Study on The Influence of Inorganic 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), 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 CK (5.38 units) had the lowest soil pH, whereas NPK (5.97 units) and OM (5.63 units) were higher (P,0.05). OM treatment had the highest C/N ratio, 9.66 to 10.98 (P,0.05). Thus, by using NPK (Chemical Fertilizer) that it boosts soil fertility in this location. Our finding shows that the both Inorganic type 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 fertilizer used, the pace at which it is applied, the soil's characteristics, and the crop's needs.

Keywords: OM, SR, NPK, GM, Fertilizer, C/N Ratio, Inorganic.

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 inorganic 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 inorganic 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 CEC, and the microbial activity. The outcomes of this research will give useful insights into the advantages and downsides of inorganic 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. Inorganic 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 inorganic 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, inorganic 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. When inorganic 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 inorganic 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. Inorganic fertilizers have the benefit of supplying plants with readily accessible nutrients, which may considerably increase crop yield. This advantage is just one of several offered by inorganic fertilizers. However, due to the fact that they are immediately released, they may also lead to nutrient leaching and runoff, which in turn causes pollution in bodies of water and contributes to eutrophication.[1]

There have been a lot of studies done on the effects that inorganic 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 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. Inorganic fertilizers, on account of their high concentration of 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. On the other hand, inorganic fertilizers either have a pH that is neutral or, depending on their specific make-up, they may cause a very minor acidification of the soil.

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. Fertilizers made of inorganic matter both provide nutrients to the soil; however, the kinds of nutrients they add and the degree to which they make those nutrients available are quite different. Inorganic 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), but in comparatively lower amounts when compared to inorganic fertilizers. Due to the fact that inorganic fertilizers are produced by chemical synthesis, they are capable of being designed to include exact nutrient ratios, which enables accurate nutrient supplementation depending on the needs of the crop. [3]

The absence of organic matter in inorganic fertilizers, they do not contribute to the accumulation of organic matter in the soil. However, the targeted nutrients they offer may indirectly influence the rates of organic matter breakdown and the processes of nutrient cycling. [4]

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 inorganic 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. In contrast, inorganic fertilizers don't directly influence microbial activity, and owing to their potential toxicity at high quantities, they may even have negative effect on microbial populations. [5]

The inquiry that will be conducted in various areas of the Betul District will add to the information base on nutrient management. This will help farmers and agricultural practitioners make educated choices about the use of fertilizer in a variety of agricultural landscapes.

The goal of this study is to investigate how nutrient variations in various parts of the Betul District are impacted by the use of organic and inorganic fertilizers. Understanding how these fertilizers affect soil pH, nutrient content, organic matter levels, and cation exchange capacity will be the main goal of the research. Additionally, the impacts on microbial diversity and activity in the soil will be investigated. By conducting the study in the Betul District, the research hopes to generate suggestions for sustainable nutrient management techniques in the area and offer insights particular to the region into the advantages and disadvantages of inorganic fertilizers.

A 2007 field experiment at Shiraz University's Bajgah research station examined the effects of different levels of inorganic (0, 80, 160, and 240 kg Nitrogen ha-1) and organic (0, 30 and 60 Mg municipal waste compost ha-1) fertilizers on wheat grain yield, gluten content, protein variability, and protein banding pattern on polyacrylamide gel in different growth stages of irrigated wheat. According to the findings, the plants had the best results when treated with 160 kg of nitrogen and 30 Mg of compost per hectare.[6]

The current research examined the effects of inorganic manures on maize and their lingering effects on the physico-chemical properties of the soil. Sheep manure (SM), poultry manure (PM), and farmyard manure (FYM) were used as organic nutrient sources, and urea, diammonium phosphate (DAP), and sulphate of potash (SOP) were used at various concentrations as inorganic nutrient sources. The treatments were as follows: T1: an unfertilized control; T2: NPK at 250-150-125 kg ha-1; T3: SM. The findings reveal a substantial and positive association between maize grain production and the accessible amounts of N, P, and K in the soil (R2 = 0.52, 0.91, and 0.55 correspondingly). Conclusively, in order to increase crop output on a sustainable basis, the combination of organic manures and inorganic fertilizers may be employed at the best rates.[7]

