Study on The Influence of Organic Fertilizers on: Soil Chemical Properties and Nutrient Changes in Different Regions of Betul District

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Abstract- Soil is an important components of the environment that supports many forms of life. It is a complex mixture of solid, liquid, and gaseous substances, and plays a vital role in crop production, environmental pollution, and human health. In this study, we examined the effects of five fertilization treatments-no fertilizer (CK), straw return (SR), chemical fertilizer (NPK), organic manure (OM), and green manure (GM)- on soil pH, SOC, TN, C/N ratio, and available nutrients (AN, AP, and AK) in the ploughed layer (0–20 cm) of 5 different crops like Wheat, Rice, Maize, Sugarcane, Soyabeans in 7 fields in in Betul District, Madhya Pradesh. The results show that Fertilizers raised SOC and TN more than CK. Compared to CK, OM and NPK increased SOC and TN by 72.5% and 51.2%. During the study period, the average AN and AP contents were greatest in OM treatment (1.6 and 29.6 times that in the CK, respectively) and second highest in NPK therapy (1.2 and 20.3 times). NPK treatments had the greatest AK content at 38.10 mg.kg^{-1}. Thus, considering soil K concentration, organic manure and K fertilizer should be administered to boost soil fertility in this location. Our finding shows that the organic forms of fertilizers, when applied properly, may provide plants the vital nutrients they need to develop and produce. The potential effect on crops is influenced by a number of variables, such as the kind of organic fertilizer used, the pace at which it is applied, the soil's characteristics, and the crop's needs.

Keywords: OM, SR, NPK, GM, Organic.

INTRODUCTION

The Betul District in the state of Madhya Pradesh in India is well-known for having a varied agricultural landscape and a wide variety of soil types. The area is home to a variety of climates and is suitable for growing a wide range of crops, such as those used for food, for profit, and for horticultural purposes. It is of utmost importance for environmentally responsible agricultural practices and efficient nutrient management that the effects of organic fertilizers on soil chemical characteristics and variations in nutrient levels in various locations of Betul District be investigated.

The purpose of this research is to explore and evaluate the effect that organic fertilizers have on the chemical characteristics of the soil and the dynamics of the nutrients therein across a number of different locations in the Betul District. The objective of this study is to gather soil samples from typical agricultural areas that have been fertilized using a variety of techniques. The samples are going to be examined in terms of pH, the amount of nutrients present, the levels of organic matter, the CEC, and the microbial activity. The outcomes of this research will give useful insights into the advantages and downsides of organic fertilizers in diverse soil types and climatic circumstances, which will facilitate the creation of region-specific nutrient management methods.

To keep up with the ever-increasing need for food production, today's farming practices place a significant emphasis on the use of fertilizers. Organic fertilizers are very important components of a healthy soil because they provide vital nutrients to the ground. These nutrients are then taken up by plants, which enables them to continue expanding and maturing. In recent years, the topic of choosing between organic fertilizers has been a subject of significant attention. This is a direct result of the need for environmentally responsible farming methods and the desire to lessen the negative effects on the environment.

To increase the fertility of the soil, organic fertilizers, which are obtained from natural sources such as animal dung, compost, and plant wastes, have been used for a number of decades, if not centuries. These fertilizers have a high concentration of organic matter and include a diverse spectrum of nutrients, including

nitrogen, phosphorus, and potassium, in addition to micronutrients. When organic fertilizers are worked into the soil, the fertilizers begin the decomposition process, which results in the gradual and consistent release of nutrients over the course of time. This pattern of slow release helps to guarantee a more sustainable supply of nutrients to the plants and encourages the formation of healthy ecosystems within the soil.

In contrast to organic fertilizers, are chemicals that are chemically manufactured and contain exact amounts of nutrients that are necessary for plant growth. Ammonium nitrate, diammonium phosphate, and potassium chloride are typical examples of the types of elements that may be found in these fertilizers. These fertilizers are produced by various industrial processes and generally consist of compounds containing nitrogen, phosphorus, and potassium.[1]

There have been a lot of studies done on the effects that organic fertilizers have on the changes that take place in the chemical properties of the soil as well as the changes that take place in the nutrient levels in order to evaluate how successful they are in encouraging plant development and to analyze how their use affects the condition of the soil. The term "chemical properties of soil" refers to a broad variety of characteristics, some of which include pH, the amount of nutrients present, the amount of organic matter, the cation exchange capacity (CEC), and the amount of microbial activity. These characteristics have a direct impact on the fertility of the soil and are very important factors in determining the amount of nutrients that are accessible to plants.[2]

