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Optimizing The Growth of Corn Plant (*Zea mays* L) Local Variety of North Sumatera, which has been Irradiated with Gamma-Rays M1 with Urea Fertilizer Application

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Abstract

Corn (*Zea mays* L.) is the second most important food crop after rice and is a cereal crop that grows in various regions worldwide. Local varieties of corn in North Sumatra require high nutrient levels for optimal cultivation, particularly nitrogen (N), which is commonly supplied through urea fertilizer. The high demand for nitrogen in urea often leads farmers to apply it in inappropriate doses, resulting in several agronomic issues. This study aims to evaluate the growth of local varieties of corn in North Sumatra in response to different doses of urea fertilizer. The research was conducted in the experimental field in Perbaungan Village, Hulu Bilah District, Labuhanbatu Regency, North Sumatra, from December 2024 to February 2025. A Non-Factorial Completely Randomized Design (CRD) was employed, consisting of five treatment levels, each repeated four times. The urea fertilizer doses applied were as follows: control (no treatment), 2 g/polybag, 4 g/polybag, 6 g/polybag, and 8 g/polybag. The results indicate that varying doses of urea fertilizer significantly influence the growth of local North Sumatra corn plants, particularly in plant height and stem diameter. The optimal dose of urea fertilizer for promoting the development of these corn plants is determined to be 4 g/polybag.

Keywords: Corn Plant Growth, Drought Stress, Gamma Irradiation, North Sumatra Local Corn, Urea fertilizer

1. Introduction

Corn is a cereal plant from the American continent, specifically Mexico. This plant is a type of grass plant with a monocotyledonous seed type. In Indonesia, corn is used for animal feed and as a basic ingredient for food, beverage, flour, oil, and other industries. Corn (*Zea mays* L.) is the second main food ingredient after rice and is also a cereal plant that usually grows almost all over the world. In several areas in Indonesia, corn is the main food ingredient. In addition to being a food ingredient, corn is also known as one of the animal feed and industrial ingredients (Khair et al., 2013)

One of the technologies currently being developed to improve seed quality is gamma-ray irradiation. Gamma rays, as a form of electromagnetic rays with high energy, are effective in triggering changes at the genetic level. Gamma-ray irradiation techniques are often used to induce mutations, becoming a method that can directly increase genetic variation in the formation of plant varieties. Gamma-ray irradiation can cause mutations that change plants' genetic structure, resulting in faster plant growth and resistance to drought stress.

Climate change causes a prolonged dry season, so drought stress has an impact on decreasing corn crop production. An alternative to overcome drought stress is to utilize local varieties, although their production is relatively low. The production of local corn varieties can be increased through gamma irradiation until local corn is found to be tolerant to drought stress with high production. Selecting local corn varieties with gamma irradiation technology can increase genetic diversity and production so that new mutants of local corn plants with potential from North Sumatra are produced. Corn is a plant that is relatively resistant to drought, but drought stress can potentially reduce productivity and plant performance in the field. Using corn seeds with local North Sumatran varieties

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resistant to drought is recommended, and using seed technology using gamma irradiation is also recommended.

The growth of the vegetative phase of corn often experiences delays caused by the lack of availability of essential nutrients in the soil, especially nitrogen, phosphorus, and potassium. This condition is exacerbated by the use of fertilizers that are not balanced or do not follow plant needs, as well as decreasing soil quality due to repeated cultivation without improving soil fertility. As a result, corn plants show slow growth, yellowing leaves, and less sturdy stems, which ultimately impact decreasing yields.

Efforts to increase the growth and yield of local varieties of corn plants in North Sumatra are by providing fertilizer. The fertilizer used can be inorganic or organic fertilizer. The availability of sufficient nitrogen during the growth period is very important. Nitrogen is the most essential nutrient for plant growth, and it is generally needed for the formation or development of vegetative parts of plants such as leaves, stems, and roots. Adding fertilizer to corn can increase activity around the roots of corn plants in terms of the soil's chemical, physical, and biological properties. Therefore, the availability of sufficient N during the growth phase needs to be considered (Soedradjad & Soeparjono, 2022)

Plants most need n fertilizer because it is included in the macronutrients. Nitrogen greatly controls the metabolic processes in plants, especially in photosynthesis. (Putra et al ., 2021) . Nitrogen in the soil is generally lacking; nitrogen is easily leached, so it is unavailable to plants. Therefore, it is necessary to add N elements such as urea fertilizer, and it is necessary to know the correct dose of urea fertilizer used for corn plants so that urea fertilizer can be more optimal.

