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Growth Improvement Corn Plant (*Zea mays* L.) F1 Local Variety of North Sumatera which has under Light Irradiation Gamma using NPK Mutiara Fertilizer

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Abstract

Corn (*Zea mays* L.) is a vital food ingredient that plays a significant role in food security in Indonesia, particularly in North Sumatra, and it has considerable potential for developing local corn varieties. This study aims to evaluate the effect of NPK Mutiara fertilizer on the growth of gamma-irradiated local corn (Zea mays L.) plants from North Sumatra. The research was conducted in Perbaungan Village, Bilah Hulu District, Labuhanbatu Regency, North Sumatra Province, from December to February. A completely randomized design (CRD) was employed, featuring one factor and five fertilizer dose treatments: control, 3 g/polybag, 6 g/polybag, 9 g/polybag, and 12 g/polybag, with four replications. The parameters observed included plant height, number of leaves, and stem diameter at 2, 4, 6, and 8 weeks after planting (WAP). The results showed that the application of NPK Mutiara fertilizer significantly affected plant height and the number of leaves at all ages of the plants. The treatment with the highest dose, 12 gr/polybag, produced the best results, with plant height reaching 160.70 cm at 8 WAP, leaves reaching 11.50 leaves, and stem diameter reaching 2.24 cm. NPK Mutiara fertilizer improved the growth of gamma-irradiated corn plants, with higher doses resulting in optimal growth. However, it is essential to apply the correct dosage to avoid harming the plants. This study recommends fertilization with the appropriate dose to optimize corn plant growth in North Sumatra.

Keywords: Corn Crop Production, Corn Seeds from North Sumatra, Drought Stress, Gamma Ray Irradiation, NPK Mutiara Fertilizer

1. Introduction

Corn (*Zea mays* L.) is a crucial food ingredient that significantly ensures food security in Indonesia, particularly in North Sumatra, and it has substantial potential for developing local corn varieties. These regional varieties demonstrate excellent adaptability to environmental conditions and resist pests and diseases. As the demand for food continues to rise, increasing corn production has become a primary focus of the agricultural sector (Arif et al., 2022). However, the productivity of local corn varieties is typically lower than hybrid varieties, necessitating effective agronomic practices to enhance intensification efforts.

Based on the Corn Commodity Balance Prognosis, the estimated domestic corn production in 2023 will reach 18.15 million tons, with a carry-over stock from 2022 of 3.08 million tons, while the need for corn throughout 2023 is estimated at 16.98 million tons, so the estimated corn balance has a surplus of around 5.08 million tons. The corn stock currently managed by Bulog is 203 tons or around 0.08% of the national corn stock target according to the NFA assignment of 250 thousand tons throughout 2023.

Efforts to increase corn productivity in North Sumatra continue to be carried out, but drought stress is one of the factors that inhibit the growth of corn plants. Drought stress causes complex effects on plant growth. Morphologically and physiologically, the impact of water shortages can be seen in changes in the appearance of leaf area, leaf growth rate, CO2 assimilation activity, and the process of opening stomata, seed growth rate, and seed filling. One of the

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efforts made to create corn seed varieties that are resistant to drought stress is through mutation breeding (Dewi, 2017)

Mutations through gamma irradiation are helpful for increasing genetic variation, especially in plants with limited genetic variation. Gamma irradiation can cause changes in the genetic structure of plants, leading to faster plant growth. Mutated corn plants often show higher variations in nutrient requirements and are sensitive to nutrient deficiencies, so improper fertilization can inhibit growth and significantly reduce yields.

In addition to irradiation, providing the right fertilizer, such as Mutiara NPK fertilizer, which contains complete nutrients (Nitrogen, Phosphorus, and Potassium), is also essential to support plant growth. This fertilizer can be applied using various methods, such as sprinkled or spread, placed between rows of plants, or placed in holes. This fertilizer can increase plant resistance to drought and disease and is more efficient in its application. Therefore, the combination of gamma-ray irradiation and proper fertilization can be an effective strategy to increase corn productivity in North Sumatra (Karim et al., 2020)

This study aims to determine the effect of giving Mutiara NPK fertilizer on the growth of local North Sumatra corn varieties irradiated with gamma rays.

