

## Evaluation of Nitrogen, Phosphorus, and Potassium Levels in Rice Straw Compost for Sweet Corn Growth in Gorontalo

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### ABSTRAK

Studi ini bertujuan untuk evaluasi kandungan nutrisi Nitrogen, fosfor, dan kalium (NPK) dalam campuran tanah dan kompos jerami. Analisis nitrogen (N-total) menggunakan metode Kjeldahl, instrumen UV-VIS, dan AAS. Hasil analisis menunjukkan bahwa tingkat NPK dalam campuran tanah dan kompos jerami adalah sebagai berikut: tingkat N antara 1,6-3,6%, P antara 0,39-44%, dan kalium antara 0,14-0,16%. Hasil yang diperoleh menunjukkan bahwa tingkat nitrogen dan fosfor memenuhi standar minimum SNI 19-7030-2004, sedangkan kandungan Kalium hanya sedikit atau tidak memenuhi standar SNI/19/7030/2004. Hasil analisis varians (ANOVA) menunjukkan bahwa campuran tanah dan kompos jerami cocok sebagai media tanam untuk jagung manis yang memiliki efek signifikan terhadap tinggi tanaman, diameter batang, lingkaran batang, dan jumlah daun.

**Kata kunci:** Jagung manis; Jerami padi; NPK; Kompos

### ABSTRACT

*This study aims to determine the NPK nutrient content of a mixture of soil and straw compost. -The determination of nitrogen, phosphorus, and potassium levels was carried out using the Kjeldahl method, UV-Vis, and AAS instrument, respectively. The results of the analysis showed that the levels of NPK in the mixture of soil and straw compost, the levels of N 1.6-3.6%, P 0.39-44%, and Potassium 0.14-0.16%, the results obtained that levels of nitrogen, phosphorus met the minimum standard of SNI 19-7030-2004, the potassium content is only slightly or does not meet the standard of SNI/19/7030/2004. The results of the analysis of variance (ANOVA) showed that a mixture of soil and straw compost was suitable as a planting medium for sweet corn which had a significant effect on plant height, stem diameter, stem circumference, and number of leaves.*

**Keywords:** Sweet corn; Rice Straw; NPK; Compost

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### INTRODUCTION

Agricultural practices worldwide are continuously evolving to address the ever-increasing demand for sustainable and environmentally friendly methods of food production. In this pursuit, composting has emerged as a valuable technique for organic waste management and soil enrichment. Compost, when used effectively, can enhance soil fertility and promote the growth of various crops, including sweet corn (Imran et al., 2022; Yong-Hong et al., 2021).

Sweet corn is one of the most important food sources in the world, ranking third after wheat and rice. In Indonesia, corn also has a significant role as the second food ingredient after rice. Even so, national corn production is still low and has not been able to meet domestic demand, both for daily consumption and for export abroad. Gorontalo Province, which is located in Indonesia, has taken a step forward as an Agropolitan province by establishing corn as the

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main commodity in the sustainable agricultural development program (Hariadi et al., 2021; Susilowati et al., 2021). However, the region faces challenges related to soil nutrient deficiencies, particularly nitrogen (N), phosphorus (P), and potassium (K). In recent years, rice straw compost has gained attention as a potential organic fertilizer due to its abundance and favorable nutrient composition (Ilahude & Miolo, 2019).

Macronutrients, such as nitrogen (N), phosphorus (P), and potassium (K), have a crucial role in the growth and development of corn plants. Nitrogen helps in the formation of protein and chlorophyll, which are essential for leaf growth and the formation of corn cobs. Phosphorus is necessary for healthy root development, flower formation, and corn seed formation. Potassium plays an important role in the regulation of osmotic pressure, protein synthesis, and increasing plant resistance to stress (Febrianti & Asridawati, 2019; Wahyudi et al., 2021).

Compost can contribute these macronutrients to corn plants. Rice straw is one of the organic materials that is often used in the manufacture of compost. Rice straw is rich in carbon and fiber, and also contains a number of macro-nutrients such as nitrogen (N), phosphorus (P), and potassium (K). These nutrients can make a valuable contribution to plant growth and development. The process of making compost involves the decomposition of organic matter by microorganisms such as bacteria, fungi, and earthworms (Girsang et al., 2023; Iwanto, 2016). During the decomposition process, microorganisms will decompose rice straw and other organic matter into humus material which is rich in nutrients (Yang et al., 2022).

