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Study on the Composition of NPK Fertilizer and Goat Manure on the Growth and Yield of Sweet Corn (Zea mays Saccharata Sturt. L)

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ABSTRACT

In agricultural cultivation technology, there are various determining factors that greatly affect plant growth and yield. One important factor in agriculture is fertilization. This study aims to examine the effect of NPK fertilizer composition and goat manure on the growth and yield of sweet corn plants. This research was conducted from June 10, 2024 to September 16, 2024 at Jaya Wijaya Experimental Farm, Mojosongo, Surakarta, at an altitude of 400 meters above sea level with Latosol soil type. This study used a Completely Randomized Group Design (CRD) with two treatment factors, NPK fertilizer and goat manure, each repeated three times to obtain 48 treatment combinations. The parameters observed included plant height, number of leaves, cob diameter, cob weight with husk, and cob weight without husk. The results of the experiment showed that the addition of NPK fertilizer significantly affected the growth and yield of sweet corn plants, while the addition of goat manure and the interaction between the two did not give any significant effect.

Keywords: *Composition, Fertilizer, Growth, Sweet Corn, Yield*

INTRODUCTION

Agriculture is an important sector for every country as it plays a major role in meeting the food demands of the population. As the population grows, the demands for food will increase. One commodity that can contribute to the fulfillment of national food demand is corn, which is widely cultivated by the community. In Indonesia, one type of corn that began to be developed in the early 1980s is sweet corn (Zea mays Saccharata Sturt. L).

An increase in sweet corn yield can be carried out in various ways, one of which is by increasing soil fertility through fertilization (Bay'ul Maryo Khan et al., 2021). Fertilization is one of the efforts to increase the availability of nutrients needed by plants, thus increasing the production and quality of crop yields (Kusumiyati et al., 2016).

Efforts are made to increase sweet corn yield by adding NPK fertilizer and manure to the planting environment. The purpose of fertilization is to improve the growing medium both biologically and chemically. Fertilization is divided into two types, inorganic fertilization and organic fertilization. The combination of NPK fertilizer and manure aims to not only improve flower quality, but also to improve soil fertility, soil health, and nutrient composition (Hasnain et al., 2020).

NPK fertilizer is a compound fertilizer that contains the elements Nitrogen, Phosphate, and Potassium, which are necessary for plants. The function of Nitrogen (N) for plants is as a component of amino acids, proteins, enzymes, vitamin B complex, hormones, and chlorophyll (Kusparwanti et al., 2023). Phosphorus (P) functions in energy transfer, cell membrane formation, as well as carbohydrate and protein metabolism (Mutiah, 2017). Potassium (K) functions as an enzyme activator, spurs the translocation of carbohydrates from leaves to other plant organs, and as an important component in the osmotic regulatory mechanism in cells (Pratiwa, 2014).

Goat manure is a type of manure that is high in organic compounds. It is environmentally friendly and given its abundant availability, can reduce production costs and increase yields through improved soil structure. The sustainable use of goat manure has a positive impact on soil fertility. Fertile soil will facilitate the development of plant roots. Well-developed roots will more easily absorb water and nutrients available in the soil, allowing plants to grow and develop optimally and produce high yields. In addition, the nutrient content in goat manure contains 1.41% N, 0.54% P, and 0.75% K (Sinuraya & Melati, 2019).

Considering this background, research on the composition of NPK fertilizer and goat manure on the growth and yield of sweet corn (Zea mays Saccharata Sturt. L) is necessary to determine the best composition of NPK fertilizer and goat manure for the growth and yield of sweet corn plants. This study aims to examine the composition of NPK fertilizer and goat manure on the growth and yield of sweet corn. Presumably, 100% NPK fertilizer (300 kg/Ha or 7.5 grams/polybag) and

100% goat manure (30 tons/Ha or 750 grams/polybag) will provide optimal growth and yield of sweet corn.

