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ORGANIC FERTILIZER PRODUCTION USING BANANA PEEL, EGGSHELLS, AND YEAST: EFFECTS ON AMARANTHUS GROWTH

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ABSTRACT

The use of organic fertilizers as an alternative to inorganic fertilizers is one way to reduce the use of inorganic fertilizers, which have negative effects when used for a long time. Banana Peels, Egg Shells, and Yeast were utilized to generate an organic fertilizer in this study. Banana peel is high in biomass fibre, nitrogen, potassium, and phosphorus, all of which are essential components of organic fertilizer. Phosphate and calcium, which are essential for plant growth, are found in eggshells, while yeast serves as a catalyst in nutrient cycling and organic matter decomposition. This study used a Randomized Completely Block Design (RCBD), which consisted of 3 treatments with 3 replications. To evaluate the yield and growth performance of Amaranthus under different organic fertilizer combinations using Banana Peels, Eggshells, and Yeast. A multi-factor Duncan Multiple Range Test (DMRT) was applied after ANOVA to determine significant differences in treatments. The results indicate that the combination of Banana Peels, Eggshells, and Yeast significantly improved yield compared to the combination without Yeast. Treatment A (Banana Peels, Eggshells, and Yeast) consistently outperformed other treatments. After four weeks, Treatment A in Combination 1 (Banana Peels, Eggshells, and Yeast) achieved a mean leaf count of 32, compared to 26.33 in Treatment B (Banana Peels and Eggshells) and 15.00 in the untreated control (Treatment C). This represents a 62% higher yield compared to the corresponding treatment in Combination 2, which did not include Yeast. The addition of Yeast was crucial in boosting Amaranthus growth, contributing to improved nutrient uptake and microbial activity.

Keywords: Organic Fertilizer, Banana Peel, Eggshells, Yeast, Plant Growth

INTRODUCTION

The growing global population, coupled with increasing concerns about environmental sustainability, has prompted a shift towards more sustainable agricultural practices. Traditional inorganic fertilizers, while effective in boosting crop yields, have been linked to numerous environmental issues, including soil degradation, water pollution, and loss of biodiversity (Ramesh, *et al;* 2015). These concerns have driven the search for alternative, eco-friendly fertilizers that can maintain or even enhance agricultural productivity without harming the environment. Organic fertilizers have emerged as a viable alternative to inorganic fertilizers, offering several benefits such as improved soil health, enhanced nutrient cycling, and reduced environmental impact (Kannan & Sinha, 2020). Among the various organic materials explored for fertilizer production, banana peels, eggshells, and yeast have gained attention due to their nutrient-rich composition and potential to support sustainable agriculture. Banana peels, a by-product of the widely consumed fruit, are rich in essential nutrients such as potassium, phosphorus, and calcium, which are critical for plant growth (Akinbile *et al;* 2016). Eggshells, primarily composed of calcium carbonate, provide a long-lasting source of calcium, essential for cell wall formation and enzyme activation in plants (Ramesh *et al.,* 2015). Yeast, a common by-product of the baking and brewing industries, which is beneficial microorganisms that can enhanced decomposition (Kannan & Sinha, 2020). The combination of these three waste materials into a single organic fertilizer offers a unique synergy, potentially leading to a more balanced and effective nutrient supply for plants. Moreover, the use of banana peels, eggshells, and yeast aligns with principles of waste recycling and resource conservation, contributing to a circular economy in agriculture (Mkhize *et al;* 2018).

