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Efficiency of Use Chicken Manure in Optimizing the use of KNO_3 Supply on Sweet Corn (*Zea mays saccharata* Sturt L.)

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Abstract— *Sweet corn (Zea mays saccharata* Sturt L.*) is one of the horticultural commodities that has increasing market demand but declining production levels. This is because most of the fertilization that is done is continuous and excessive chemical fertilization. The use of chemical fertilizers can have a negative impact on the soil, one of which can cause damage to soil structure and function, so that it will slowly reduce soil quality. This study aims to assess the effectiveness of using chicken manure in optimizing KNO_3 fertilizer so as to increase the growth and yield of sweet corn plants (Zea mays saccharata* Sturt L.*). The research was conducted in Jemekan Village, Ringinrejo Subdistrict, Kediri District, using a Spli Plots Design using doses of chicken manure (0, 4, 8, and 12 tons.ha^{-1}) and KNO_3 fertilizer (0, 25, 50, and 75 kg.ha^{-1}). The results showed that the combination of chicken manure dose of 12 ton.ha^{-1} with KNO_3 25 kg.ha^{-1} produced higher cob fresh weight than other treatments. Chicken manure contributed to the improvement of soil structure and increased nutrient availability, while KNO_3 supported vegetative growth and yield. The interaction between the two fertilizers showed an increase in macronutrient uptake (N, P, K) by plants, with nitrogen and potassium uptake increasing significantly in the late vegetative to early generative phase. This study concludes that the use of chicken manure and KNO_3 is an effective and environmentally friendly solution to increase sweet corn productivity.*

Keywords— ***Sweet Corn, Chicken Manure, KNO_3 Fertilizer.***

I. INTRODUCTION

Sweet corn (*Zea mays saccharata* Sturt L.) is a high economic value horticultural commodity with significant development potential. However, the high demand has not been met optimally, as seen from the increase in import volume by 42.46% from 517.5 thousand tons in 2020 to 737.2 thousand tons in 2021 (Badan Pusat Statistik Republik Indonesia, 2022). Therefore, optimizing fertilization is the main strategy in increasing sweet corn productivity to support national food security. Fertilization has a central role in supporting plant growth and yield. Applying large amounts of inorganic fertilizers, such as 300 kg ha^{-1} compound NPK and 200 kg ha^{-1} urea, has been shown to increase yields (Murzani & Nurhayati, 2011). However, excessive use of chemical fertilizers can cause a decrease in soil organic matter because microorganisms that rely on organic matter lose their food source, leading to a decrease in the activity of soil microorganisms and degradation of soil structure. The Directorate General of Food Crops also confirms that excessive use of chemical fertilizers causes soil to become compacted due to lack of aggregation in soil particles (Kementerian Pertanian, 2022).

The use of organic fertilizers, such as chicken manure, is a strategic solution to reduce the negative impact of chemical fertilizers and increase the efficiency of nutrient uptake. Chicken manure is considered more effective than goat and cow manure in increasing the growth and yield of sweet corn (Melese Damtew, 2022). Chicken manure has high nitrogen, phosphorus, and potassium content as well as microorganisms that support soil fertility (Hartatik *et al.*, 2015; Manogaran *et al.*, 2022). Nitrogen plays a role in chlorophyll formation and vegetative growth, phosphorus supports root development and seed formation, while potassium increases photosynthetic efficiency and plant resistance to environmental stress (Fathi, 2022; Taufiq & Yetti, 2016). The combination of chicken manure with KNO_3 fertilizer has the potential to increase fertilizer efficiency and yield. KNO_3 fertilizer which contains 46% K_2O and 13% nitrogen plays a role in photosynthesis, carbohydrate translocation, and increases plant resistance to environmental stress (Pangaribuan *et al*., 2017).

The optimal dose of KNO_3 fertilizer of 100 kg ha^{-1} can increase yields up to 24 tons ha^{-1}, while the application of 150 kg ha^{-1} increases the sweetness level of corn (Dewanda *et al*., 2021). This study aims to assess the effectiveness of a combination of chicken manure in optimizing the use of KNO_3 fertilizer in increasing the growth and yield of sweet corn and determining the optimal dose that is efficient. The results of this study are expected to be a reference for farmers in developing a fertilization system that is more productive, sustainable, and supports the improvement of the quality of former sweet corn land.