RESEARCH METHODOLOGY

The research design used in this study is a Complete Randomized Group Design with two treatment factors. The first factor is the application of NPK fertilizer (N), and the second factor is the application of goat manure (K). The treatment types for the two factors are as follows:

1. Factor 1: Mutiara NPK fertilizer (N) consists of 4 levels, including:
   a. N_0 = 0% NPK fertilizer (no NPK fertilizer is given)
   b. N_1 = 30% NPK fertilizer (90 kg/Ha or 2.25 grams/polybag)
   c. N_2 = 60% NPK fertilizer (180 kg/Ha or 4.5 grams/polybag)
   d. N_3 = 100% NPK fertilizer (300 kg/Ha or 7.5 grams/polybag)
2. Factor 2: Goat Manure (K) consists of 4 levels, which are:
   a. K_3 = 100% goat manure (30 tons/Ha or 750 grams/polybag)
   b. K_2 = 60% goat manure (18 tons/ha or 450 grams/polybag)
   c. K_1 = 30% goat manure (9 tons/ha or 225 grams/polybag)
   d. K_0 = 0% goat manure

Based on these two factors, 16 treatment combinations were obtained which were repeated 3 times, resulting in 48 treatment combinations, as follows:

1. N_0K_0 = Control (0% NPK and 0% goat manure)
2. N_0K_1 = 0% NPK and 30% goat manure (0 NPK and 225g PK)
3. N_0K_2 = 0% NPK and 60% goat manure (0 NPK and 450g PK)
4. N_0K_3 = 0% NPK and 100% goat manure (0 NPK and 750g PK)
5. N_1K_0 = 30% NPK and 0% goat manure (2.25g NPK and 0g PK)
6. N_1K_1 = 30% NPK and 30% goat manure (2.25g NPK and 225g PK)
7. N_1K_2 = 30% NPK and 60% goat manure (2.25g NPK and 450g PK)
8. N_1K_3 = 30% NPK and 100% goat manure (2.25g NPK and 750g PK)
9. N_2K_0 = 60% NPK and 0% goat manure (4.5g NPK and 0g PK)
10. N_2K_1 = 60% NPK and 30% goat manure (4.5g NPK and 225g PK)
11. N_2K_2 = 60% NPK and 60% goat manure (4.5g NPK and 450g PK)
12. N_2K_3 = 60% NPK and 100% goat manure (4.5g NPK and 750g PK)
13. N_3K_0 = 100% NPK and 0% goat manure (7.5g NPK and 0g PK)
14. N_3K_1 = 100% NPK and 30% goat manure (7.5g NPK and 225g PK)
15. N_3K_2 = 100% NPK and 60% goat manure (7.5g NPK and 450g PK)
16. N_3K_3 = 100% NPK and 100% goat manure (7.5g NPK and 750g PK)

In order to determine the effect of dosing NPK Mutiara fertilizer and goat manure on sweet corn plants, the research data were analyzed using analysis of variance and continued with Tukey's range test at the 5% level.

This research was conducted at the Research Center of the Faculty of Agriculture of UNISRI, Jl. Jaya Wijaya No. 384, Kadipiro, Banjarsari, Surakarta, at an altitude of 110 meters above sea level, with regosol soil type. This research took place from June 10, 2024 to September 16, 2024. Materials used in this research include sweet corn seeds, goat manure, Mutiara NPK fertilizer, planting media, water, and polybags of 40 x 40 cm. Whereas the tools used included hoes, knives, scales, buckets, plastic solation, stationery, and a vernier caliper. The variables used in this study were plant height (cm), number of leaves (strands), cob diameter, cob weight (grams), and cob weight without husk (grams).

RESULT AND DISCUSSION

Growth of Sweet Corn Plants

Table 1. Average Growth of Sweet Corn Age 49 Days

Treatment	Plant Height	Number of Leaves
N_0K_0	134.67	11.00
N_0K_1	153.00	12.33
N_0K_2	139.67	12.00
N_0K_3	139.00	11.67
N_1K_0	152.33	11.67
N_1K_1	156.67	12.33
N_1K_2	157.33	12.67
N_1K_3	157.00	12.33
N_2K_0	153.67	12.00
N_2K_1	170.00	12.33
N_2K_2	168.67	12.00
N_2K_3	159.00	13.00
N_3K_0	163.67	12.33
N_3K_1	159.33	13.00
N_3K_2	152.00	11.67
N_3K_3	168.33	12.33