This article aims to evaluate the nitrogen, phosphorus, and potassium content in rice straw compost and its effectiveness in promoting sweet corn grown in the unique agricultural context of Gorontalo. By analyzing the nutrient composition of rice straw compost and assessing its impact on sweet corn cultivation, we can provide valuable insights for farmers and agricultural practitioners in the region.

The study will employ a comprehensive experimental design that involves collecting rice straw waste from local paddy fields and subjecting it to a well-controlled composting process. The resulting compost will be analyzed for its N, P, and K content using standard laboratory procedures. Subsequently, a field trial will be conducted to assess the growth performance of sweet corn plants cultivated using the rice straw compost as a fertilizer. The study will employ a comprehensive experimental design that involves collecting rice straw waste from local paddy fields and subjecting it to a well-controlled composting process. The resulting compost will be analyzed for its N, P, and K content using standard laboratory procedures. Subsequently, a field trial will be conducted to assess the growth performance of sweet corn plants cultivated using rice straw compost as a fertilizer.

## **METODE PENELITIAN**

### ***Tools and Materials***

The tools used in the study included scales, measuring instruments, polybags, containers (buckets), hoes, sacks, plastic, pipettes, beakers, measuring cups, stir bars, spatulas, erlenmeyer, shakers, mortar and pestle, measuring flasks, analytical balance, burette, titration set, distillation set, digestion set, Kjeldahl flask, watch glass, reagent bottle, Shimadzu UV-1800 UV-Vis spectrophotometer, atomic absorption spectrophotometer (BIOBASE BK-AA320N). Meanwhile, the materials used included soil samples, sweet corn seeds, rice straw, rice husks, EM-4, H<sub>2</sub>SO<sub>4</sub>, NaOH, selenium, BCG + MR indicators, H<sub>3</sub>BO<sub>3</sub>, HNO<sub>3</sub>, vanadate molybdate, distilled water, brown sugar.

### ***Sample Preparation***

Soil sampling in Diloato Village, Boalemo Regency, was carried out by cleaning the top of the soil of dirt. Soil sampling was carried out at a depth of 20 cm from the surface. The number of soil samples used was 30 kg. Meanwhile, rice straw samples were taken at points adjacent to

soil sampling. This is taken from the dry stems and leaves, separated from the fruit (grain) at harvest. The rice straw was chopped to a size of 2-5 cm. To speed up the composting process, EM-4 and brown sugar solution were added, at a dose of 20 mL EM-4, and 3000 mL brown sugar solution. Mixing and stirring are done evenly and covered with black plastic to control and stabilize the air inside. The rice straw compost fermentation process is successful if the aroma smells like fresh soil, is easily weathered, and has a blackish-brown color.

### **Preparation of Growth Media**

The growing medium used was a mixture of soil and straw compost. The planting media experiment was carried out in 4 treatments, each consisting of 2 polybags. Each polybag contains 10 kg of a mixture of soil and straw compost. This study used a randomized block design consisting of 4 treatments which were repeated twice.

Table 1. Experimental design

Treatment	Planting Media
1	Control (soil without rice straw compost)
2	Soil: Rice Straw Compost (80% Soil: 20% Rice Straw Compost)
3	Soil: Rice Straw Compost (65% Soil: 35% Rice Straw Compost)
4	Soil: Rice Straw Compost (50% Soil: 50% Rice Straw Compost)

### **Plant Growth Media Testing**

The planting medium was incubated for 1 day. Furthermore, the seeds of sweet corn (Paragon) which had been soaked before were planted. The planting medium for the first treatment was only filled with 10 kg of soil as a control planting medium. The second treatment was filled with 8 kg of soil with 2 kg of straw compost. As for the third and fourth treatments, each was filled with soil and straw compost with a ratio of 6.5 kg: 3.5 kg and 5 kg: 5 kg. Sweet corn seeds are inserted into the planting medium as deep as 2-5 cm. Observations were made every 2 weeks until the 8th week covering plant height, stem diameter, stem circumference, and number of leaves.

