

Research Article

Review of Organic Fertilizer and Its Role in Organic Farming

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Abstract

The use of organic fertilizers is a major component of organic farming practices. The decline in soil quality is becoming a significant process of soil degradation. Optimizing organic fertilizer incorporation practices in cropland is essential to enhancing crop productivity and soil health. Organic fertilizers are substances with a specific chemical composition and high nutritional content that supply essential nutrients for plant growth. Organic materials are used as food sources because of organic fertilizer, which involves the biochemical breakdown of dead organic tissue into its inorganic constituent forms, primarily through the action of microbes. The important crop nutrients (N, P, K, S, Ca, Mg, B, Cl, Cu, Fe, Mn, Mo, Ni, and Zn) are provided in balanced forms by organic fertilizers, including micronutrients during decomposition by micro-organisms. Organic fertilizers also play a crucial role in improving soil health, crop yield, and help in climate change and conservation through various mechanisms. It also plays a key role in enhancing production, mainly because of their high content of organic matter, which enhances the physical, chemical, and biological characteristics of the soil, besides promoting proper growth development for an economically viable production yield for farmers.

Keywords

Organic Farming, Crop Yield, Soil Health, Climate Change, Balanced Nutrient

1. Introduction

The Codex Alimentarius Commission defines organic agriculture as a comprehensive management system that excludes synthetic fertilizers, pesticides, and genetically modified organisms. It aims to reduce pollution in air, soil, and water, while enhancing the health and productivity of interconnected communities of plants, animals, and people [1].

Humans have been aware of organic farming for a very long time, specifically since our forefathers used the agricultural science. Everything was done the old-fashioned manner back then, with natural materials. The requirement for food rises in tandem with the growth of agricultural science and the human population. Food needs in Indonesia have been significantly met as a result of the green revolution [2]. There has

been a rise in the use of pesticides, high-yielding variety planting, synthetic fertilizers, and land intensification. But as times have changed, a number of issues have recently been discovered as a result of agricultural land being mismanaged. These issues include pollution from chemical pesticides and fertilizers, which arises from their overuse, and the effects these synthetic materials have on human health and the environment [3].

The widespread use of inorganic fertilizers in agriculture causes irreversible environmental harm and a number of health problems, despite the fact that fertilizers are meant to improve soil fertility. Therefore, in an attempt to mitigate and ultimately eliminate the detrimental effects of synthetic ferti-

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lizers on the environment and human health, a new farming method called as organic agriculture, sustainable agriculture, or ecological agriculture has arisen [4, 5].

Organic nutrient sources are specifically derived from plant and animal origins. Microbial fertilizers are very economical, non-bulky, and environmentally benign, and they are important for plant [6]. Organic fertilizers are generally more readily available and less expensive than chemical fertilizers from local [7]. Soil fertility is based on organic matter [8].

Organic materials are used as food sources because of organic fertilizer, which involves the biochemical breakdown of dead organic tissue into its inorganic constituent forms, primarily through the action of microbes [9]. Organic fertilizer boosts the soil's organic matter, carbon content, cation and anion exchange capacity, and microbial activity. Similar to inorganic fertilizers, organic fertilizers improve the quality and productivity of agricultural crops [10].

In order to maximize crop production, organic farming techniques rely on managing soil organic matter to improve the soil's chemical, biological, and physical qualities [11]. Because organic matter improves and maintains soil quality [12] and soil health [13] it has an impact on crop productivity. Other physical, chemical, and biological characteristics and processes are intricately connected to SOM composition. However, they do not pollute the environment. Due to its beneficial effects on soil processes and characteristics, organic matter content is a crucial indication of soil health [14].

FAO indicated that when organic materials are added over a number of seasons, their decomposition is slowed by the tannin and lignin content, which also has a long-term effect on nutrient availability [15]. Low doses of N and P fertilizers applied with various organic materials, such as farmyard and compost, have also been shown to increase maize grain yield when compared to the control treatment. When compared to the prescribed rate of N and P fertilizers (110/20 kg/ha), the combined use of organic materials with N and P fertilizers produced a comparable grain yield. [16] in his report also indicated that the potential yield increases of $10\% \pm 11\%$ for maize and $23\% \pm 37\%$ for wheat with increase in SOM content. Oldfield and colleagues concluded that enhancing SOM stocks in degraded soils, and in those where a large yield gap exists, can narrow the yield gap. These yield increments according to the conclusion of Oldfield and colleagues amount to abridging the yield gap of 30% for maize and 55% for wheat, while also reducing the fertilizer inputs by 5% to 7%. Oldfield and colleagues also observed that higher concentrations of SOC are associated with greater crop yields up to SOC concentration of 2%, and that led to decreased inputs of fertilizer and irrigation.

Oldfield reported that to maintain soil productivity and tilth to supply plant nutrients and to control insects, weeds, and other pests, organic farming depends on crop rotation, crop residues, animal manures, legumes, green manures, off-farming organic wastes, agricultural cultivation, mineral-bearing rocks, and biological pest control [17].

Hence, the main objective of this review paper was to explain organic fertilizer and its role on organic farming and crop production.