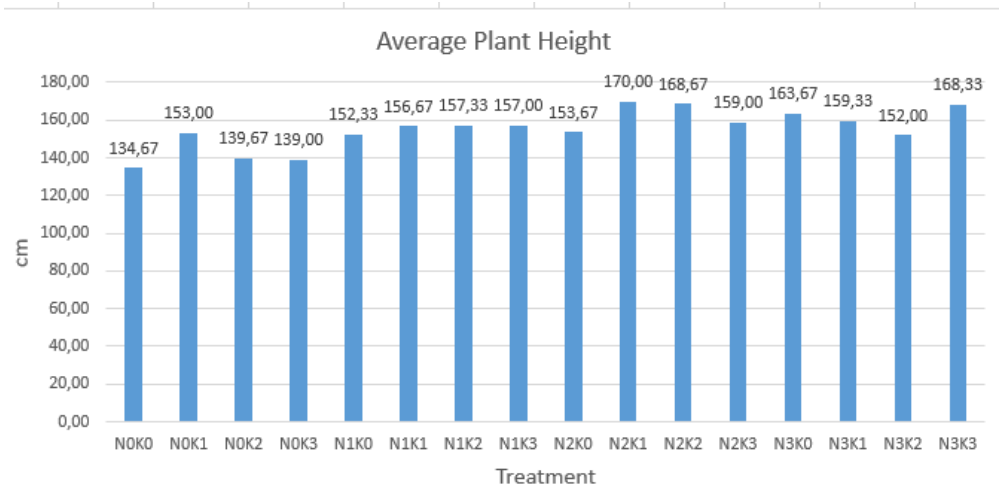
Source: Processed Data by Researchers

The results of the analysis of variance illustrates that the addition of NPK fertilizer composition has a significant effect on the height of sweet corn plants. Plant height is influenced by various factors. According to Nio et al. (2021), factors that affect plant growth can be divided into internal and external factors. Internal factors include factors in plants, such as genetics and hormones, while external factors include environmental factors such as light, water, temperature, and humidity.

External factors that affect plant growth are the availability of nutrients in the soil that plants need to grow and develop. Plant height is strongly dependent on the nutrient nitrogen (N). The research data showed that the N_2K_1 treatment (medium dose of NPK with a combination of low doses of manure) produced the highest plant height (170 cm) and a stable number of leaves (12.33-13 leaves). This

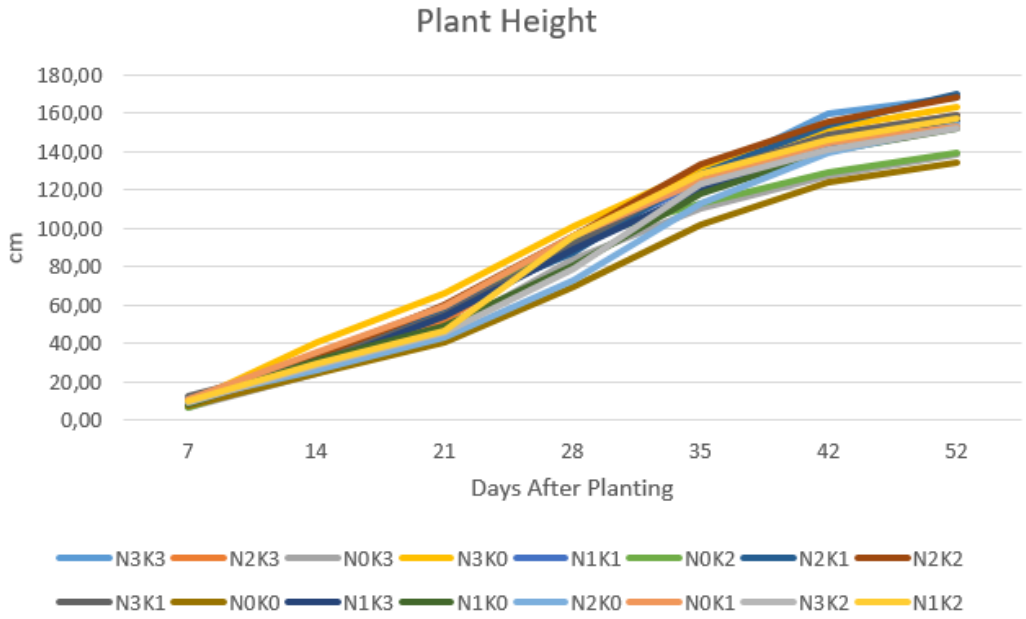
indicates that the optimal dose of NPK provides essential nutrients, especially nitrogen, which supports the formation of plant vegetative tissues.

