. The semi-permeability of the membrane is also maintained by zinc.

Copper is a constituent of cytochrome oxidase besides being a component of many enzymes such as ascorbic acid oxidase, phenolase lactase, etc. Copper also promotes formation of vitamin A in plants. It participates in lignin formation, protein and carbohydrate metabolism and is possibly required for symbiotic nitrogen fixation.

Iron has been regarded as necessary element for the syntheses and maintenance of chlorophyll in plants. Iron is an essential component of many enzymes and carriers such as catalase. Peroxidase, cytochrome and ferredoxin and performs essential role in nucleic acid metabolism. Manganese is part of many enzymes such as pyroate, carboxylase and orginase which are associated with the metabolism of nitrogen and synthesis of chlorophyll. Manganese is involved in the plants respirotory process oxidation of carbohydrates to CO₂ and H₂O and also control the redox potential in plant cell during the phases of light and darkness. Boron is the only non-metallic element among the micronutrients. It is one of the most important essential micronutrient for plant growth. Boron changes the activity of catalase peroxidase invert age etc. as well as it form complexes with various polyhydroxy compound. It helps in lignin and
protein synthesis and affects the cell division. Boron also increases the permeability of cell membrane and transport of sugar is increased. The information on status of micronutrient in soils of rice based cropping sequence is scanty. Hence, this study has been under taken with the following objective.

1. To evaluate the available Zn, Cu, Fe and Mn status in mixed red and black soils of Rewa district of Madhya Pradesh.
2. To evaluate the Zn, Cu, Fe and Mn status in plant grown on mixed red and black soils of Rewa district of Madhya Pradesh.
3. To study the relationship between physicochemical properties of soil and the available micronutrients in soils.
4. Categorization of soils in low, medium and high categories of nutrients.

**Available Zn, Cu, Fe and Mn status in mixed red and black soils**

Soil available nutrients role in the growth, development and yield of plant and information on the nutritional status of an area can go a long way in planning judicious fertilizer and soil management practices to develop economically viable alternative for the farming community. Role of micronutrient in balanced plant nutrition is well established. However, exploitive nature of modern agriculture involving use of high analysis NPK fertilizer coupled with limited use of organic manures and less recycling of crop residues are important factor contributing towards accelerated exhaustive of micronutrient from soil.

Trace elements are found sparingly in most of the soils and their availability to plant is very low. Consequently, even though their removal by plants is a small quantity, the cumulative effect rapidly reduce the quantity of micronutrients, originally present in soils.

A number of factors can be affecting the availability of micronutrients to crops. The most important include the nature of parent rock, soil pH, the organic matter in the soil, drainage, interactions with other nutrients, calcium carbonate, plant part and stage of plant sampling.

**Distribution of available micronutrients in soils**

Kathaliya and Saxena (1993) reported that available zinc, iron, manganese and copper in these soils varied from 0.36 to 1.41, 2.4 to 11.0, 4.4 to 23.6 and 0.25 to 1.44 ppm, respectively, in soils of Jaipur district Rajasthan. Maji et al. (1993) studied the status of available micronutrients in coastal soil of Sunderban, West Bengal. Available Zn, Cu, Fe and Mn content ranged from the 0.3 to 13.0, 1.0 to 9.6, 2.6 to 30.0, 14.4 to 370.5 mg kg⁻¹. Lindsey and Norvell (1978) suggested the critical limits of DTPA – extractable Zn, Cu, Fe and Mn as 0.5 to 1.0, 0 - 20, 4.5 to 6.0, 1.0 mg kg⁻¹, respectively. The multiple regression studies revealed that 26, 10, 41 and 33 % variation in available Fe, Mn, Zn and Cu, respectively were accounted for the combined effect of pH, EC, and organic carbon content. Manchanda and Chhibba (1993) revealed that the DTPA- extractable zinc, copper, iron and manganese content of the soil varied widely with mean of 1.2, 2.5, 46 and 34 mg kg⁻¹. Based on the general critical values used for the soil of Punjab, 17 percent of the sample were deficient in available zinc, whereas, the content of Cu, Fe and Mn was high. Rice plant sample also showed wide variation in micronutrients status on the average the content of zinc, copper, iron and manganese in plants was 46, 45, 250, and 497 ug g⁻¹, respectively.