Urea fertilizer is essential in corn cultivation because it is critical in helping plant growth. Urea fertilizer is a nutrient provider for the vegetative growth of corn plants. Urea fertilizer chemically has a reasonably high nitrogen content. Most urea fertilizers on the market contain nitrogen (N) nutrients with a content of 46%. This means every 100 kilograms of urea fertilizer includes 46 kilograms of nitrogen. If local corn plants experience a deficiency of N, it will disrupt the plant's vegetative development, affecting its generative development. The function of nitrogen contained in urea fertilizer is to stimulate the vegetative growth of plants, especially in leaf shoots, and increase plant height if sufficient nitrogen is available, it will accelerate the synthesis of carbohydrates into protoplasm and protein, where protoplasm and protein are used to compose plant tissue cells so that plants grow taller and larger. Therefore, this study aims to determine the appropriate urea fertilizer dose for growing local North Sumatra corn plants.

2. Material and Methods

2.1. Time and Place of Research

This research activity was implemented from December 2024 to February 2025. This research was conducted in Perbaungan Village, Bilah Hulu District, Labuhanbatu Regency, North Sumatra, with geographical coordinates of around 2°3′25.2″ N and 99°58′15.6″ E at an altitude of 500 meters above sea level (masl).

2.2. Research Implementation

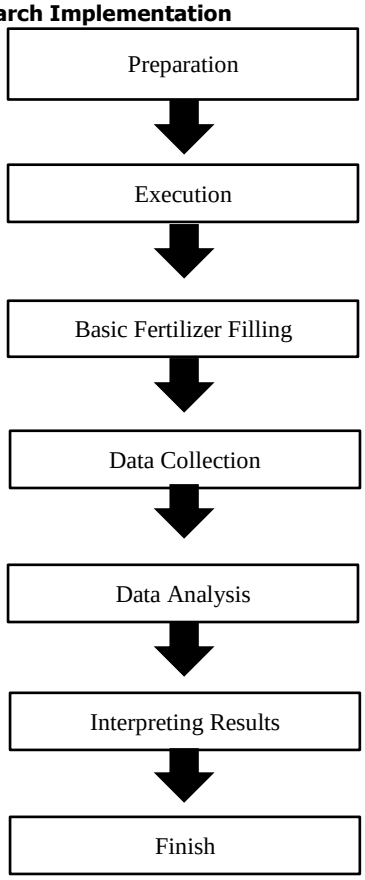

Figure 1. Research flow diagram

2.3. Tools and materials

The materials used in this study were corn seeds of local varieties of North Sumatra that had been irradiated with gamma-rays, urea fertilizer, topsoil, and sufficient water. At the same time, the tools used were hoes, machetes, scales, calipers, stationery, meters, labels, bucket cameras, watering cans, and 40x50 cm polybags.

2.4. Experimental Design

This study used a Completely Randomized Design (CRD) with a single factor experiment, namely the treatment of urea fertilizer on the growth of corn plants (*Zea mays* L) with 5 treatments repeated 4 times for 20 experiments. The doses of urea fertilizer given are as follows. Control (without treatment), 2 gr / polybag, 4 gr / polybag, 6 gr / polybag, 8 gr / polybag. The research data will be analyzed using Analysis of Variance (ANOVA).

Data analysis was conducted using a factorial completely randomized design (CRD) method. If there is a significant difference, it is further tested using the Tukey test or Honestly Significant Difference (HSD) at the 5% level. This analysis was conducted using Microsoft Excel 2016 software.