Chart 1. Average Plant Height



Source: Processed Data by Researchers

Chart 2. Plant Height



Source: Processed Data by Researchers

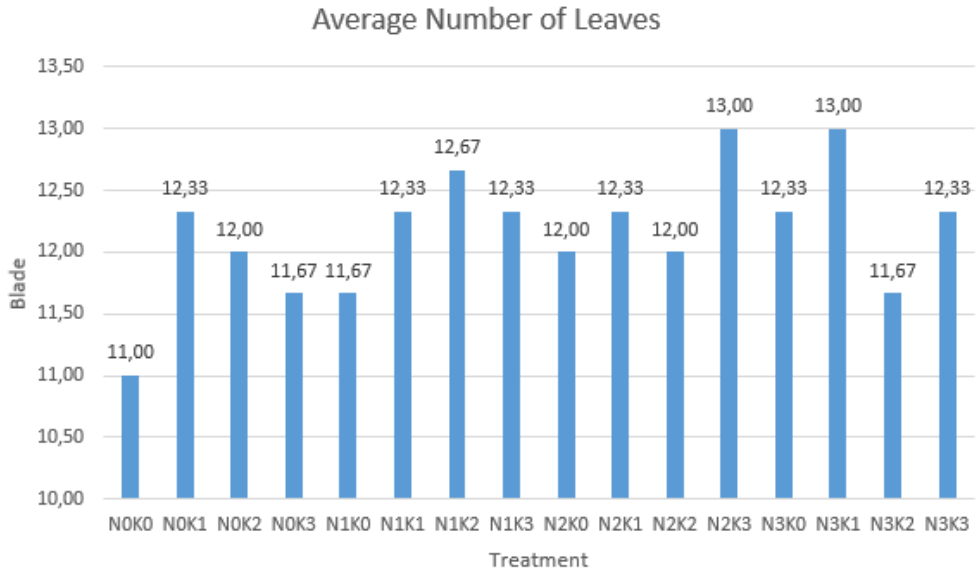
Table 2. Effect of NPK Fertilizer Composition on Plant Height of Sweet Corn Age 49 Days After Planting

Treatment	Average	Notation
N_0	141.58	b
N_1	155.83	a
N_2	162.83	a
N_3	160.83	a

Source: Processed Data by Researchers

The addition of NPK fertilizer composition can improve soil chemical properties and increase the availability of N, P and K elements in the soil, which in turn supports the availability of nutrients for plants. However, since the soil already contains enough nutrients to support plant growth, the addition of nutrients from NPK fertilizers does not contribute significantly to the increase in plant height.

Chart 3. Average Number of Leaves



Source: Processed Data by Researchers

Jiaying et al. (2022) stated that the number of leaves is strongly influenced by the nutrients N, P, and K contained in the soil. As the nutrient content in the soil is already quite high, the addition of NPK fertilizer and goat manure cannot be absorbed optimally by the plants. According to White et al. (2016), plants with more leaves will grow faster. The number of leaves determines the speed of plant growth; the more the number of leaves on the plant, the higher the photosynthetic yield, which contributes to better growth.

Yield of Sweet Corn Plants

Table 3. Yield of Sweet Corn Plants

Treatment	Diameter of Cob (cm)	Weight of Cob with Husk (g)	Weight of Cob without Husk (g)
N_0K_0	3.00	75.20	59.38
N_0K_1	3.53	131.84	102.40
N_0K_2	3.40	156.44	104.04
N_0K_3	2.83	77.80	61.97
N_1K_0	4.17	198.95	142.14
N_1K_1	4.03	195.34	144.57
N_1K_2	3.87	155.31	116.81
N_1K_3	4.00	200.96	158,49
N_2K_0	4.20	257.33	144.53