Sangwan and Singh (1993) studies on the vertical distribution of zinc, manganese copper and iron in relation to depth and important soil properties in ten representative soil profiles of southern semi-arid soils of Haryana. Multiple regression equation show that 4.0, 53, 52 and 20 % variation in available zinc, manganese, copper and iron respectively, were accounted for by the combined effect of all the soil properties. Singh et al. (1993) analyzed one hundred eight surface soil samples were collected from cultivators field in thirty village covering nine blocks of Ranchi districts. Soil were slightly acidic to neutral in reaction, low to medium in organic carbon and coarse textured. Total sulphur content in soil had a wide variation ranging from 212 to 1881 mg kg⁻¹, total sulphur had significantly positive correlation with organic carbon and clay.

Dhane and Shukla (1995) analyzed twenty five surface soil samples collected from benchmark and established soils series of Maharashtra. The DTPA- extractable zinc, copper, iron and manganese content in the soils ranged from 0.2 to 0.6, 0.9 to 2.1, 2.6 to 8.3 and 10.8 to 29.9 mg kg⁻¹, respectively. As compared to zinc (72%) and iron (52%), the deficiency of manganese (12%) was found to be limited. None of the soils of the study was found deficient in available copper. Sakal et al. (1995) studied that the seven hundred and fifty-six soil samples from plough layer (0-15 cm depth) were collected from sub- Himalayan hill and forest region of Bihar. The DTPA- extractable zinc, copper, iron and manganese in all these soil samples varied from 0.13 to 7.80, 0.21 to 5.88, 0.25 to 4.43 and 0.25 to 1.44 mg kg⁻¹, respectively. The overall deficiency was observed to be 42 %, 16 %, 12 %, 11 %, respectively. A number of factors were deficient in these soils. Shukla et al. (1995) studies the status of available micronutrient in soils of Malwa plateau (Rajasthan). Available Zn, Cu, Fe and Mn contents ranged from 0.62 to 3.58, 0.44 to 9.67, 5.58 to 25.92 and 7.55 to 44.96 mg kg⁻¹ with mean value 1.60, 4.09,15.12 and 21.81 mg kg⁻¹. Sharma et al. (1995) studied available boron in the surface and associate surface sample of combined districts in Madhya Pradesh. About 98.4 percent surface and 91 percent profile samples were moderate in available boron content up to 60 cm depth and there after increased.

Chhabra et al. (1996) reported that the all available micronutrients cations decrease with soil pH. The available copper content increase with clay content in tarai zone of goleksi inter bation of Hissar. In alluvial plains, available Zn and Fe decreased with soil pH. Available Cu increased with organic carbon content and available Fe decreased with sand content. Dhaker et al. (1996) reported that the amount of DTPA- Mn, Fe, Zn and Cu of the acid soils of rice growing area were sufficient to support plant growth. Only 17 % soils in available Zn and 35 % soils in available B were deficient. Kumar et al. (1996) revealed that the DTPA - extractable available Zn, Cu, Fe and Mn contents of Andhra Pradesh, soils varied from 0.83 to 2.89 mg kg⁻¹, 1.01 to 8.19 mg kg⁻¹, 9.0 to 59.9 mg kg⁻¹ and 15 to 86 mg kg⁻¹, respectively. Surface soils contained more available nutrients than sub surface soils. The available nutrient content in all profile decreased regularly with depth. All the soils were found to be adequate in available zinc, copper, iron manganese contents as the critical concentration 0.7, 0.2, 4.5 and 1.0 mg kg⁻¹, were, respectively.