2.5. Observed parameters

The observation parameters carried out on local North Sumatra corn (*Zea mays* L.) varieties are as follows:

2.5.1. Plant Height (cm)

Plant height observation is done by measuring from the ground surface to the highest tip of the plant using a ruler and meter. Measurements begin when the plant is 2 MST old, with a measurement interval of once every 2 weeks.

2.5.2. Number of leaves (blades)

Observation of the number of leaves is done by counting all the leaves that have opened perfectly. The calculation is carried out when the plant is 2 weeks old after planting (MST) with a measurement interval of once every 2 weeks.

2.5.3. Stem diameter (cm)

The stem diameter was measured at the base of the corn stalk using a vernier caliper. Measurements began when the plant was 2 weeks old, with a measurement interval of once every 2 weeks.

3. Results and Discussion

3.1. Plant height (cm)

The results of the variance analysis conducted on the height of local corn plants in North Sumatra showed that the provision of urea fertilizer for the growth of local corn plants in North Sumatra gave significantly different results.

Table 1. Effect of urea fertilizer dose treatment on the height of local corn plants in North Sumatra at 2, 4, 6, and 8 MST.

Treatment	Plant Height (cm)			
	2 MST	4 MST	6 MST	8 MST
control	44.58±0.71a	82.55±4.45b	105.90±6.69c	141.60±5.83b
2 grams/polybag	47.38±0.71a	99.10±4.45a	129.45±6.69b	162.25±5.83a
4 grams/polybag	49.38±0.71a	113.40±4.45a	152.25±6.69a	181.98±5.83a
6 gr/polybag	49.48±0.71a	104.75±4.45a	142.33±6.69a	165.15±5.83a
8 gr/polybag	48.38±0.71a	103.13±4.45a	141.60±6.69a	164.88±5.83a

Note: Numbers followed by letters in the same column are not significantly different in the Tukey test (HSD) at the 5% level.

Table 1 shows that the administration of urea fertilizer to corn plants had a significant effect at the ages of 4, 6, and 8 weeks after planting (MST) but had no significant impact at the age of 2 weeks after planting (MST). At the age of 2 MST, the highest average yield was in the treatment of 6 gr/polybag, namely (49.48 cm). It is suspected that the plants had not absorbed the urea given because urea fertilizer was applied together with observations of plant height at the age of 2 MST, so it did not significantly affect local corn plants in North Sumatra. Table 1 explains an increase in plant height growth due to urea fertilizer treatment at 4, 6, and 8 MST. Plant height in the treatment of 4 gr/polybag starting at 4, 6, and 8 weeks after planting (MST) showed the highest plant (181.98 cm). The lowest data was in the control treatment (141.60 cm). This study is in line with showing that the administration of urea fertilizer with a dose of 300 kg/ha significantly affects the growth and yield of sweet corn. This result aligns with the researcher's findings that a specific dose of urea fertilizer increases the height of corn plants at the ages of 4, 6, and 8 MST. Different studies have found that variations in urea fertilizer doses do not significantly affect the growth and quality of sweet corn production (Kusparwanti et al., 2022). These results differ from the researcher's findings, which show a real effect of urea fertilizer administration on the growth of corn plant height.

3.2. Number of leaves (blades)

The results of the variance analysis conducted on the number of leaves of local North Sumatran corn showed that the provision of urea fertilizer for the growth of local North Sumatran plants produced results that were not significantly different.

Table 2. Effect of urea fertilizer dose treatment on the number of leaves of local North Sumatra corn plants at 2, 4, 6, and 8 MST.

Treatment	Number of leaves (blades)			
	2 MST	4 MST	6 MST	8 MST
control	5.00±0.10a	6.50±0.18a	7.25±0.21a	11.25±0.28a
2 grams/polybag	5.50±0.10a	6.75±0.18a	8.25±0.21a	12.00±0.28a
4 grams/polybag	5.75±0.10a	7.75±0.18a	8.75±0.21a	13.25±0.28a
6 gr/polybag	5.75±0.10a	7.50±0.18a	8.50±0.21a	12.50±0.28a
8 gr/polybag	5.75±0.10a	7.50±0.18a	8.50±0.21a	13.00±0.28a

Note: Numbers followed by letters in the same column are not significantly different in the Tukey test (HSD) at the 5% level.

