

Original Research Article

# Effects of Rubber Factory Wastewater Sludge Compost on the Growth Parameters of Rubber Seedlings: A Nursery Study and Environmental Perspective

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## Abstract

Conducted at the University of Jambi's Teaching and Research Farm in Mendalo Indah Village, this three-month study from September to November 2022 utilized a Completely Randomized Design (CRD) with a single variable: rubber factory wastewater sludge compost application. Five treatment levels were tested: a0 = 25 g NPKMg dose, a1 = 100 g rubber factory wastewater sludge compost + 20 g NPKMg dose, a2 = 200 g rubber factory wastewater sludge compost + 15 g NPKMg dose, a3 = 300 g rubber factory wastewater sludge compost + 10 g NPKMg dose, and a4 = 400 g rubber factory wastewater sludge compost + 5 g NPKMg dose. Statistical analysis, employing ANOVA and the Honestly Significant Difference (HSD) test, determined treatment effects at a 5% significance level. The study assessed various rubber plant growth parameters, such as live seedling percentage, shoot emergence, budded shoot height, leaf count, stem diameter, root count, shoot and root dry weight. Notably, the application of 400 g of rubber factory wastewater sludge compost significantly influenced plant growth, specifically enhancing shoot emergence, stem diameter growth, and budded shoot height.

**Keywords:** Rubber (*Hevea brasiliensis* Muell. Arg), rubber factory wastewater sludge

## 1. Introduction

Rubber (*Hevea brasiliensis* Muell. Arg) is a highly valuable economic crop that is widely cultivated for its latex, which serves as a fundamental ingredient in the production of various rubber-based products (Rodrigo et al., 2012). The growth and productivity of rubber plants are influenced by numerous factors, including the availability of essential nutrients in the soil (Cahyo et al., 2019). As a result, there is a growing interest in finding sustainable solutions to supplement soil nutrients and enhance rubber plant growth. One potential source of nutrient supplementation is the application of compost derived from rubber factory wastewater sludge (Mironov et al., 2020), which is generated during the treatment of wastewater in the rubber manufacturing process. However, the disposal of rubber factory wastewater sludge poses significant environmental challenges due to its high organic content and potential contaminants. The improper management of this waste can lead to pollution of water bodies, soil degradation, and adverse effects on ecosystems (Mousavi & Khodadoost, 2019; Nunes et al., 2021; Rashmi et al., 2020). Therefore, it is crucial to

develop effective waste management strategies to minimize the negative impact on the environment and promote sustainable practices in the rubber industry.

Converting rubber factory wastewater sludge into compost offers a promising solution that not only reduces waste but also enhances soil fertility and supports plant growth. Composting is a natural process that transforms organic waste materials into a nutrient-rich soil amendment through the activity of microorganisms (Siedt et al., 2021). Rubber factory wastewater sludge compost has the potential to provide a valuable source of organic matter and essential nutrients, such as nitrogen, phosphorus, and potassium, for rubber plantations (Ho et al., 2023). While several studies have investigated the use of various organic amendments in agriculture, limited research has specifically focused on the application of rubber factory wastewater sludge compost in rubber plantations. This research gap highlights the need to understand the potential effects of this compost on the growth and development of rubber plants, particularly in the context of sustainable waste management practices in the rubber industry.

Therefore, this study aims to evaluate the impact of different levels of rubber factory wastewater sludge compost on various growth parameters of rubber plants. The study will assess variables such as seedling survival rate, shoot emergence time, budded shoot height, leaf count, stem diameter, root count, shoot dry weight, and root dry weight. By carefully analyzing these variables, we can gain valuable insights into the effectiveness of rubber factory wastewater sludge compost as an organic amendment for enhancing rubber plant growth and productivity. The findings of this research will contribute to our understanding of sustainable waste management practices in the rubber industry and provide valuable information for rubber plantation management. Moreover, the results may have broader implications for the utilization of organic waste materials in agriculture, promoting environmentally friendly practices and reducing dependency on synthetic fertilizers.