Saha et al. (1996) studied on DTPA extractable available Fe, Cu, Mn and Zn in sixty three fish pond soils of Orissa and relation to soil characteristics were calculated. Singh and Hansraj (1996) analyzed two hundred and forty-five
surface soil samples representing cotton-wheat growing area of Sirsa and Hisar districts of Haryana. The DTPA-extractable available cations (Zn, Cu, Mn and Fe) ranged from trace to 1.5, 2.0 to 3.8, 1.7 to 14.0 and 1.3 to 41.70 mg kg⁻¹, respectively, 75% of the samples were deficient in zinc. All the sample have adequate quantity of available copper and manganese. About 53% and 30% of the variation in soil, was recorded and about 28% of the sample was deficient in available iron. Thakar (1996) [61] evaluated the DTPA - extractable zinc, copper, iron and manganese of the middle Narmda Valley of M.P. and reported that the amount of available copper, iron and manganese was sufficient in all soils whereas the available Zn status was in the deficient range. Khattak et al. (1997) [30] analyzed fifty eight soil samples from 29 different sites of districts Lashi Marwat (Pakistan) to determine boron level and physico-chemical properties. Hot water soluble boron ranged from 0.19 to 3.30 mgkg⁻¹. Boron was deficient in 49 percent and marginal in 9 percent soils samples. Boron showed positive correlation with calcium carbonate, organic carbon, electrical conductivity and silt. It was found negatively co-related with soil pH. Sen et al. (1997) [47] studied the status of micronutrient in some dominant soil of Manipur and reported that the available zinc, iron, manganese and copper contents of the soil ranged from 0.2 to 1.4 mg kg⁻¹, 45.4 to 261 mgkg⁻¹, 34.6 to 212.8 mg kg⁻¹ and 1.0 to 7.2 mg kg⁻¹, respectively. Saha et al. (1998) [41] analyzed one hundred - three surface (0-15 cm) soil samples collected from Sehore and Raisen districts, three hundred-fifty from Raipur district and three hundred twenty eight sample from Morena district of Madhya Pradesh. The available boron content in the Bhopal, Sehore and Raisen districts was 0.50 mg kg⁻¹, 0.41mg kg⁻¹ and 0.51 mg kg⁻¹, respectively and Raipur districts 0.35 mg kg⁻¹ and content of boron in alluvial soil of Morena districts were found 0.75 mg kg⁻¹. Sahoo et al. (1998) studied the distribution of available Zn, Cu, Fe and Mn in surface and sub-surface soils from sonder bans Islands. Available Zn, Cu, Fe and Mn content ranged from 1.36 to14.0 ppm, 16 to 82 ppm. 10.7 to 32.9 ppm and 1.5 to 25.7 ppm positively correlated with organic carbon and electrical conductivity. Available Zn was negatively correlated with calcium carbonate content while available Fe was negatively correlated with EC and organic carbon content of soils.

Parmar et al. (1999) [35] studies on the soils from vegetable growing potholes in cold desert area of the state showed that 38 to 42, 22 to 34, 42 to 65 percent sample were deficient in DTPA-extractable Fe, Mn, Zn, respectively. Simple correlation studies also indicated significant and negative correlation of Fe and Mn with soil pH and calcium carbonate, while significant and positively correlated with organic carbon. Siddhamali et al. (1999) [53] reported that the DTPA-extractable Zn, Cu, Fe and Mn contents ranged from 0.52 to 8.4, 0.40 to 8.48, 3.90 to 33.34 and 3.00 to 43.2 mg kg⁻¹. Based on the critical limits of the micronutrient for Tamil Nadu soil sulphur (1.20, 0.62, 2.0 and 3.7 mg kg⁻¹ for Zn, Cu, Fe and Mn) only two sample were deficient in Zn and Cu while Fe and Mn content were in sufficient range. Singh et al. (1999) [54] studied the status of micronutrient DTPA - extractable Zn, Mn, Cu and Fe in wetland rice soils and their availability to rice under submergence Maghahlaya. The DTPA – extractable Zn, Mn, Cu and Fe content in soils varied from 5.1 to 10.0, 0.36 to 0.92 1.10 to 1.80 and 105 to 325, mg kg⁻¹ with the mean content values of, 6.80, 0.60 and 1.30 mg kg⁻¹ and 195 mg kg⁻¹, respectively. The soils appeared to be sufficient in these micronutrient cations.

