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The Effect of Potassium Fertilizer and Chicken Manure on the Growth and Production and Potassium Absorption of Sweet Corn Plants (Zea mays saccharata Sturt)

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***Abstract**. The purpose of this study was to determine the effect of Potassium Fertilizer and Chicken Manure on the Growth, Production and Potassium Absorption of Sweet Corn Plants. This study used a Randomized Block Design (RAK) consisting of 2 factors. The first factor is Potassium Fertilizer (K) consisting of 4 levels, namely:K0 = Control (Without fertilizer), K1 = 7.2 g/plot, K2 = 14.4 g/plot, K3 = 21.6 g/plot. The second factor of Chicken Manure Fertilizer (C) consists of 3 treatment levels, namely: C1 = 2160 g/plot, C2 = 2880 g/plot, C3 = 3600 g/plot. The results of this study indicate thatPotassium fertilizer treatment had a significant effect onplant height, weight of cobs with husks per plant, weight of cobs per plot.The treatment of chicken manure has a significant effect onplant height, weight of cobs with husks per plant, and weight of cobs per plot.The interaction between potassium fertilizer and chicken manure had no significant effect on all observation parameters.*

***Keywords**: Chicken Manure, Potassium Fertilizer, Sweet Corn.*

1. INTRODUCTION

Sweet corn plants (Zea Mays Saccharata Sturt) are one of the food commodities that are cultivated because the price of sweet corn on the market is relatively higher than ordinary corn, both in traditional and modern markets. Sweet corn is one of the types of corn that is classified based on the nature of its endosperm, where the endosperm of sweet corn has a higher sugar (starch) content and wrinkles when dry (Wahyurini et al., 2022).

According to (Awallia, 2021; Purwanto et al., 2021), Sweet corn production in Indonesia is relatively low, with a production of 8.31 tons/ha. The potential yield of sweet corn can reach 14-18 tons/ha. One of the causes of the low level of productivity of agricultural commodities, lovely corn, is the declining soil fertility and the reduction of agricultural land. Increasing production is a significant concern because currently, the land available for expanding planting areas is suboptimal land, such as swamps that are widespread in several regions of Indonesia (Wahyudi et al., 2016).

Corn serves as a significant source of both carbs and protein in Indonesian diets. Corn is abundant in functional food constituents, including dietary fiber, essential fatty acids, isoflavones, minerals (calcium, magnesium, potassium, sodium, phosphorus, and iron), anthocyanins, beta-carotene (provitamin A), and a complete profile of necessary amino acids, among others. The development of functional food is currently underway, driven by rising demand, heightened public health awareness, an increasing prevalence of degenerative

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diseases, a growing elderly population, advancements in commercial products, scientific validation of functional food components, and progress in food technology. The demand for maize as a food component will rise, particularly among customers who prioritize health and seek affordability across all demographics (Ardani et al., 2023; Dewi et al., 2020; Kaur et al., 2023; Sine, 2021).

Fertilization is one of the intensification programs that can improve land and plant productivity. Continuous nutrient uptake and depletion through harvests without being balanced by nutrient returns through organic and inorganic fertilization will make the soil increasingly thin, nutrient-poor, and unproductive. Manure is a fertilizer that comes from various types of livestock waste, including cow, goat, sheep, and chicken manure (Gulo, 2024; Thamrin & Hama, 2022).

According to (Diyanti et al., 2024; Ritonga et al., 2022), Chicken manure serves as an organic fertilizer for several plant commodities. Sweet corn plants may enhance their development and improve soil fertility, hence positively affecting their overall fertility.

According to (Hidayah et al., 2016; Ritonga et al., 2022), the provision of chicken manure can improve the soil structure, which is very deficient in organic elements and can strengthen the roots of sweet corn plants. The provision of organic fertilizer in the soil is essential so that plants can grow well. The manure used for sweet corn plants is chicken manure, which comes from chicken droppings; chicken manure contains relatively high nitrogen, needed by plants in the vegetative growth phase. The N nutrient element accumulates with a number of substances from photosynthesis, which can stimulate the formation of new shoots and leaves.

