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Optimizing Bokashi Fertilizer Dosage on the Growth of Corn Plants (*Zea mays* L) Local Varieties of North Sumatra That Have Been Irradiated with Gamma Rays

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Abstract

Corn (*Zea mays* L.) is a primary agricultural commodity in Indonesia, alongside rice and soybeans. This study aims to evaluate the growth of local corn plants in North Sumatra after applying various doses of bokashi fertilizer. The research was conducted in Perbaungan Village, Bilah Hulu District, Labuhanbatu Regency, North Sumatra, from December 2024 to February 2025. The study employed a Completely Randomized Design (CRD) with a one-factor experiment, focusing on applying bokashi fertilizer to corn plants. Five treatments were tested: Control (no application), 80 grams per polybag (4 x 20 grams every 2 weeks), 120 grams per polybag (4 x 30 grams every 2 weeks), 180 grams per polybag (4 x 40 grams every 2 weeks), and 200 grams per polybag (4 x 50 grams every 2 weeks). The parameters observed included plant height, number of leaves, and stem diameter. Data analysis was performed using the Tukey Test (BNJ) at a significance level of 5%. The results indicated that the application of bokashi fertilizer significantly influenced the growth of local corn in North Sumatra, with the most favorable outcomes observed at 8 weeks after planting (WAP). The highest plant height recorded was 141.65 cm (P4), the number of leaves was 11.50 strands (P3), and the stem diameter measured 2.73 cm (P4).

Keywords: Bokashi Fertilizer, Drought Stress, Irradiation, Gamma Rays, Local Corn Varieties of North Sumatra

1. Introduction

Corn (*Zea mays* L.) is a vital food crop in Indonesia, ranking second after rice. Corn is a staple food in certain regions, particularly in North Sumatra. It is the second-largest source of carbohydrates after rice. Additionally, corn is rich in essential nutrients, including sugars (such as fructose), crude fiber, phosphorus, iron, calcium, protein, and vitamins A, B1, and C.

Drought stress significantly impacts the growth and productivity of corn plants. In tropical regions, drought conditions can lead to a reduction in corn yields ranging from 17% to 60%. Consequently, developing local North Sumatra corn resistant to drought stress and pests and diseases is essential.

In developing local corn plants in North Sumatra, increasing the availability of quality seeds is also necessary. Mutation breeding is a way to obtain high-quality corn seeds. This process involves the induction of mutations that can change the genetic makeup of plants (Sani & Annisa, 2019).

Mutation induction can be done using various methods, including gamma-ray irradiation. Gamma rays, as a form of electromagnetic radiation with high energy, are effective in triggering changes at the genetic level. Using mutations through gamma rays is useful for increasing genetic variation, especially in plants with low genetic variation.

In addition to gamma-ray irradiation, plant growth can be influenced by fertilization. Organic fertilization plays a role in mobilizing nutrients in the soil so that plant roots can absorb them well. Organic fertilizers contain macro and micronutrients needed by plants. Lack of nutrients in the soil and low fertility can inhibit plant growth, cause decreased yields, and require interventions such as organic and inorganic fertilization to improve soil quality. (Siregar et al ., 2017) . One of the organic fertilizers that can be

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made is through the utilization of livestock waste, which is made in the form of bokashi fertilizer.

Bokashi fertilizer is a type of fertilizer made from animal waste or other waste that is processed, then a solid fermentation process is carried out, which is enriched with mineral or microbial materials of the EM4 (Effective Microorganisms 4) type, which are useful in increasing nutrient content so that they can improve the physical, chemical and biological properties of the soil. Applying market waste bokashi with a dose of 15 tons/ha has the best effect on the growth and yield of sweet corn, indicated by an increase in plant height, stem diameter, root wet weight, plant dry weight, cob length, and cob weight.

However, the optimal dose of bokashi fertilizer for local corn varieties in North Sumatra has not been widely studied. This study aims to determine the effect of bokashi fertilizer on the growth of local corn plants in North Sumatra.

2. Material and Methods

2.1. Place and Time of Research

This research was conducted in Perbaungan Village, Bilah Hulu District, Labuhanbatu Regency, North Sumatra, with coordinates 2.2794° N, 99.8277° E, at an altitude of 40 MDPL. It took place from December 2024 to February 2025.

2.2. Research Materials and Tools

The materials used in this study were: Local North Sumatra corn seeds, bokashi fertilizer, water, 40x50 cm polybags, 15 kg/polybag topsoil. The tools used in this study were a meter, vernier caliper, ruler, hoe, machete, watering can, camera, and stationery.

2.3. Research methods

The design used in this study was a Completely Randomized Design (CRD) with a single-factor experiment, namely, the provision of bokashi fertilizer to corn plants with 5 treatments repeated 4 times for 20 plant experiments.

The dose of bokashi fertilizer is given to local corn plants in North Sumatra with graduated doses, namely 80 grams, 120 grams, 180 grams, and 200 grams per polybag, which are given gradually every two weeks in four applications. This method aims to determine the optimal dose that can increase the growth and yield of corn plants to the maximum.

