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# Study of Correlation of Physico-Chemical Properties and Available Micronutrients in Farmland Soils of Mahagaon Dist. Yavatmal (MS)

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***Abstract:***
*Soil fertility and crop productivity are significantly influenced by the interaction between soil physico-chemical properties and micronutrient availability. This study investigates the correlation between key soil physico-chemical parameters (pH, EC, organic carbon, macronutrients) and the availability of essential micronutrients (Zn, B, Fe, Mn, Cu) in farmland soils of Mahagaon, District Yavatmal, Maharashtra. Soil samples were systematically collected and analyzed using standard laboratory procedures. Correlation analysis revealed significant relationships among soil properties and micronutrients. pH exhibited a strong negative correlation with Mn and B, indicating reduced availability in alkaline soils, while Zn and P showed positive correlations with pH. Organic carbon correlated positively with Fe, suggesting its role in Fe retention. Nitrogen showed a strong positive correlation with Zn but a negative correlation with Cu and B, highlighting possible nutrient antagonism. The study underscores the importance of balanced soil management practices for optimizing nutrient availability and sustaining agricultural productivity. These findings can guide region-specific fertilization strategies to enhance soil health and crop yield in Mahagaon.*

***Keywords: Soil Properties, Micronutrients, Correlation, Mahagaon, Soil Fertility, Agricultural Sustainability.***

## Introduction:

Soil is a fundamental natural resource that plays a crucial role in sustaining agricultural productivity and environmental stability. The fertility of soil is largely determined by its physico-chemical properties and the availability of essential micronutrients, which directly influence crop growth and yield.[1] Micronutrients such as iron (Fe), zinc (Zn), copper (Cu), and manganese (Mn) are vital for plant metabolism, enzyme activation, and overall health. However, their availability in soil depends on several factors, including soil texture, pH, organic matter content, and other chemical properties.[2]

Soil fertility is a crucial factor in determining agricultural productivity and ecosystem sustainability.[3] It refers to the soil's ability to supply essential nutrients to plants in adequate amounts for optimal growth. Fertile soil contains balanced levels of macronutrients (such as nitrogen, phosphorus, and potassium) and micronutrients, along with beneficial microbial activity and proper physical structure.[4] The fertility of soil is influenced

by several factors, including organic matter content, soil texture, pH, moisture retention, and nutrient cycling.[5]

The study of the correlation between soil physico-chemical properties and micronutrient availability is essential for understanding nutrient dynamics and ensuring balanced fertilization practices.[6,7] Variations in soil properties due to differences in land use, climatic conditions, and agricultural practices can significantly affect micronutrient mobility and uptake by crops.[8] In regions like Mahagaon, District Yavatmal (Maharashtra), where agriculture is the primary livelihood, assessing these correlations can aid in developing effective soil fertility management strategies to enhance sustainable agricultural productivity.[9,15]

Understanding soil fertility is essential for sustainable agriculture, as it directly impacts crop yield, food security, and environmental health. Overuse of chemical fertilizers and improper land management practices can lead to soil degradation, loss of nutrients, and reduced productivity over time. The integration of bio-fertilizers and organic amendments can enhance soil fertility while maintaining ecological balance.[10,11]

This research paper aims to investigate the relationship between key soil physico-chemical parameters and the availability of micronutrients in farmland soils of Mahagaon. By analyzing soil samples from different agricultural fields, this study will provide insights into nutrient distribution patterns and their dependence on soil characteristics. The findings will help farmers and policymakers in implementing appropriate soil management and fertilization techniques to improve soil health and crop yield.