K fertilizer plays an important role in plant metabolism, including the physiological processes involved, which are grouped into two aspects, namely: (1) the biophysical aspect, where potassium plays a role in controlling osmotic pressure, cell turgor, pH stability and water regulation through stomata control, and (2) the biochemical aspect, potassium plays a role in enzyme activity in carbohydrate and protein synthesis, as well as increasing the translocation of photosynthate from leaves (Amir et al., 2017; Hidayah et al., 2016)

K fertilizer plays a role in strengthening cell walls and is involved in the lignification process of sclerenchyma tissue. Potassium can increase plant resistance to certain diseases (Tumewu et al., 2015). The provision of K can form thicker lignin compounds so that cell walls become stronger and can protect plants from external disturbances. Plants require high amounts of potassium, ranging from 50-300 kg K/ha/planting season. The need for K by plants is equivalent to the need for N; even in some plants, the absorption of K is higher than N, such as rice in paddy fields and dry land. This shows that the need for K by plants is relatively high, and if this need is not met, the plant metabolism process is disrupted, resulting in low plant productivity and yield quality. The K fertilizer that is widely used in Indonesia is potassium chloride (KCl), but recently, it has been developed using potassium sulfate (K_2SO_4). The research results show that it has been proven that K_2SO_4 able improves the quality characteristics of several vegetable products (Eddy & Muksin, 2019).

The addition of nutrients through fertilization can replace nutrients lost due to erosion and leaching. (Pangaribuan et al., 2017) explained that there are two types of commonly known fertilizers, namely organic fertilizers and inorganic fertilizers. Inorganic fertilizers are synthetic fertilizers made by industrial factories, while organic fertilizers are chemical fertilizers resulting from the fermentation of natural materials. Balanced and rational fertilization is the key to successfully increasing corn productivity. Liquid organic fertilizer is an important component in organic farming. Liquid organic fertilizers contain many macro, micro, hormone, and amino acid nutrients needed by plants (Kurniawan et al., 2017; Pangaribuan et al., 2017).

2. LITERATURE REVIEW

Chicken Manure

Chicken manure is an organic fertilizer originating from poultry excrement, with the greatest P2O5 (%) nutrient concentration relative to other manures. When assessed relative to its body weight, chicken dung surpasses other animal manures, since each 1,000 kg/year of live chicken weight generates 2,140 kg/year of dry manure. In contrast, cow dung of same body weight yields just 1,890 kg annually of dry manure. Similarly, each ton of chicken manure yields 65.8 kg of nitrogen, 13.7 kg of phosphorus, and 12.8 kg of potassium. Cow dung of equivalent weight comprises 22 kg of nitrogen, 2.6 kilogram of phosphorus, and 13.7 kg of potassium. Consequently, it can be said that the application of chicken manure is superior to that of other animal manures Manure may enhance the availability of nutrients for plants that can be assimilated from the soil. Furthermore, manure positively influences the physical and chemical qualities of the soil, promoting the proliferation of microorganisms. Manure may alter many soil parameters, hence contributing to soil fertility (Hulu, 2024)

Manure can be said to contain not only macro elements (N, P, and K) but also micronutrients (Ca, Mg, and copper), which all form fertilizer, providing elements or nutrients for the benefit of plant growth and development. Manure has better properties compared to other natural fertilizers and artificial fertilizers. However, the way it works when compared to the way artificial fertilizers work can be said to be slow because it must undergo a process of change first before it can be absorbed by plants (Simanungkalit et al., 2006)

Chicken manure can be used as green fertilizer or compost because the N, P, and K nutrients contained in plants are equivalent to the nutrient content of manure. Its use can improve soil fertility, increase C-organic, available N, P2O5, and total K2O5 in the soil, and increase yields in several horticultural commodities and food crops, namely corn, tomatoes, lettuce, and caisim, but it does not affect the yield of kale (Hadisuwito, 2012)

The addition of manure aims to improve the physical properties of the soil and the composition of soil nutrients. The texture of chicken manure is a relatively fast process of mixing with the soil physically, so it dramatically affects the decomposition and nutrient supply process. Good manure must have a C/N ratio <20, so chicken manure must be composted. The K nutrient content in chicken manure is relatively lower than goat manure, and the N and P nutrient content is almost the same as other manures (Lingga, 2001)

Potassium Fertilizer

The K element is the second macronutrient after N, which is most absorbed by plants. The total potassium content in the soil is generally relatively high. It is estimated to reach 2.6% of the total soil weight, but the potassium available in the soil is relatively low (Nenobesi, 2017).