The widespread use of inorganic fertilizers in agriculture has led to significant environmental issues, such as soil degradation and water pollution, while also diminishing long-term soil fertility (Ramesh, *et al;* 2015). To address these challenges, there is a pressing need for sustainable alternatives, such as organic fertilizers. Despite their potential, the inconsistent quality and nutrient content of organic fertilizers have limited their adoption. Banana peels, eggshells, and yeast are nutrient-rich organic waste materials that are underutilized but could be combined to create an effective, eco-friendly fertilizer. (Akinbile, *et al.,* 2016; Ramesh *et al.,* 2015). Recent studies and field trials have demonstrated the effectiveness of organic fertilizers made from banana peels, eggshells, and yeast in various agricultural contexts. For example, a study by Oyedeji *et al.* (2019) investigated the application of a banana peel and eggshell-based organic fertilizer on tomato plants. The study found that the use of this organic fertilizer resulted in a significant increase in tomato yield, plant height, and leaf area compared to plants treated with synthetic fertilizers. Also, A study by Singh and Sharma (2021) explored the use of banana peel and eggshell fertilizers in urban gardens and found that these fertilizers. A study by Mbatha and Mhlongo (2022) demonstrated that continuous use of banana peel and eggshell-based fertilizer improved soil structure and water retention capacity, leading to higher resilience against drought conditions. The researchers attributed these improvements to the balanced nutrient supply and enhanced soil structure provided by the organic fertilizer.

However, more research is needed to develop and optimize such a fertilizer, which could reduce dependency on inorganic fertilizers and promote sustainable agriculture. Organic fertilizers made from banana peels and egg shells offer several benefits for plants and environment. Organic fertilizers made from banana peel and egg shell are more sustainable than

synthetic ones, as they are made from natural materials that can be easily replenished. Using banana peels and egg shells reduces waste and promotes a circular economy. Organic fertilizers made from banana peels and egg shells have a lower carbon foot print compared to synthetic fertilizers. Creating organic fertilizer from banana peels and egg shells is affordable option for gardeners and farmers. Addressing this gap could contribute to sustainable agricultural practices, reduce dependency on inorganic fertilizers, and support the global transition towards more sustainable food production systems. This study seeks to develop and evaluate an organic fertilizer derived from banana peels, eggshells, and yeast.

MATERIALS AND METHODS

Description of The Study Area

This research was carried out at Birnin Kebbi in one of the local government areas of Kebbi State in Nigeria. The elevation of the region is between 150 and 300 meters Above Sea Level (ASL). The area is geographically located between Latitudes 12˚ 20' to 12˚ 39' North of the Equator and Longitudes 04˚ 04' to 04˚ 28' East of the Greenwich Meridian.

Organic Fertilizer Preparation

In this study, organic fertilizer was made from banana peels, eggshells, and yeast. Initially, banana peels and eggshells were cleaned to remove contaminants. They were then cut into small pieces and air-dried. The dried materials were grinded into powder using a blender, as shown in Figure 1. The proportions of 1g of each component were selected to maintain a balanced nutrient composition and ensure consistency across treatments. This quantity also aligns with previous studies emphasizing uniform application rates for small-scale experiments (Akinbile *et al*., 2016). To ensure uniformity and accuracy, the preparation process was conducted under controlled conditions, with the same drying time and blending settings applied for all samples.

(a) (b)

(c)

Figure 1: (a) Banana peel powder and (b) Egg shell powder (c) Yeast

Experimental Design

The study employed a Randomized Complete Block Design (RCBD) with three treatments and three replications. The treatments included:
Treatment A: Banana Peels, Eggshells, and Yeast.
Treatment B: Banana Peels and Eggshells.
Treatment C: Control (no fertilizer).

Environmental Control Measures

To minimize the influence of external variables, several control measures were implemented:
Soil Type*:* All plots used the same soil type, sourced and homogenized from the study area.
Watering: Each plot was watered with an equal amount of water daily, ensuring consistent moisture levels.
Plot Size and Spacing: The plot size was standardized at 2m × 2m, with uniform spacing (50cm × 50cm) between plants.
Weather Monitoring: The experiment was conducted during a season with stable weather conditions to reduce variability.

Plant Growth

Plant growth analysis is used to know the effectiveness of the organic fertilizer. Amaranthus was divided to 3 parts where Amaranthus was fertilized with a same amount of fertilizer. Sample (A) contains Banana Peels, Eggshells, and Yeast, while sample (B) contains Banana Peels and Eggshell and

sample (C) is the control. The Amaranthus was planted and watered with the same amount of water for four (4) weeks' durations. However, in this study, we focus on the task of leaf counting. The number of leaves a plant has is one of the visual key traits (phenotype) describing its development and growth (Dobrescu et al., 2017). It enables growth rate estimation and is related to the health status of the plant and its yield potential (Telfer *et al.,* 1997; Walter and Schurr, 1999).The number of leaves of the Amaranthus plant were recorded in two weeks and four weeks.

