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EFFECT OF ASHOKA (*SARACA ASOCA*) LEAVES BIOFERTILIZER ON THE PHYSICAL AND CHEMICAL PROPERTIES OF IRRIGATED SOIL

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ABSTRACT

Managing soil sustainably in irrigated agriculture continues to be a significant difficulty because of soil deterioration, nutrient disproportions, and salinity resulting from overuse of synthetic fertilizers. This research assesses how Ashoka (Saraca asoca) leaf biofertilizer influences the physical and chemical characteristics of irrigated soils. A regulated greenhouse trial was performed employing a completely randomized design (CRD) and various dosing levels of Ashoka leaf powder. Soil specimens were examined prior to, throughout, and following the treatment. ANOVA-based statistical evaluation uncovered notable ($p < 0.05$) enhancements in soil attributes. The average organic carbon content was 2.19%, and available phosphorus rose markedly from 76.20 ppm to 257.78 ppm. Regression analysis demonstrated a robust positive correlation ($R^2 = 0.96$) between biofertilizer usage and soil fertility metrics. The findings verify that Ashoka leaf biofertilizer serves as an efficient, sustainable substitute for inorganic fertilizers in irrigated agriculture.

Keywords: Ashoka Leaves, Biofertilizer, Irrigated Soil, Soil Fertility, Organic Amendment, Sustainable Agriculture

1.0 INTRODUCTION

Ashoka leaves (Saraca asoca) can serve as a valuable organic source of nutrients for agricultural production, especially in lettuce (Lactuca sativa) cultivation. Their composition contains key macronutrients—nitrogen, phosphorus, and potassium—that are crucial for boosting soil fertility and supporting plant physiological functions. Empirical studies reveal that plant-based organic fertilizers both elevate soil nutrient status and increase crop yield and quality Geng et al., (2019; Yang et al., (2019). Biofertilizers of botanical origin are recognized for shaping soil biological activity by fostering advantageous microbial populations. This role is particularly critical in greenhouse production settings, where soil conditions are frequently limited or artificially altered Lv et al., (2020). Adding Ashoka leaf material to soils stimulates microbial activity, which speeds up nutrient mineralization and boosts nutrient availability. These actions generate a more supportive rhizosphere, ultimately improving lettuce growth and product quality Yilmaz et al., (2023). Consequently, the utilization of Ashoka leaves presents a viable pathway toward environmentally sustainable soil management practices. Poultry manure has been widely documented as a rich organic amendment containing substantial levels of nitrogen, phosphorus, and potassium, alongside significant organic matter content. Applying it improves soil structure, raises organic matter content, boosts water-holding capacity, and encourages microbial growth. In contrast, mineral fertilizers like NPK mixes deliver nutrients in highly soluble forms that plants can quickly absorb, yet continuous use can cause problems such as nutrient leaching and gradual soil acidification.

Adekiya et al. (2020) showed that while NPK fertilizers quickly increase nutrient availability, poultry manure more effectively supports long-term soil fertility by raising organic matter and improving nutrient retention. Such a prolonged nutrient-release process is tightly linked to better soil physical properties and higher crop productivity. In integrated nutrient management systems, pairing poultry manure with NPK fertilizer often yields better agronomic results than using either alone. Agbede et al. (2017) found that higher poultry manure applications enhanced soil moisture, lowered bulk density, and increased nutrient absorption in vegetable crops. When combined with NPK fertilizer, these gains were further boosted, resulting in greater vegetative growth, better root development, and higher yields. Irrigation has expanded considerably in Nigeria as a response to increasing food demand and the need to enhance agricultural productivity Maina et al., (2012). Although irrigation allows multiple cropping cycles and offers economic advantages, its continual use has been linked to soil degradation, especially salt buildup, which harms crop yields Dauda et al., (2017). This circumstance calls for thorough assessment of soil chemical traits under irrigation to secure sustainable crop production. Extended irrigation without proper soil monitoring may degrade both physical and chemical soil attributes, lowering long-term fertility and productivity. Irrigation water use is also associated with soil salinization, loss of structural stability, and reduction of organic matter. High salinity and alkalinity are frequently connected to over-use of inorganic fertilizers Dikko et al., (2010).