The goal of this study was to compare two organic fertilizers from different sources-compost coupled with biofertilizer (CCB) and filter mud cake (FMC)-to traditional inorganic fertilizers in order to determine how they affected the quality of sunflower seeds, sunflower oil, and soil characteristics. Results for the chemical makeup of sunflower seeds revealed no differences in protein or ash levels between treatments, but there was a significant difference in oil content, with the FMC recording the highest levels of oil, followed by compost (CCB), and then the inorganic treatment. An excellent source of organic matter and vital nutrients for plants and animals are organic fertilizers.[8]

Investigated was integrated nutrition management using inorganic fertilizers. To determine their impact on production and oil quality in basil, six different combinations of organic manure (FYM and Vermicompost) and inorganic fertilizers (nitrogenphosphorus-potassium (NPK)) were tested in the field. The experiment's findings showed that the combination of Vermicompost at 5 t ha^{-1} and fertilizer NPK 50:25:25 kg ha^{-1} outperformed the other five treatments in terms of growth, herb, dry matter, oil content, and oil production.[9]

The purpose of this research was to evaluate and contrast the effects of applying chemical fertilizers and inorganic 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 inorganic 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.[10]

The purpose of this research was to compare the effects of various inorganic fertilizers and mixtures of inorganic fertilizers on the qualitative and quantitative characteristics of two rice cultivars, DRR Dhan 39 and RP.BIO.226. The experiment was done on a farm in Fasalwadi village, Sangareddy district, Telangana during kharif season. The treatment includes two controls and 10 combinations of four inorganic fertilizers (60:75:75 N, P, K). At harvest, physical characteristics were assessed on grain and straw samples. This research indicated that increased quantitative and qualitative characteristics, which increased rice cultivar grain and straw production.[11]

In this research, the impact of 59 years of continuous application of inorganic fertilizers is evaluated in relation to soil organic matter and enzyme activity. The long-term field experiment in Prague-Ruzyn's soil was examined for total organic C, total organic N, hot water soluble C, microbial biomass C, and dehydrogenase activity. The findings show that the impact of adding organic matter from different sources on soil biological activity and organic matter vary. Manure had the best results; over time, applying cow slurry and straw is equivalent to applying mineral fertilizer.[12]

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 NH4OAc, AK was measured by flame photometry.

Data Analysis

The obtained data may be evaluated using Analysis of Variance (ANOVA) to determine the influence of inorganic 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 (inorganic, 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 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 pH:

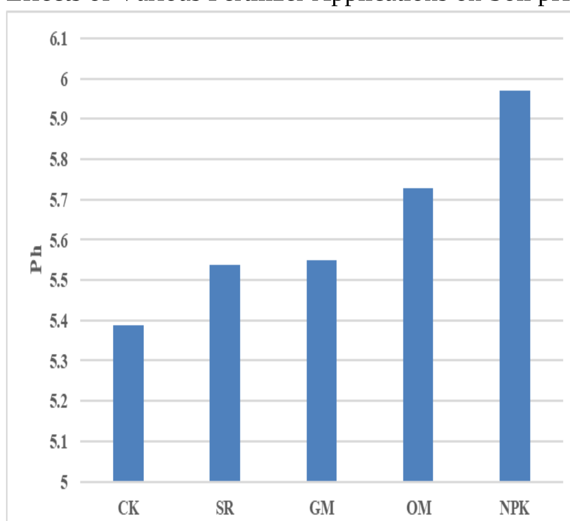

Fig 1.

Fig.1 shows soil pH averages. Fertilization treatments significantly increased soil pH compared to the CK treatment ($P<0.05$). CK had the lowest soil pH (5.38 units) and NPK the highest (5.97 units). OM soil pH was 5.72 units higher than CK, the soil pH with NPK treatment was reasonably steady (Fig.2). Despite minor variances, some therapies exhibited a definite decreasing tendency over time. After fertilization, all treatments had similar soil pH, but CK's pH dropped quickly from 5.71 to 5.03 (0.68 units lower). SR, GM, and OM treatments decreased soil pH by 0.57, 0.57, and 0.27 units, respectively.