Fertilizing with large amounts of nitrogen and phosphorus also increases the absorption of potassium from the soil. Potassium loss can be caused by plant absorption (immobilization), K-fixation due to absorption by the space in colloids and leaching, and washing and erosion cause more significant potassium loss. According to(Riyanto, 2021), although potassium plays a more significant role in seed because potassium plays an important role in the process of photosynthesis, the results of photosynthesis (photosynthate) are not only stored in seeds but also distributed to other organs such as in the seed pods besides that the function of potassium is to form and transport carbohydrates, regulate stomata movement, strengthen the uprightness of the stem, plant seeds become fuller and denser, improve fruit quality, become resistant to pests and diseases, and for plant root development

The size of the cob and also the sweetness of corn are significantly affected by potassium fertilization. This is because potassium plays an important role in the formation of fruit in food crops such as corn. Potassium deficiency will cause failure to fill the glucose contained in sweet corn. Plants that lack potassium show symptoms of weak plant stems, so the plants easily collapse. Plant turgor decreases, cells become weak, plant leaves become dry, leaf tips are brown, or there are brown spots (necrosis). If potassium deficiency continues, necrosis becomes dry and dead tissue, then falls off, and the leaves become perforated. Potassium supplies in the soil can be reduced due to potassium uptake by plants, potassium leaching by water, and soil erosion. Usually, plants absorb more potassium than other nutrients, except nitrogen. Some types of plants, especially grasses and legumes, will continue to absorb potassium above everyday needs. Often occurs with high doses of potassium fertilization. If this is allowed to continue, potassium fertilization will no longer be economical (Yusdian et al., 2021).

3. RESEARCH METHODS

This research was conducted on Jalan Anggrek Raya, Simpang Selayang Village, Medan Tuntungan District, Medan. With an altitude of ± 30 meters above sea level. The purpose of this study was to determine the effect of Potassium fertilizer and Chicken Manure on the Growth, Production, and Potassium Absorption of Sweet Corn Plants. This study used a Randomized Block Design (RAK) consisting of 2 factors. The first factor is the Provision of Potassium Fertilizer (K) consisting of 4 levels, namely: K0 = Control (Without fertilizer), K1 = 7.2 g/plot, K2 = 14.4 g/plot, K3 = 21.6 g/plot. The second factor of Chicken Manure Fertilizer (C) consists of 3 treatment levels, namely: C1 = 2160 g/plot, C2 = 2880 g/plot, C3 = 3600 g/plot. The observation parameters are plant height, weight of cobs with husks per plant, and weight of cobs per plot. Analysis of variance was used to assess the impact of the treatment. In contrast, honest significant difference tests, regression, and correlation were conducted at the 5% significance level to evaluate the differences in averages across treatments.

4. RESULT AND DISCUSSION

Research result

1. **Plant Height (cm)**

Data on corn plant height at the ages of 2, 3, 4, 5, and 6 weeks after planting (WAP) due to potassium fertilizer and chicken manure treatment. The analysis of the variance list shows that potassium fertilizer has a significant effect on plant height at the observation ages of 3, 4, 5, and 6 WAP but has no significant effect at the age of 2 WAP. Chicken Manure treatment has a significant effect on plant height at the ages of 4, 5, and 6 WAP but has no significant effect at the ages of 2 and 3 WAP. The interaction between potassium fertilizer and chicken manure has no significant effect on plant height at all observation ages. The average height of corn plants at the observation ages of 2, 3, 4, 5, and 6 WAP due to the administration of potassium fertilizer and chicken manure can be seen in Table 1.