The pH of the soil, which is a measurement of the acidity or alkalinity of the soil, influences chemical reactions and the solubility of nutrients. This has an effect on the availability of nutrients. It is vital to maintain a pH range that is appropriate in order to maximize nutrient absorption, and different types of crops have different pH preferences. Organic fertilizers, on account of their high concentration of organic matter, may contribute to an increase in soil pH over time, especially in acidic soils; this results in an increase in the amount of nutrients that are available to plant.

The amount of nutrients that are present in the soil is an important component in influencing the amount of plant growth that may be achieved. Organic fertilizers provide a wide variety of nutrients to plants, including both macronutrients (such as nitrogen, phosphorus, and potassium) and micronutrients (such as iron, manganese, zinc, and other such elements).

The presence of organic matter in the soil is an essential indication of the soil's overall health. Organic fertilizers incorporate the byproducts of plants and animals into the soil, which leads to an increase in the amount of organic matter present in the soil. The presence of organic matter helps to improve the structure of the soil, increases its ability to retain water and nutrients, and creates an environment that is advantageous to the creatures that live in the soil.

The activity of microbes in the soil is very necessary for the cycling of nutrients and the breakdown of organic materials. Microorganisms in the soil are very important because they decompose organic matter, which results in the release of nutrients and adds to the total availability of nutrients for plants. Because organic fertilizers include a high percentage of organic matter, they are able to provide soil microorganisms with a source of both energy and nutrients, which in turn encourages the activity and variety of these organisms. Following are the various methods or factors which impacts the chemical properties and nutrient changes in different regions of Betul district.

The application of organic fertilizer to soil, either alone or in combination with chemical fertilizer, is regarded as appropriate management practice in any agricultural production system since it increases plant quality and soil fertility. The current research aims to assess the impact of compost on cucumber production and soil attributes. During the summer of 2012, a greenhouse experiment was conducted in Tulkarm, Palestine. The experimental results showed that organic fertilizers increased crop productivity (7005 kg / dunum, dunum is 0.1 ha) compared to chemical fertilizers (6017 kg / dunum), increased soil fertility, and saved water (180 m3 / season vs. 213 m3/season). [3]

This experiment examined how organic and mineral fertilizers affect onion quality and productivity. Application rates of cattle dung were 0, 20, 40, and 60 t/ha. At the required dosage of 120:100:150, nitrogen, phosphorus, and potassium were administered at half the recommended rate. Measurements were made of yield, yield components, and macro-micro element contents. The K concentration of the onion bulb was affected by treatments in the first year, but not the N, P, Ca, Na, Mg, Fe, Zn, Cu, or Mn levels. The

treatments affected Na content in the second year but had no effect on the other variables. [4]

The purpose of this research was to evaluate and contrast the effects of applying chemical fertilizers and organic fertilizers, such as cow and chicken manure, on the accumulation of heavy metals and metalloids in wheat samples. To compare the effects of chemical and organic fertilizers on the accumulation of heavy metals and metalloids in a wheat variety (Lasani-08), a field experiment was carried out using a full randomized block design with three replicates for each treatment. AAS was used to measure heavy metal/metalloid concentrations in wheat root, shoot, and grain samples. Additionally, wheat sample growth parameters were allocated. Results revealed that while using chemical fertilizer, morphological characteristics exhibited their highest growth.[5]

The author of this research examined the biochemical properties of orchard soil, fruit nutrients, and pesticide residues in apples produced either organically (with organic fertilizers and lowered pesticide rates) or with standard chemical fertilizers and pesticide rates. The organic fertilizer treatment generated soil with greater levels of total carbon, total nitrogen, and total phosphorus as well as fruit with much higher sugar contents when compared to the traditional chemical fertilizer treatment. These findings suggest that ecologically friendly arboricultural soil management strategies like organic fertilizer and less pesticide cultivation may improve soil nutrient cycling, minimize environmental impact, and improve food security.[6]

MATERIALS AND METHODS

Experimental Site

The Betul district is situated in the country of India's Madhya Pradesh. The geographical characteristics of the Betul district, which include plains, hills, and plateaus, are varied. The district is located inside the Satpura Range, which adds to its varied topography. The Betul district has a subtropical climate, with hot summers and moderate winters. The land usage in the area is largely agricultural, with a mix of rainfed and irrigated farming practices. Wheat, soybeans, pulses, oilseeds, and maize are among the principal crops farmed in the area.