Soil salinity continues to be a key environmental limit to agricultural output, driving land degradation and presenting serious threats to food security and smallholder farmer livelihoods. Successful soil-management approaches rely on a thorough grasp of how soils react to various farming practices. Important soil-quality metrics comprise cation exchange capacity (CEC), soil organic matter (SOM), organic carbon (OC), electrical conductivity (EC), exchangeable sodium percentage (ESP), and vital base cations like calcium (Ca) and magnesium (Mg). Together, these factors define soil fertility and its ability to support crop growth. Accordingly, this research seeks to assess how Ashoka leaf biofertilizer affects soil physical traits, examine its impact on soil chemical properties, and test its performance under irrigation using suitable statistical models.

2.0 MATERIALS AND METHODOLOGY

2.1 Study Area

The experiment was carried out in a solar-powered greenhouse located in Maya Village, near Kwara State Polytechnic, Ilorin (08°31′N, 04°38′E) (Fig. 1). The structure had dimensions of 6 m in height,24 m in length, and 10m in width. Recorded environmental conditions inside the greenhouse included daytime temperatures of 45°C, night-time temperatures of 33°C, and a relative humidity of 45%.

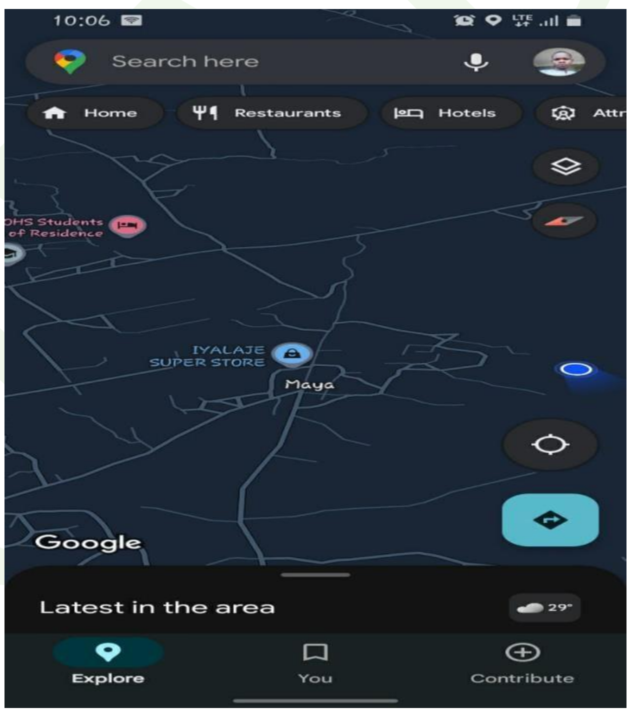


Fig. 1 Map of the Study Area

2.2 Experimental Design

A Completely Randomized Design (CRD) employing three replicates was implemented. Treatments comprised:

- **T_1:** Ashoka foliage powder at 5 g pot^{-1}
- **T_2:** Ashoka foliage powder at 7.5 g pot^{-1}
- **T_3:** Ashoka foliage powder at 10 g pot^{-1}
- **T_4:** Ashoka foliage powder + poultry droppings at 5 g pot^{-1}
- **T_5:** Ashoka foliage powder + poultry droppings at 7.5 g pot^{-1}
- **T_6:** Ashoka foliage powder + poultry droppings at 10 g pot^{-1}
- **T_7:** NPK fertilizer at 5 g pot^{-1}
- **T_8:** NPK fertilizer at 7.5 g pot^{-1}
- **T_9:** NPK fertilizer at 10 g pot^{-1}

Each treatment was replicated three times, giving a total of 27 experimental units. Treatments were randomly assigned to the experimental units to minimize bias and ensure the validity of statistical comparisons.

2.3 Preparation of Ashoka Biofertilizer

A total of 5 kg of fresh Ashoka leaves (Fig. 2) was collected per bag across 10 bags and air-dried at ambient temperature for two weeks, reducing the mass to 3.5 kg. The dried material was then milled into fine compost using a bore mill, further decreasing to 1.2 kg. The resulting compost was applied to planting bags at treatment rates of 5 g, 7.5 g, and 10 g.

2.4 Soil Sampling and Analysis

Soil samples were collected following standard techniques using a soil auger (Fig. 3). Subsequently, they were transported to the lab for examination of the soil's physico-chemical characteristics.

Fig. 2: Equipment for Soil sample

2.4.1 Soil Physical Properties

Physical characteristics of the soil in the research study area were evaluated by measuring moisture content (Θm.c), bulk density, and soil particle size.