2. Organic Fertilizer

Organic fertilizers are substances with a specific chemical composition and high nutritional content that supply essential nutrients for plant growth [18]. They are primarily produced through the composting of animal manure, human waste, or plant materials (such as straw and garden waste), with the help of microorganisms that ferment these materials at high temperatures [19]. Organic fertilizers enhance soil structure, offer a variety of nutrients to plants, and introduce beneficial microorganisms into the soil. Due to their positive effects on soil health and crop yields, organic fertilizers are widely used in agricultural practices [20].

Sarkar reported that organic fertilizers have a significant potential to enhance plant growth and environmental sustainability [21]. Chew also listed the materials that organic fertilizer can be made of: animal manure, human waste, household garbage, municipal waste, agricultural waste, and plant components are typically composted to create organic fertilizers. They are known for increasing the amount of organic matter in the soil and releasing nutrients gradually [22].

Abott clearly reported the importance of organic fertilizer that crop productivity is significantly increased when organic fertilizers are applied because they improve the soil's organic matter (SOM), structure, nutrient availability, and microbial activity [23]. Ogbalu., stated that organic fertilizers alter the cation exchange capacity (CEC) of the soil [24]. Better soil texture, water retention, and erosion resistance are a few of the significant benefits of organic fertilizers. While organic fertilizers do not burn roots or destroy beneficial microorganisms in the soil, they can offer nitrogen in a form that plants may absorb to increase plant development.

By providing for the nutritional needs of the plants and increasing their tolerance, organic fertilizers aid in the prevention of diseases. A significant source of stress is eliminated by this activity. According to [25] plant wastes such as wood ash, spent grain, rice bran, and sawdust worked well as fertilizers. [26] asserts that while farmers have access to ancient sources of nutrients, artificial fertilizers are not frequently used by people.

Haynes Corroborated that organic fertilizer boosts yield and maintains soil productivity [27]. According to [28], using a variety of organic resources as soil amendments particularly cow dung, chicken droppings, and farm yard manure is appropriate for boosting crop yields.

2.1. The Role of Organic Fertilizer on Soil Health

The ability of soil to promote the health of people, animals, and plants as a living ecosystem is referred to as soil health

[29]. [30] reported that the chemical, physical, and biological properties of the soil are used to determine the healthiness of soil.

Lehmann, reported that organic fertilizers play a crucial role in improving soil health through various mechanisms [31]. These mechanisms ensure that nutrients are available to plants when they need them the most, enhancing overall soil fertility and crop yield. These mechanisms were: (1). Nutrient Synchrony and Release: Organic fertilizers provide a steady release of nutrients over time. This slow release matches the nutrient needs of plants, ensuring they get what they need at the right time. This process, known as nutrient synchrony, helps in reducing nutrient loss to the environment. (2). Priming Effect on Soil Nutrients: -The priming effect refers to the short-term changes in soil nutrient turnover caused by adding organic materials. This effect can lead to a more rapid mineralization rate, making previously unavailable nutrients accessible to plants. The priming effect is enhanced by the improvement in *microbial activity* due to organic material addition. (3). Impact on Soil Microbial Activity:-Organic fertilizers boost soil microbial activity, which is essential for nutrient cycling and soil health. The addition of organic matter provides a food source for microbes, increasing their population and diversity. This, in turn, enhances the soil's ability to retain water and nutrients, leading to better crop growth.

The best manures to raise the pH of an acidic soil and act as a buffer against pH fluctuations once in the soil are those with a high carbonate and organic matter content. One crucial determinant of soil fertility and quality was the amount of organic matter present [31]. An excellent compost of animal by-products is a safe fertilizer due to the low content in soluble salts, the minimal load of plant and pathogens, the slower release of its nutrients, and the higher amount of humus fractions [32].

One of the three elements of soil that is essential to its physicochemical characteristics, including its sporting and buffering capacities, biodiversity, and biological activity, is organic matter. It was necessary to preserve or enhance the resources of organic matter because of its beneficial effects on soil functionality [33]. Compared to the unkempt areas Campbell, the soils that were subjected to frequent applications of bovine dung felt softer to the touch and were less compacted underfoot. Natural organic materials with enough nutrients to improve soil health are referred to as organic fertilizer [34, 35].

Organic fertilization methods provide a sustainable way to maintain soil health over time by supplying a range of soil nutrients [36, 37]. According to a number of studies, applying organic fertilizers to the soil changes its cation exchange capacity (CEC), organic matter (SOM), and acidity while also raising its moisture content. An important precursor to essential and trace elements, soil organic carbon (SOC) is raised by increasing the amount of SOM [38]. As a result, applying organic fertilizers improves the degraded soils' resistance and fosters the sustainability of soil health over the long run [39].

2.2. Importance of Organic Fertilizer on Balanced Nutrient Supply

All of the important crop nutrients (N, P, K, S, Ca, Mg, B, Cl, Cu, Fe, Mn, Mo, Ni, and Zn) are provided in balanced forms by organic fertilizers, including micronutrients. Frequently, this isn't true for any one inorganic fertilizer. All of these nutrients are released into the soil during the decomposition process since they comprise the biomass of organic wastes. The drawback of using only organic fertilizers is that they are deficient in these nutrients and must therefore be administered in large quantities to satisfy crop nutrient requirements [40]. When using organic fertilizers, it's also important to keep in mind that only a portion of the nutrients can be released each season.