Table 1 indicates that at the age of 5 MST, the application of potassium fertilizer treatment considerably influenced plant height, with K3 yielding the most excellent average, which was markedly different from K0 and K1 but not statistically different from K2. At 6 MST, the effect of potassium fertilizer treatment on plant height reached its peak average in K3, showing a substantial difference from K0 but no significant difference from K1 and K2. The application of chicken manure on plant height at 5 MST was most excellent in C3, considerably differing from C1 but not from C2. At 6 MST, the peak was seen in C3, markedly distinct from C1 but not substantially different from C2. The interaction between the two treatments was not substantially different at 6 MST; the tallest plant was seen in the K3C3 treatment, measuring 189.33 cm.

Table 1. Difference Test of Average Height of Corn Plants (cm) Due to Potassium Fertilizer and Chicken Manure Treatment at Ages 2, 3, 4, 5, and 6 MST

Treatment	Plant Height (cm)				
	2 MST	3 MST	4 MST	5 MST	6 MST
Potassium Fertilizer					
K0	31.31	54.31 b	92.06 b	135.83 c	170.36 b
K1	31.58	56.47 ab	95.72 a	140.44 bc	174.03 ab
K2	33.08	57.94 ab	99.36 a	147.28 ab	180.03 a
K3	34.67	61.08 a	99.92 a	148.64 a	180.53 a
Chicken Manure					
C1	31.31	55.52	91.60 b	136.94 b	168.90 b
C2	33.08	57.29	97.44 a	142.94 ab	179.67 a
C3	33.58	59.54	101.25 a	149.27 a	180.15 a
Combination					
K0C1	30.50	55.58	87.50	133.50	166.00
K0C2	32.67	54.17	96.33	138.92	175.25
K0C3	30.75	53.17	92.33	135.08	169.83
K1C1	34.25	55.08	91.50	135.25	167.25
K1C2	28.67	55.25	92.33	136.25	175.92
K1C3	31.83	59.08	103.33	149.83	178.92
K2C1	29.42	54.50	98.42	144.67	177.25
K2C2	35.00	56.50	96.67	140.42	180.33
K2C3	34.83	62.83	103.00	156.75	182.50
K3C1	31.08	56.92	89.00	134.33	165.08
K3C2	36.00	63.25	104.42	156.17	187.17
K3C3	36.92	63.08	106.33	155.42	189.33

Description: Numbers followed by the same letter in the same column are not significantly different at the $\alpha = 0.05$ level based on Duncan's distance test.

The response curve of plant height to potassium fertilizer treatment can be seen in Figure 1.

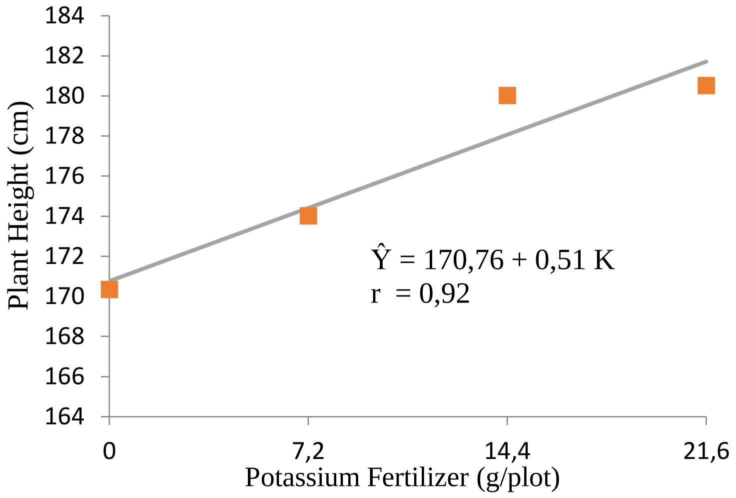

Figure 1. Response of Corn Plant Height at 6 MST on Potassium Fertilizer Treatment

Figure 1 shows that the response between potassium fertilizer and plant height is positive linear. This means that the height of corn plants will increase in line with the increasing dose of potassium fertilizer given.