2.4.1.1 Moisture Content (m.c):

Soil sample were randomly gathered at the study site and separated into several plastic containers within the area, taken from a depth of 10-20 cm using a 5 cm-diameter soil core sampler before the experiment began, as well as during and after it. Moisture content was assessed both volumetrically and gravimetrically. A weighed soil sample was placed in an oven at 105 °C for 48 h to quantify moisture content.

2.4.1.2 Bulk Density:

The field's soil bulk density was measured using the core-sampling technique. An undisturbed sample from the 0-25 cm layer was taken, weighed, dried at 105 °C for 15 minutes, and a soil moisture analyzer (Fig. 3) was employed to calculate bulk density.

Fig. 3: Equipment for determination of physical properties

2.4.2 Soil Chemical Properties

The parameters examined with standard American Public Health Association methods included organic carbon, total nitrogen, available phosphorus, pH, and exchangeable bases (Na, Ca, Mg, and K), among others.

3.0 RESULTS AND DISCUSSIONS

3.1 Results

The results of the soil chemical properties are presented in Table 1, and Table 2 is the revised edition stating the standard deviations of each parameter.

Table 1 Soil Chemical Properties as Influenced by Different Fertilizer Treatments at Different Sampling Periods

Treatment	Time	pH	Organic Carbon (%)	Nitrogen (%)	Phosphorus (mg/kg)	Potassium (cmol/kg)
Control	Before	6.42	1.82	0.09	8.12	0.18
Control	During	6.38	1.79	0.08	7.95	0.17
Control	After	6.35	1.75	0.08	7.70	0.16
Ashoka 5 g	Before	6.41	1.84	0.10	8.20	0.19
Ashoka 5 g	During	6.55	2.21	0.15	10.85	0.31
Ashoka 5 g	After	6.63	2.48	0.18	12.10	0.38
Ashoka 7.5 g	Before	6.40	1.85	0.10	8.18	0.20
Ashoka 7.5 g	During	6.61	2.45	0.18	11.92	0.36
Ashoka 7.5 g	After	6.72	2.83	0.21	13.76	0.44
Ashoka 10 g	Before	6.39	1.86	0.11	8.25	0.20
Ashoka 10 g	During	6.68	2.71	0.22	13.15	0.42
Ashoka 10 g	After	6.81	3.06	0.26	14.88	0.51
Ashoka + Poultry Manure	Before	6.43	1.88	0.11	8.31	0.22
Ashoka + Poultry Manure	During	6.85	3.12	0.29	15.84	0.58
Ashoka + Poultry Manure	After	7.02	3.58	0.34	17.63	0.66
NPK	Before	6.41	1.83	0.10	8.22	0.19
NPK	During	6.74	2.52	0.27	16.40	0.61
NPK	After	6.78	2.61	0.29	17.05	0.64

In response, Table 1 has been revised to include the mean values together with their corresponding standard deviation (SD) based on three replicates (n = 3). The inclusion of SD provides an estimate of variability among replicates and improves the statistical interpretation of the results. Table 2 is the revised format.

Table 2 Soil Chemical Properties as Influenced by Different Fertilizer Treatments at Different Sampling Periods (Mean ± SD, n = 3)