2. Material and Methods

2.1. Time and Place of Research

The time of this research activity took place from December to February. This research was conducted in Perbaungan Village, Bilah Hulu District, Labuhanbatu Regency, North Sumatra Province, at coordinates 1 ° 59′36 ″ N and 99 ° 54′52 ″ E, with an altitude of 29 meters above sea level.

2.2. Research Implementation

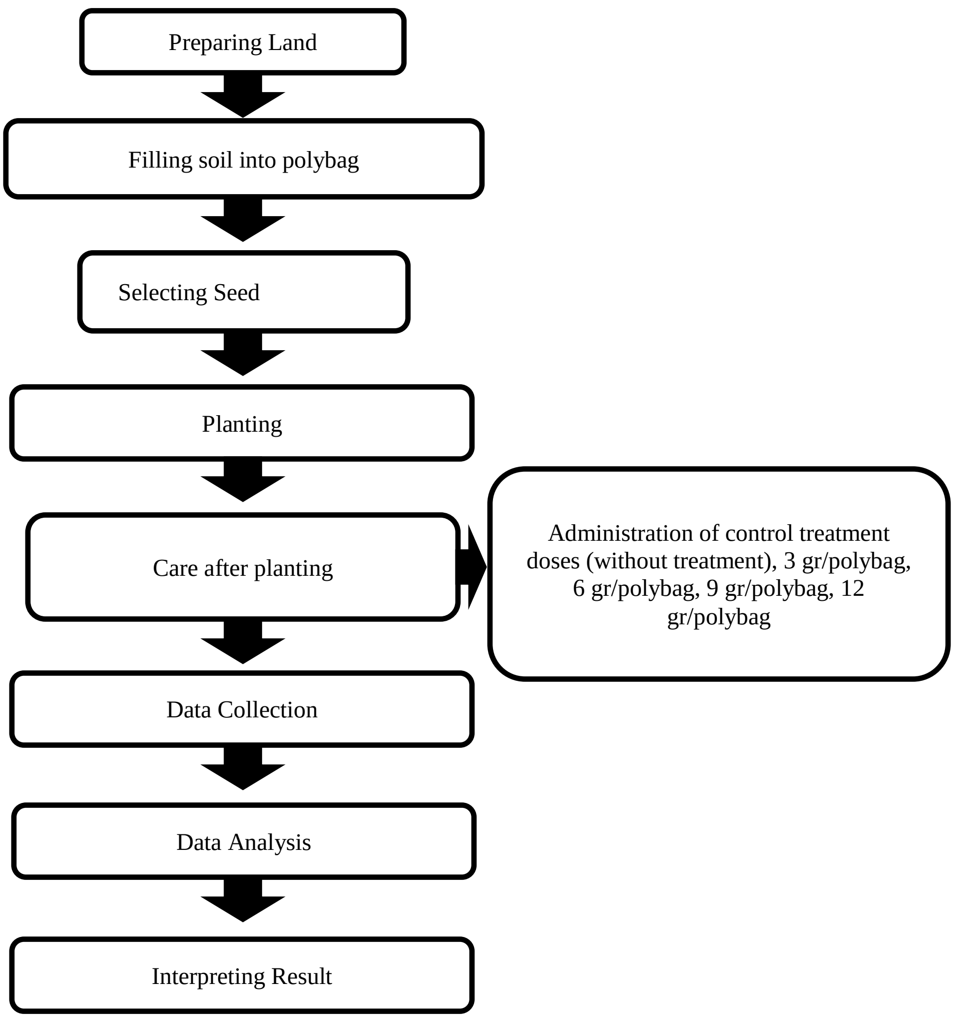

Figure 1. Research flow diagram

2.3. Tools and materials

The tools used in this study were a polybag size 45x50 cm, stationery, ruler, label, caliper, hoe, machete, digital scale, watering can/bucket, and camera. The materials used in this study were local varieties of corn seeds from North Sumatra, NPK pearl fertilizer, water, and topsoil.

2.4. Experimental Design

This study used a Completely Randomized Design

(CRD). In this study, an experiment was conducted with 1 factor, "the effect of giving pearl NPK fertilizer on the growth of corn plants (*Zea mays* . L) local varieties of North Sumatra that have been irradiated with gamma rays" with 5 treatments and 4 repetitions, the total number of all is 20 experiments. With the dose of pearl NPK fertilizer given is control (without treatment), 3 gr / polybag, 6 gr/polybag, 9 gr/polybag, 12 gr/polybag

2.5. Data analysis

The research data will be analyzed using Analysis Of Variance (ANOVA). Data analysis was carried out using a completely randomized design (CRD) non-factorial method, and if there is a fundamental difference, then it is further tested for Honestly Significant Difference (HSD) at the 5% level, using the Microsoft Excel 2016 application.

