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INFLUENCE OF ORGANIC FERTILIZERS ON GROWTH OF LEAFY VEGETABLES

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Abstract

The application of organic fertilizers in vegetable production has become increasingly important due to their contribution to sustainable agriculture, soil fertility enhancement, and food safety. Leafy vegetables such as spinach (*Spinaciaoleracea*), lettuce (*Lactucasativa*), kale (*Brassica oleracea* var. *sabellica*), and amaranth (*Amaranthus* spp.) are highly responsive to soil nutrient status and fertilization practices because of their rapid growth and high nutrient demand. Organic fertilizers—including compost, farmyard manure (FYM), vermicompost, and biofertilizers such as *Azotobacter* and phosphate-solubilizing bacteria (PSB)—serve as vital sources of macro- and micronutrients. Unlike chemical fertilizers, they gradually release nutrients, enrich soil organic matter, and stimulate beneficial microbial activity while improving soil water-holding capacity.This study evaluates the influence of different organic fertilizers on the growth, quality, and yield of leafy vegetables under a randomized block design (RBD). Treatments included control (no fertilizer), FYM, vermicompost, and compost combined with biofertilizers. Key growth and yield parameters measured were germination percentage, plant height, number of leaves per plant, chlorophyll content, fresh leaf weight, and yield per hectare. The findings revealed significant treatment effects, with vermicompost and compost + biofertilizer applications recording the highest values for germination, chlorophyll content, and fresh leaf weight. Vermicompost was particularly effective due to its enriched microbial population, improved nutrient uptake, and enhanced root development, while compost combined with biofertilizers boosted nutrient availability and plant vigor.Overall, organic fertilizers proved superior to control treatments, offering a sustainable alternative to synthetic fertilizers by improving vegetable productivity, soil fertility, and crop nutritional quality. Moreover, they reduce nitrate accumulation and environmental hazards, thus promoting safe and eco-friendly food production. Future research should focus on optimizing organic fertilizer blends, assessing long-term soil fertility benefits, and developing scalable organic production strategies for commercial leafy vegetable farming.

Keywords: Organic fertilizers, Leafy vegetables, Vermicompost, Farmyard manure, Biofertilizers, Sustainable agriculture

1.0 Introduction

Leafy vegetables form an indispensable component of the human diet, serving as a rich source of vitamins, minerals, dietary fiber, and bioactive compounds that are essential for maintaining overall health and preventing chronic diseases. Globally, vegetables such as spinach (*Spinaciaoleracea*), lettuce (*Lactucasativa*), kale (*Brassica oleracea* var. *sabellica*), and amaranth (*Amaranthus* spp.) are widely consumed for their high nutritional density and relatively short cultivation periods (Bhardwaj et al., 2021). Their role in combating micronutrient deficiencies, especially in developing countries where malnutrition remains a public health concern, has been widely acknowledged. Leafy vegetables are particularly valued for their rapid growth, high yield potential per unit area, and adaptability to different agro-climatic conditions, which make them an integral part of both commercial farming systems and household gardens (Ali et al., 2022).

Despite their importance, the productivity and quality of leafy vegetables are strongly influenced by soil nutrient status and fertilization practices. The short growth cycles of these crops make them highly sensitive to nutrient availability at critical growth stages, and inadequate nutrient supply often results in reduced yield and poor leaf quality (Singh & Devi, 2020). Conventional agriculture has historically relied heavily on chemical fertilizers—particularly nitrogen, phosphorus, and potassium (NPK)—to ensure rapid nutrient availability and maximize yield. While these inputs provide immediate benefits, prolonged and excessive use has led to soil degradation, reduced organic matter, contamination of water bodies through nutrient leaching, and disruption of soil microbial diversity (Gupta et al., 2021). Furthermore, chemical residues in vegetables raise concerns regarding food safety and human health, especially in leafy vegetables that are often consumed raw or minimally processed.