By exploring the effects of rubber factory wastewater sludge compost on the growth of rubber plants, this study aims to fill the existing research gap and provide comprehensive insights into the potential benefits and limitations of utilizing this compost as an organic amendment in rubber plantations. Understanding the optimal application rates and the long-term effects of this compost on rubber plant growth will be crucial for developing sustainable agricultural practices and effective waste management strategies in the rubber industry

## 2. Methods

This research was conducted at the Teaching and Research Farm of the Faculty of Agriculture, University of Jambi, located in Mendalo Indah Village, Jambi Luar Kota Subdistrict, Muaro Jambi Regency. The study was carried out over a period of three months, from September to November 2022. The experiment was designed using a Completely Randomized Design (CRD) with one factor, which was the application of rubber factory wastewater sludge compost. The compost was applied at five treatment levels:

a<sub>0</sub> = 25 g NPKMg dose,

a<sub>1</sub> = 100 g rubber factory wastewater sludge compost + 20 g NPKMg dose,

a<sub>2</sub> = 200 g rubber factory wastewater sludge compost + 15 g NPKMg dose,

a<sub>3</sub> = 300 g rubber factory wastewater sludge compost + 10 g NPKMg dose,

a<sub>4</sub> = 400 g rubber factory wastewater sludge compost + 5 g NPKMg dose.

Each treatment was replicated five times, resulting in a total of 25 experimental units. Each experimental unit consisted of four plants, resulting in a total of 100 plants. Two plants were randomly selected from each experimental unit as sample plants for further analysis. To prepare the rubber factory wastewater sludge compost, the research site was first cleared of weeds using a hoe and machete, and the soil was leveled. The planting media was prepared by digging the top layer of soil and removing any debris. The

soil was then placed in polybags measuring 25 x 35 cm, with a weight of 5 kg. The compost was weighed according to the specified treatment levels (100, 200, 300, or 400 g per polybag) and mixed with the 5 kg of soil. Each polybag was labeled accordingly. Afterward, the polybags were incubated for one week before the rubber seedlings were transplanted into them.

Observations were made on the percentage of seedling survival at four weeks after planting. The emergence time of shoots was recorded by counting the number of emerging shoots each day for 30 days after planting. The height of budded shoots was measured starting from the fourth week after planting, and subsequent measurements were taken every two weeks until the twelfth week, resulting in six observations. Leaf count was conducted starting from the fourth week after planting, with measurements taken every two weeks until the twelfth week. Shoot diameter measurements were taken every two weeks until the twelfth week after planting using a caliper. Root count was conducted at the end of the study by carefully uprooting the sample plants and submerging them in water until the root neck, allowing the soil attached to the roots to wash off without disturbing the root conditions.

The dry weight of roots was determined by cutting the roots that grew from the taproot of the sample plants, placing them in labelled envelopes according to the treatments. The roots were then dried in an oven at 80 °C for 2 x 24 hours and weighed using an analytical balance until a constant dry weight was obtained. The dry weight of shoots was measured at the end of the study by cutting the shoots of the sample plants, placing them in labelled envelopes according to the treatments. The shoots were dried in an oven at 80°C for 2 x 24 hours and weighed using an analytical balance until a constant dry weight was obtained. The obtained data were analysed using analysis of variance (ANOVA) followed by the Honestly Significant Difference (HSD) test at a significance level of  $\alpha = 5\%$ . Supporting data, such as the analysis of rubber factory wastewater sludge compost (pH, C/N ratio, N, P, and K), were also collected and analysed to provide additional information related to the main data source

### **3. Result**

#### **3.1 Impact of Compost on Improving Soil Quality**

Rubber factory wastewater compost offers numerous benefits for soil quality and sustainable agriculture (De Corato, 2021). Firstly, it enriches the soil with essential nutrients, such as nitrogen, phosphorus, and potassium, which are crucial for plant growth (Kanok-Nukulchai et al., 2009). The compost converts these nutrients into plant-available forms, reducing nutrient loss and improving plant nutrition (Smith et al., 2014). The slow release of nutrients from compost provides a sustained source of nourishment, supporting healthier growth and higher crop yields.