The response curve of plant height to chicken manure treatment can be seen in Figure 2.

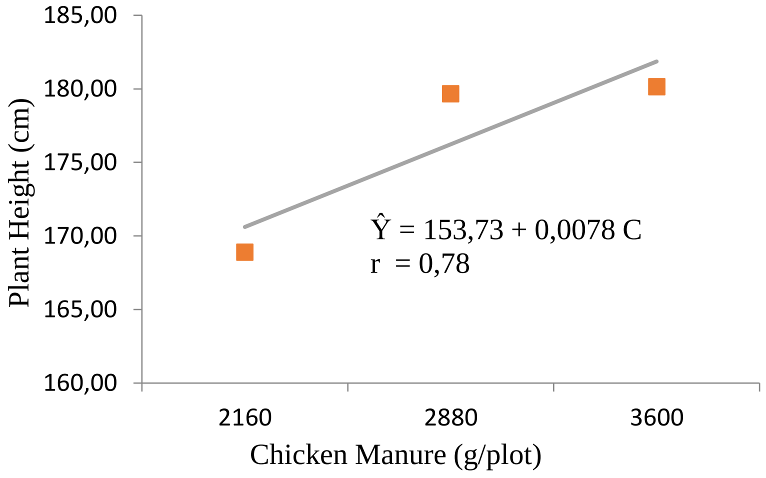

Figure 2. Response of Corn Plant Height at 6 MST on Chicken Manure Treatment

Figure 2 shows that the response between chicken manure and plant height is positive linear. This means that the height of the corn plant will increase in line with the increasing dose of chicken manure given.

2. Weight of Cobs with Husks per Plant (g)

Results of the analysis of the variance test of the weight of cobs with husks per plant due to potassium fertilizer and chicken manure treatments The analysis of the variance list shows that potassium fertilizer and chicken manure treatments have a significant effect on the weight of cobs with husks per plant. In contrast, the interaction between the two treatments has no significant effect on the weight of cobs with husks per plant. The average weight of cobs with husks per corn plant due to potassium fertilizer and chicken manure treatments can be seen in Table 2

Table 2. Difference Test of Average Weight of Corn Cobs and Husks per Corn Plant (g) Due to Potassium Fertilizer and Chicken Manure Treatment

Chicken Poultry	K0	K1	K2	K3	Average
	...........g................				
C1	202.08	235.83	250.83	215.00	225.94 b
C2	216.67	265.83	255.00	258.33	248.96 ab
C3	225.83	275.00	278.33	280.00	264.79 a
Average	214.86 b	258.89 a	261.39 a	251.11 a	

Description: Numbers followed by the same letter in the same column are not significantly different at the α = 0.05 level based on Duncan's distance test.

Table 2 indicates that the use of potassium fertilizer resulted in the highest cob weight with husk per plant in K2 (261.39 g). The weight of the cob with husk per plant was most significant in the C3 treatment, at 264.79 g.

Figure 3 shows the response curve of cob weight with husk per plant to potassium fertilizer treatment.