Nayak et al. (2000) [32] studied the status of available micronutrient in alluvial soils of Arunachal Pradesh. The available zinc, copper iron and manganese content of surface soils ranged from 0.2 to 1.12, 0.5 to 3.57, 7.0 to 73.6 and 2.70 to 53.8 mg kg⁻¹, respectively. Considering 0.5, 0.2, 4.5 and 2.0 mg kg⁻¹ as the threshold value of available Zn, Cu, Fe and Mn. All the soils are quite in Cu, Fe and Mn. Surface soils of most the profile are deficient or marginally adequate in available zinc. Samanta et al. (2002) [44] studied the status of total and available iron and zinc in soils of West Bengal under continuous cultivation of mulberry. Total Zn and Fe content in the soils varied from 8.0 to 136.0 ug g⁻¹ and 0.65 to 8.78 percent with a mean values of the 66.1 ug g⁻¹ and 4.97 %, respectively. Content of both the element were higher in soils of Darjiling district but lower in soil of Coocoheber and Birbhum. The available Fe and Zn in soils extracted by DTPA varied from 3.3 to 205.0 ug g⁻¹ and 0.2 to 5.2 ug⁻¹, respectively. Bansal et al. (2003) [5] collected surface soil samples numbering 200, 100 and 100 from Ludhiana, Jalander and Sangur districts of central plain region of Punjab. Samples were analyzed for boron and physical properties. The available boron content varied between 0.22 to 2.16, 0.28 to 1.85 and 0.32 to 2.00 mg kg⁻¹, respectively, considering soil containing available boron less than 0.5 and 5 to 1.0 mg kg⁻¹ soil as low and medium in boron supply respectively, 78 percent samples of Ludhiana districts were medium to adequate in available boron while 22 percent were low in available boron in 25 and 53 percent of investigated soil in the low and medium range, respectively and 22 percent samples had adequate boron status. Similarly, in Sangur district 96 percent of samples were medium to adequate in the available boron. Born deficiency increased with increase in fineness of soil texture, soil alkalinity and organic carbon. Sharma et al. (2003) [52] studied the status of micronutrients and effect of soils properties in some soil of semi-arid region of Rajasthan. Available Zn, Cu, Fe, Mn and B content ranged from 0.1 to 1.7, 0.5 to 3.9, 1.0 to 6.6, 2.7 to 7.2, and 0.2 to 2.0 mg kg⁻¹ with mean values of 0.73, 2.11, 4.32, 5.15 and 0.68 mg kg⁻¹, respectively. Silt plus clay, electrical conductivity, pH, organic carbon and calcium carbonate in soil ranged from 7.9 to 21.8 0 percent,11 to 0.52 dsm⁻¹, 8.0 to 9.3, 0.08 to 0.31 percent and 0.1 to 1.2 percent with the mean values of 12.9 %, 0.28 dsm⁻¹ 8.5, 0.2 and 0.5 percent respectively. Available Zn, Fe and B were deficient in 46%, 51.5% and 26.5 % soil samples respectively, while copper and manganese were adequate in all the soil samples. Multiple correlation analysis indicated that available Zn, Cu, Fe, Mn and B were significantly influenced by soil properties. Panwar and Totawat (2004) [34] reported that the DTPA-extractable zinc, copper, iron and manganese content in salt affected soils of sub humid southern plain of Rajasthan, ranged from 0.21 to 