Methods

Land preparation

The land was pulverized and levelled manually using hoe.

Experimental Field Layout

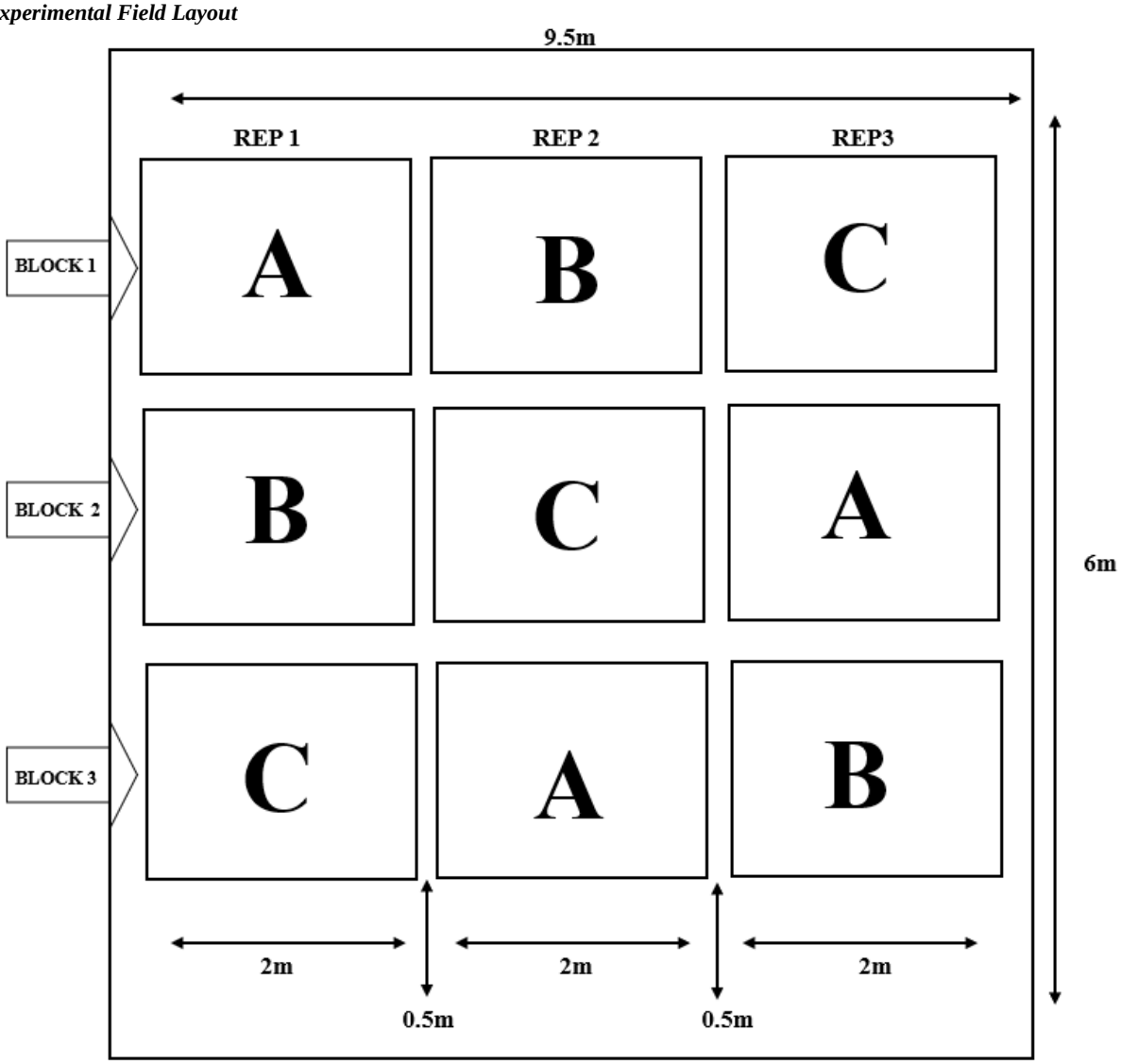

Figure 2: Field Experimental Layout