**Materials and Methods:**

**Study Area and Soil Sampling:**

The study was conducted in the agricultural farmlands of Mahagaon, District Yavatmal, Maharashtra, India. This region is characterized by diverse soil types, cropping patterns, and climatic conditions that influence soil properties and nutrient availability. The selected farmlands represent varying land-use practices to ensure a comprehensive analysis of soil characteristics. A total of *5* soil samples were collected from different farmland locations using a systematic random sampling technique. The samples were collected from a depth of 0–15 cm (topsoil layer) using a stainless steel auger. Each sample was placed in labeled polyethylene bags and transported to the laboratory for further analysis. Before analysis, the soil samples were air-dried, ground, and sieved through a 2 mm mesh to remove debris and ensure uniformity.[12]

**Analysis of Soil Physico-Chemical Properties:**

The physico-chemical properties of soil were analyzed using standard laboratory procedures: Soil pH was determined by using a digital pH meter, Electrical Conductivity (EC) by a conductivity meter, Organic Carbon (OC) Estimated by the Walkley-Black method, Nitrogen (N) ware determined by the Kjeldahl method, Phosphorus (P) measured by using the Olsen's method, Potassium (K) assessed using a flame photometer, Sulfur (S) determined by extracting soil with 0.15% calcium chloride and measuring using a turbidimeter and micronutrients (Zn, Fe, Mn, Cu) analyzed using an atomic absorption spectrophotometer (AAS).[13,14]

**Statistical Analysis:**

To determine the correlation between soil physico-chemical properties and the availability of micronutrients, Correlation coefficient (r) was computed

using statistical software. A regression analysis was also performed to assess the influence of soil parameters on micronutrient availability. The significance of correlations was tested at a 5% ($p < 0.05$) and 1% ($p < 0.01$) level. The obtained results were systematically analyzed to identify patterns and relationships between soil properties and micronutrient availability.

**Results and Discussion:**

**Correlation between Soil Physico-Chemical Properties and Available Micronutrients:**

The correlation matrix provides insights into the relationships between various soil physico-chemical properties and micronutrient availability in the farmland soils of Mahagaon, District Yavatmal. The key findings are discussed below:

**pH and Micronutrients:**

Soil pH exhibited a strong negative correlation with manganese (Mn) (-0.926) and boron (B) (-0.435), indicating that higher pH levels reduce their availability. This aligns with established findings that Mn and B solubility decrease in alkaline conditions. Conversely, a strong positive correlation was observed between pH and zinc (Zn) (0.801) and phosphorus (P) (0.592), suggesting their increased availability in neutral to slightly alkaline soils.

**Electrical Conductivity (EC) and Micronutrients:**

EC showed a strong negative correlation with iron (Fe) (-0.908) and phosphorus (-0.849), suggesting that increased salinity may hinder Fe and P availability. However, a weak positive correlation was found between EC and sulfur (S) (0.196), indicating that sulfur solubility may not be significantly affected by soil salinity.

**Organic Carbon (OC) and Micronutrients:**

Organic carbon exhibited a strong positive correlation with Fe (0.699), suggesting that organic matter enhances Fe availability, likely by forming chelates. However, OC showed a moderate negative correlation with potassium (K) (-0.815) and sulfur (S) (-0.588), indicating that organic matter may not directly contribute to these nutrients' retention in soil.

**Macronutrients and Micronutrients:**

**Nitrogen (N):** showed a strong positive correlation with Zn (0.864) and a negative correlation with boron (-0.682) and copper (Cu) (-0.871). This suggests that higher nitrogen levels enhance Zn availability but may reduce B and Cu uptake by plants.

**Phosphorus (P):** correlated positively with Fe (0.796), indicating that soils with higher phosphorus levels also maintain better Fe availability. However, it showed a negative correlation with K (-0.546), suggesting potential nutrient antagonism.

**Potassium (K):** exhibited a negative correlation with Fe (-0.627) and phosphorus (-0.546), indicating potential competition for absorption sites in soil.

**Sulfur (S):** showed a weak negative correlation with Zn (-0.245) and Fe (-0.040), suggesting that sulfur presence does not significantly influence these micronutrients.

**Micronutrient Interrelationships:**

**Zinc (Zn) and Manganese (Mn):** had a strong negative correlation (-0.835), indicating that higher Zn levels may suppress Mn availability.