0.75, 0.27 to 1.04, 1.13 to 4.28 and 2.76 to 7.79 mg kg⁻¹, respectively. Dwivedi et al. (2005) [14] analyzed surface soil samples collected from five cultivated fields, each from 96 and 50 villages of Leh and Kargil districts of Ladakh region. The DTPA-exactable Zn, Cu,Fe and Mn were found to range from 0.54 to 33.79, 0.43 to 3.52, 0.06 to 16.3 and 0.20 to 32.17 mg kg⁻¹, respectively in soil of Leh districts, while the range of Zn, Cu,Fe and Mn was observed from 0.20 to 38.04, 0.50 to 3.41, 0.14 to 5.17 and 0.34 to 4.74 mg kg⁻¹, respectively in soils of Kargil district. Mehra et al. (2005) [26] studied of 1110 samples from Haplustalfs of sub humid plain and Aravalli of Rajasthan. 18.77 %, 40.63 %, 9.63 %, 2.41 % and 36.12% deficiency of Cu, Fe, Mn, Zn and S, respectively were observed. Critical
limits for DTPA Fe was found to be 4.69 mg kg\(^{-1}\) soil and for 45 days- old maize plant was 44.2 mg kg\(^{-1}\). The critical limits for DTPA- Zn were 0.95 mg kg\(^{-1}\) soil and 32.7 mg kg\(^{-1}\) in plant. Minakshi et al. (2005) [38] studied the Patiala district to assess the micronutrients status of the soils using Arc-info GIS. The 690 surface soil samples were analyzed for soil physio-chemical properties and DTPA - extractable micronutrients. About 11.0 percent of the districts was found deficient in zinc. Only 4 and 5 percent of the area were deficient in manganese and iron, respectively. While copper was in sufficient amount in nearly 95 percent area of the Patiala districts. Sarastwat et al. (2005) [40] reported that the micronutrient accumulation in TSW irrigated soils and vegetable crops. The TSW- irrigated vegetables contained relatively higher amounts of micronutrients than the non TSW –irrigated vegetables but were within the range of phytotoxic limits. Sharma and Chaudhary (2007) [51] studied the vertical distribution of available micronutrients and their relationship with soil properties in thereby two profiles of eight tentative soil series of Mandhala watershed. The content of available Zn Cu, Fe and Mn were higher in surface horizons and decreased with depth of the soil series. Available micronutrients were influenced by silt, clay and silt contributed significantly towards these micronutrients. Dhaliwal et al. (2008) [12] studied the profile distribution of chemical, physical and microbial characteristics in four land use system of Sadhikad watershed in sub monotonous tract of Punjab. The available zinc, copper iron and manganese content 1.14 mg kg\(^{-1}\), 0.48 mg kg\(^{-1}\), 0.930 mg kg\(^{-1}\) and 84.5 mg kg\(^{-1}\) at 0-16 cm and 0.68, 0.26, 7.16 and 10.64 mg kg\(^{-1}\) at 16- 41 cm depth in cultivated land, 0.96, 0.28, 7.84 and 7.36 mg kg\(^{-1}\) at 19- 49 cm depth in undisturbed land use system and 0.72, 0.34, 7.086 and 8.06 mg kg\(^{-1}\) at 0-23 cm depth and 0.38, 0.22, 5.60, 9.86 mg kg\(^{-1}\) at 23-44 cm depth in pasture land use system, 1.22, 0.48, 9.38, 10.16 mg kg\(^{-1}\) at 0-10 cm and 0.84, 0.22, 8.10 and 9.80 mg kg\(^{-1}\) at 10-30 cm depth in forest land use system.