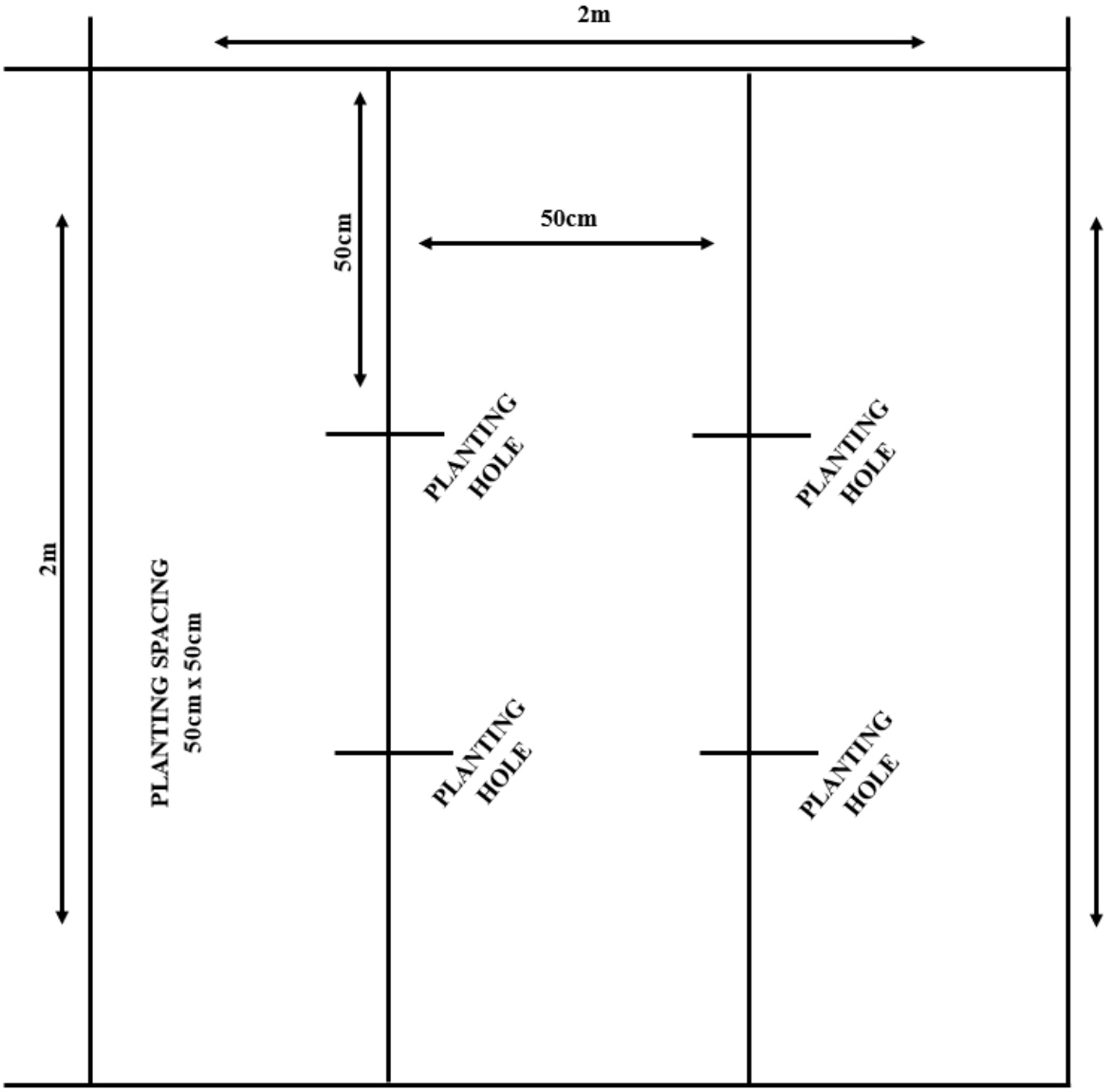

Figure 3: Planning Layout for All the Treatment

Planting Materials

Local seeds of Amaranthus source from the local farmer within Birnin Kebbi Area.