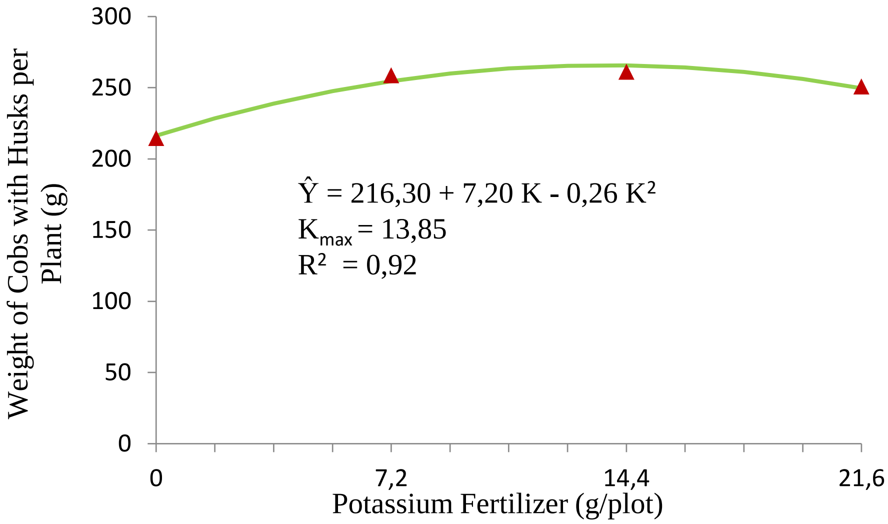

Figure 3. Response of cob weight to husk per corn plant on Potassium Fertilizer Treatment

Figure 3 shows that the response between potassium fertilizer and the weight of cobs with husks per corn plant is quadratic. This means that the weight of cobs with husks per corn plant will increase up to a dose of 13.85 g of potassium fertilizer; after exceeding this dose, the weight of cobs with husks per plant will decrease again.

Figure 4 shows the response curve of cob weight with husk per plant to chicken manure treatment.

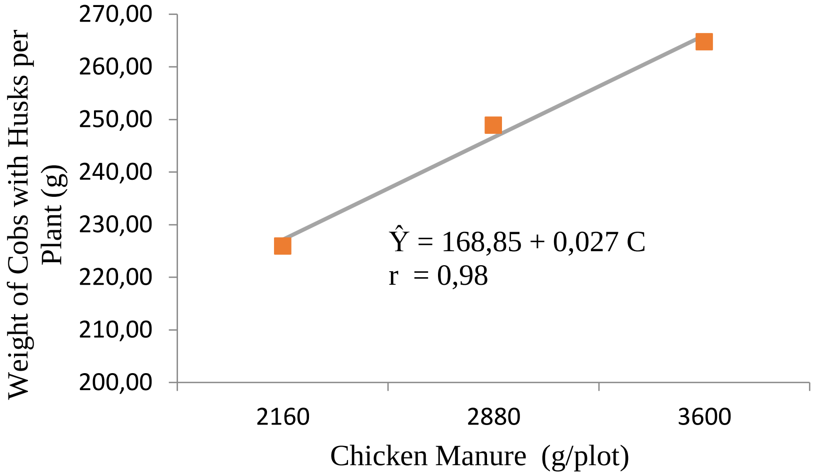

Figure 4. Response of cob weight to husk per plant on Chicken Manure Treatment

Figure 6 shows that the response between chicken manure and the weight of cobs with husks per plant is positive linear. This means that the weight of cobs with husks per corn plant will increase in line with the increasing dose of chicken manure given.

3. Weight of Cob per Plot (g)

Results of analysis of variance test of cob weight per plot due to potassium fertilizer and chicken manure treatments The analysis of the variance list shows that potassium fertilizer and chicken manure treatments have a significant effect on cob weight per plot. In contrast, the interaction between the two treatments has no significant effect on cob weight per plot. The average cob weight per plot of corn plants due to potassium fertilizer and chicken manure treatments can be seen in Table 3.

From Table 6, it can be seen that the heaviest cob weight per plot was in the K2 treatment of potassium fertilizer (1394.44 g). In the treatment of chicken manure, the heaviest cob weight per plot was in the C3 treatment (1362.50 g).

Table 3. Test of Differences in Average Weight of Corn Cobs Per Plot (g) Due to Potassium Fertilizer and Chicken Manure Treatment

Treatment	Potassium Fertilizer				
Chicken Poultry	K0	K1	K2	K3	Average
	...........g................				
C1	900	1050	1350	967	1066.67 b
C2	983	1217	1367	1150	1179.17 b
C3	1083	1467	1467	1433	1362.50 a
Average	988.89 b	1244.44 a	1394.44 a	1183.33 ab	

Description: Numbers followed by the same letter in the same column are not significantly different at the α = 0.05 level based on Duncan's distance test.

The response curve of cob weight per plot to potassium fertilizer treatment can be seen in Figure 5.