Secondly, rubber factory wastewater compost enhances soil organic matter content (Jha et al., 2004). Organic matter improves soil structure, aeration, and water infiltration (Adeyemo et al., 2019). It acts as a reservoir for nutrients, prevents nutrient leaching, and stimulates beneficial microbial activity. The increased organic matter fosters a diverse soil microbiome that aids in nutrient cycling and disease suppression. Furthermore, rubber factory wastewater compost improves water retention in the soil, reducing water stress during dry periods and mitigating the risk of drought. It also acts as a natural mulch, preventing soil erosion caused by wind and water, particularly on sloping landscapes.

Moreover, the compost introduces a diverse microbial community into the soil, promoting nutrient cycling, disease suppression, and plant resilience (Carr et al., 2019; van Bruggen et al., 2019). This reduces the reliance on synthetic pesticides and fungicides, contributing to environmentally friendly farming practices. The initial soil conditions presented in Table 1 indicate acidic pH levels and low nutrient availability, highlighting the need for soil improvement. Table 2 demonstrates that the rubber factory wastewater compost has an alkaline pH, which can help neutralize soil acidity and create a more favorable environment

for plant growth. The compost's high organic carbon content enhances soil structure, fertility, and moisture retention.

The compost's nutrient composition in Table 2 shows a significant enrichment of nitrogen, which is beneficial for plant growth. The slight decrease in phosphorus content suggests efficient plant uptake from the compost, providing a slow-release source of phosphorus. Additionally, the presence of potassium in the compost addresses the initial deficiency in the soil, promoting nutrient balance and supporting plant growth. Thus the application of rubber factory wastewater compost has multiple advantages for soil quality and sustainable agriculture. It enriches the soil with essential nutrients, increases organic matter content, improves water retention, and fosters beneficial microbial activity. Incorporating rubber factory wastewater compost into agricultural practices promotes efficient and environmentally friendly food production.

**Table 1.** Initial soil condition

| Name | pH 1:5           |        | N-total<br>kjeldahl (%) | Available P (ppm)<br>in Bray 1-P (P <sub>205</sub><br>ppm) | Exchangeable K in 1M<br>NH <sub>4</sub> OAc (cmol(+)/kg) |
|------|------------------|--------|-------------------------|--|--|
|      | H <sub>2</sub> O | KCl 1M |                         |  |  |
| Soil | 4.22             | 3.63   | 0.11                    | 0.24   | 0.28   |

**Table 2.** Compost's nutrient composition

| Sample Name     | pH   | Organic C<br>Combustion<br>Method (%) | N-total<br>Kjedahl<br>(%) | Total P Extracted<br>with H <sub>2</sub> SO <sub>4</sub> & H <sub>2</sub> O <sub>2</sub> | Total K<br>Extracted with<br>H <sub>2</sub> SO <sub>4</sub> & H <sub>2</sub> O <sub>2</sub><br>(%) |
|-----------------|------|---------------------------------------|---------------------------|--|--|
| Organic compost | 8.22 | 28.00                                 | 1.52                      | 0.20   | 0.20   |

## 2.2 Impact of Compost on Plants

The study investigated the effect of rubber factory wastewater sludge compost on seed germination and seedling growth of rubber plants. The results indicated that treatment A<sub>3</sub>, consisting of 300 grams of compost and 10 grams of NPKMg, had the highest percentage of viable seedlings (100%) compared to other treatments. This suggests that the application of rubber factory WWTP sludge compost, combined with NPKMg fertilizer, positively influenced seed viability and growth. The compost's nutrient content, particularly nitrogen, phosphorus, and potassium, played a crucial role in the development and overall health of the seedlings. Soil analysis results showed that the soil pH was acidic, with low nutrient availability. However, the compost samples had alkaline pH levels and contained significant amounts of organic carbon, nitrogen, phosphorus, and potassium. These findings support the use of rubber factory WWTP sludge compost as a beneficial organic fertilizer to improve soil fertility and nutrient availability for plant growth.

The study analyzed various growth parameters, including shoot emergence time, budded shoot height, leaf count, stem diameter, root count, root dry weight, and shoot dry weight. While there were no significant differences among treatments for shoot height, leaf count, stem diameter, and root count, significant differences were observed for shoot emergence time, root dry weight, and shoot dry weight. Treatment A<sub>3</sub> showed the shortest average shoot emergence time, indicating faster shoot development. Treatment A<sub>4</sub> resulted in the tallest budded shoots, while treatment A<sub>0</sub> had the lowest shoot height. Treatment A<sub>3</sub> also exhibited the highest leaf count, indicating improved leaf growth. Stem diameter did not show significant differences among treatments, but potassium availability influences stem growth and strength.