II. MATERIALS AND METHOD

This research was conducted from September to November 2024 in Jemekan Village, Ringinrejo District, Kediri Regency, with a gray brown regosol soil type at an altitude of 67 meters above sea level. The experimental design used was the Split Plots Design, with chicken manure doses as the main plot (0, 4, 8, and 12 $tons.ha^{-1}$) and KNO_3 fertilizer doses as subplots (0, 25, 50, and 75 $kg.ha^{-1}$), so there were 16 treatments with 3 replications in a total of 48 experimental plots. The research stages included land preparation, planting, fertilization, maintenance, and harvesting. Land preparation was carried out by clearing weeds, tillage, and soil analysis in the laboratory before and after fertilizer application. Planting was done using the tugal method, by planting one seed per planting hole. The

The parameters observed included plant growth and yield. Growth parameters included plant height, number of leaves, stem diameter, chlorophyll index, leaf area, wet and dry weight, crop growth rate, and number and condition of leaf stomata. Yield parameters included length and diameter of the cob, fresh weight of the cob with and without kelobot, brix content. In addition, farming business analysis was conducted through the calculation of Revenue Cost Ratio (R/C Ratio) to evaluate economic aspects. As supporting parameters, soil analysis was conducted for C-organic content, N, P, K, and Cation Exchange Capacity (CEC) before and after treatment. Nutrient accumulation of N, P, and K were analyzed using wet deconstruction, spectrophotometry, and atomic absorption spectrophotometry (AAS) methods. The data obtained were analyzed using analysis of variance (F test) at the 5% level, followed by the Honestly Significance Difference (HSD) test if there were significant differences.

III. RESULT AND DISCUSSION

The application of chicken manure and KNO_3 fertilizer showed a relationship between the uptake of macronutrients (nitrogen, phosphorus, and potassium) by sweet corn plants at 35 DAP (Days After Planting) and 63 DAP with changes in nutrient content in the soil after planting. Based on the results of N, P and K uptake, it can be seen that the uptake of nitrogen (N), phosphorus (P), and potassium (K) by plants increased significantly from 35 DAP to 63 DAP. Meanwhile, nitrogen, phosphorus and potassium contents in the soil decreased after planting. This pattern shows a close relationship between the physiological needs of plants at various growth phases and the dynamics of nutrients in the soil due to the influence of the fertilizer used, namely the combination of chicken manure and KNO_3. This is evidenced by the results of the analysis presented in diagram.

Based on Figure 1 to Figure 5, the application of chicken manure and KNO_3 had a significant effect on the uptake of macronutrients (N, P, K) by sweet corn at 35 DAP and 63 DAP and the changes in nutrient content in the soil after planting. The uptake of nitrogen, phosphorus, and potassium increased significantly from 35 DAP to 63 DAP, while the content of nitrogen, phosphorus and potassium in the soil also decreased. This indicates that plant nutrient requirements increase during the late vegetative to early generative phase. The higher nitrogen uptake at 63 DAP reflects its role in protein synthesis, chlorophyll formation and photosynthesis. In the early phase (35 DAP), nitrogen demand is lower because the plant is still in the stage of root and leaf formation, but it increases sharply at 63 DAP when the plant enters the rapid growth phase (Wang *et al*., 2021). Chicken manure releases nitrogen gradually through microbial mineralization, while KNO_3 provides nitrogen in the form of nitrate that is quickly absorbed by plants. However, the high uptake of nitrogen leads to a decrease in soil nitrogen content, as the release from chicken manure is not able to fully replace what the plants have absorbed. Phosphorus uptake increases from 35 DAP to 63 DAP, due to its role in ATP synthesis, cell division and root development. Phosphorus in chicken manure is released gradually through soil microbial activity, causing the accumulation of phosphorus that is not directly utilized by plants (Zhang *et al*., 2014). Meanwhile, potassium uptake increases with plant requirements in osmotic regulation and photosynthate transport, but soil potassium content decreases due to high uptake and leaching (Li *et al*., 2022).