2.6. Observation Parameters

2.6.1. Plant height (cm)

Plant height is measured from the base of the stem to the last stem segment before the flower. Plant height is a plant measurement often observed as an indicator of growth or as a parameter to measure the influence of the environment or the treatment applied because plant height is the easiest measure of growth. Measurements begin when the plant is 2 MST old.

2.6.2. Number of leaves (blades)

To observe the number of leaves, just count the fully opened leaves. Counting is done from when the plant shows leaf growth until the early generative phase. Usually, the counting starts at age 2 (MST) and continues until the formation of male flowers.

2.6.3. Stem Diameter (cm)

Measurements are made during the vegetative phase of the plant, usually starting from 30 days after planting (DAP) until approaching flowering. Observations can be made periodically, for example, every 2 DAP. The tool used to calculate the stem diameter is a Vernier Caliper. This tool is used to obtain precise measurement results.

3. Results and Discussion

3.1. Plant height (cm)

Based on the variance analysis, the provision of NPK pearl fertilizer had a significant effect at the 2.6 and 8 MST and at the 4 MST. The highest data was found in the treatment of 12 gr/polybag (160.70 cm). The results of the further test of Honestly Significant Difference (HSD) at the 5% level showed that the treatment of 12 gr/polybag was not significantly different from the treatment of 9 gr/polybag at each plant age, the treatment of 12 gr/polybag showed no difference with the treatment of 6 gr/polybag at the ages of 2 and 4 MST but significantly different at the ages of 6 and 8 MST. At the same time, the treatment of 3 gr/polybag and control were significantly different from the treatments of 12 gr/polybag and 9 gr/polybag at each plant age.

Table 1. Average Plant Height with Mutiara NPK Fertilizer Treatment at Ages 2, 4, 6, and 8 MST

Treatment	Plant Height			
	2 MST	4 MST	6 MST	8 MST
control	42.18±15.44b	70.83±15.44b	93.98±15.44b	113.9±15.44c
3 gr/polybag	42.53±17.78b	71.75±17.78b	97.55±17.78b	125.7±17.78c
6 gr/polybag	46.65±17.44a	74.90±17.44a	103.8±17.44b	126.9±17.44b
9 gr/polybag	49.13±20.99a	83.17±20.99a	108.6±20.99a	148.6±20.99a
12 gr/polybag	51.98±23.33a	86.87±23.33a	121.9±23.33a	160.7±23.33a

Note: Numbers followed by the same letter are significantly different in the 5 % BNJ test (lowercase letters) and significantly different in the 1% BNJ α test.

The treatment of 12 gr/polybag in the provision of Mutiara NPK fertilizer is the best compared to other treatments. As seen in table 1. At the age of 8 MST, the plant height reached 160.70 cm. This is due to the content of NPK fertilizers such as Nitrogen, Phosphorus, and Potassium, which can improve the nutrients in the soil and help the growth period of plants (Simanjuntak et al., 2021)

(Aprilia, 2023) the combination of NPK fertilizer (15-15-15 or 15-10-12) with Nutremag micronutrient fertilizer significantly increased nutrient absorption and production of sweet corn plants in swampy soil.

3.2. Number of leaves (blades)

Based on the variance analysis, the average number of leaves at the ages of 2 and 4 MST did not have a significant effect but was significantly different at the ages of 6 and 8 MST. The largest number of leaves was obtained in the 12 gr/polybag treatment, namely 11.50 strands, and the lowest number of leaves was in the control treatment, 8.5 strands. The results of the further Honestly Significant Difference (HSD) test at the 5% level showed that the 12 gr/polybag treatment was not significantly different from the 9 gr/polybag treatment at the ages of 6 and 8 MST. The 12 gr/polybag and 9 gr/polybag treatments were significantly different from the 6 gr/polybag, 3 gr/polybag, and control treatments at 6 MST and 8 MST.