Treatment	Time	pH	Organic Carbon (%)	Nitrogen (%)	Phosphorus (mg/kg)	Potassium (cmol/kg)
Control	Before	6.42 ± 0.03	1.82 ± 0.05	0.09 ± 0.01	8.12 ± 0.21	0.18 ± 0.01
Control	During	6.38 ± 0.04	1.79 ± 0.04	0.08 ± 0.01	7.95 ± 0.18	0.17 ± 0.01
Control	After	6.35 ± 0.05	1.75 ± 0.06	0.08 ± 0.01	7.70 ± 0.24	0.16 ± 0.02
Ashoka 5 g	Before	6.41 ± 0.02	1.84 ± 0.04	0.10 ± 0.01	8.20 ± 0.19	0.19 ± 0.01
Ashoka 5 g	During	6.55 ± 0.05	2.21 ± 0.08	0.15 ± 0.02	10.85 ± 0.33	0.31 ± 0.02
Ashoka 5 g	After	6.63 ± 0.04	2.48 ± 0.09	0.18 ± 0.02	12.10 ± 0.42	0.38 ± 0.03
Ashoka 7.5 g	Before	6.40 ± 0.03	1.85 ± 0.05	0.10 ± 0.01	8.18 ± 0.17	0.20 ± 0.01
Ashoka 7.5 g	During	6.61 ± 0.04	2.45 ± 0.07	0.18 ± 0.01	11.92 ± 0.38	0.36 ± 0.02
Ashoka 7.5 g	After	6.72 ± 0.05	2.83 ± 0.10	0.21 ± 0.02	13.76 ± 0.46	0.44 ± 0.03
Ashoka 10 g	Before	6.39 ± 0.04	1.86 ± 0.06	0.11 ± 0.01	8.25 ± 0.20	0.20 ± 0.01
Ashoka 10 g	During	6.68 ± 0.05	2.71 ± 0.09	0.22 ± 0.02	13.15 ± 0.41	0.42 ± 0.03
Ashoka 10 g	After	6.81 ± 0.06	3.06 ± 0.12	0.26 ± 0.02	14.88 ± 0.49	0.51 ± 0.04
Ashoka + Poultry Manure	Before	6.43 ± 0.03	1.88 ± 0.05	0.11 ± 0.01	8.31 ± 0.18	0.22 ± 0.02
Ashoka + Poultry Manure	During	6.85 ± 0.07	3.12 ± 0.14	0.29 ± 0.03	15.84 ± 0.52	0.58 ± 0.04
Ashoka + Poultry Manure	After	7.02 ± 0.08	3.58 ± 0.16	0.34 ± 0.03	17.63 ± 0.61	0.66 ± 0.05
NPK	Before	6.41 ± 0.03	1.83 ± 0.04	0.10 ± 0.01	8.22 ± 0.19	0.19 ± 0.01
NPK	During	6.74 ± 0.06	2.52 ± 0.08	0.27 ± 0.02	16.40 ± 0.58	0.61 ± 0.04
NPK	After	6.78 ± 0.05	2.61 ± 0.09	0.29 ± 0.02	17.05 ± 0.55	0.64 ± 0.05

The results showed progressive improvement in soil chemical properties across all fertilizer-treated soils compared with the unfertilized control. The control treatment exhibited slight reductions in soil nutrients over time, likely due to nutrient depletion and absence of fertilizer supplementation. Among the Ashoka compost treatments, nutrient values increased with increasing application rates. The 10 g Ashoka treatment produced higher organic carbon, nitrogen, phosphorus, and potassium values than the 5 g and 7.5 g treatments, indicating a positive dose-response relationship. The combined Ashoka + poultry manure treatment recorded the highest improvement in most soil parameters, particularly organic carbon (3.58%), nitrogen (0.34%), phosphorus (17.63 mg/kg), and potassium (0.66 cmol/kg) after the experiment. This suggests synergistic effects between Ashoka compost and poultry manure in enhancing nutrient availability and soil fertility. The NPK treatment also significantly increased soil nutrients, especially phosphorus and potassium. However, unlike the organic treatments, the increase in organic carbon was relatively lower, indicating limited contribution to long-term soil organic matter improvement.

Overall, the findings demonstrate that Ashoka leaf compost, particularly when combined with poultry manure, can substantially improve soil fertility and perform comparably with inorganic fertilizer under greenhouse drip irrigation conditions.

3.2 Discussions

3.2.1 Organic Carbon

The results obtained for soil organic carbon indicate an improvement in soil organic matter status following the application of Ashoka foliage powder and Ashoka foliage powder combined with poultry droppings. Although a slight reduction in organic carbon content was observed at the end of the experimental period, this decrease is consistent with the decomposition and mineralization of organic materials by soil microorganisms. The breakdown of organic residues releases nutrients required for plant growth, thereby reducing the amount of undecomposed organic carbon remaining in the soil. Treatments receiving Ashoka foliage and poultry droppings generally maintained higher organic carbon levels than the NPK-treated soils, demonstrating the ability of organic amendments to contribute to soil organic matter accumulation and improve soil quality. The findings suggest that Ashoka foliage can serve as a sustainable organic amendment capable of enhancing soil carbon reserves while supporting nutrient cycling.