N_2K_1	4.50	249.57	190.75
N_2K_2	4.13	208.70	155.67
N_2K_3	3.83	150.18	156.05
N_3K_0	4.07	208.89	156.24
N_3K_1	3.97	161.36	124.83
N_3K_2	4.07	184.02	137.01
N_3K_3	4.03	187.79	135.45

Source: Processed Data by Researchers

The results of the analysis of variance showed that the treatment of NPK fertilizer composition had a very significant effect on cob diameter, as well as a significant effect on the weight of the cob and the weight of the cob without the husk in sweet corn plants (Zea mays Saccharata Sturt. L). The addition of NPK fertilizer composition gives significantly different results on the diameter of the cob of sweet corn plants. This shows that the provision of different NPK fertilizer compositions produces significant differences. The N_2K_1 treatment produced the largest cob diameter (4.50 cm) and the highest cob weight with husk (249.57 g) and without husk (190.75 g). This reflects the role of NPK, especially phosphorus and potassium, in supporting cob filling.

The results of Tukey's range test 5% cob diameter are presented in the following table:

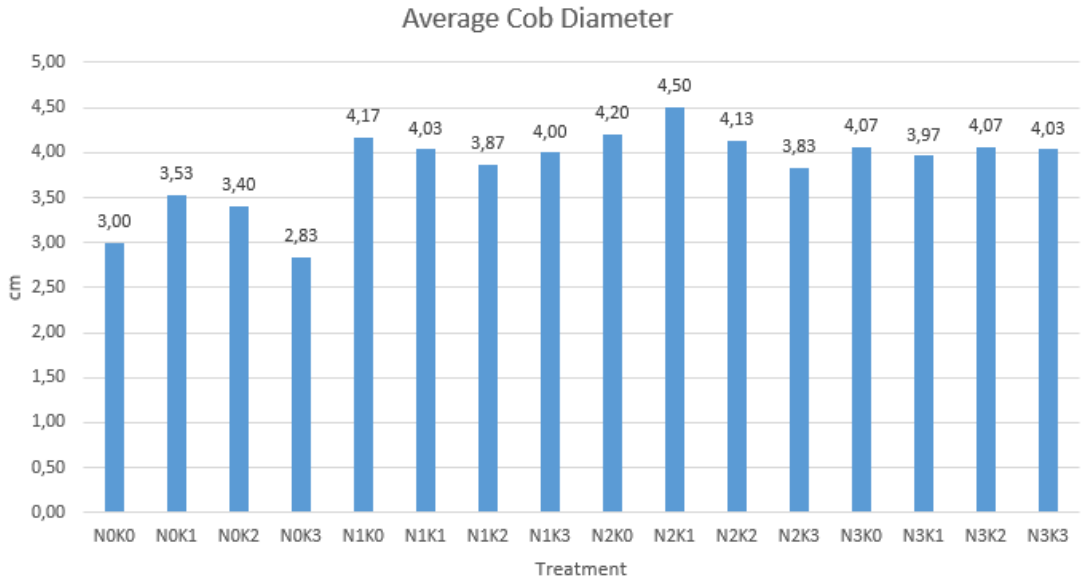
Table 4. Effect of NPK Fertilizer Composition on Cob Diameter

Treatment	Average	Notation
N_0	3.19	b
N_1	4.02	a
N_2	4.17	a
N_3	4.03	a

Source: Processed Data by Researchers

The N_0 (0 gram/polybag) treatment was significantly different from the N_1 (2.25 gram/polybag), N_2 (4.5 gram/polybag), and N_3 (7.5 gram/polybag) treatments. However, treatments N_1 (2.25 grams/polybag), N_2 (4.5 grams/polybag), and N_3 (7.5 grams/polybag) did not show significant differences. The N_2 treatment gave the best cob diameter results with an average of 4.17 cm.

Chart 4. Average Cob Diameter



Source: Processed Data by Researchers

Maximum seed formation will increase cob diameter. According to Li et al. (2022), inherited genetic variance results from the interaction of genes that contribute to each component of yield characteristics. Environmental factors that affect corn growth include pH, water availability, and nutrient content. Ning et al. (2018) asserts that sufficient nitrogen (N) content can increase carbohydrate production to support cell growth, which in turn encourages the enlargement of cob diameter.