Soil Sampling Analysis:

Soil samples were taken from 7 sites. In each plot, using a 5 cm auger in the plough layer (0–20 cm) and blended into one sample. All fresh soil samples were air-dried, sieved, and kept for nutritional analysis. It is important to take samples of the soil at regular intervals over the course of the research project, such as before planting, in the middle of the growing season, and after harvesting, in order to capture the temporal changes that occur in the soil's characteristics and the dynamics of its nutrients.

Following the collection of soil samples, the physical and chemical properties of the soil were evaluated. The pH of the soil was tested using a glass electrode and a soil/water solution of 1:2,5. SOC was detected using K_2CrO_7-H_2SO_4 oxidation, whereas TN was measured using the Kjeldahl method. The soil C/N levels were calculated using the SOC/TN ratio. AN was determined by micro-diffusion after alkaline hydrolysis. Olsen computed AP. After neutral extraction with NH_4OAc, AK was measured by flame photometry.

Data Analysis:

The obtained data may be evaluated using Analysis of Variance (ANOVA) to determine the influence of organic fertilizers on soil chemical characteristics and nutrient changes in various locations of Betul District. ANOVA is a statistical approach that compares means across several groups or treatments. ANOVA may be used in this research to see whether there are any significant variations in soil characteristics like pH, nutrient content, organic matter levels, and cation exchange capacity (CEC) across the various fertilizer treatments (organic, and control) within each area.

Anova Test:

The Analysis of Variance (ANOVA) test is a statistical tool for comparing the means of three or more groups or treatments. It helps in determining if there are substantial differences between these groups based on the observed variance in the data.

ANOVA assesses if the differences found in the data are statistically significant by calculating the variance within each group and comparing it to the variation between groups. If the variance between groups is much greater than the variation within groups, it shows that the groups being compared have important distinctions.

ANOVA is often used in research projects to examine data from trials with several treatment groups or when comparing various conditions or variables. It offers a statistical framework for determining whether or not there are true differences between groups, enabling researchers to draw solid conclusions and make educated choices based on the findings.

RESULTS

Effects of various fertilizer applications on soil organic carbon and total nitrogen:

The SOC and TN contents across the five treatments revealed statistically significant variations (Fig. 1) from below. Fertilizers—particularly OM and NPK fertilizers—improved SOC and TN levels compared to CK. OM produced the greatest SOC and TN concentrations (16.20 and 1.54 $g.kg^{-1}$, respectively), 72.5% and 51.2% higher than CK. In NPK therapy, SOC and TN were 11.15 and 1.20 $g.kg^{-1}$, respectively, higher than CK. In SR and GM treatment, SOC was significantly greater than CK at 10.08 and 9.78 $g.kg^{-1}$, while TN levels were not significantly different.

SOC trends in various treatments were comparable (Fig.4A). The SOC rose from 9.65–9.78 $g.kg^{-1}$ in 2016 to 11.51–20.00 $g.kg^{-1}$ in 2022 owing to fertilization. SOC content plummeted but stabilized. OM had the highest SOC content throughout the trial, whereas CK's remained consistent (approximately 10 $g.kg^{-1}$). The five treatments' TN content trends mirrored SOC (Fig. 4B). TN content increased quickly in OM (from 1.02 to 1.41 $g.kg^{-1}$) and NPK (1.03 to 1.19). Both dropped and then stabilized. SR, GM, and CK soil TN concentrations were stable at 1.05 $g.kg^{-1}$

