Effect of Organic Manure on Different Soil Properties: A Review

Abstract

Organic manure application is a common practice in sustainable agriculture, with significant effect for soil health, fertility, and productivity. This review provides a comprehensive analysis of the effects of organic manure on various soil properties, including physical, chemical, and biological parameters. The review elucidates the complex interactions between organic manure and soil, highlighting the impacts on soil structure, nutrient availability, microbial activity, and overall soil health. Additionally, the review discusses the role of organic manure in mitigating soil degradation, enhancing crop productivity, and promoting sustainable agricultural practices. By understanding the diverse effects of organic manure on soil properties, farmers and policymakers can make informed decisions to improve soil management practices and ensure long-term agricultural sustainability.

Key words: Fertility,Organic manure, Productivity, Soil health

Introduction:

Organic manure, derived from plant or animal sources, is a valuable input in sustainable agricultural systems, offering numerous benefits for soil health, fertility, and productivity. Unlike chemical fertilizers, organic manure enriches the soil with organic matter, essential nutrients, and beneficial microorganisms, promoting soil structure stability, nutrient cycling, and biological activity (Brady & Weil, 2008). The application of organic manure has been practiced for centuries, providing a natural and environmentally friendly approach to soil fertility management (Gomiero et al., 2011). However, the effects of organic manure on soil properties are complex and multifaceted, influenced by various factors such as manure type, application rate, soil type, climate, and cropping system (Kumar et al., 2015). Understanding the diverse impacts of organic manure on different soil properties is essential for optimizing soil management practices, enhancing agricultural sustainability, and mitigating the adverse effects of chemical inputs on soil and the environment.

Effect of organic manures on soil physical properties:

Organic manure application significantly influences various soil physical properties, including bulk density, porosity, soil structure, and water retention capacity, ultimately impacting soil health and agricultural productivity. Here's a detailed overview of the effects of organic manure on soil physical properties:

Bulk Density: Organic manure incorporation tends to reduce soil bulk density, by enhancing soil aggregation and pore formation (Magdoff& van Es, 2009). The addition of organic matter improves soil structure, leading to better soil porosity and reduced compaction. As a result, soil bulk density decreases, allowing for greater root penetration, water infiltration, and air exchange within the soil profile (Brady & Weil, 2008). Lower bulk density facilitates root growth, nutrient uptake, and overall crop development, contributing to improved agricultural productivity (Angers & Caron, 1998).

Porosity: Organic manure application enhances soil porosity, influencing both macro- and micro-porosity within the soil matrix (Lal, 2004). Increased organic matter content promotes the formation of soil aggregates, creating macro-pores that facilitate water movement, root penetration, and gas exchange (Lehmann et al., 2008). Moreover, organic matter serves as a substrate for microbial growth, contributing to the formation of micro-pores and enhancing soil biological activity (Gupta et al., 2017). Improved soil porosity enhances soil aeration, water retention, and nutrient diffusion, which are essential for sustaining plant growth and soil health.

Soil Structure: Organic manure plays a crucial role in improving soil structure, leading to the formation of stable aggregates and granules (Brady & Weil, 2008). Soil structure refers to the arrangement of soil particles into aggregates of various sizes and shapes, which influence soil stability, water infiltration, and root penetration (Six et al., 2006). Organic matter acts as a binding agent, promoting soil aggregation and reducing soil erosion (Lehmann et al., 2008). Well-aggregated soils exhibit improved resistance to compaction, crusting, and surface sealing, maintaining soil structure integrity even under adverse environmental conditions (Angers & Caron, 1998). Enhanced soil structure facilitates root growth, enhances nutrient availability, and promotes soil microbial activity, contributing to overall soil fertility and productivity.

Water Retention Capacity: Organic manure application enhances soil water retention capacity, primarily by increasing soil organic matter content and improving soil structure (Lal, 2004). Organic matter acts as a sponge-like reservoir, capable of holding water and releasing it gradually to plant roots over time (Magdoff& van Es, 2009). The presence of organic matter improves soil water-holding capacity, reducing the risk of waterlogging during wet periods and minimizing drought stress during dry periods (Brady & Weil, 2008). Moreover, organic matter enhances soil structure, promoting the formation of water-stable aggregates and reducing water runoff and erosion (Lehmann et al., 2008). Improved water retention capacity ensures adequate soil moisture availability for plant growth, supporting sustainable crop production and minimizing the risk of yield losses due to water stress.