The number of lateral roots varied among treatments, with treatment A2 having the highest root count. Adequate watering played a crucial role in root development, as water acts as a reagent in photosynthesis and influences root formation. Treatment A3 had the highest root dry weight, indicating enhanced root development and water absorption capacity. Similarly, treatment A3 also resulted in the highest shoot dry weight, reflecting increased shoot growth and biomass accumulation. Thus, the study demonstrated that the application of rubber factory wastewater sludge compost, in combination with NPKMg fertilizer, positively affected seed viability and various growth parameters of rubber seedlings. Treatment A3 consistently showed favorable results across multiple variables, including shoot emergence time, leaf count, root dry weight, and shoot dry weight. The compost's nutrient content and the proper balance of nitrogen, phosphorus, and potassium contributed to the optimal growth and development of the seedlings.

The research highlights the potential benefits of using rubber factory WWTP sludge compost as an organic fertilizer for sustainable agriculture. The composting process helps manage the waste sludge, reduce environmental pollution, and improve soil health. Proper composting techniques, monitoring, and adherence to guidelines are crucial to ensure the quality and safety of the compost product. Further research is recommended to investigate long-term effects, optimize composting processes, and explore innovative applications of rubber factory wastewater sludge compost. Additionally, considering the environmental challenges associated with waste disposal, finding sustainable solutions and implementing proper waste management practices are essential for minimizing negative impacts on ecosystems and human health.

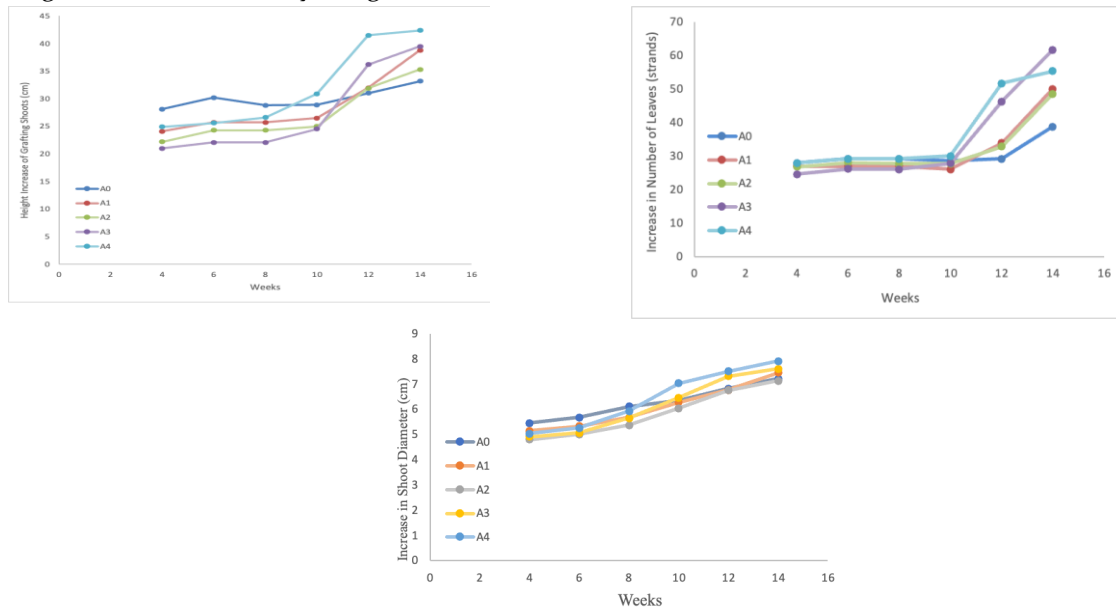
**Table 3.** Percentage of live seeds

| WWTP Sludge Waste Compost Rubber and Fertilizer<br>Factory NPKMg(g) | PBH (%) |
|---|---------|
| A0 : 25 g NPKMg   | 95%     |
| A1 : 100 g of compost + 20 g of NPKMg                               | 85%     |
| A2 : 200 g of compost + 15 g of NPKMg                               | 80%     |
| A3 : 300 g of compost + 10 g of NPKMg                               | 100%    |
| A4 : 400 g of compost + 5 g of NPKMg                                | 95%     |