**Boron (B) and Fe** showed a weak negative correlation (-0.407), suggesting that excessive boron may slightly reduce Fe availability.

**Copper (Cu) correlated negatively with nitrogen (-0.871) and Zn (-0.534), suggesting that excessive nitrogen fertilization may reduce Cu and Zn uptake.**

**Table 1 Observation table**

| Sample | S1 | S2 | S3 | S4 | S5 |
|---|---|---|---|---|---|
| **pH** | 7.69 | 8.39 | 8.37 | 7.78 | 7.4 |
| **EC** | 0.46 | 0.14 | 0.27 | 0.26 | 0.23 |
| **OC** | 0.15 | 0.42 | 0.14 | 0.2 | 0.54 |
| **N** | 250.88 | 225.79 | 175.26 | 150.12 | 112.9 |
| **P** | 6.61 | 21.77 | 11.3 | 9.64 | 11.85 |
| **K** | 397.6 | 215.04 | 631.68 | 451.36 | 266.56 |
| **S** | 15.04 | 13.49 | 14.6 | 19.71 | 12.6 |
| **Zn** | 0.6 | 0.71 | 0.6 | 0.36 | 0.28 |
| **B** | 0.46 | 0.07 | 0.83 | 0.46 | 0.92 |
| **Fe** | 3.14 | 7.03 | 4.07 | 5.85 | 5.77 |
| **Mn** | 10.3 | 7.85 | 5.15 | 11.77 | 15.86 |
| **Cu** | 0.91 | 1.61 | 2.52 | 2.27 | 2.4 |

**Table 2 correlation analysis**

| | *pH* | *EC* | *OC* | *N* | *P* | *K* | *S* | *Zn* | *B* | *Fe* | *Mn* | *Cu* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 1 | | | | | | | | | | | |
| EC | -0.404 | 1 | | | | | | | | | | |
| OC | -0.291 | -0.625 | 1 | | | | | | | | | |
| N | 0.43 | 0.4005 | -0.431 | 1 | | | | | | | | |
| P | 0.5923 | -0.849 | 0.5608 | 0.1142 | 1 | | | | | | | |
| K | 0.2791 | 0.3706 | -0.815 | -0.06 | -0.546 | 1 | | | | | | |
| S | -0.065 | 0.1956 | -0.588 | -0.074 | -0.406 | 0.4153 | 1 | | | | | |
| Zn | 0.8012 | 0.0212 | -0.338 | 0.8638 | 0.4333 | 0.0556 | -0.245 | 1 | | | | |
| B | -0.435 | 0.1977 | 0.036 | -0.682 | -0.547 | 0.4467 | -0.187 | -0.61 | 1 | | | |
| Fe | 0.1617 | -0.908 | 0.6986 | -0.329 | 0.7964 | -0.627 | -0.04 | -0.133 | -0.407 | 1 | | |
| Mn | -0.926 | 0.0436 | 0.5873 | -0.556 | -0.265 | -0.53 | -0.014 | -0.835 | 0.3013 | 0.2169 | 1 | |
| Cu | 0.0485 | -0.552 | 0.2047 | -0.871 | 0.0694 | 0.3456 | 0.0906 | -0.534 | 0.6032 | 0.3197 | 0.0791 | 1 |

**Conclusion:**

The correlation analysis highlights the interdependence of soil physico-chemical properties and micronutrient dynamics. The negative correlation of pH with Mn and B confirms that micronutrient deficiencies may arise in alkaline soils. The strong correlation of organic carbon with Fe emphasizes the role of organic matter in micronutrient retention. Additionally, the antagonistic relationships observed between certain nutrients, such as Zn-Mn and P-K, underscore the importance of balanced fertilization practices.

Understanding these correlations is crucial for formulating nutrient management strategies to enhance soil fertility and crop productivity in Mahagaon's farmland soils. Future studies may focus on evaluating these interactions under different cropping patterns and soil amendment practices to develop region-specific recommendations.

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