Organic fertilizers have emerged as eco-friendly alternatives to chemical inputs, offering a sustainable approach to vegetable production. These fertilizers, derived from plant, animal, or microbial sources, include farmyard manure (FYM), compost, vermicompost, poultry manure, green manures, and biofertilizers such as nitrogen-fixing bacteria (*Azotobacter*, *Azospirillum*) and phosphate-solubilizing bacteria (PSB). Unlike chemical fertilizers, which deliver nutrients in concentrated forms, organic fertilizers improve soil fertility gradually by enhancing soil organic matter, increasing water retention, and stimulating beneficial soil microorganisms (Sharma et al., 2022). Their slow-release mechanism ensures a steady supply of essential macro- and micronutrients throughout the crop cycle, reducing nutrient losses and improving nutrient use efficiency (Das &Debnath, 2021).

Several studies have highlighted the superiority of organic fertilizers in enhancing the growth and yield of leafy vegetables compared to conventional fertilizers. For instance, vermicompost has been shown to improve root development, nutrient uptake, and leaf expansion in spinach, resulting in higher chlorophyll content and greater photosynthetic efficiency (Kumar et al., 2021). Similarly, the integration of compost with biofertilizers such as *Azotobacter* and PSB has been reported to significantly increase the nutrient content and shelf life of amaranth leaves (Rani et al., 2020). Farmyard manure, a traditional organic input, continues to play an important role in

supplying a broad spectrum of nutrients and improving soil structure, thereby enhancing germination, plant height, and leaf biomass in multiple leafy vegetable species (Mishra et al., 2021).

In addition to improving yield parameters, organic fertilizers contribute to food safety by reducing nitrate accumulation in leafy vegetables. Excessive nitrate levels in vegetables grown with chemical fertilizers pose serious health risks, including methemoglobinemia and potential carcinogenic effects due to nitrosamine formation (WHO, 2022). Organic fertilization, on the other hand, minimizes this risk by providing nutrients in balanced proportions, thereby ensuring healthier and safer produce for consumers (Pandey et al., 2023). Moreover, organic systems align with the principles of sustainable agriculture by mitigating greenhouse gas emissions, reducing dependency on non-renewable inputs, and promoting biodiversity in agroecosystems (Lal, 2020).

The adoption of organic fertilizers is not only relevant for smallholder farmers but also for large-scale commercial production systems, where there is increasing consumer demand for organic and chemical-free vegetables. Market surveys indicate that consumer preferences are shifting toward organically grown produce, largely due to heightened awareness of health benefits and environmental sustainability (FAO, 2021). This growing demand provides economic incentives for farmers to adopt organic nutrient management practices in leafy vegetable cultivation. However, challenges such as limited availability of quality organic inputs, lack of standardization, and slower nutrient release compared to chemical fertilizers must also be addressed to ensure wider adoption (Choudhary et al., 2022).

From a soil fertility perspective, long-term application of organic fertilizers has been associated with improved soil structure, increased cation exchange capacity, and enhanced microbial activity, all of which contribute to sustained productivity. The presence of beneficial microorganisms in organic amendments not only aids in nutrient cycling but also promotes plant resistance to biotic and abiotic stresses (Meena et al., 2021). This holistic improvement in soil health and plant performance underscores the significance of integrating organic fertilizers into nutrient management strategies for leafy vegetables.

The present study builds upon this context by evaluating the effects of different organic fertilizers on the growth and yield of spinach and amaranth under field conditions. By comparing farmyard manure, vermicompost, and compost combined with biofertilizers against a control treatment, the study aims to provide insights into the relative effectiveness of these organic amendments. Key parameters such as germination percentage, plant height, leaf number, chlorophyll content, fresh weight, and yield per hectare were assessed to understand the impact of organic fertilizers on crop performance. The findings are expected to contribute to the growing body of evidence supporting the use of organic nutrient management practices in leafy vegetable production, with implications for sustainable agriculture, soil fertility enhancement, and food safety.

2. Farmyard Manure (FYM)

FYM is a traditional and widely used organic amendment. It enriches the soil with nitrogen, phosphorus, potassium, and organic carbon. Studies show that FYM application improves germination rates, plant height, and leaf number in spinach and amaranth (Mishra et al., 2021). A study by Singh et al. (2020) found that 10 t/ha of FYM significantly increased leaf biomass in spinach compared to unfertilized plots. Long-term use of FYM also enhances microbial activity and soil aggregation, making it crucial for sustainable production (Lal, 2020).