### **Determination of soil nutrients (NPK)**

Determination of nitrogen and phosphorus levels respectively using the Kjeldahl and Shimadzu UV-1800 UV-Vis spectrophotometer methods. Potassium levels were determined using an atomic absorption spectrophotometer (BIOBASE BK-AA320N).

### **Observation of Sweet Corn Growth**

The effect of sweet corn growth for each treatment was carried out on plant height, stem diameter, stem circumference, and number of leaves. The measurement results were then carried out by the Anova test to determine differences in responses to each treatment.

## **RESULTS AND DISCUSSION**

### **Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium**

Nutrients are supporting the development and growth of plants. Every plant really needs nutrients for its survival. Nitrogen, phosphorus, and potassium nutrients play an important role in large quantities. Analysis of the nutrients in the planting medium showed that the levels of nitrogen and phosphorus for each treatment reached an average amount above the minimum standard SNI/19/7030/2004, while the levels of potassium did not meet as shown in figure 1.

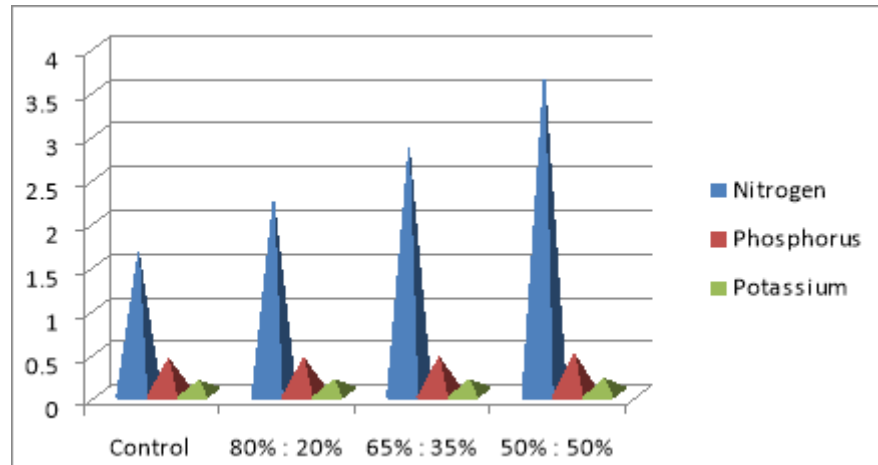


Figure 1. Nutrient analysis of growing media

The measurement results showed nitrogen levels in each treatment, namely 3.6%, 2.8%, 2.2%, and 1.6%. From all treatments, the nitrogen yield obtained was above the SNI 19-7030-2004 standard of 0.40%. The highest nitrogen content was in the treatment (50%:50%) and the lowest was in the treatment without straw compost (control) at 1.6%. Straw is an organic material rich in carbon and nitrogen. The use of straw compost can increase nitrogen levels in the soil and improve soil fertility and crop yields. When straw is broken down by microorganisms in the decomposition process, they release nitrogen into the soil in the form of minerals that can be taken up by plants (Indis et al., 2022; Mayly, 2022). However, keep in mind that the decomposition process takes time, so the benefits may not be immediately apparent. In addition, the effect of increasing the nitrogen content of straw compost may vary depending on straw quality, soil conditions, and other environmental factors.

Phosphorus levels based on the measurement results of each treatment met the established standards, namely above 0.10%. The control treatment had the highest phosphorus content, namely 0.44%, but the results were not much different for each treatment. Straw has a relatively low phosphorus content compared to nitrogen. Although straw contains little phosphorus, straw compost usually does not produce a significant increase in soil phosphorus levels after it has been applied (Irfan et al., 2021; Muliarta, 2020). However, while straw composts may not directly increase soil phosphorus levels, they can provide other benefits to overall soil fertility. Straw compost increases soil organic matter content, increases water retention, improves soil structure, and provides micronutrients that are essential for soil microbial activity. All of these contribute to better soil conditions and overall better plant growth

Furthermore, the potassium content of each treatment did not meet the SNI 19-7030-2004 standard, namely below 0.20%. The addition of straw compost did not have a significant effect on increasing soil potassium levels. Although straw compost contains some potassium, the concentration tends to be lower than in specific potash fertilizers. Therefore, applying straw compost alone will not provide a significant supply of potassium to the soil. This happens because when straw compost is applied to the soil, microorganisms will start to decompose the organic matter in the compost. This decomposition process requires the presence of nitrogen, and microorganisms will use the potassium in the soil to maintain their nutritional balance. As a result, the potassium present in the soil can be taken up by microorganisms during the decomposition of straw compost (Safriyani & Hermanto, 2022).