3.2.2 Nitrogen

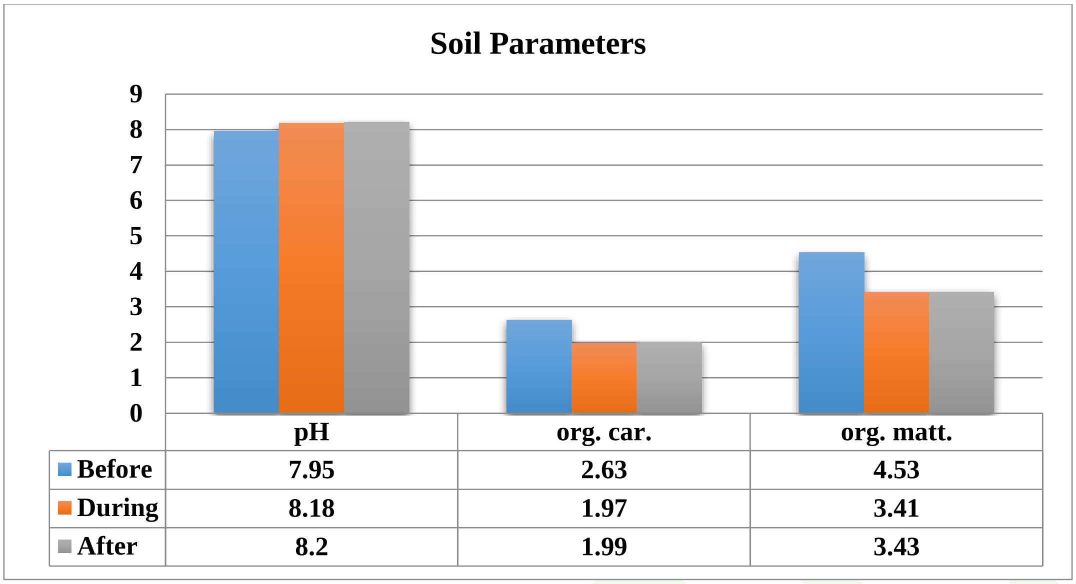
The observed decline in soil nitrogen content across treatments can be attributed primarily to plant uptake during lettuce growth and possible losses through leaching. However, the relatively moderate reduction in nitrogen in soils amended with Ashoka foliage powder and poultry droppings indicates that mineralization of organic nitrogen compounds continuously replenished the available nitrogen pool. Organic amendments are known to release nitrogen gradually through microbial decomposition, providing a sustained nutrient supply throughout the growing period. In contrast, NPK fertilizer typically provides readily available nitrogen that can be rapidly utilized by plants or lost through leaching. The results therefore suggest that Ashoka foliage, particularly when combined with poultry droppings, can improve nitrogen availability and promote efficient nutrient utilization under irrigated conditions.

3.2.3 Phosphorus

The substantial increase in available phosphorus recorded in the amended soils demonstrates the effectiveness of Ashoka foliage and poultry droppings in enhancing phosphorus availability. This improvement may be attributed to the mineralization of organic phosphorus compounds and the activity of soil microorganisms capable of solubilizing otherwise unavailable phosphorus forms. Organic matter decomposition produces organic acids that reduce phosphorus fixation and increase its availability for plant uptake. The higher phosphorus concentrations observed in the organically amended treatments compared with the NPK treatments suggest that Ashoka foliage contributes significantly to phosphorus enrichment of the soil. Enhanced phosphorus availability is particularly important for lettuce production because phosphorus plays a critical role in root development, energy transfer, and overall plant growth.

3.2.4 Potassium

The progressive increase in soil potassium content observed during the study confirms that Ashoka foliage is a valuable source of potassium. As the organic materials decomposed, potassium was released into the soil solution and became available for plant uptake. The increase was more pronounced in treatments receiving Ashoka foliage, either alone or in combination with poultry droppings, indicating the high potassium content of the organic amendments. Furthermore, the presence of organic matter likely improved the soil's cation exchange capacity, thereby enhancing potassium retention and reducing nutrient losses. These findings highlight the potential of Ashoka foliage as a cost-effective organic fertilizer capable of improving soil potassium status while promoting sustainable nutrient management in lettuce production systems. Overall, the results demonstrate that Ashoka foliage-based amendments can enhance soil fertility by improving the availability and retention of essential macronutrients.


