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Influence of Organic Manure on Soil Health and Crop Yield

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Abstract

Organic manure is an important component of sustainable agriculture because it supplies plant nutrients while improving soil physical, chemical, and biological properties. The present study was designed to evaluate the influence of different organic manure treatments on soil health and crop yield. Five treatments were considered: untreated control, farmyard manure, compost, vermicompost, and farmyard manure combined with compost. The experiment was assumed to be conducted using a randomized complete block design with three replications. Soil organic carbon, available nitrogen, phosphorus and potassium, soil pH, microbial activity, bulk density, and crop yield were evaluated. The illustrative results indicated that organic manure application improved soil organic carbon, nutrient availability, microbial activity, and crop productivity compared with the untreated control. Vermicompost and the combined application of farmyard manure and compost produced particularly favorable results. The combined treatment recorded the highest illustrative soil organic carbon, available nutrients, and crop yield. Soil bulk density decreased under organic manure treatments, indicating improvement in soil structure. Crop yield increased by approximately 31% under the combined organic-manure treatment compared with the untreated control. These results suggest that regular application of organic manure can improve soil health and contribute to sustainable crop production. However, the numerical values presented in this manuscript are illustrative and should be replaced with actual experimental observations before scientific publication.

Keyword: Organic manure, soil health, farmyard manure, compost, vermicompost, soil fertility, soil organic carbon, crop yield, sustainable agriculture

Introduction

Soil is one of the most important natural resources supporting agricultural production. Sustainable crop production depends not only on the availability of nutrients but also on favorable soil physical, chemical, and biological conditions. Continuous cultivation, intensive tillage, removal of crop residues, and excessive dependence on inorganic fertilizers can gradually reduce soil organic matter and negatively affect soil quality.

Organic manure has traditionally been used by farmers to maintain soil fertility. Farmyard manure, compost, vermicompost, poultry manure, green manure, and other organic materials contain varying amounts of nitrogen, phosphorus, potassium, secondary nutrients, and micronutrients. In addition to supplying nutrients, organic amendments contribute organic matter to the soil.

The decomposition of organic manure increases soil organic carbon and supports microbial activity. Soil microorganisms play an important role in nutrient cycling, decomposition of organic residues, and formation of stable soil aggregates.

Organic manure can also improve soil structure by increasing aggregation, reducing bulk density, and improving water-

holding capacity. These changes can enhance root growth and improve the availability of water and nutrients to crops.

Farmyard manure is a widely available organic amendment consisting mainly of animal dung, urine, bedding material, and partially decomposed organic residues. Compost is produced through controlled decomposition of plant and other biodegradable materials. Vermicompost is produced through the activity of earthworms and is generally characterized by relatively stable organic matter and readily available nutrients. The use of organic manure can also improve soil biological health. Organic materials provide substrates for microorganisms and may increase microbial biomass, enzymatic activity, and biological nutrient cycling.

However, the nutrient concentration of organic manure is generally lower than that of concentrated inorganic fertilizers. Nutrients are also released gradually as organic matter decomposes. Therefore, the long-term benefits of organic manure are often more important than its immediate nutrient-supply effect. Integrated nutrient management, in which organic and inorganic nutrient sources are used together, can further improve crop productivity while maintaining soil fertility.

The present study was therefore designed to evaluate the influence of different organic manure sources on soil health and crop yield.

Objectives

The objectives of the study were:

1. To evaluate the effect of organic manure on soil physical properties.
2. To assess changes in soil organic carbon following manure application.
3. To determine the influence of organic manure on available soil nutrients.
4. To evaluate the effect of organic amendments on soil microbial activity.
5. To study the influence of organic manure on crop growth and yield.
6. To compare different organic manure sources for improving soil health.
7. To assess the potential of organic manure for sustainable agricultural production.

Materials and Methods

Experimental Site

The experiment was assumed to be conducted at an agricultural research farm during one complete cropping season.

For an actual research paper, the study location should include information on geographical coordinates, altitude, climate, rainfall, temperature, soil classification, previous cropping history, and initial soil characteristics.

The numerical data reported in this manuscript are illustrative because no original experimental dataset was supplied.

Experimental Design

The experiment was arranged in a randomized complete block design with five treatments and three replications.

The treatments were:

- T₁: Control – no organic manure
- T₂: Farmyard manure (FYM) @ 10 t ha⁻¹
- T₃: Compost @ 5 t ha⁻¹
- T₄: Vermicompost @ 5 t ha⁻¹
- T₅: FYM @ 5 t ha⁻¹ + compost @ 5 t ha⁻¹

All treatments received similar crop-management practices except for the specified organic manure treatments.

Soil Sampling

Soil samples were collected before application of manure and after crop harvest.

Samples were collected from the root-zone depth using a soil auger. Several samples from each plot were combined to obtain a representative composite sample.

Samples were air-dried, gently crushed, passed through an appropriate sieve, and analyzed using standard soil-testing procedures.

Application of Organic Manure

Organic manure was incorporated into the soil before crop establishment.

The manure was thoroughly mixed with the upper soil layer to promote decomposition and nutrient release.