### **Sweet Corn Growth**

Sweet corn was used as the object of this research because it is responsive to fertilization, and its growth has a shorter production period with a harvest age of 65-70 days after planting.

Essential nutrients (nitrogen, phosphorus, and potassium) play an important role. If the plant lacks nitrogen, phosphorus, and potassium, it will affect the growth of sweet corn plants. Measurement of plant height, stem diameter, stem circumference, and number of leaves are important parameters for monitoring the growth of sweet corn plants.

The results of the analysis of variance (ANOVA) showed that the average yield of sweet corn height in each treatment experienced a different increase as shown in figure 2. The fourth treatment (50%:50%) gave a yield of 31 cm - 150 cm which gave the highest yield and this result was not much different from the third treatment (60%:35%) and the second treatment (80%:20%). The lowest results were obtained in the treatment without additional rice straw compost (control) of 20 cm - 99 cm.

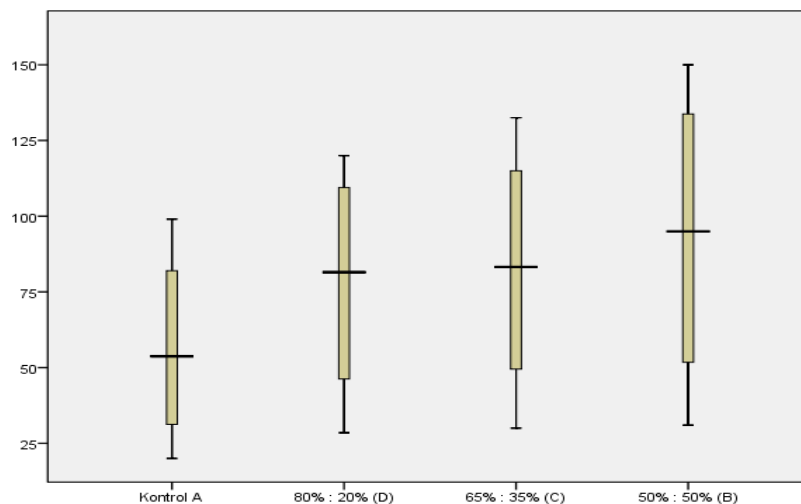


Figure 2. Increase in average plant height

Plant height is the measurement from the ground to the tallest tip of the sweet corn plant. Plant height can give an idea of the vertical growth rate of plants. Regular plant height measurements can help monitor the growth and development of sweet corn plants over time.

Rice straw compost contains important nutrients such as nitrogen, phosphorus, and potassium. These nutrients are needed for the growth and development of corn plants. By applying rice straw compost to the soil before or during corn planting, the plants get a better source of nutrients for growth and increase the potential for plant height. Rice straw compost improves soil structure, increases water retention, and increases the activity of beneficial microorganisms. By improving soil quality, corn plant roots can grow better and achieve higher growth potential (I Nengah & Sukmadewi, 2023). In addition, organic matter in rice straw compost provides micro-nutrients and provides better conditions for soil microbial life. This can increase the availability of nutrients and increase the diversity of microbes that help in the absorption of nutrients by plants.

The addition of straw compost also had a significant effect on stem diameter. The results of the analysis of variance (ANOVA) showed that the addition of straw compost to the 50%:50% treatment had a larger stem diameter. Meanwhile, the smallest growth in stem diameter was the control treatment as shown in figure 3.