**Table 4.** Growth of sleeping eye stum rubber seedlings

| Waste Sludge Compost<br>from Wastewater<br>Treatment Plant | ET (days) | SH (cm) | LC<br>(leaves) | SD<br>(mm) | RC      | DWR<br>(gr) | DWS<br>(gr) |
|--|-----------|---------|----------------|------------|---------|-------------|-------------|
| A0 : 25 gr NPKMg   | 15.00 c   | 33.20 a | 38.70 a        | 7.21 a     | 15.80 a | 0.78 a      | 6.34 a      |
| A1 :100 g of compost + 20 gr<br>NPKMg                      | 13.50 ab  | 38.80 a | 50.00 ab       | 7.44 a     | 22.50 a | 1.01 ab     | 8.41 ab     |
| A2 : 200 g of compost + 15 gr<br>NPKMg                     | 14.80 b   | 35.30 a | 48.50 ab       | 7.12 a     | 25.10 a | 1.86 b      | 8.49 ab     |
| A3 : 300 g of compost + 10 gr<br>NPKMg                     | 11.90 a   | 39.50 a | 61.60 b        | 7.60 a     | 19.90 a | 2.00 b      | 12.80 c     |
| A4 : 400 g of compost + 5 gr<br>NPKMg                      | 12.60 ab  | 42.40 a | 55.30 ab       | 7.91 a     | 17.30 a | 1.34 ab     | 11.74 bc    |

Note: Values followed by the same lowercase letter are not significantly different based on LSD test at  $\alpha = 5\%$ . ET: Emergence Time, SH: Shoot Height, LC: Leaf Count, SD: Shoot Diameter, RC: Root Count, DWR: Dry Weight of Roots, DWS: Dry Weight of Shoots



**Figure 1.** Shoot height grafting (a), leaf count (b), and shoot diameter grafting (d)

#### 4. Discussion

The study examined the impact of rubber factory wastewater sludge compost on dormant bud rubber seedlings in rubber propagation. The research measured various variables such as shoot height, leaf count, stem diameter, root count, emergence time of shoots, root dry weight, and shoot dry weight of rubber plants. The findings revealed that while there were no significant differences in shoot height, leaf count, stem diameter, and root count among the treatments, significant differences were observed in the emergence time of shoots, root dry weight, and shoot dry weight of rubber plants. Table 4 provides further analysis of the emergence time of shoots in dormant bud rubber seedlings. Treatment A3, which involved the application of 300 g of rubber factory wastewater sludge compost and 10 g of NPKMg, resulted in the shortest average emergence time of shoots at 11.9 days. This treatment was not significantly different from treatment A1 but significantly different from treatment A0. The results suggest that the nutrient content in the rubber factory wastewater sludge compost, combined with the application of NPKMg fertilizer, accelerated the emergence of rubber shoots. The emergence time of shoots in dormant bud rubber seedlings is closely related to root formation and development, which are stimulated by the availability of sufficient nutrients and improvements in soil properties (Bindraban et al., 2015; Fageria & Moreira, 2011).

Regarding other growth parameters, treatment A4, which involved the application of 400 g of rubber factory wastewater sludge compost and 5 g of NPKMg, resulted in the highest increase in the height of budded shoots, while treatment A0 showed the lowest increase. The compost treatment significantly influenced the growth of budded shoots from 4 weeks after planting until the 14th week. The results indicate that the nutrient content in the compost, combined with NPKMg fertilizer, positively influenced shoot growth in rubber seedlings. Similarly, treatment A3 showed the highest leaf count, treatment A4 exhibited the highest shoot diameter, and treatment A2 resulted in the highest number of lateral roots. The findings demonstrate that the compost treatments have varying effects on different growth parameters of the rubber seedlings. Treatment A3 consistently showed favorable results in terms of emergence time, shoot height, leaf count, and

root dry weight. Treatment A4 excelled in shoot diameter, while treatment A2 had the highest number of lateral roots. These results indicate that the compost treatments, especially treatment A3, promote overall growth and development of rubber seedlings.