Number of repetitions	: 4 repetitions
Total number of samples	: 20 plants
Distance between plants	: 50 cm
Soil weight/polybag	: 15 kg

2.4. Making Organic Fertilizer

Making Bokashi Fertilizer and the Steps are as follows:

1. Prepare the following ingredients: rice husks, straw, granulated sugar, goat manure, EM4 and water.
2. Goat manure is mixed with rice husks and straw on a tarpaulin.
3. Stir or turn the ingredients until they are mixed and even.
4. Dissolve EM4 with water and add granulated sugar.
5. Then mix it with the raw materials slowly.
6. After mixing, form a small handful of dough into a ball with your hand. The dough is ready to be fermented if it doesn't fall apart.
7. Then move the dough to a bucket with a lid and close it tightly.
8. So that the temperature is not too hot due to fermentation, stir it once a day.
9. Then leave it for 2 weeks, after 2 weeks of fermentation the fertilizer is ready and ready to be used as bokashi fertilizer.

2.5. Research Implementation

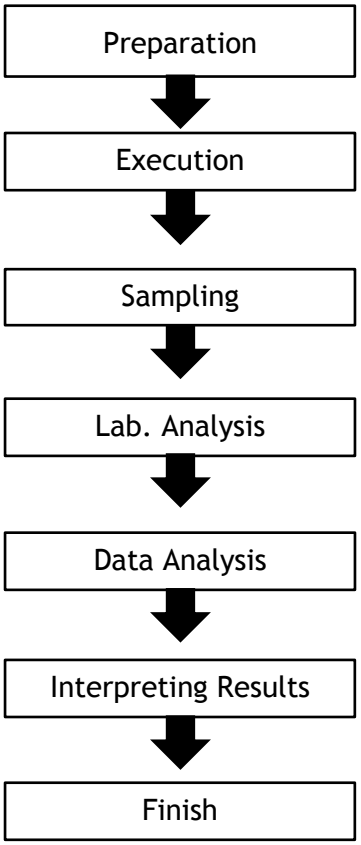

Figure 1. Research Flow Diagram

2.6. Data analysis

The data from this study were analyzed using the Analysis of Variance (ANOVA) method. It was carried out with a completely randomized design (CRD) factorial; if there was a significant difference, it was tested further at the 5% level. The analysis of the variance equation model is as follows:

$$Yij = \mu + \alpha i + \varepsilon ij$$

Information:

Yij = Observations on the i-th experimental unit that obtained the j-th level treatment combination

μ = General mean

αi = Effect of treatment i

εij = Random effect on the ith treatment and jth replication

If the results of the variance analysis show a real influence, then continue with the difference test. The average is based on the Tukey Test (BNJ) at the 5% level.

2.7. Observation Parameters

The parameters observed were plant height (cm), number of leaves (strands), and stem diameter (cm). And analyzed using Microsoft Excel.

3. Results and Discussion

3.1. Plant height

The results of the analysis of variance on the height of North Sumatra Local Corn plants show that the treatment of bokashi fertilizer on the growth of North Sumatra Local Corn plants gives different results.

Based on the Tukey Test (HSD) results, 5% of the application of bokashi fertilizer yielded different results, as seen in Table 1. Application of bokashi fertilizer on the height of North Sumatra Local Corn plants had a significant effect at the ages of 4 MST, 6 MST, and 8 MST but had no significant effect on plant height at the age of 2 MST. Increased growth in the height of North Sumatra local corn plants treated with bokashi fertilizer at the ages of 2 MST, 4 MST, 6 MST, and 8 MST, where each age that had a significant effect on plant height showed the ages of 4 MST, 6 MST, and 8 MST so that the highest data was at the age of 8 MST in the P4 treatment with a dose (200 grams/polybag) which had an average of 141.65 cm.

Bokashi fertilizer contains beneficial microorganisms that are an important part of the soil, can provide nutrients to plants through the recycling process, and form a soil structure suitable for plant growth and height. Bokashi fertilizer treatment can have a significant effect because it contains macronutrients such as nitrogen (N), phosphorus (P), and potassium (K), which are very important for plant growth. Nitrogen supports vegetative plant growth, phosphorus stimulates flowering, root fertilization, and seed formation, and potassium plays a role in forming strong stems.

Table 1. Comparison of local corn plant height at ages 2, 4, 6, and 8 MST

Treatment	Number of Leaves			
	2 MST	4 MST	6 MST	8 MST
control	4.75 ±0.88 a	5.75 ±2.69 a	6 ±3.07 a	8.75 ±2.89 a
80 grams of bokashi	4.25 ±0.88 a	6.75 ±2.69 a	6.75 ±3.07 a	9.75 ±2.89 ab
120 grams of bokashi	4.50 ±0.88 a	7 ±2.69 a	6.70 ±3.07 a	9.75 ±2.89 ab
180 grams of bokashi	4.50 ±0.88 a	6.75 ±2.69 a	7.50 ±3.07 a	11.50 ±2.89 b
200 grams of bokashi	4.25 ± 0.88a	7 ±2.69 a	7.50 ±3.07 a	10.75 ±2.89 ab

Description: Numbers followed by the same letter in the same column are not significantly different in the Tukey Test (HSD) at the 5% level, with 5 treatments and 4 replications.