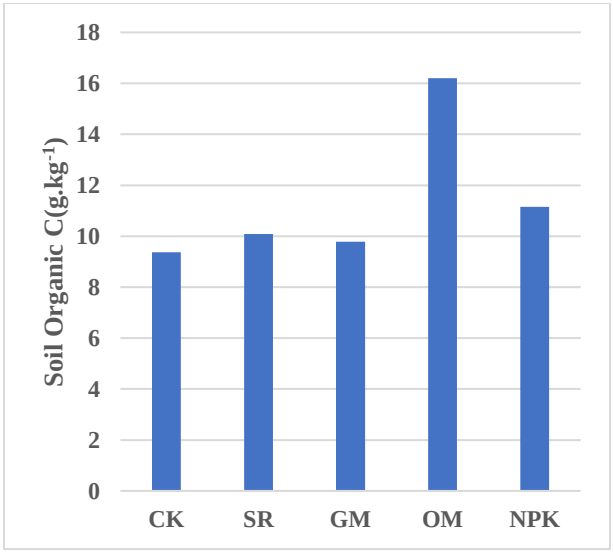
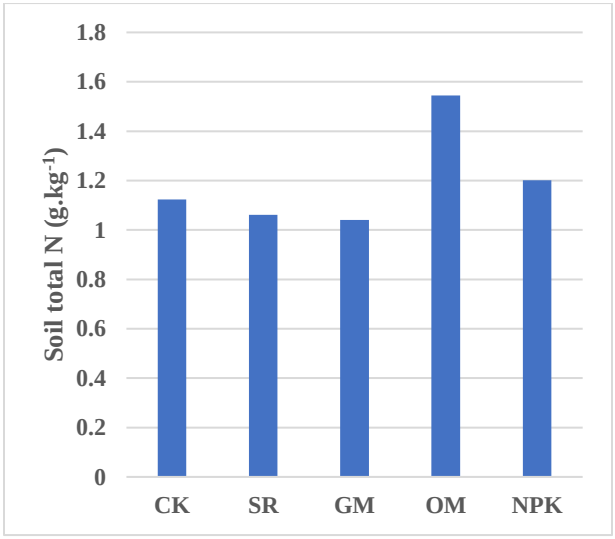


Fig 1(a).



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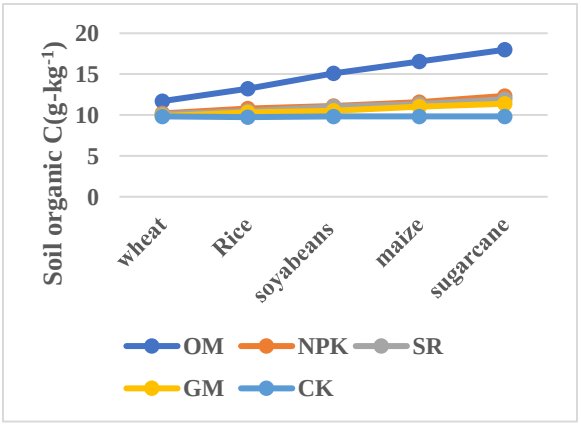

Fig 2(a).

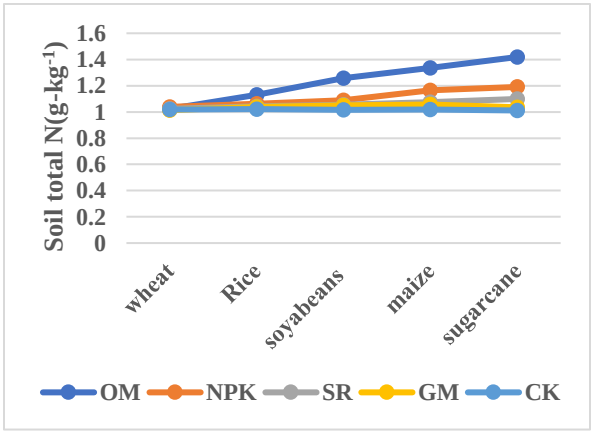

Fig 2(b).

Effects of Various Fertilizer Applications on the Soil's Absorbable Nutrients:

According to a comparison of the treatments' available nutrients, fertilizer had a significant impact on soil AN, AP, and AK ($P<0.05$, Fig. 3A-C). The average AN and AP contents in OM throughout the trial were at their greatest levels (1.6 and 29.6 times CK, respectively), while NPK treatment was second (1.2 and 20.3 times CK). In contrast to AN and AP, the highest value of AK content was found in the NPK treatment, which was 37.76 $mg.kg^{-1}$ (roughly 2.2 times that of the CK), and there were no obvious differences among the other four treatments (Fig. 3C).