Hundal et al. (2008) [11] reported that the nutrient status of rice crops cultivated in low land areas in the vicinity of Satluj River in district Ludhiana. The range for Fe, Mn, Zn and Cu were 64-217, 72-187, 15-24 and 3-6 mg kg\(^{-1}\), respectively. Dahifule et al. (2009) [9] studied the nutrient diagnosis for bronzing of leaves in guava orchards, grown on Entisols, Inceptisols and Vertisols and reported that The DTPA-extractable micronutrient status of iron, manganese, copper and zinc content of Entisols was 5.88, 10.71, 0.37 and 0.24 mg kg\(^{-1}\), respectively. In Vertisols 6.00, 10.88, 0.47 and 0.23 mg kg\(^{-1}\), respectively. The micronutrients status of Vertisols was higher than the Inceptisols and Entisols. The soils of these order were sufficient in DTPA-iron manganese copper and deficient in DTPA- Zinc content. The boron content in Entisols, Inceptisols and Vertisols was 0.34, 0.29, 0.37 mg kg\(^{-1}\), respectively. Akporhoron and Agbaire (2009) [1] studies on To this end 20 soil samples were collected from 10 locations in Abraka (10 topsoil and 10 subsoil) to ascertain the level of total micronutrients. The total cationic micronutrients were determined using atomic absorption spectrophotometer (AAS). Fe has a range between 2214 - 4820 mgkg\(^{-1}\), Cu ranged between 4.00 - 18.00 mgkg\(^{-1}\), Zn ranged between 12.00 - 44.00 mgkg\(^{-1}\), B ranged between 58.00 - 158.00 mgkg\(^{-1}\), and Mn ranged between 4.00 - 16.00 mgkg\(^{-1}\). Soil properties are as follows: pH 4.00 - 6.90, CEC (c molkg\(^{-1}\)) between 0.69 - 6.94. Percentage organic matter ranged between 0.71 - 2.46% with a mean of 1.218%. There is relatively low correlation between soil properties with total micronutrient. Bali et al. (2010) [3] studies of detailed characterization of soil of Punjab was carried out. The descriptive statistics on soil characteristics indicated that the pH of the soils varied from 6.77 to 9.30 (mean =7.93). The electrical conductivity ranged from 0.14 to 4.57 dS m\(^{-1}\) (mean =0.63 dS m\(^{-1}\)). The organic carbon ranged from 0.0 to 1.55% (0.57%). Calcium carbonate varied from 0.5 to 10.46% (mean =3.94%). The DTPA-Zn ranged from 0.07 to 3.06 mg kg\(^{-1}\) (mean =1.10 mg kg\(^{-1}\)). The GIS aided thematic map indicated that 10% of the total geographical area of Punjab was affected by the Zn deficiency based on the existing critical limits. Ashokkumar and Prasad (2010) [10] studies on six pedons in Ahmadnagar district of Maharashtra were characterized for their physical and chemical properties and nutritional status of soil and leaves. The DTPA extractable –Fe, Mn, Cu and Zn ranged from 7.2 to 17.9, 7.9 to 25.0, 1.2 to 4.0 and 0.2 to 0.9 mg kg\(^{-1}\) respectively, in different pedons. Mustaq et al. (2010) [31] studies on in view of widespread micronutrients deficiencies, rice soils of submerged area around Wular Lake of Kashmir were studied for their availability and mapped by GIS technique. Forty surface soil samples from the representative areas were collected to assess the available micronutrient status. DTPA extractable Fe, Mn and Cu were found to be adequate in major part of the area while as Zn was deficient in most of the soils. Mapping of available micronutrients status by GIS technique revealed that out of 472.02ha area of submerged area, 354.01ha was in deficient category, 106.02ha in sufficient category and 11.80ha in excess category with respect to available zinc status. The entire study area was sufficient in available manganese and available iron. Available copper content of the study area (472.02ha) was under sufficient rating. Mustapha et al. (2010) A study was conducted to determine the status and distribution of extractable Zn, Cu, Fe and Mn in Haplustults in Yamaltu-Deba Local Government Area (LGA) of Gombe State, Nigeria. Composite soil samples representative of the soils in the LGA were collected from 0 - 15 and 15 - 30 cm depths of five locations (Hinna, Kanti, Jangargari, Gidan Waya and Dadin Kowa) and analyzed. Results indicate that the soils were dominantly sandy loam, very strongly to moderately acidic (pH = 4.7 - 5.9) and low in CEC (mean = 7.21 cmolkg\(^{-1}\)), exchangeable bases (Means for Ca = 3.34, Mg = 0.71, K = 0.21, Na = 0.10 cmolkg\(^{-1}\)) and organic carbon (mean = 7.27 g kg\(^{-1}\)). Extractable Zn, Cu, Fe and Mn (in mgkg\(^{-1}\)) were 0.48 - 0.75(mean = 0.58), 0.18 - 0.26 (mean = 0.21), 18.40 - 21.91 (mean = 19.96) and 30.54 - 38.58 (mean = 33.00), respectively. The Fe and Mn contents were above the critical limits for crop production in all the locations. Copper was low in soils from Hinna and Jangargari and will consequently benefit from its application, Zinc was, however, generally low and its application in all the locations are recommended for successful crop production in the area. Mustapha et. al. (2011) this study has been conducted to assess the status and distribution of available zinc (Zn), copper (Cu), iron (Fe) and manganese (Mn) in soil of akko local government area (LGA), Gombe state, Nigeria. Sixty composite soil samples were collected from 0-15 and 15-30 cm depths from 15 purposively selected representative location in the LGA and analyzed in the laboratory using standard procedures. Results obtained showed that the soils were generally clayey to sandy clay.