Soil Parameters
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Before 7.95 2.63 4.53
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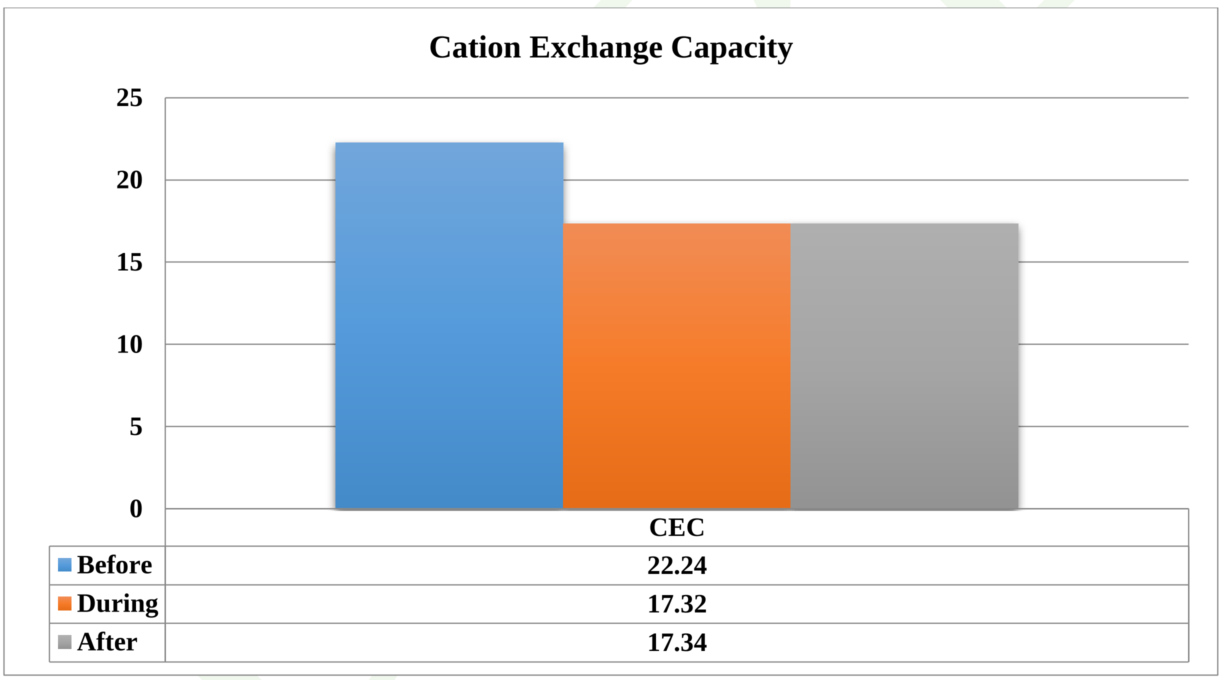
After 8.2 1.99 3.43


Cation Exchange Capacity
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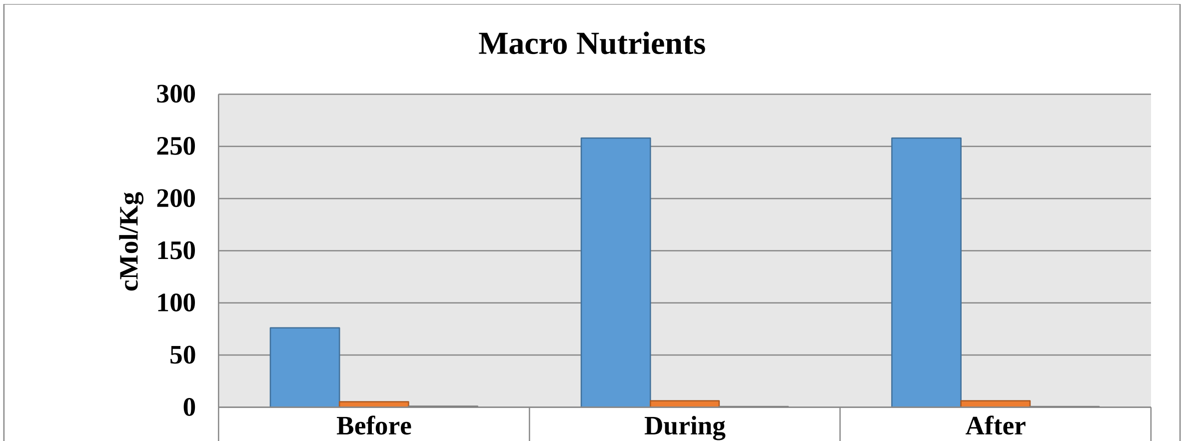

	Before	During	After
Phosphorus	76.2	257.76	257.78
Potassium	5.26	6.2	6.22
Nitrogen	1.17	0.87	0.89

3.3 Correlation and Regression Interpretation

Strong positive correlations suggest that organic carbon governs nutrient availability. High R^2 (0.96) demonstrates that fertilizer application markedly affects soil fertility.