The study also emphasizes the importance of balanced nutrient supply for seedling growth. Nitrogen (N) availability plays a crucial role in promoting plant growth, increasing the number of leaves, and enhancing plant height. Phosphorus (P) stimulates root growth, while potassium (K) accelerates the growth of meristematic tissues and strengthens the stem. Adequate and balanced nutrient supply, as facilitated by the compost treatments, contributes to the optimal development of rubber seedlings. Furthermore, the research acknowledges the environmental challenges associated with rubber factory wastewater sludge disposal. Improper handling and disposal can lead to pollution and negative impacts on ecosystems and human health (Ghulam & Abushammala, 2023). The study proposes the conversion of rubber factory wastewater sludge into compost as a sustainable and environmentally friendly solution. Composting can transform the waste into a beneficial product that enhances soil fertility, supports plant growth, reduces greenhouse gas emissions, and minimizes groundwater contamination (Ayilara et al., 2020).

The composting process requires proper management to mitigate potential environmental risks. Best practices should be followed for odor control, leachate management, and containment of contaminants. Regular monitoring and testing of the compost product are essential to ensure its quality and safety for agricultural use. Additionally, proper application rates, timing, and nutrient management practices should be implemented to optimize compost utilization and prevent adverse effects on the environment. Thus, the study demonstrates that rubber factory wastewater sludge compost has positive effects on seed germination and seedling growth of dormant bud rubber seedlings. Treatment A3, consisting of 300 g of compost and 10 g of NPKMg, consistently showed favorable results across various growth parameters. However, other compost treatments also exhibited promising outcomes. The application of compost from rubber factory wastewater sludge contributes to the circular economy, improves soil health, reduces environmental pollution, and offers economic benefits. Further research is recommended to optimize the composting process, investigate long-term effects, and explore innovative applications of rubber factory wastewater sludge.

## **5. Recommendation for Future Research Direction**

Based on the findings and implications of using rubber factory wastewater compost in agriculture, several recommendations and future research directions can be outlined to further enhance its effectiveness and promote its sustainable utilization. These recommendations aim to address potential challenges, optimize composting processes, explore innovative applications, and ensure environmental stewardship including optimal Application Rates: Conduct further research to determine the optimal application rates of rubber factory wastewater compost for different crop types and soil conditions. This research should focus on assessing the nutrient requirements of specific crops and developing guidelines for compost application based on crop nutrient uptake, soil characteristics, and environmental considerations. Determining the appropriate application rates will help maximize the benefits of compost while avoiding nutrient imbalances or potential environmental risks. The second recommendation is compost Maturity and Stability, this part is crucial part to investigate the effects of compost maturity and stability on plant growth and soil health. Compost maturity refers to the degree of decomposition and stabilization of organic matter, while stability refers to the resistance of compost to further decomposition. Understanding the relationship between compost maturity, stability, and nutrient availability will help optimize composting processes and ensure consistent quality and efficacy of the compost product.

The third recommendation is nutrient Release Dynamics, this part is explore the nutrient release dynamics of rubber factory wastewater compost in different soil types and environmental conditions. Investigate the timing and duration of nutrient availability from compost, especially for slow-release nutrients such as phosphorus and potassium. This research will provide insights into the appropriate timing of compost application and help develop nutrient management strategies that align with plant nutrient requirements throughout the growing season. The fourth recommendation is long-Term Effects, in this part conduct long-term field studies to assess the sustained benefits of using rubber factory wastewater compost on soil quality, crop productivity, and environmental impacts. Investigate the effects of repeated compost application over multiple cropping cycles to evaluate the long-term changes in soil fertility, organic matter content, microbial activity, and nutrient cycling. Long-term studies will provide valuable information on the cumulative effects of compost application and its contribution to sustainable agricultural practices. Then, Explore the microbial ecology of rubber factory wastewater compost and its interactions with the soil microbiome. Investigate the dynamics of microbial communities in compost and their roles in nutrient cycling, disease suppression, and plant-microbe interactions. This research will provide insights into the mechanisms underlying the beneficial effects of compost on soil health and plant growth, allowing for targeted management strategies to enhance microbial activity and functional diversity in agricultural systems.