Table 2. Explaining the increase in leaf number growth at 6 and 8 WAP due to NPK Mutiara fertilizer treatment The difference in results found at the age of corn plants 2-4 WAP and 6-8 WAP in response to the administration of NPK Mutiara fertilizer is most likely caused by differences in plant growth phases, the ability of plants to respond to fertilizer as they age, and the influence of environmental factors. In the early phase, the plants did not fully respond to fertilizer. In contrast, in the later phase, the plants are more developed and can utilize fertilizer more optimally,

which shows a significant difference in the number of leaves.

Table 2. The average number of leaves with Mutiara NPK Fertilizer treatment at ages 2,4,6 and 8 MST

Treatment	Number of leaves			
	2 MST	4 MST	6 MST	8 MST
control	4.00±1.04a	5.75±1.04a	6.50±1.04b	9.00±1.04c
3 gr/polybag	4.25±0.93a	6.75±0.93a	7.75±0.93b	8.5±0.93b
6 gr/polybag	4.50±1.10a	7.00±1.10a	8.00±1.10b	9.75±1.10b
9 gr/polybag	4.75±1.18a	6.75±1.18a	8.5±1.18a	10.25±1.18a
12 gr/polybag	5.25±1.33a	7.25±1.33a	9.00±1.33a	11.50±1.33a

Note: numbers followed by the same letter are significantly different in the 5 % BNJ test (lower case letters) and significantly different in the 1% BNJ α test.

Research (Marulitua Sipayung, Tutty Matondang, 2020) revealed that using NPK fertilizer can accelerate the vegetative growth of corn plants. This is due to the ability of NPK fertilizer to provide macro and micronutrients in balanced amounts, which support plant growth and development.

3.3. Stem diameter (cm)

Based on the analysis of variance, the average stem diameter of local corn varieties of North Sumatra showed that at 2 MST, there was no significant effect from all treatments; the highest observation results due to the administration of Mutiara NPK fertilizer at 2 MST were in the 12 gr/polybag treatment with a dose of 12gr/polybag. At the ages of 4.6 and 8 MST, there was an increase and a significant effect. The best observation results were in the 12 gr/polybag treatment seen at the age of 8 MST; the stem diameter reached 2.24 cm, and the results of the Honestly Significant Difference (HSD) test showed no difference between the 9 gr/polybag and 12 gr/polybag treatments at each plant age. The 6 gr/polybag treatment was not significantly different from the 3 gr/polybag treatment at each plant age. Still, it was seen that at the age of 4 MST, the control, 3 gr/polybag, and 6 gr/polybag treatments showed no significant effect.

(Hartanti, 2019) showed that the provision of mycorrhizal biofertilizer significantly increased stem diameter, cob length, percentage of roots infected with mycorrhizae, and cob weight per husk/m² of sweet corn plants.

Table 3. Average stem diameter with Mutiara NPK fertilizer treatment at ages 2,4,6 and 8 MST

Treatment	Stem diameter			
	2 MST	4 MST	6 MST	8 MST
control	0.82±0.16a	1.21±0.16b	1.39±0.16c	1.57±0.16c
3 gr/polybag	0.80±0.18a	1.29±0.18b	1.44±0.18b	1.66±0.18b
6 gr/polybag	0.86±0.22a	1.36±0.22b	1.72±0.22b	1.86±0.22b
9 gr/polybag	0.89±0.25a	1.47±0.25a	1.89±0.25a	2.01±0.25a
12 gr/polybag	0.97±0.29a	1.69±0.29a	2.11±0.29a	2.24±0.29a

Note: Numbers followed by the same letter are significantly different in the 5 % BNJ test (lower case letters) and significantly different in the 1% BNJ α test.

Figure 2. Research documentations

4. Conclusion

Based on the results of the observations, the application of NPK Mutiara fertilizer at a rate of 12 grams per polybag had a significant effect on plant height from the early vegetative phase to the late vegetative phase. However, the application of NPK Mutiara fertilizer did not significantly impact the early growth phase in terms of the number of leaves and stem diameter. This lack of effect may be attributed to several factors, including environmental conditions, extreme weather, and the specific variety of corn plants used.

Based on the observational results, it can be concluded that applying Mutiara NPK fertilizer at a dosage of 12 grams per polybag yields the most favorable outcomes in promoting the growth of corn plants. Corn plants treated with this dosage exhibit enhanced growth characteristics, including increased plant height, a greater number of leaves, and improved resistance to diseases and pests.

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