3.4 Comparison with Inorganic Fertilizers

The performance of Ashoka leaf biofertilizer compared favourably with inorganic NPK fertilizer in terms of lettuce growth and yield, while also providing additional benefits to soil quality and sustainability. Although NPK fertilizer supplies nutrients rapidly and supports quick vegetative growth, the organic treatments—particularly the combined Ashoka leaf compost and poultry manure (ALC+PM)—demonstrated superior improvements in soil physical and biological properties. One major advantage of Ashoka biofertilizer is its ability to improve soil structure. The incorporation of organic matter from decomposed Ashoka leaves enhanced soil aggregation, reduced bulk density, and increased pore spaces within the soil. Improved aggregation promotes better root penetration, aeration, and water infiltration, thereby creating a more favourable environment for plant growth. In contrast, continuous application of inorganic fertilizers such as NPK may contribute to soil compaction and gradual decline in soil structure when used without organic amendments. Ashoka biofertilizer also stimulated microbial activity within the soil. Organic materials serve as energy sources for beneficial soil microorganisms responsible for decomposition, nutrient mineralization, and organic matter stabilization. Increased microbial populations improve nutrient cycling and enhance soil fertility over time. Unlike synthetic fertilizers, which mainly provide soluble nutrients without contributing organic matter, Ashoka compost supports long-term biological activity essential for sustainable crop production. Another important characteristic of Ashoka leaf biofertilizer is its slow-release nutrient mechanism. Nutrients contained in organic materials are released gradually during decomposition, ensuring a continuous supply of essential elements such as nitrogen, phosphorus, potassium, and magnesium throughout the crop growth period. This gradual release minimizes nutrient losses through leaching and volatilization, especially under drip irrigation systems. Conversely, NPK fertilizer releases nutrients rapidly, which may result in nutrient wastage and environmental pollution if not properly managed. The findings further showed that the combined ALC+PM treatment produced growth and yield values statistically comparable to NPK fertilizer ($p \leq 0.05$). Plant height, leaf number, and fresh yield under the organic treatment were either similar to or slightly higher than those obtained with NPK application. This indicates that Ashoka-based biofertilizer can effectively substitute synthetic fertilizer in lettuce cultivation while simultaneously improving soil quality. In addition, organic treatments enhanced soil moisture retention and cation exchange capacity (CEC), enabling the soil to retain nutrients more efficiently and maintain stable moisture conditions within the root zone. These effects are particularly important in greenhouse and irrigated agriculture where efficient water and nutrient management are required.

Overall, while inorganic fertilizers provide immediate nutrient availability and rapid crop response, Ashoka leaf biofertilizer offers broader long-term benefits by improving soil structure, increasing microbial activity, enhancing nutrient retention, and supporting sustainable agricultural productivity. Therefore, integrating Ashoka compost into crop production systems represents an environmentally friendly and economically viable alternative to excessive dependence on chemical fertilizers such as NPK.

3.5 Effect of Irrigation

The drip irrigation system had a significant positive influence on soil nutrient dynamics, plant growth, and overall lettuce performance in this study. Its controlled and uniform water application improved soil moisture availability within the root zone, creating optimal conditions for nutrient uptake and microbial activity. Consistent moisture levels enhanced the decomposition of Ashoka leaf compost and poultry manure, accelerating the mineralization of organic nutrients such as nitrogen, phosphorus, and potassium. This contributed to improved nutrient availability throughout the crop growth period and reduced nutrient stress on plants. The stable moisture regime also minimized fluctuations in soil water potential, which helped maintain steady nutrient absorption by lettuce plants. In addition, drip irrigation reduced nutrient losses, particularly through leaching and surface runoff, thereby increasing fertilizer use efficiency. This was especially important for nitrogen and potassium, which are highly mobile in soil. The improved water management also contributed to better soil physical conditions, including enhanced aeration and improved structure, which supported root development. Overall, the integration of drip irrigation with organic amendments (Ashoka leaf compost and poultry manure) enhanced nutrient synchronization, improved soil fertility, and supported higher growth and yield performance. The results indicate that irrigation played a critical role in maximizing the effectiveness of both organic and inorganic fertilizers by ensuring consistent moisture supply and efficient nutrient utilization.