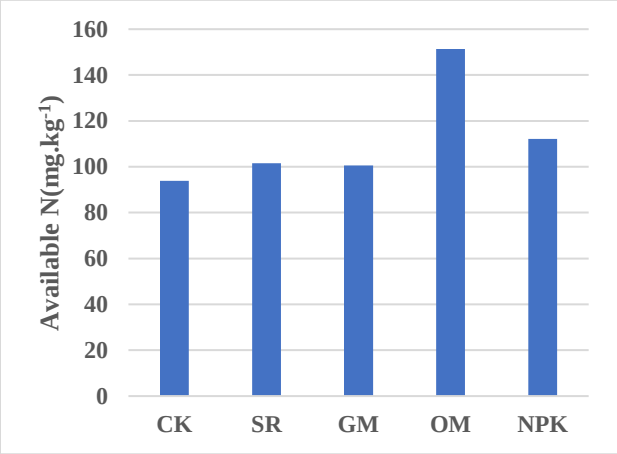

Fig 3(a).

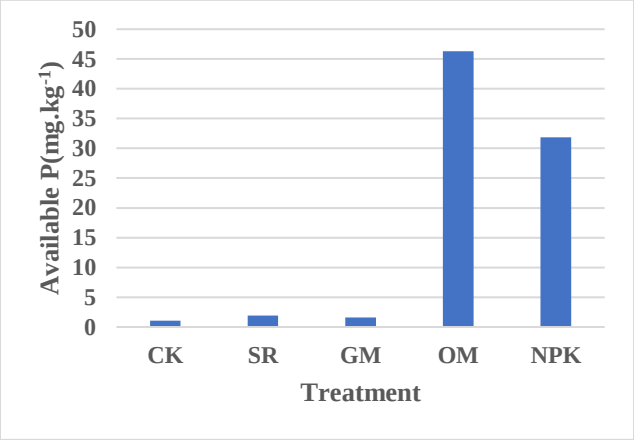

Fig 3(b)

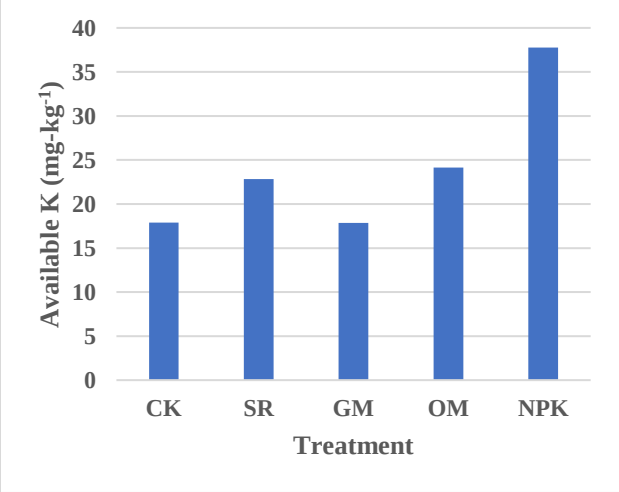

Fig 3(c)

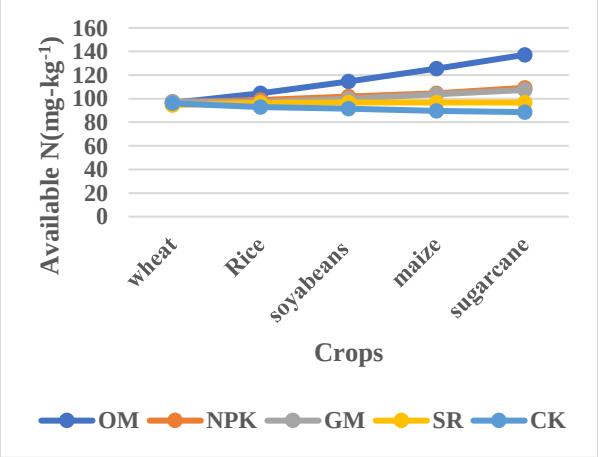

Fig 4(a)

Fertilization caused AN in the OM therapy to grow initially, then it varied until it reached the highest amount of the other treatments. NPK had a similar pattern, although it was lower than OM and did not vary significantly from SR, GM, and CK (Fig. 4A). Throughout the experiment, the AP concentrations in the CK, SR, and GM treatments were relatively low (1.80 mg.kg-1). and came close to matching the beginning values. In both the OM and NPK treatments, AP altered similarly. The value increased considerably in the fertilization year 2022-23 (51.21 and 36.52 mg.kg-1, respectively in 2022-23). (Fig.4B). NPK significantly increased AK content from wheat to sugarcane crops, as shown in Fig 4(c). AK in other therapies increased and decreased during time.