**Soil pH**

Rathore et al. (1990) [37] studied on some mixed red and black
soils of Tikamgarh district and reported that available manganese and iron showed negative and significant relationship with soil pH. Maji et al. (1993) [24] analyzed the available micronutrients in coastal soils of Sunderbans, West Bengal in relation to soil characteristics, reported that the available copper and iron were negatively correlated with pH. Kumar et al. (1996) [25] estimated the micronutrient cations in some soil profile in Northern Telangana of Andhra Pradesh. Available zinc, copper, iron and manganese were negatively and significantly correlated with soil pH. Rajkumar et al. (1996) [26] studied the micronutrient distribution in paddy soil in relation to parent material and soil properties Karnataka. Observed that the content of available iron, manganese and zinc correlated significantly and negatively with pH in paddy growing soils of Karnataka. Singh and Rao (2001) studied the availability of micronutrient in some alluvial soils of Kanpur region and revealed that the iron, manganese, zinc showed highly significant negative correlation with soil pH. Pandey et al. (2002) [33] studied the availability of phosphate and sulphur in Inceptisols of central Uttar Pradesh and reported that the available sulphur had significant positive correlation with pH in typic Ustifluents (r= 0.521) Aquic Haplustalfs (r= 0.77) typic Haplquepts (r= 0.331).

Electrical conductivity
Sangwan et al. (1993) [45] studied on the vertical distribution of zinc, manganese copper and iron in relation to depth and important soil properties in ten representatively soil profile of southern semi-arid soils of Haryana. Simple correlation analysis indicated that the amount of available iron is significantly and negatively influenced by electrical conductivity and positively by available manganese and copper. Sahoo et al. (1998) studied available of micronutrients status of some mangrove soils and reported that zinc, copper, iron and manganese content ranged from 1.36 to 14.0, 16 to 82.0, 10.7 to 32.9 and 1.5 to 25.7 ppm and positively correlated with electrical conductivity. Pandey et al. (2002) [33] studied the availability of phosphate and sulphur in Inceptisols of central Uttar Pradesh and reported that the soil association available S had significant correlation with electrical conductivity in typic Ustifluents, Aquic Haplustalfs, typic Haplquepts and Ustifluents in Inceptisols of Central Uttar Pradesh. Singh et al. (2004) [59] reported that available boron in these soils ranged from 0.20 to 2.60 mg kg⁻¹ with a mean value of 1.20 mg kg⁻¹ in alluvial soils of Agra districts. It had significant positive correlation with electrical conductivity (r= +0.35 **) and pH (r= +0.23 **) and non-significant with calcium carbonate (r= -0.17 **) and organic carbon. (r= -0.36 **). Sharma and Chaudhary (2007) [51] studied the vertical distribution of micronutrients cation in lower Shiwalik of Solan districts in North West Himalayan and reported that the available zinc and iron showed significant and negative regression coefficient, copper and manganese showed significant and positive regression coefficient with electrical conductivity in lower Shiwalik of Solan districts in North – West Himalayas. Bikram et al. (2008) analyzed seventy five surface soil samples representing three soil order Entisols, Inceptisols and Alfisols of Assam and revealed that sulphate- S exhibited a positive and significant correlation with electrical conductivity in Entisols and Inceptisols soil of Assam.