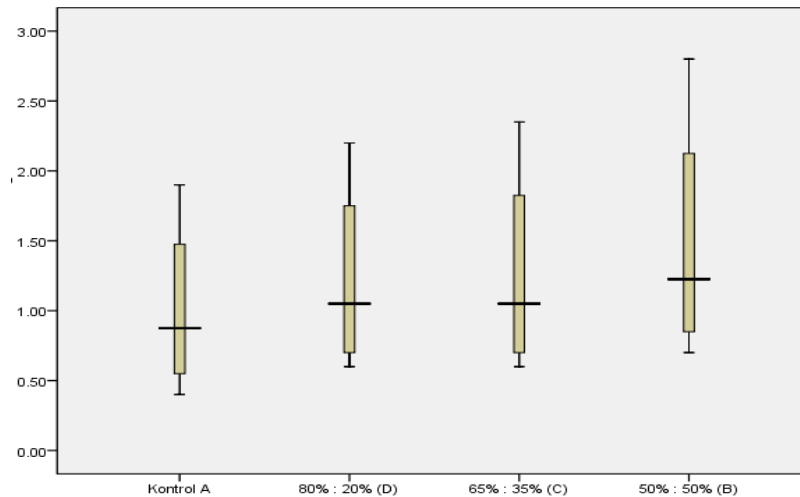


Figure 3. Increase in average stem diameter

Stem diameter is an important parameter in the growth of corn plants because it can be an indicator of plant strength, stability, and productivity. A larger stem diameter indicates stronger and higher-quality stem tissue growth. Strong stems are able to support the weight of the plant, including fruit or corn cobs that will form later. Plants with strong stems are more resistant to wind pressure, rain, and other environmental factors.

The NPK content of rice straw compost is necessary for plant growth and development, including the formation of plant tissues such as the formation and development of strong and quality stems. In addition, rice straw compost can contribute to increasing the stem diameter of corn plants. The organic matter in rice straw compost helps form larger soil aggregates and increases soil porosity. This allows for better air circulation, more efficient water absorption, and easier root penetration. Corn plant roots can grow better in soil that has a good structure. Healthy and strong roots allow plants to absorb more nutrients and water from the soil. With strong roots, stem growth will also be encouraged because good roots support the transportation of nutrients and water throughout the plant, including the stem (Hamidi & Dharma, 2020; Safriyani & Hermanto, 2022).

The results of the analysis of variance (ANOVA) showed that the application of straw compost to each treatment had an effect on the circumference of the sweet corn stalks (figure 4). Measurements from the 2nd to the 8th week showed that the highest average trunk circumference in the 50%:50% treatment ranged from 2.25 cm - 9 cm, while the lowest average trunk circumference in the treatment (control) ranged from 1.5 cm - 6 cm.

Stem circumference is the measurement of the circumference of the stem at a given level above the ground. These measurements also give an idea of stem growth and overall plant size. The NPK content of rice straw compost is very necessary for formation and development of sweet corn stalks. By adding rice straw compost to the soil, the corn plants get a better supply of nutrients, which can increase growth and stem thickness. Adequate nutrition allows corn plants to produce more cells and tissues, which contributes to an increase in the girth of the stalks.

Larger girth generally indicates good growth and greater biomass accumulation. Larger stems mean an increased number of cells and tissues are formed, which can yield more biomass and higher production potential. This relates to the plant's ability to produce more leaves, fruit, or corn cobs. Rice straw compost contains important macro-nutrients such as nitrogen, phosphorus, and potassium. These nutrients play an important role in plant growth and development, including stem formation and development. This is needed for the growth of corn

plants in the vegetative phase. Stem circumference measured during the vegetative phase can provide an indication of the growth and development of the plant (Setiawati et al., 2022).