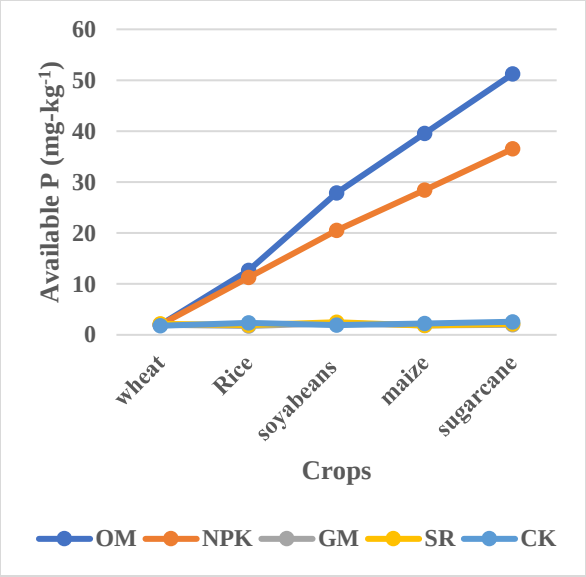

Fig 4(b)

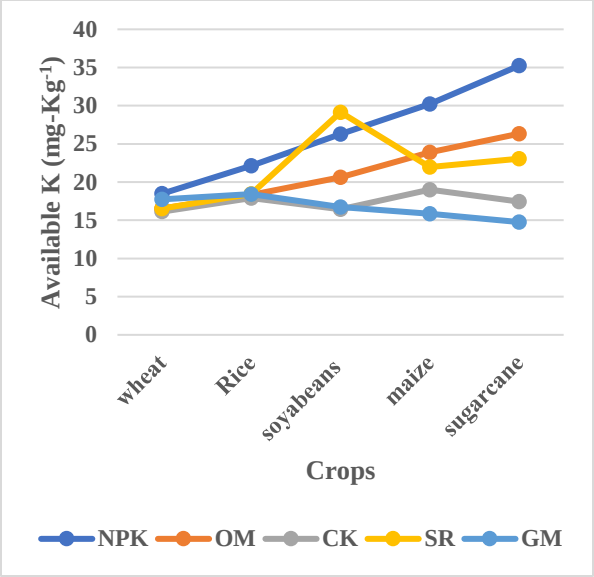

Fig 4(c).

CONCLUSION

In conclusion, fertilization treatments significantly affected soil fertility in the Betul district region soil area. Compared to other fertilization treatments, OM and NPK increased SOC, TN, C/N ratios, AN, and AP. Thus, OM and NPK may increase soil fertility. NPK increases soil AK to the greatest levels. Continuous SR also maintained SOC, TN, and C/N ratios. Compared to CK, GM has little impact on soil fertility. Thus, considering soil K concentration, organic manure and K fertilizer should be administered to boost soil fertility in this location. For long-term fertilizer efficiency, this trail section might use yearly straw returning application.

This research will reveal how organic fertilizers affect soil chemical characteristics and nutrient changes in Betul District. We will learn which fertilizer improves soil health and nutrient levels by studying and comparing the data. Farmers and agriculturalists may choose the appropriate fertilizer for their requirements using this information. The study's results will boost sustainable farming and fertilizer efficiency, increasing agricultural output and reducing environmental impact. This study will help Betul District and other agricultural regions improve fertilizer management.

Abbreviations: No fertilizer (CK), Straw return (SR), Chemical fertilizer (NPK), Organic manure (OM), Green manure (GM), Soil organic carbon (SOC),Total Nitrogen (TN), Carbon/Nitrogen (C/N) ratio, Available Nitrogen (AN), Available Phosphorus (AP), Available Potassium (AK), Cation Exchange Capacity (CEC), Analysis of Variance (ANOVA), Nitrogen (N), Phosphorus (P), Calcium (Ca), Sodium (Na), Magnesium(Mg), Iron (Fe), Zinc (Zn), Copper (Cu), Manganese (Mn).

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