Effect of organic manureson soil chemical properties

Organic manure application profoundly influences various soil chemical properties, including nutrient availability, pH, cation exchange capacity (CEC), and soil organic carbon content. Here's an elaboration on the effects of organic manure on soil chemical properties:

Nutrient Availability: Organic manure serves as a rich source of essential nutrients, including nitrogen (N), phosphorus (P), potassium (K), micronutrients, and organic matter (Brady & Weil, 2008). Upon application, organic manure undergoes decomposition and mineralization processes, releasing nutrients gradually into the soil solution (Magdoff& van Es, 2009). The slow release of nutrients from organic matter ensures a sustained supply of plant-available nutrients throughout the growing season, supporting crop growth and development (Lehmann et al., 2008). Additionally, organic matter improves soil structure and microbial activity, enhancing nutrient cycling and nutrient uptake by plants (Gupta et al., 2017). As a result, organic manure application improves soil fertility, increases nutrient availability, and reduces the reliance on synthetic fertilizers, thereby promoting sustainable agriculture.

pH: Organic manure application can influence soil pH, albeit to a lesser extent compared to liming or acidifying agents (Brady & Weil, 2008). The pH of organic manures varies depending on their composition and decomposition stage, ranging from acidic to neutral or slightly alkaline (Magdoff& van Es, 2009). Generally, fresh organic manures may have a slightly acidic pH due to the presence of organic acids, while well-decomposed organic matter tends to have a neutral or slightly alkaline pH (Brady & Weil, 2008). Organic matter acts as a buffer, moderating changes in soil pH and stabilizing soil acidity or alkalinity (Lal, 2004). However, excessive application of certain organic manures, such as poultry litter or animal manure, can lead to localized increases in soil pH, especially in areas with high nutrient loading (Magdoff& van Es, 2009). Proper management and incorporation practices are essential to minimize pH fluctuations and maintain optimal soil conditions for crop growth.

Cation Exchange Capacity (CEC): Organic manure application enhances soil CEC, primarily through the addition of organic matter and clay-humus complexes (Brady & Weil, 2008). Organic matter serves as a reservoir for cations, such as calcium (Ca), magnesium (Mg), potassium (K), and ammonium (NH4+), which are readily exchangeable with soil particles (Magdoff& van Es, 2009). The high CEC of organic matter allows it to retain and exchange nutrients with plant roots, enhancing nutrient availability and uptake (Brady & Weil, 2008). Moreover, organic matter improves soil structure and aggregation, increasing the surface area available for cation exchange reactions (Lehmann et al., 2008). Enhanced CEC promotes soil fertility, nutrient retention, and buffering capacity, reducing nutrient leaching and runoff, and improving overall soil health.

Soil Organic Carbon (SOC) Content: Organic manure application increases soil organic carbon content, contributing to soil fertility, water retention, and microbial activity (Lal, 2004). Organic matter serves as a source of carbon input into the soil, promoting soil organic carbon accumulation and stabilization (Lehmann et al., 2008). The addition of organic matter stimulates microbial decomposition and humification processes, leading to the formation of stable organic carbon pools in the soil (Brady & Weil, 2008). Increased soil organic carbon content improves soil structure, water holding capacity, and nutrient cycling, enhancing soil productivity and resilience to environmental stresses (Magdoff& van Es, 2009). Moreover, soil organic carbon sequestration contributes to climate change mitigation by reducing atmospheric CO2 levels and enhancing soil carbon storage (Lal, 2004).