The application of fertilizer in accordance with the dose and needs of the plant can increase yields, while excessive application can actually reduce plant yields. Increasing the dose of fertilizer will not continue to increase crop yield after reaching the optimum point. Plant growth and production will reach optimal levels if the contributory factors, such as balanced nutrients, the right dose of fertilizer, and the availability of nutrients needed, are in optimal conditions (Penuelas et al., 2023). The availability of nutrients and good external factors greatly affect plant metabolism. This metabolic process involves not only the formation of compounds, but also the breakdown of organic compound elements in the plant, which in turn affects the productivity of the plant itself.

The results of the analysis of variance showed that the treatment of NPK fertilizer composition had a significant effect on the weight of the cob of sweet corn (Zea mays Saccharata Sturt. L). The results of Tukey's range test 5% for the weight of the cob is presented in the following table.

Table 5. Effect of NPK Fertilizer Composition on Weight of Cob with Husk

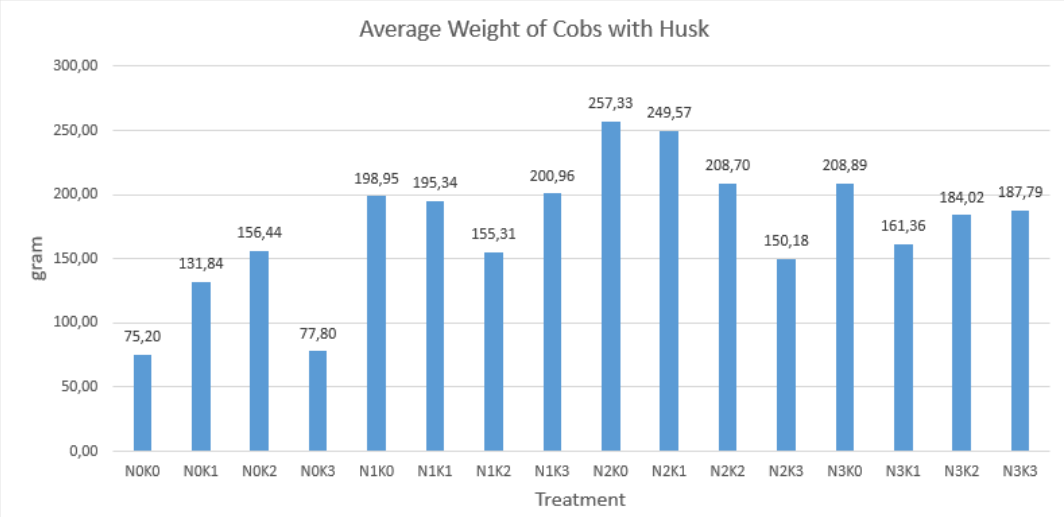
Treatment	Average	Notation
N_0	110.32	b
N_1	187.64	a

N_2	216.44	a
N_3	185.51	ab

Source: Processed Data by Researchers

The N_0 treatment (0 grams/polybag) was significantly different from the N_1 (2.25 grams/polybag) and N_2 (4.5 grams/polybag) treatments, while the N_3 treatment (7.5 grams/polybag) showed no significant difference. The N_1 (2.25 grams/polybag) and N_2 (4.5 grams/polybag) treatments were not significantly different, with N_2 giving the best results on the weight of the cob, with an average value of 216.44 grams.

Chart 5. Average Weight of Cobs with Husk



Source: Processed Data by Researchers

The application of NPK fertilizer composition has a significant effect on the weight of the cob of sweet corn plants. This is due to the fact that not all plants obtain sufficient nutrients in the process of cob and seed formation. Phosphorus has an important role in the process of plant growth, especially in blooming, cob and seed formation (Malhotra et al., 2018). If the cob of the plant is formed perfectly, it will produce a high cob weight. Paul et al. (2023) stated that nutrients affect cob weight, especially seeds, because nutrients absorbed by plants are used to form proteins, carbohydrates, and fats, which are then stored in corn kernels, thus increasing the weight of corn kernels.