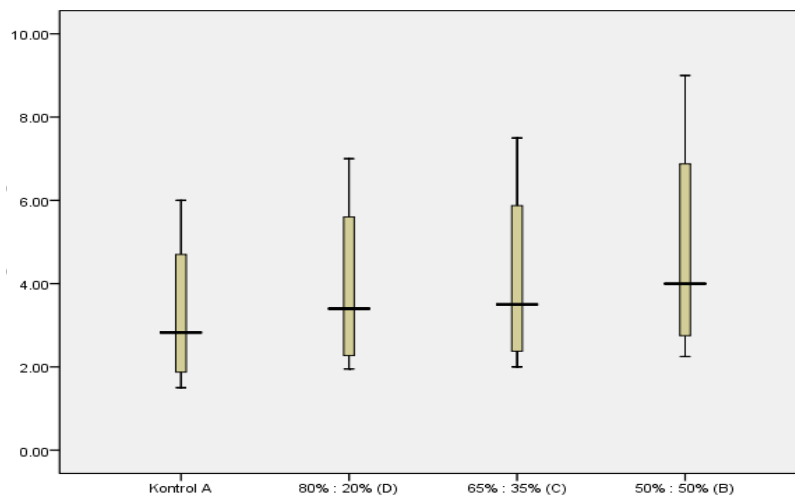


Figure 4. Increase in average stem circumference

The last parameter carried out in this study was the measurement of the number of sweet corn leaves. This refers to the total number of leaves present on the plant. These measurements can provide information about plant development and productivity. Healthy and well-developed sweet corn tends to have a larger number of leaves. The results of the analysis of variance showed that the average number of leaves in each treatment was significantly different. The number of leaves in each treatment ranged from 6 -13 leaves. The highest average number of leaves was found in the 50%:50% treatment with 8-13 leaves, while the lowest was in the control treatment with 6-11 leaves as shown in figure 5.

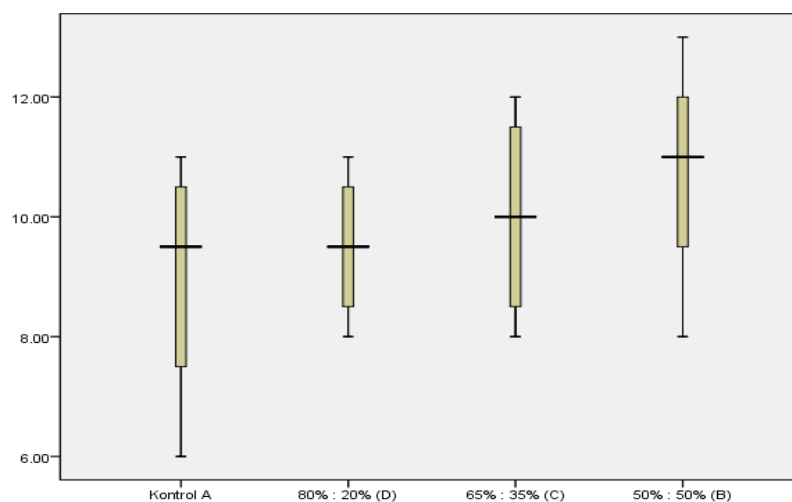


Figure 5. Increase in average number of leaves

The 50%:50% treatment had the highest number of leaves because the planting medium used had a relatively high nitrogen content. Nitrogen is an essential element for plant growth, development, and reproduction, and it is involved in the formation of important compounds such as proteins, chlorophyll, and amino acids. Adequate nitrogen availability allows corn plants to produce more chlorophyll, thereby maximizing their photosynthetic capacity. With increased chlorophyll production and enhanced photosynthetic capacity, corn plants are able to generate

more energy and nutrients, which promotes better leaf growth and results in an increased number of leaves. Nitrogen is found in various parts of the plant in different forms, and there is more nitrogen in plants than any other element, with the exception of carbon, hydrogen, and oxygen. Small changes in nitrogen content for some crops can result in large effects on yield, plant growth, and the quality of forage and fruit (Brune & Buchholz, 2022; Eckert, 2023; Plank & Kissel, 2023; Sirait et al., 2020).

## CONCLUSION

Based on the results of the research and discussion that has been carried out, the following conclusions are obtained: (a) the nitrogen content of each treatment was 1.6, 3.6, 2.8, and 2.2%, which met the SNI 19-7030-2004 standard which was above 0.40%; (b) phosphorus content for each treatment was 0.39, 0.44, 0.41, and 0.40%, which met the SNI 19-7030-2004 standard, which was above 0.10%; (c) the potassium content of each treatment did not meet the SNI 19-7030-2004 standard, which was below the 0.20% threshold. The results of statistical analysis using ANOVA on the growth of sweet corn were significantly different for all treatments. But the difference is very small, in terms of plant height, stem diameter, stem circumference and number of leaves

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