Calcium carbonate
Sharma et al. (2003) [52] studied the status of micronutrient and effect of soil properties in some soils of Nagaur districts in semi-arid region of Rajasthan and reported that the zinc, copper, iron, manganese and boron were negative correlated with calcium content. Balpandey et al. (2007) [4] studied the micronutrients status in grape- growing soils in Nasik districts Maharashtra and reported that the availability of zinc (r= -0.41), iron (r= -0.78), copper (r= -0.27) and manganese (r= -0.06) were negatively affected by calcium carbonate.

Pandey and Girish (2007) studied attractant and critical limits of available soil sulphur for maize and reported that the calcium carbonate content of initial soil sample varied from 1.0 to 14.0 g kg⁻¹ with mean value of the 4.3 g kg⁻¹ in pot experiment were conducted for two year using twenty four soils. Singh et al. (2008) [58] analyzed micronutrients cation in some Vertisols under the Agro-Eco region of eastern Rajasthan, reported that the exchangeable zinc showed positive correlation with silt and was negatively correlated with available calcium carbonate of eastern Rajasthan. Waghmare et al. (2008) [63] analyzed one hundred soil sample were collected from 20 villages of Ausa tahsil and reported that available iron and manganese content were negative significantly correlated with pH and calcium carbonate.

Kumar and Babel (2011) [22] The aim of this study was to evaluate available micronutrient (Fe, Cu, Zn, Mn and B) status and their relationship with soil properties. To study this, there were seventy surface soil (0-30 cm depth) and plant samples, each collected from wheat growing fields of Jhunjhunu tehsil. The soils were analyzed for physico-chemical properties and status of available micronutrients. The soils were moderately calcareous in nature and having CaCO3 content ranges from 3.90 to 12.00 per cent. The analyzed samples showing lower in organic carbon ranges from 0.06 to 0.43 percent. The pH (8.10 to 9.20) and EC (0.20 to 2.14 dSm⁻¹) values indicated that soils were found to be moderately alkaline and non-saline in nature. The 90 per cent of analyzed soil samples were found to be deficient in iron and 70 per cent deficient in zinc and their values ranges from 1.22 to 5.87 and 0.12 to 1.30 mg kg⁻1, respectively. While the remaining micronutrients (Cu, Mn and B) shown to be sufficient and their values ranges between 0.17 to 3.32, 2.03 to 5.67 and 0.37 to 1.51 mg kg⁻1, respectively. The availability of micronutrients indicating positive and significantly correlated with silt, clay, organic carbon and CEC of soils, whereas, negative and significantly correlated with sand, calcium carbonate and pH of the soils. The availability of micronutrients in wheat grains and straw positively correlated with silt, clay, organic carbon and CEC and negatively correlated with sand, CaCO3 and pH of soils.

Organic carbon
Sharma et al. (1992) [50] analyzed the distribution of micronutrient in arid zone soils of Punjab and their relation with soil properties arid soil and reported that the coefficient of correlation DTPA- extractable micronutrient increased with an increase in organic carbon content in arid zone soils of Punjab. Dhane and Shukla (1995) [13] analyzed twenty five surface soil sample collected from benchmark and established soils series of Maharashtra. The DTPA- extractable zinc and manganese were positively and significantly correlated with organic carbon iron also showed similar relationship with organic carbon and clay content of soil, while copper was positively and significantly correlated with only organic carbon.

Sahoo et al. (1998) reported that the total sulphate and organic S showed positive significant correlation with organic carbon in some mangrove soils of Sunderbans. Pandey et al.


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