The results of the analysis of variance showed that the treatment of NPK fertilizer composition had a significant effect on the weight of the cob without the cob on sweet corn plants (Zea mays Saccharata Sturt. L). The results of Tukey's range test 5% for the weight of the cob without the husk are presented in the following table:

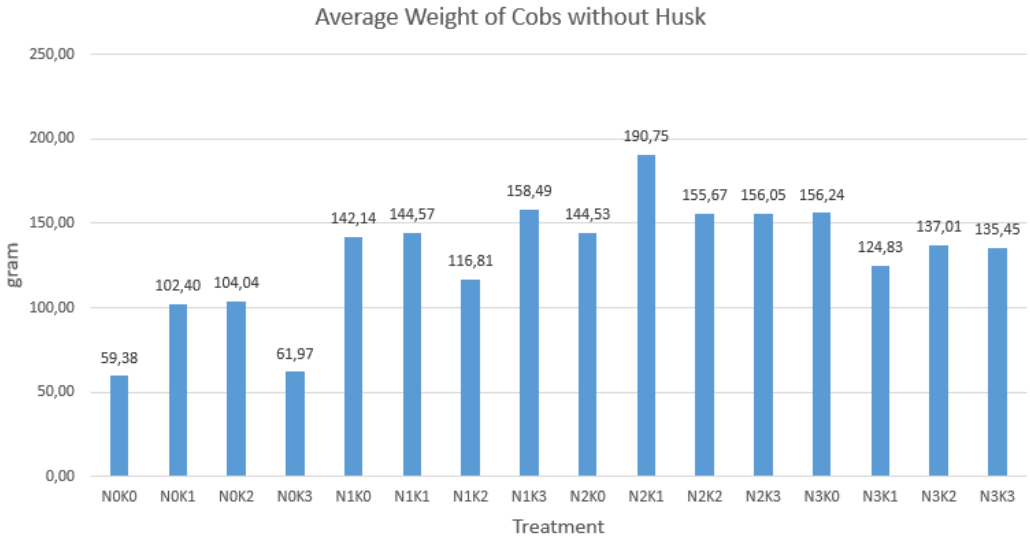
Table 6. Effect of NPK Fertilizer Composition on Weight of Cobs without Husk

Treatment	Average	Notation
N_0	81.95	b
N_1	140.50	a
N_2	161.75	a
N_3	138.38	ab

Source: Processed Data by Researchers

The N_0 treatment (0 grams/polybag) was significantly different from the N_1 (2.25 grams/polybag) and N_2 (4.5 grams/polybag) treatments, while the N_3 treatment (7.5 grams/polybag) was not significantly different from the N_1 and N_2 treatments. The N_1 (2.25 grams/polybag) and N_2 (4.5 grams/polybag) treatments were also not significantly different. The N_2 treatment gave the best results on the weight of the cob without the husk with an average value of 161.75 grams.

Chart 6. Average Weight of Cobs without Husk



Source: Processed Data by Researchers

Adequate nutrient availability during the seed filling process is a determining factor for the weight of the cob without the husk. Maximum seed formation will increase cob weight. Phosphorus (P) affects cob growth and seed size, while potassium (K) plays a role in promoting nutrient transportation to improve cob quality (Chandrakar et al., 2023). In addition, according to Patrick & Colyvas (2014), the increase in fresh weight of cob with and without husk is closely related to the amount of photosynthesis that is translocated to the cob, resulting in an increase in the fresh weight of the cob, both with and without husk.

CONCLUSION

NPK fertilizer composition significantly affected plant height, cob diameter, cob weight, and cob weight without husk, indicating that macronutrients (nitrogen, phosphorus, potassium) play important roles in supporting the vegetative and generative phases of sweet corn plants. The optimal NPK fertilizer composition was N_2 (4.5 grams/polybag), which yielded the highest results in plant height (161.83 cm), cob diameter (11.17 cm), cob weight (216.44 grams), and cob weight without husks (161.18 grams). Goat manure tends to release nutrients slowly (slow-release) because it depends on the decomposition process of organic matter, thus the direct effect on growth and yield parameters in short growing seasons such as sweet corn may not be significant. The insignificance of the interaction suggests that the two fertilizer types work independently, with NPK being more quickly available to the plants, while manure works more slowly.

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