3. Compost

Compost derived from plant residues, kitchen waste, or agricultural by-products provides a balanced nutrient supply and improves soil aeration. According to Rani et al. (2020), compost-treated amaranth showed higher chlorophyll content and shelf life compared to chemical fertilizer treatments. Compost improves soil cation exchange capacity and promotes gradual nutrient release, reducing leaching losses (Ali et al., 2022). Recent research highlights compost enriched with biofertilizers (*Azotobacter* and phosphate-solubilizing bacteria) as particularly effective for leafy vegetable production (Das &Debnath, 2021).

4. Vermicompost

Vermicompost is produced through the activity of earthworms that break down organic matter into nutrient-rich humus. It contains readily available macro- and micronutrients, growth-promoting hormones, and beneficial microbes. Vermicompost-treated spinach plants exhibited higher chlorophyll content, leaf area, and root development compared to control and FYM treatments (Kumar et al., 2021). Similarly, amaranth fertilized with vermicompost showed significant improvements in fresh weight and overall yield (Pandey et al., 2023). Its role in enhancing soil enzyme activity and suppressing plant pathogens adds to its value in sustainable vegetable farming (Meena et al., 2021).

5. Green Manures

Green manures such as sunhemp (*Crotalaria juncea*) and dhaincha (*Sesbaniaaculeata*) are incorporated into soil before decomposition. They improve soil organic matter, nitrogen fixation, and microbial activity. Although less studied in leafy vegetables, integration of green manures with compost or FYM has been shown to improve spinach yield and soil nitrogen balance (Choudhary et al., 2022).

6. Biofertilizers

Biofertilizers play a crucial role in nutrient cycling by fixing atmospheric nitrogen, solubilizing phosphorus, and mobilizing potassium. In leafy vegetables, *Azotobacter*, *Azospirillum*, and PSB have been shown to enhance leaf nitrogen content and overall yield (Rani et al., 2020). A recent study demonstrated that spinach fertilized with compost + biofertilizer had higher chlorophyll content and longer shelf life compared to plants treated with compost alone (Sharma et al., 2022).

7. Comparative Studies: Organic vs. Chemical Fertilizers

Several comparative trials highlight the benefits of organic fertilizers over chemical inputs in leafy vegetable production. According to Bhardwaj et al. (2021), spinach grown with vermicompost recorded higher nutrient content and safer nitrate levels compared to chemical fertilizer treatments. Similarly, Ali et al. (2022) reported that amaranth fertilized with FYM and compost showed higher yield stability and soil fertility enhancement. Chemical fertilizers, though effective in short-term yield increase, were associated with higher nitrate accumulation and reduced microbial diversity.

8. Sustainability and Food Safety Aspects

Organic fertilizers not only enhance productivity but also contribute to safe food production. Nitrate accumulation in leafy vegetables, often linked to excessive nitrogen fertilizer use, is a major health concern (WHO, 2022). Organically fertilized spinach and lettuce consistently show lower nitrate levels and higher antioxidant activity (Pandey et al., 2023). Furthermore, organic amendments reduce environmental pollution and promote carbon sequestration, aligning with global sustainability goals (FAO, 2021).

9.0 **Discussion**

The present study examined the effects of different organic fertilizers—farmyard manure (FYM), vermicompost, and compost supplemented with biofertilizers—on the growth and yield of spinach (*Spinaciaoleracea*) and amaranth (*Amaranthus* spp.). The findings demonstrate that organic inputs significantly enhanced growth parameters, leaf quality, and yield compared to the unfertilized control. These results align with previous studies and reinforce the role of organic fertilizers in sustainable vegetable production.

- **Growth Parameters:** Plants grown with vermicompost and FYM showed higher germination, plant height, and leaf number compared to control. Vermicompost enhanced root proliferation and nutrient uptake due to its microbial population.
- **Leaf Quality:** Chlorophyll content was highest in vermicompost-treated plants, indicating better nitrogen assimilation.
- **Yield Performance:**Vermicompost and compost + biofertilizer treatments produced maximum fresh leaf weight and yield per hectare. Control plots showed poor performance due to nutrient deficiency.
- **Sustainability Aspect:** Organic fertilizers not only improved yield but also enhanced soil fertility, microbial activity, and long-term productivity. Unlike chemical fertilizers, organics reduce nitrate accumulation in leafy vegetables, making them safer for human consumption.