Next, develop standardized protocols and quality assurance guidelines for the production and utilization of rubber factory wastewater compost. This includes establishing criteria for compost maturity, stability, nutrient content, and potential contaminants. Implementing quality control measures will ensure consistent compost quality and minimize the risks associated with excessive nutrient levels or the presence of harmful substances in compost. Then, environmental Impact Assessment: Conduct comprehensive environmental impact assessments to evaluate the potential risks and benefits associated with the application of rubber factory wastewater compost. Assess the fate of compost-derived nutrients in soil and water systems, including the potential for nutrient leaching, runoff, and groundwater contamination. Additionally, evaluate the greenhouse gas emissions and carbon sequestration potential associated with compost production and utilization to assess the overall environmental footprint of rubber factory wastewater composting. Investigate value-added applications of rubber factory wastewater compost beyond traditional agriculture. Explore its potential for land reclamation, horticulture, urban greening, and ecological restoration projects. Assess the benefits of using compost in remediation efforts for degraded or contaminated soils, such as heavy metal or organic pollutant removal. Expanding the range of applications for rubber factory wastewater compost will contribute to waste management solutions and promote circular economy principles. The Facilitate knowledge transfer and promote the adoption of rubber factory wastewater compost among farmers and stakeholders. Conduct outreach programs, training workshops, and demonstration sites to educate farmers about the benefits of compost and proper compost application techniques. Engage with local communities, agricultural extension services, and policymakers to raise awareness and support the implementation of sustainable waste management practices in the rubber industry and the last recommendation is assess the economic viability and market potential of rubber factory wastewater compost. Conduct cost-benefit analyses to evaluate the economic feasibility of compost production and its integration into agricultural systems. Identify potential markets and value chains for compost products, considering the diverse needs of different agricultural sectors, including smallholder farmers, commercial agriculture, and horticulture industries.

## 6. Conclusion

This study highlights the potential benefits of using rubber factory wastewater compost in agriculture. The findings demonstrate that the application of compost derived from rubber factory



wastewater can enhance soil quality, improve plant growth, and promote sustainable agricultural practices. The compost enriches the soil with essential nutrients, increases organic matter content, improves water retention, and fosters beneficial microbial activity. These factors collectively contribute to enhanced soil fertility, nutrient availability, and crop productivity. The results of the study indicate that the rubber factory wastewater compost positively influences various growth parameters of rubber seedlings, such as shoot emergence time, shoot height, leaf count, stem diameter, root count, and dry weights of roots and shoots. The compost, combined with NPKMg fertilizer, accelerates shoot emergence, stimulates root development, promotes shoot growth, and increases biomass accumulation. The research also identifies the optimal application rates and compositions of compost and fertilizer that result in the most favorable growth outcomes.

The study further emphasizes the importance of considering environmental aspects associated with the application of rubber factory wastewater compost. Proper management of waste sludge from rubber factories is crucial to minimize negative environmental impacts. Composting presents a sustainable solution by converting the waste into a valuable resource. Compost application improves soil health, reduces reliance on synthetic fertilizers, mitigates soil erosion, and promotes biodiversity. However, careful monitoring and adherence to guidelines are necessary to ensure compost quality, nutrient balance, and prevention of potential environmental risks. To maximize the benefits of rubber factory wastewater compost, the study recommends further research and development. Areas of focus include optimizing composting processes, understanding nutrient release dynamics, assessing long-term effects, exploring microbial interactions, establishing quality assurance protocols, evaluating environmental impacts, identifying value-added applications, promoting knowledge transfer, and assessing economic viability.

Implementing the recommendations and future research directions will contribute to the widespread adoption of rubber factory wastewater compost as a sustainable waste management solution in the rubber industry. The integration of compost into agricultural practices can enhance soil fertility, reduce dependence on synthetic inputs, mitigate environmental risks, and foster sustainable food production. Furthermore, the utilization of rubber factory wastewater compost aligns with circular economy principles by converting waste into a valuable resource and promoting the efficient use of resources

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