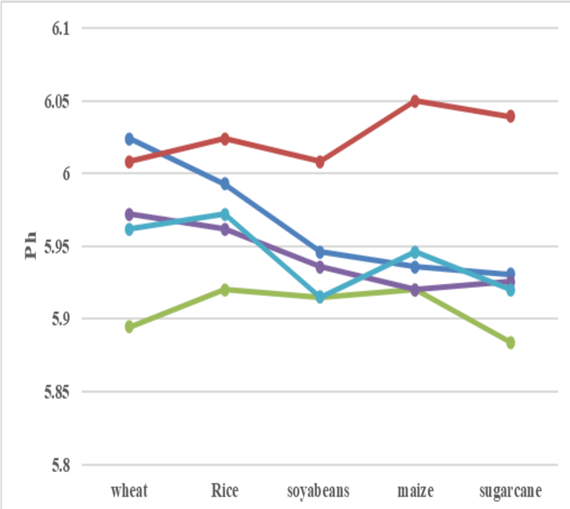

Fig 2.

Effects of Various Fertilizer Applications on Soil C/N Ratio

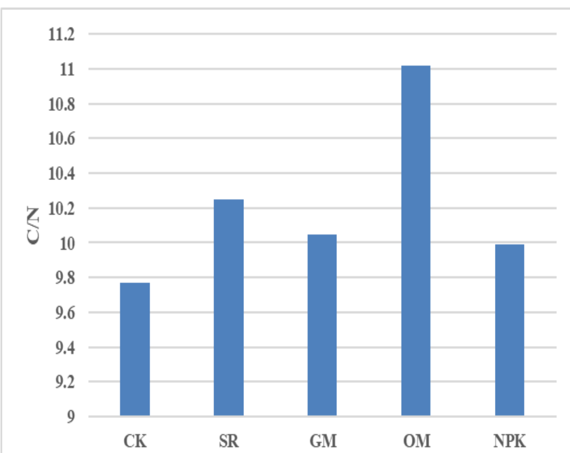

Fig 3.

The soil C/N ratio across different treatments clearly changed as a result of fertilizer application (Figure 3). The average C/N ratio (11.02) of the OM therapy was significantly higher than that of the other treatments ($P < 0.05$). The SR therapy's C/N ratio was likewise much higher than CK's. C/N ratios varied from 9.76 to 10.24 in the CK, SR, GM, and NPK treatments, with no discernible differences between them.

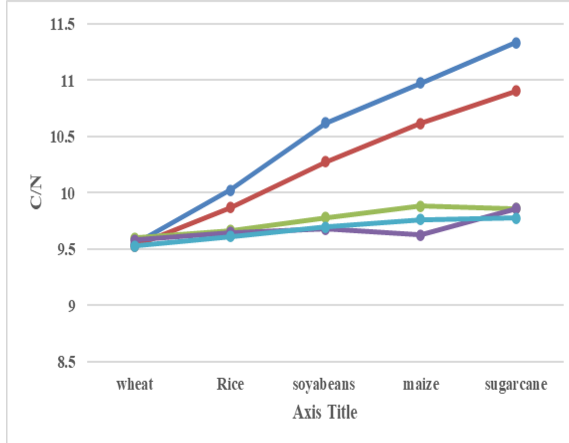

Fig 4.

Figure 4 depicts the dynamics of soil C/N ratios from Crops like wheat, Rice, Soybeans, Maize, Sugarcane. In OM and GM treatments, the C/N ratios rose significantly (20.0% and 12.9% greater than the starting quantity). And after that, until 2020 (when they reached 10.14 and 11.98, respectively), the levels gradually and steadily increased. All five treatments showed comparable patterns without a significant difference in the year between (2022-2023) of the trial, with modest variations between 8.28 and 11.68.

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 inorganic 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), Sheep manure (SM), Poultry Manure (PM), Farmyard Manure (FYM), Diammonium Phosphate (DAP), Sulphate of Potash (SOP), Compost Coupled with Biofertilizer (CCB, Filter Mud Cake (FMC), 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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