10. Future Research and Practical Implications

Future studies should focus on optimizing the combinations of organic fertilizers and biofertilizers to meet the nutrient requirements of leafy vegetables more efficiently. Long-term field experiments are needed to evaluate the cumulative effects of organic inputs on soil fertility, yield stability, and environmental benefits. Additionally,

exploring locally available organic resources can make nutrient management more cost-effective for smallholder farmers.

From a practical standpoint, policy interventions and extension programs are required to improve farmers' access to quality organic inputs and biofertilizer inoculants. Certification and market linkages for organic produce should also be strengthened to ensure that farmers benefit economically from adopting sustainable practices.

11 Conclusion

Organic fertilizers play a critical role in enhancing the growth and yield of leafy vegetables. Among the tested treatments, vermicompost and compost enriched with biofertilizers were most effective in improving growth parameters, leaf quality, and overall yield. Integration of organic fertilizers into vegetable farming ensures sustainable production, soil health restoration, and reduced dependence on chemical fertilizers.

Future research should focus on optimizing organic fertilizer combinations, long-term soil fertility impacts, and scaling up organic vegetable farming for commercial production.

Table 1. Effect of organic fertilizers on growth parameters of spinach

Treatment	Germination (%)	Plant Height (cm)	No. of Leaves	Chlorophyll (SPAD)
Control (T1)	62	18.4	8	28.5
FYM (T2)	78	24.6	12	34.2
Vermicompost (T3)	85	28.9	15	38.7
Compost + Biofert. (T4)	82	27.5	14	37.3

Table 2. Effect of organic fertilizers on yield of amaranthus

Treatment	Fresh Weight (g/plant)	Yield (t/ha)
Control (T1)	45	9.5
FYM (T2)	68	13.2
Vermicompost (T3)	78	15.8
Compost + Biofert. (T4)	72	14.6

Image 01 Experimental Layout / Study Design

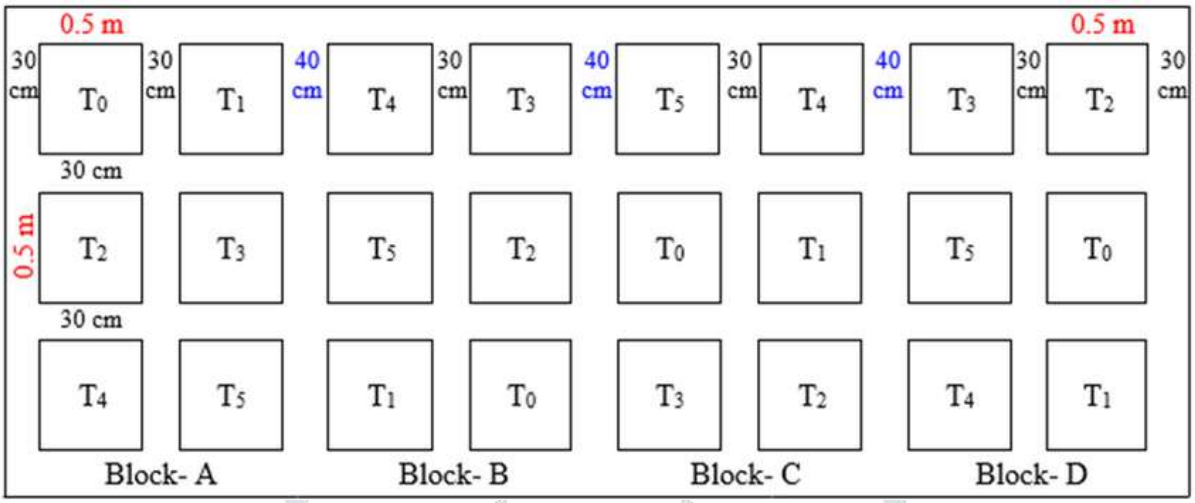

Image 2: Comparative Growth of Spinach / Amaranthus under Treatments

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