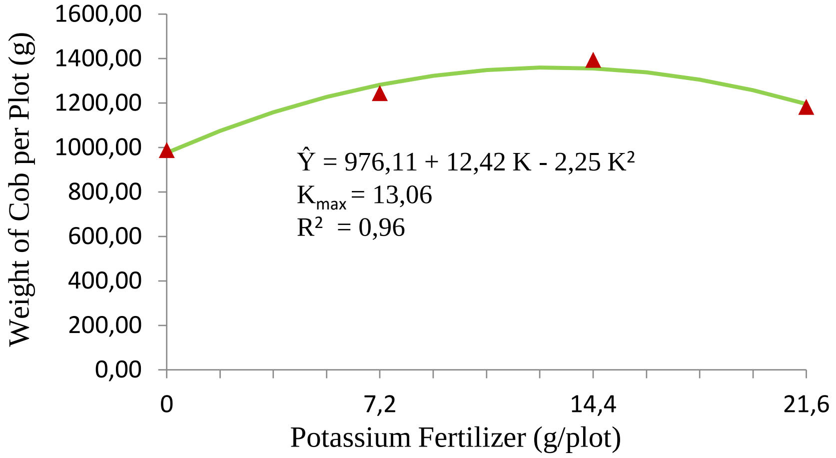

Figure 5. Response of corn cob weight per plot to Potassium Fertilizer Treatment

Figure 5 shows that the response between potassium fertilizer and the weight of the corn cob per plot is quadratic. This means that the weight of the corn cob per plot will increase up to a dose of 13.06 g of potassium fertilizer given; after exceeding this dose, the weight of the corn cob per plot will decrease again.

The response curve of cob weight per plot to chicken manure treatment can be seen in Figure 6.

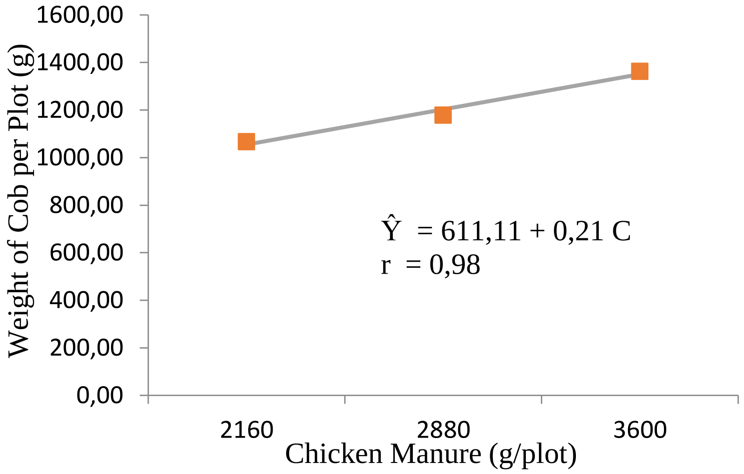

Figure 10. Response of cob weight per plot to treatment Chicken Manure

Figure 6 shows that the response between chicken manure and the weight of corn cobs per plot is positive linear. This means that the weight of corn cobs per plot will increase in line with the increasing dose of chicken manure given.

DISCUSSION

1. The Effect of Chicken Manure Treatment on Corn Plant Growth and Production

The results of the analysis of variance test showed that the treatment of chicken manure significantly affected plant height, cob weight with husk per planting, and cob weight per plot. This is because the nitrogen nutrient content in chicken manure helps stimulate plant growth, mainly stems and leaves.

(Khair et al., 2013) stated that nitrogen is useful for plant growth, increasing plant growth, increasing protein levels in the soil, increasing leaf-producing plants such as vegetables and livestock grass, and increasing the proliferation of microorganisms in the soil. Lack of nitrogen in the soil will cause corn plants to grow thin, old leaves to be light green and then turn yellowish, plant tissue to dry and die, and stunted fruit to be small and ripen quickly and then fall off.