The organic amendments were analyzed for moisture content and nutrient concentration before application in an actual experiment.

Soil pH

Soil pH was determined using a calibrated digital pH meter in a soil-water suspension.

Soil pH is an important indicator because it influences nutrient availability, microbial activity, and plant growth.

Soil Organic Carbon

Soil organic carbon was determined using a standard laboratory method.

Organic carbon is a major indicator of soil health because it influences aggregation, nutrient cycling, water retention, microbial activity, and overall soil fertility.

Available Nitrogen

Available nitrogen was estimated using a standard soil-testing procedure.

Nitrogen is essential for vegetative growth, chlorophyll formation, protein synthesis, and yield development.

Available Phosphorus

Available phosphorus was determined using an appropriate extraction method based on soil type.

Phosphorus plays an important role in root development, energy transfer, flowering, and seed formation.

Available Potassium

Available potassium was measured using a standard soil extraction and analytical procedure.

Potassium contributes to enzyme activation, water regulation, disease resistance, and overall plant vigor.

Soil Bulk Density

Bulk density was determined using an appropriate soil-core method.

Organic amendments were expected to reduce soil bulk density by increasing soil organic matter and improving aggregation.

Soil Microbial Activity

Soil microbial activity was assessed using a suitable laboratory indicator such as soil respiration, microbial biomass carbon, or dehydrogenase activity.

Organic manure provides carbon substrates that can stimulate microbial activity.

Crop Growth Observations

Crop growth was evaluated using parameters such as:

- Plant height
- Number of tillers or branches
- Leaf area
- Root development
- Number of reproductive structures
- Biomass production

Measurements were recorded at appropriate crop-growth stages.

Yield Assessment

The crop was harvested at physiological maturity.

Grain or economic yield was recorded from the net plot area and converted to tonnes per hectare.

Where appropriate, biological yield and harvest index were also calculated.

Statistical Analysis

Data from the experiment should be subjected to analysis of variance (ANOVA).

Treatment means should be compared using an appropriate statistical test at the 5% probability level.

Since the values in this manuscript are illustrative, statistical significance should be recalculated using actual replicated observations before publication.

Results

Effect of Organic Manure on Soil Organic Carbon

The untreated control recorded the lowest soil organic carbon. All organic-manure treatments increased soil organic carbon compared with the control. The combined FYM and compost treatment recorded the highest value, followed by vermicompost.

The improvement can be attributed to the addition of carbon-rich organic materials and their decomposition within the soil.

Effect on Soil Nutrient Availability

Organic manure application improved the availability of nitrogen, phosphorus, and potassium compared with the untreated control.

The combined FYM and compost treatment produced the highest available nitrogen, phosphorus, and potassium.

The increase in nutrient availability may be associated with mineralization of organic nutrients and improved microbial activity.

Effect on Soil Bulk Density

The untreated soil showed the highest bulk density.

Organic manure treatments reduced soil bulk density, with the lowest value observed under the combined FYM + compost treatment.

Lower bulk density indicates improved soil structure and potentially greater pore space for air and water movement.

Effect on Soil Microbial Activity

The highest microbial activity was recorded in the combined FYM + compost treatment.

Vermicompost also produced a substantial increase in microbial activity compared with the control.

The improvement may be attributed to the addition of decomposable carbon compounds and nutrients that support microbial growth.

Effect on Soil pH

Organic manure caused a modest reduction in soil pH compared with the control.

The change was relatively small but may be beneficial in soils where slightly alkaline conditions limit the availability of certain nutrients.

Effect on Crop Growth

Organic manure treatments improved plant height and productive tiller number compared with the untreated control.

The combined FYM + compost treatment produced the greatest growth response.

Improved soil nutrient availability, water retention, and biological activity may have contributed to enhanced crop growth.

Effect on Crop Yield

The highest grain yield was recorded under the combined FYM + compost treatment.

Vermicompost also produced a substantial improvement in yield.

Compared with the control, the combined organic-manure treatment increased illustrative crop yield by approximately 31%.

Discussion

Improvement in Soil Organic Carbon

Organic carbon is one of the most important indicators of soil quality.

The increase in soil organic carbon following manure application indicates that organic amendments can help replenish carbon lost through intensive cultivation and decomposition.

Higher organic carbon contributes to improved soil aggregation, nutrient retention, water-holding capacity, and microbial activity.

The combined FYM + compost treatment produced the highest organic carbon content because it supplied organic matter from two complementary sources.

Improvement in Nutrient Availability

Organic manure contains both macro- and micronutrients.

As manure decomposes, nutrients are gradually mineralized and become available to plants.

The increase in available nitrogen, phosphorus, and potassium observed under organic manure treatments indicates improved nutrient-supplying capacity of the soil.

Organic matter can also improve nutrient retention by increasing the soil's cation-exchange capacity and providing sites for nutrient adsorption.

Effect on Soil Physical Properties

Organic manure improved soil physical conditions.

The reduction in bulk density observed under organic-manure treatments suggests improved soil aggregation and pore structure.

Improved aggregation can increase infiltration, aeration, root penetration, and water retention.

These changes are particularly important in intensively cultivated soils where repeated tillage and low organic matter may cause compaction.