Effect of organic manureson soil biological properties

Organic manure application exerts profound effects on soil biological properties, influencing microbial abundance, diversity, activity, and overall soil health. Here's an overview of the effects of organic manure on soil biological properties:

Microbial Abundance and Diversity: Organic manure serves as a substrate and energy source for soil microorganisms, promoting microbial growth and activity (Gupta et al., 2017). The addition of organic matter stimulates the proliferation of diverse microbial communities, including bacteria, fungi, actinomycetes, and protozoa, contributing to soil biodiversity and ecosystem functioning (Lehmann et al., 2008). Organic matter provides carbon, nitrogen, and other nutrients essential for microbial metabolism, supporting microbial biomass accumulation and diversity (Six et al., 2004). Moreover, organic manure application enhances microbial habitat availability and soil moisture retention, creating favorable conditions for microbial colonization and activity (Brady & Weil, 2008). Increased microbial abundance and diversity promote nutrient cycling, organic matter decomposition, and soil biogeochemical processes, ultimately enhancing soil fertility and ecosystem resilience.

Microbial Activity: Organic manure application enhances soil microbial activity, as indicated by increased enzyme production, nutrient mineralization, and organic matter decomposition rates (Lehmann et al., 2008). Soil microorganisms play a vital role in nutrient cycling, organic matter turnover, and soil ecosystem functioning (Gupta et al., 2017). Organic matter serves as a substrate for microbial growth, providing energy and nutrients for microbial metabolism (Brady & Weil, 2008). Microbial decomposition of organic matter releases nutrients such as nitrogen, phosphorus, and sulphur into the soil solution, making them available for plant uptake (Magdoff& van Es, 2009). Moreover, soil microorganisms contribute to the stabilization of soil aggregates, soil structure formation, and carbon sequestration through the formation of microbial biomass and extracellular polymeric substances (Lehmann et al., 2008). Enhanced microbial activity promotes soil health, nutrient cycling efficiency, and crop productivity, highlighting the importance of organic manure in sustainable soil management.

Soil Organic Matter: Organic manure application accelerates soil organic matter turnover, leading to increased decomposition rates and nutrient cycling dynamics (Brady & Weil, 2008). Soil organic matter serves as a reservoir of carbon, nitrogen, phosphorus, and other nutrients essential for plant growth and soil fertility (Lal, 2004). Organic matter decomposition by soil microorganisms releases labile and recalcitrant organic compounds, which serve as energy sources for microbial growth and activity (Lehmann et al., 2008). The turnover of soil organic matter influences soil carbon dynamics, nutrient availability, and soil structure stability (Magdoff& van Es, 2009). Moreover, microbial decomposition of organic matter contributes to humus formation, soil aggregation, and carbon sequestration, enhancing soil fertility and resilience to environmental stresses (Six et al., 2004). Organic manure application accelerates soil organic matter turnover, leading to increased nutrient cycling, soil fertility, and crop productivity.

Soil Health and Resilience: Organic manure application enhances soil health and resilience by promoting beneficial soil microbial communities and ecosystem processes (Gupta et al., 2017). Soil microorganisms play a crucial role in nutrient cycling, disease suppression, and soil structure formation, contributing to overall soil health and productivity (Lehmann et al., 2008). Organic matter serves as a source of energy and nutrients for soil microbes, supporting their growth, activity, and diversity (Brady & Weil, 2008). Increased microbial activity and diversity improve soil structure, nutrient availability, and disease suppression, enhancing soil resilience to environmental stresses (Six et al., 2004). Moreover, organic manure application reduces soil erosion, nutrient leaching, and pollution risks associated with chemical inputs, promoting sustainable soil management practices (Magdoff& van Es, 2009). By enhancing soil biological properties, organic manure contributes to soil health, fertility, and ecosystem sustainability.

Conclusion

In conclusion, organic manure application profoundly influences soil biological properties, enhancing microbial abundance, diversity, activity, and overall soil health. By providing a rich source of organic matter, nutrients, and energy for soil microorganisms, organic manure promotes the proliferation of beneficial microbial communities, supporting nutrient cycling, organic matter turnover, and soil ecosystem functioning. Increased microbial activity and diversity improve soil structure, nutrient availability, and disease suppression, contributing to soil health, fertility, and resilience to environmental stresses. Sustainable soil management practices that integrate organic manure application are essential for maintaining soil biological properties, supporting soil health, and promoting agricultural sustainability in the face of ongoing global environmental challenges.

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