3.2. Number of Local Corn Leaves (strands)

The observations on the number of leaves of local North Sumatran corn plants show that bokashi fertilizer yields different results. Based on the Tukey Test (HSD) results, 5% of the application of bokashi fertilizer yielded different results, as seen in Table 2. Application of bokashi fertilizer on the number of leaves of North Sumatra Local Corn had a significant effect at the age of 8 MST but had no significant effect at the age of 2 MST, 4 MST, and 6 MST on the number of leaves. Table 2. This shows an increase in growth in the number of leaves of North Sumatra local corn plants at the age of 8 MST, where the P3 treatment, which had a significant effect, had the highest value, with an average of 11.50 strands.

Table 2. Comparison of the number of leaves of local corn plants aged 2, 4, 6, and 8 MST

Treatment	Number of Leaves			
	2 MST	4 MST	6 MST	8 MST
control	4.75 ±0.32 a	5.75 ±0.48 a	6 ±0.44 a	8.75 ±0.48 a
80 grams of bokashi	4.25 ±0.32 a	6.75 ±0.48 a	6.75 ±0.44 a	9.75 ±0.48 ab
120 grams of bokashi	4.50 ±0.32 a	7 ±0.48 a	6.70 ±0.44 a	9.75 ±0.48 ab
180 grams of bokashi	4.50 ±0.32 a	6.75 ±0.48 a	7.50 ±0.44 a	11.50 ±0.48 b
200 grams of bokashi	4.25 ±0.32 a	7 ±0.48 a	7.50 ±0.44 a	10.75 ±0.48 ab

Description: Numbers followed by the same letter in the same column are not significantly different in the Tukey Test (HSD) at the 5% level, with 5 treatments and 4 replications.

According to the study, the number of leaves and cell size formation are also influenced by the nutrients absorbed by the roots that are used as food. The presence of Nitrogen nutrients that function as a component of enzymes and chlorophyll molecules, radium functions as an activator as an enzyme for protein synthesis and carbohydrate metabolism, phosphorus plays an active role in transferring energy in plant cells, and magnesium as a component of

chlorophyll and forms phosphorus in plants.

3.3. Local Corn Stem Diameter (cm)

The observations on the number of leaves of local North Sumatran corn plants show that bokashi fertilizer yields different results.

Based on the Tukey Test (HSD) results, 5% of the application of bokashi fertilizer yielded different results, as seen in Table 3. Application of bokashi fertilizer on stem diameter. Local North Sumatra Corn had a significant effect on stem diameter at the age of 8 MST but did not significantly affect stem diameter at the ages of 2 MST, 4 MST, and 6 MST. Table 3 explains an increase in growth in the diameter of corn plant stems due to bokashi fertilizer treatment at the age of 8 MST. In contrast, the P4 treatment, which had a significant effect, had the highest value at an average of 2.73.

Table 3. Comparison of stem diameters of local corn plants aged 2, 4, 6, and 8 MST

Treatment	Stem diameter			
	2 MST	4 MST	6 MST	8 MST
control	0.38 ±0.07 a	1.51 ±0.15 a	1.69 ±0.18 a	1.91 ±0.16 a
80 grams of bokashi	0.50 ±0.07 a	1.62 ±0.15 a	1.97 ±0.18 a	2.28 ±0.16 ab
120 grams of bokashi	0.53 ±0.07 a	1.63 ±0.15 a	2.17 ±0.18 a	2.45 ±0.16 ab
180 grams of bokashi	0.65 ±0.07 a	1.89 ±0.15 a	2.20 ±0.18 a	2.52 ±0.16 ab
200 grams of bokashi	0.50 ±0.07 a	2.03 ±0.15 a	2.41 ±0.18 a	2.73 ±0.16 b

Description: Numbers followed by the same letter in the same column are not significantly different in the Tukey Test (HSD) at the 5% level, with 5 treatments and 4 replications.

The effect of bokashi fertilizer on the diameter of corn stalks is significant. Based on research (Permayani et al ., 2020) which states that sufficient nutrient content in the soil will cause good vegetative growth of corn plants. As stated by (Sarief, 1985) which states that the availability of nutrients that plants can absorb is one of the factors that affect plant growth, which will increase cell enlargement, which affects stem diameter.

Figure 2. Research Documentation

4. Conclusion

Based on the results of the research that has been done, this study shows that the provision of Bokashi Fertilizer has a significant effect on increasing plant height (cm), number of leaves (strands), and stem diameter (cm) in local corn plants in North Sumatra. Bokashi Fertilizer treatment for plant height, number of leaves and stem diameter, which gives the best results at the age of 8 MST. Plant height shows the highest value of Treatment P4 with a value of 141.65 cm, the number of leaves of treatment P3 with a value of 11.50 strands, and the stem diameter of treatment P4 with a value of 2.73 cm.

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