Effect on Soil Biological Activity

Organic manure provides energy and nutrients for soil microorganisms.

The increase in microbial activity under manure treatments suggests enhanced biological functioning of the soil.

Microorganisms contribute to:

- Organic matter decomposition
- Nutrient mineralization
- Soil aggregation
- Nutrient cycling
- Disease suppression
- Formation of stable soil organic matter

Vermicompost and compost may be particularly effective because they contain relatively decomposed organic matter and biologically active compounds.

Effect on Crop Growth

Improved soil conditions resulted in better crop growth under organic manure treatments.

Higher nutrient availability and improved soil moisture conditions can increase plant height, leaf development, root growth, and reproductive development.

The highest plant growth was observed in the combined FYM + compost treatment.

Effect on Crop Yield

Crop yield increased following organic manure application. The increase may be explained by the combined effects of:

1. Improved nutrient availability.
2. Increased soil organic carbon.
3. Improved soil structure.
4. Enhanced microbial activity.
5. Better water retention.
6. Improved root development.
7. Gradual nutrient release throughout the crop season.

The combined organic-manure treatment produced the highest yield in the illustrative experiment.

Vermicompost and Soil Health

Vermicompost showed strong effects on soil health and crop productivity.

Earthworm activity during vermicomposting can transform organic materials into a more stable and biologically active amendment.

Vermicompost may contain readily available nutrients, humified organic matter, beneficial microorganisms, and plant-growth-promoting substances.

However, the quality of vermicompost depends strongly on the original feedstock and production conditions.

Long-Term Benefits of Organic Manure

The benefits of organic manure may become more apparent after repeated applications.

Unlike soluble fertilizers, organic manure contributes directly to soil organic matter.

Long-term manure application can help maintain:

- Soil fertility
- Soil structure
- Biological activity
- Water-holding capacity
- Nutrient cycling
- Soil resilience

Therefore, organic manure should be viewed not only as a source of plant nutrients but also as an important soil-health management practice.

Advantages of Organic Manure

The major advantages of organic manure include:

1. Improvement in soil organic carbon.
2. Increased microbial activity.
3. Improved soil structure.
4. Reduced soil bulk density.
5. Improved water-holding capacity.
6. Gradual release of nutrients.
7. Improved nutrient availability.
8. Enhanced root development.
9. Increased crop productivity.
10. Recycling of farm and livestock wastes.
11. Reduction in dependence on external fertilizer inputs.
12. Long-term improvement in soil fertility.

Limitations of Organic Manure

Despite its benefits, organic manure has certain limitations:

- Low nutrient concentration compared with mineral fertilizers.
- Large quantities may be required.
- Transportation can be expensive.
- Nutrient composition varies among manure sources.
- Nutrient release depends on decomposition.
- Improperly decomposed manure may contain weed seeds or pathogens.
- Storage may result in nutrient losses.
- Labor requirements can be relatively high.

Therefore, proper composting, storage, application rate, and nutrient management are important.

Role of Organic Manure in Sustainable Agriculture

Organic manure can contribute significantly to sustainable agriculture by closing nutrient cycles and recycling locally available organic resources.

Farmyard manure and compost can convert agricultural and livestock wastes into useful soil amendments.

Regular organic-matter management can improve soil resilience against drought and degradation.

Organic manure can also complement inorganic fertilizers. Combining organic and mineral nutrient sources may provide both immediate nutrient availability and long-term soil-health benefits.

Integrated nutrient management is therefore an important strategy for maintaining productivity while protecting soil resources.

Conclusion

The present study evaluated the influence of organic manure on soil health and crop yield.

The illustrative results demonstrated that application of farmyard manure, compost, and vermicompost improved soil organic carbon, nutrient availability, microbial activity, and physical soil properties compared with the untreated control.

The combined FYM + compost treatment produced the most favorable overall results, including higher soil organic carbon, available nitrogen, phosphorus and potassium, improved microbial activity, reduced bulk density, and greater crop yield.

The combined treatment increased illustrative grain yield by approximately 31% compared with the untreated control.

These findings indicate that organic manure is an effective tool for improving soil health and maintaining crop productivity. Its regular use can enhance soil fertility, support beneficial soil microorganisms, improve soil structure, and contribute to sustainable agricultural production.

For long-term benefits, organic manure should be properly decomposed, applied according to soil and crop requirements, and integrated with other nutrient-management practices.

Recommendations

Based on the findings, the following recommendations are proposed:

1. Farmers should incorporate well-decomposed organic manure into agricultural soils.
2. Farmyard manure should be properly composted before application.
3. Vermicompost can be used where suitable raw materials and production facilities are available.

4. Soil testing should be used to determine nutrient requirements.
5. Organic manure should be combined with balanced fertilizer management where necessary.
6. Crop residues should be recycled rather than continuously removed or burned.
7. Regular application of organic matter should be encouraged to maintain soil organic carbon.
8. Long-term experiments should be conducted to assess cumulative effects of manure application.
9. Manure quality should be evaluated before large-scale application.
10. Farmers should be trained in composting, vermicomposting, manure storage, and nutrient management.

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