Cultural Practices

Land Preparation

The land was level and constructed into beds. The plot size is 2x2m ($4m^2$). Space measuring 1.5m is left between blocks and 1m between and in between plots. Each plot contained 2 planting row sand spacing of 50x50cm that is 50cm inter row spacing and 50cm intra row spacing.

Sowing

Plant the seedlings 30-60 cm apart, depending on their size. After two weeks of germination, the seeding was thinned to two or more plants per stand.

Data Collection

Data collection focused on leaf counts as a primary growth indicator due to its correlation with plant health and yield potential (Dobrescu *et al.*, 2017). Statistical analyses, including A multi-factor Duncan Multiple Range Test (DMRT) was applied after ANOVA were used to evaluate significant differences among treatments. The harvesting, and measurement of the above agronomic data was done on the 3rd July, 2024.

RESULTS AND DISCUSSION

Number of leaves at Four weeks after Planting

The number of leaves for the two combinations were obtained by counting the number of leaves in each replication by randomly selecting at least 5 plants and taking the average. Table 1 shows that after four weeks, Treatment A in Combination 1 (Banana Peels, Eggshells, and Yeast) achieved a mean leaf count of 32.00 compared to 26.33 in Treatment B (Banana Peels and Eggshells) and 15.00 in the untreated control (Treatment C). Table 2 shows Treatment A in Combination 1 (Banana Peels, Eggshells, and Yeast) achieved a mean leaf count of 19.67, compared to 15.33 in Treatment B (Banana Peels and Eggshells) and 13.67. in the untreated control (Treatment C). Also, Figure 4 is a bar chart visualizing the mean leaf counts for Treatments A, B, and C across the two fertilizer combinations.

Table 1: Combination of Banana Peels, Eggshell and Yeast

Treatment	Replication 1	Replication 2	Replication 3	Mean
A	34	32	30	32.00
B	28	25	26	26.33
C	14	14	17	15.00

Table 2: Combination of Banana Peels, Eggshell

Treatment	Replication 1	Replication 2	Replication 3	Mean
A	24	20	15	19.67
B	15	17	14	15.33
C	11	13	17	13.67