Chicken manure also has a significant effect on the weight of cobs with husks per planting and the weight of cobs per plot. In addition to containing nitrogen, chicken manure also contains phosphorus and potassium nutrients. Chicken manure contains phosphorus nutrients, which function to stimulate root growth and accelerate flowering, seed, and fruit ripening. (Kalasari et al., 2021) added that phosphorus (P) nutrients for plants function more to stimulate root growth, especially the roots of young plants; phosphorus also functions to help assimilation and respiration, as well as accelerate flowering and seed and fruit ripening. Deficiency of this element results in reduced fruit and seed formation and stunted, purplish, or reddish leaves.

Chicken manure contains the nutrient potassium, which helps corn plants activate a number of enzymes in the process of photosynthesis and protein formation. (Minwal & Syafrullah, 2018) added that the element potassium (K) is an activator of a large number of enzymes that are important for photosynthesis and respiration processes. Potassium also activates enzymes that form starch and protein. A deficiency of this element is characterized by the stems and leaves becoming limp/falling, the leaves being dark bluish green and not fresh and healthy green, the tips of the leaves turning yellow and dry, and brown spots appearing on the tops of the leaves.

2. Effect of Potassium Fertilizer Treatment on Corn Plant Growth and Production

The results of the analysis of the variance test showed that potassium fertilizer treatment significantly affected plant height, cob weight with husk per plant, and cob weight per plot. This is thought to be due to the increased growth activity of corn plants. The photosynthesis process can run well so that the translocation of photosynthate to the cob can be optimal. The potassium element plays a role in regulating water in cells and the transfer of cations through the membrane.

Potassium is needed in photosynthesis, CO_2 fixation, and the transfer of photosynthate to various parts of the plant. In a balanced manner, potassium fertilization, in addition to N and P fertilizers on sweet corn plants, improves plant growth and resistance to lodging.

(Isfa'ni et al., 2018) stated that potassium needs are absorbed by plants in the form of K + and is found in various levels in the soil. The form available to plants is usually found in small amounts. Potassium plays an important role in physiological processes, carbohydrate metabolism, formation, breakdown, and translocation of starch. Sufficient potassium levels in plants result in normal formation and enlargement of cell size in plant parts. There is a real response to the results due to the increased rate of photosynthesis, where potassium plays a role in photophosphorylation in the photosynthesis process. Plants that get enough K will grow faster because K can maintain constant cell turgor pressure.

With the potassium fertilization given, it can be seen that the sweetness index parameter has a significant effect; this is due to the increase in enzyme activity in the formation of sugar and starch in the process of photosynthate, which is channeled to seed formation. In line with the research of (Uliyah et al., 2017) stated that potassium in plants functions to regulate many processes in plants, such as in the process of sugar and starch formation, cellulose formation, increasing protein, sugar translocation, enzyme activation, and stomata movement.

The application of KCL fertilizer in this study increased K absorption in plants. This is also related to the availability of K in the soil, with the increasing dose of KCL given. Several factors, including the concentration of KCL in the soil solution, determine the amount of K absorbed by plants. The amount of K absorption increased in line with the increasing dose of KCL given up to a dose of 14.4 g/pot, an increase in K absorption of 3.03% K/plant, and K absorption decreased again after passing a KCL dose of 21.6 g/plot with K absorption of 2.17% K/plant.

3. Effect of Interaction of Chicken Manure Treatment with Potassium Fertilizer on Corn Plant Growth and Production

The results of the variance test analysis show that the interaction of chicken manure and potassium fertilizer has no significant effect on plant height, cob weight with husk per planting, or cob weight per plot. The absence of interaction between the provision of chicken manure and potassium fertilizer on all observations is suspected because the two treatments were not able to synergize (work together) optimally to interact with each other to support the relatively short growth of corn plants.

5. CONCLUSION

Conclusion: Chicken manure significantly affected plant height, weight of cob with husk per planting, and weight of cob per plot. Potassium fertilizer significantly affected plant height, weight of cob with husk per planting, and weight of cob per plot. The interaction of chicken manure and potassium fertilizer did not significantly affect all parameters. Suggestion: To determine the optimum dose of chicken manure for the growth and production of corn plants, further research is recommended, while the optimum dose of potassium fertilizer is 13.06 g/plot.

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