Table 2 shows that the administration of urea fertilizer treatment on the number of corn plant leaves did not have a significant effect at the ages of 2, 4, 6, and 8 weeks after planting (MST). The average number of leaves showed that the number of local corn leaves in North Sumatra increased from 2 to 8 weeks after planting. The average number of

leaves of local corn plants in the treatments of 4 gr/polybag, 6 gr/polybag, and 8 gr/polybag was higher at 2 weeks after planting (5.75 strands). Still, at the age of 4 weeks after planting to 8 weeks after planting, the 4 gr/polybag treatment increased so that it tended to be higher than the other treatments, namely (13.25 strands) with a dose of 4 gr/polybag considered more capable of meeting the needs of N elements in increasing the growth of the number of leaves. In the control treatment, the lowest leaf growth was found (11.25 strands). The study aligns with the study (Basri et al., 2017), which found that the provision of urea derivative fertilizer had no significant effect on the number of sweet corn leaves at 14, 21, 28, and 35 HST. These results align with the findings of researchers who showed that the provision of urea fertilizer had no significant effect on the number of leaves of local North Sumatra corn plants at the ages of 2, 4, 6, and 8 MST. A different study (Dani & Sukmasari, 2024) showed that urea fertilizer treatment significantly affected the number of leaves of corn plants at the ages of 14, 21, and 28 HST.

3.3. Stem Diameter (cm)

The results of the variance analysis conducted on the stem diameter of local corn plants in North Sumatra showed that the provision of urea fertilizer for the growth of local corn plants in North Sumatra gave significantly different results.

Table 3. Effect of urea fertilizer dose treatment on stem diameter of local North Sumatra corn plants at ages 2, 4, 6, and 8 MST.

Treatment	Stem Diameter (cm)			
	2 MST	4 MST	6 MST	8 MST
control	0.56±0.008a	1.36±0.08b	1.40±0.089c	1.46±0.09c
2 grams/polybag	0.58±0.008a	1.71±0.08a	1.73±0.089b	1.78±0.09b
4 grams/polybag	0.62±0.008a	1.92±0.08a	2.02±0.089a	2.12±0.09a
6 gr/polybag	0.60±0.008a	1.88±0.08a	2.00±0.089a	2.11±0.09a
8 gr/polybag	0.60±0.008a	1.87±0.08a	2.00±0.089a	2.11±0.09a

Note: Numbers followed by letters in the same column are not significantly different in the Tukey test (HSD) at the 5% level.

Table 3 explains that urea fertilizer treatment significantly affects the stem diameter of local North Sumatra corn plants at the ages of 4, 6, and 8 WAP, while at the age of 2 WAP, it has no significant effect. Table 3 explains an increase in plant stem diameter due to urea fertilizer treatment at 4, 6, and 8 weeks after planting (WAP). The stem diameter of the plant in the 4 gr/polybag treatment shows the highest stem diameter, namely (2.12 cm) with a dose of 4 gr/polybag. The control treatment (control) has the lowest stem diameter growth (1.46 cm). Research that is in line with this shows that the administration of urea fertilizer significantly affects the stem diameter of sweet corn plants. The statistical analysis results show that urea fertilizer treatment significantly affects stem diameter, with an increase in urea dose producing a larger stem diameter. Different research (Kusparwanti et al., 2022) found that urea fertilizer treatment with various doses did not significantly affect the growth and quality of sweet corn production.

Figure 2. Research documentations

4. Conclusion

Based on the results of the study, it can be concluded that the application of urea fertilizer had a significant effect on the growth of local maize plants from North Sumatra. The analysis of variance indicated a significant effect of treatment 4 g/polybag, which showed the best response in plant height and stem diameter at 4, 6, and 8 weeks after planting (WAP). However, the application of urea fertilizer had no significant effect on the number of leaves.

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