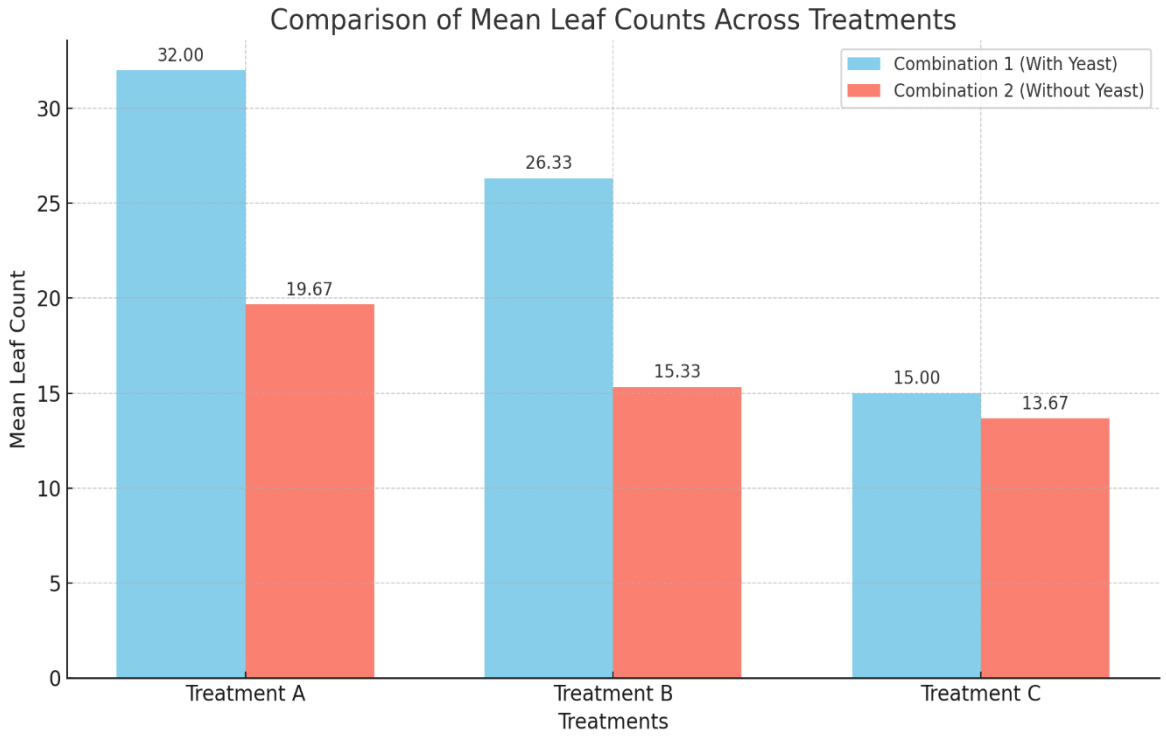

Figure 4: Bar chart visualizing the mean leaf counts for Treatments A, B, and C across the two fertilizer combinations

Discussion

The results of this study provide significant insights into the efficacy of organic fertilizers made from banana peels, eggshells, and yeast on Amaranthus growth.

The inclusion of yeast in the organic fertilizer (Combination 1: Banana Peels, Eggshells, and Yeast) consistently demonstrated superior performance compared to the fertilizer without yeast (Combination 2: Banana Peels and Eggshells). Treatment A in Combination 1 yielded the highest mean leaf count of 32, significantly surpassing the other treatments in both combinations. This trend underscores the critical role of yeast in enhancing plant growth.

Yeast serves as a biological catalyst, accelerating the decomposition of organic matter and the release of nutrients essential for plant development. Specifically, yeast enhances the bioavailability of key nutrients such as nitrogen, phosphorus, and potassium, which are critical for vegetative growth. This aligns with findings by Kannan and Sinha (2020), who emphasized yeast's role in nutrient cycling and improving soil fertility. The improved yield in Combination 1 can be attributed to this enhanced nutrient cycling.

Yeast is known to promote beneficial microbial activity in the soil, creating a synergistic environment for root growth and nutrient absorption. This microbial activity may have facilitated the uptake of calcium from eggshells and potassium and phosphorus from banana peels, further boosting Amaranthus growth. Studies by Oyedeji *et al*. (2019) and Mbatha and Mhlongo (2022) corroborate the positive effects of organic fertilizers enriched with microbial agents like yeast.

The results of this study align with existing literature on the use of organic fertilizers. For instance, Oyedeji *et al.* (2019) reported significant increases in tomato yield, plant height, and leaf area when banana peel and eggshell-based fertilizers were applied. Similarly, Singh and Sharma (2021) observed improved plant growth in urban gardens using organic fertilizers derived from banana peels and eggshells. However, this study goes further by demonstrating the added benefits of yeast inclusion, which enhanced nutrient cycling and microbial activity, resulting in a 62% higher yield compared to treatments without yeast. Moreover, Mbatha and Mhlongo (2022) highlighted the long-term benefits of using banana peel and eggshell-based fertilizers, such as improved soil structure and water retention. These findings are consistent with the enhanced soil conditions observed in this study, which likely contributed to the superior performance of Combination 1.

The study underscores the potential of organic fertilizers in reducing reliance on inorganic options, thereby promoting environmental sustainability. The use of banana peels,

eggshells, and yeast aligns with principles of waste recycling and a circular economy, addressing both agricultural productivity and environmental concerns. The findings also suggest broader applications of this fertilizer combination in other crops, given its demonstrated efficacy with Amaranthus

CONCLUSION

Based on the results of the investigation, it is can be concluded that;

The organic fertilizer combination of Banana Peels, Eggshell, and Yeast significantly increases the growth and yield of *Amaranthus*. Among the treatments, Treatment A (Combination 1) is the most effective, suggesting that Yeast plays a crucial role in optimizing plant growth.

Future studies should investigate the specific mechanisms by which Yeast enhances nutrient absorption and plant development, as well as its potential applications in other crops.

Assess the feasibility of large-scale production and application of this organic fertilizer, considering cost-effectiveness and farmer adoption rates.

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