2.3. The Role of Organic Fertilizer on Crop Yield

Organic agriculture is frequently considered more resilient and capable of maintaining higher yield stability [41] one potential explanation is the use of organic amendments, which enhance soil organic matter and can improve yields during droughts [42]. Additionally, implementing more diverse crop rotations may contribute to greater yield stability [43].

Applying organic fertilizers is considered an effective strategy for improving crop yields, particularly in challenging conditions. Research highlights several benefits of using organic materials, including enhanced crop resistance to heavy metals, heat, salinity, and drought [44]. Combining organic with inorganic fertilizers is seen as a practical approach to maintaining crop ecosystem sustainability, improving both soil quality and crop yields [45]. Organic fertilizers boost soil fertility and structure [46, 47] by increasing organic matter (SOM), which provides plant nutrients and enhances soil health, especially in nutrient-limited environments with low chemical fertilizer inputs [48]. Studies suggest that higher SOM content improves crop productivity by reducing the need for mineral nitrogen and enhancing overall soil conditions, which can be especially valuable for degraded soils [49]. In comparison to no application, numerous studies have demonstrated that adding organic fertilizers to the soil surface can greatly enhance the diversity and composition of the microbial community and offer microorganisms a rich food source [50, 51].

2.4. The Role of Organic Fertilizer on Climate Change

The application of organic fertilizers in agriculture has been widely used and is shown to significantly impact greenhouse gas (GHG) emissions. Some studies suggest that using organic fertilizers can help reduce GHG emissions [52, 53]. This reduction in GHG emissions is primarily attributed to two factors. First, the use of organic fertilizers helps lower

environmental impact by reducing dependence on chemical nitrogen fertilizers, which in turn cuts emissions associated with their production. Second, organic fertilizers improve nitrogen use efficiency (NUE) in the field, leading to further reductions in GHG emissions [54]. In compacted and poorly drained soils, adding organic fertilizers can enhance soil aggregation and structure, allowing for better water infiltration and reducing the risk of flooding by preventing water from lingering on the surface. Additionally, incorporating organic matter helps lower the amount of greenhouse gases released by agriculture, as it facilitates the sequestration of carbon into the soil. Without this intervention, carbon would likely escape into the atmosphere as CO₂ or CH₄ [55]. Therefore, using organic fertilizers not only mitigates greenhouse gas emissions that contribute to global warming and climate change but also aids in adapting the soil to current and future climatic shifts. The use of organic fertilizers, which has been widely advocated worldwide, helps decrease agriculture's reliance on chemical fertilizers, thereby preventing soil degradation [56]. Organic fertilizers not only promote the reduction and increased efficiency of chemical fertilizers but also enhance crop yield and quality [57, 58]. Additionally, they improve soil microbial diversity, biomass, and [59], which in turn boosts soil quality and aids climate protection by increasing carbon sequestration in agricultural ecosystems [60].

2.5 The Role of Organic Fertilizer on Conservation Agriculture

Soil conservation methods are essential for maintaining long-term productivity [61]. [62] Conservation agriculture (CA) helps retain soil moisture, reduces erosion and runoff, enhances water quality, and supports biodiversity and aboveground ecosystems [63]. It also offers benefits for pest control and pollination. Studies show that conservation agriculture significantly lowers water usage and energy inputs [64]. This approach is especially valuable in extreme climate conditions, as it helps alleviate heat and water stress, leading to higher crop yields and improved resilience [65]. Organic agriculture hinders the use of synthetic inputs, such as pesticides and fertilizers. Research indicates that organic farming boosts biodiversity and minimizes environmental harm, though it typically leads to lower productivity [66].

3. Conclusion

In order to maximize crop production, organic farming techniques rely on managing soil organic matter to improve the soil's chemical, biological, and physical qualities. Because organic matter improves and maintains soil quality and soil health, it has an impact on crop productivity. Organic fertilizers are crucial for boosting production due to their high organic matter content, which improves the physical, chemical, and biological properties of the soil. This, in turn, supports healthy crop growth and contributes to an economically

viable yield for farmers. Organic fertilizers offer several benefits for farmers: the benefits of organic fertilizers are contains higher soil organic matter content which improves crop productivity by reducing the need for mineral nitrogen and enhancing overall soil conditions, improves soil structure with better oxygenation, healthier, and more fertile soil, longer-lasting effects for crops compared to chemical fertilizers, environmentally sustainable and important in climate change, and simple to apply.

Abbreviations

CA	Conservation Agriculture
CEC	Cation Exchange Capacity
FAO	Food and Agricultural Organization
SOM	Soil Organic Matter
SOC	Soil Organic Carbon
GHG	Green House Gas
NUE	Nitrogen Use Efficiency

Author Contributions

Merga Boru is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

No conflict of interest because since the author is single

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