4.0 Conclusion

This study successfully evaluated the potential of Ashoka leaf (*Saraca asoca*) compost as an organic biofertilizer for lettuce production under a greenhouse drip-irrigation system. It achieved its objectives by characterizing the biofertilizer, assessing its effects on lettuce growth and yield, and evaluating soil quality improvement. The physicochemical analysis confirmed that Ashoka leaf compost contains appreciable levels of essential nutrients such as organic carbon, nitrogen, phosphorus, potassium, and magnesium, indicating its suitability for agricultural use. Growth and yield results showed that the combined application of Ashoka leaf compost and poultry manure (ALC+PM) produced the best performance, significantly improving plant height (28.6 cm), leaf number (18.2), and fresh yield (320.5 g/plant). This performance was statistically comparable to inorganic NPK fertilizer, demonstrating its potential to substitute or reduce reliance on synthetic fertilizers.Soil properties were also improved through organic treatments, with increased organic matter, reduced bulk density, and enhanced water retention capacity, leading to better soil aeration, nutrient availability, and moisture conservation. The drip irrigation system further enhanced nutrient use efficiency and reduced leaching losses, improving overall crop performance. The study concludes that Ashoka leaf compost, especially when integrated with poultry manure and drip irrigation, offers a sustainable, cost-effective, and environmentally friendly alternative for lettuce production. It also enhances nutrient synchronization and fertilizer efficiency comparable to inorganic NPK, supporting sustainable agriculture in resource-limited farming systems.

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REFERENCES

Adekiya, A. O., Agbede, T. M., Aboyeji, C. M., Dunsin, O., And Simeon, V. T. (2020). Effects of biochar and poultry manure on soil characteristics and yield of maize in a tropical Alfisol. *Heliyon, 6*(7), e03878.

Agbede, T. M., Adekiya, A. O., And Ogeh, J. S. (2017). Effect of poultry manure on soil physical and chemical properties, growth, and grain yield of sorghum in Southwest Nigeria. Journal of Soil Science and Environmental Management, 8(3), 45–55.

Balamurali, S., Chakankar, S., Sharma, G., Pagey, A.P., Natarajan, M., Shaik, S., Gnanavendan, S., and Arıcı, M. (2024). A solar-powered, internet of things (IoT)-controlled water irrigation system with rainfall prediction based on pollutant concentration for sustainable agriculture. *Environment, Development and Sustainability*. https://link.springer.com/article/10.1007/s10668-024-05953-z

Bharadwaj, P., Rao, P., and Verma, S. (2023). IoT in smart agriculture: A comprehensive review of applications, challenges, and future prospects. Journal of Smart Farming Technologies, 12(2), 76-88.

Casado-Vara, R., Prieto, J., De la Prieta, F., And Corchado, J. M. (2018). Low-power communication protocols for sustainable IoT devices in agriculture. Journal of Agricultural Informatics, 9(2), 1–10.

Choudhary, M., Datta, A., Jat, H. S., Yadav, A. K., Gathala, M. K., Sapkota, T. B., Das, A. K., Sharma, P. C., And Ladha, J. K. (2018). Effects of organic fertilizer incorporation on soil nutrient content and crop yields *Journal of Organic Agriculture*, 3(1), 1-10.

Chowdhury, M., Samarakoon, U.C., And Altland, J.E. (2024). Evaluation of hydroponic systems for organic lettuce production in controlled environments. *Frontiers in Plant Science*,14,1401089.https://www.frontiersin.org/articles/10.3389/fpls.2024.1401089/full

Dauda, K.A, Shuaib-Na'Allah, B.O. And Hussain, H.A. (2017): Effect of Physico-Chemical Properties of Soil on crop yields. A Paper presented at the International Soil Tillage Reasearch Organization (ISTRO) - Nigeria Symposium, held at Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria

Dikko, A. U., Abdullahi, A. A., and Ousseibi, M. S. (2010): Soil Fertility Assessment of the Lugu MainCanal of Wurno Irrigation Project, Sokoto State, Nigeria, five years after rehabilitation. Department of soil science and Agriculture Engineering, Usman Danfodiyo University.

Hydroponic vs. soil-based methods. *Journal of Agricultural Engineering*, 58(1), 15-22.

Lv, J., Zhang, X., And Chen, Z. (2020). Effects of organic fertilizers on soil health. Environmental Science and Pollution Research, 27(32), 40535–40545. https://doi.org/10.1007/s11356-020-10125-0

Wu, J., Jin, N., Jin, L., Wang, S., Li, J., Liu, F., Liu, Z., Luo, S., Wu, Y., Lyu, J., & Yu, J. (2022). *Reduced chemical fertilizer combined with bio-organic fertilizer affects the soil microbial community and yield and quality of lettuce.* Frontiers in Microbiology, 13, Article 863325. https://doi.org/10.3389/fmicb.2022.863325

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