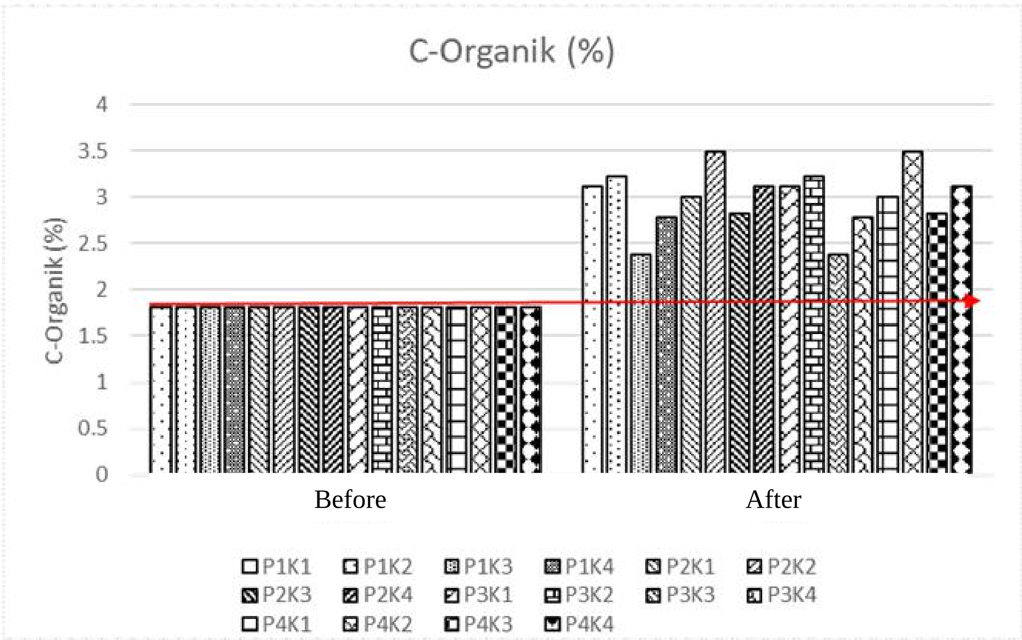


Fig. 1. Diagram of Changes in Soil Nutrient C-Organic Elements

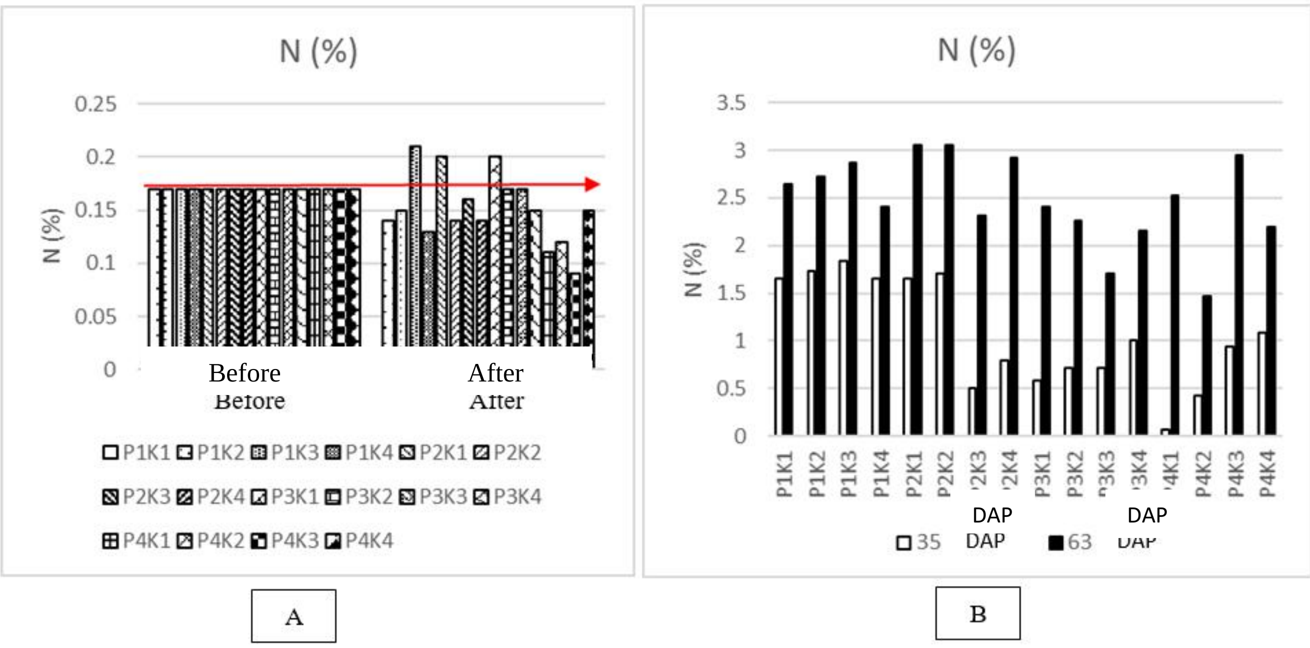
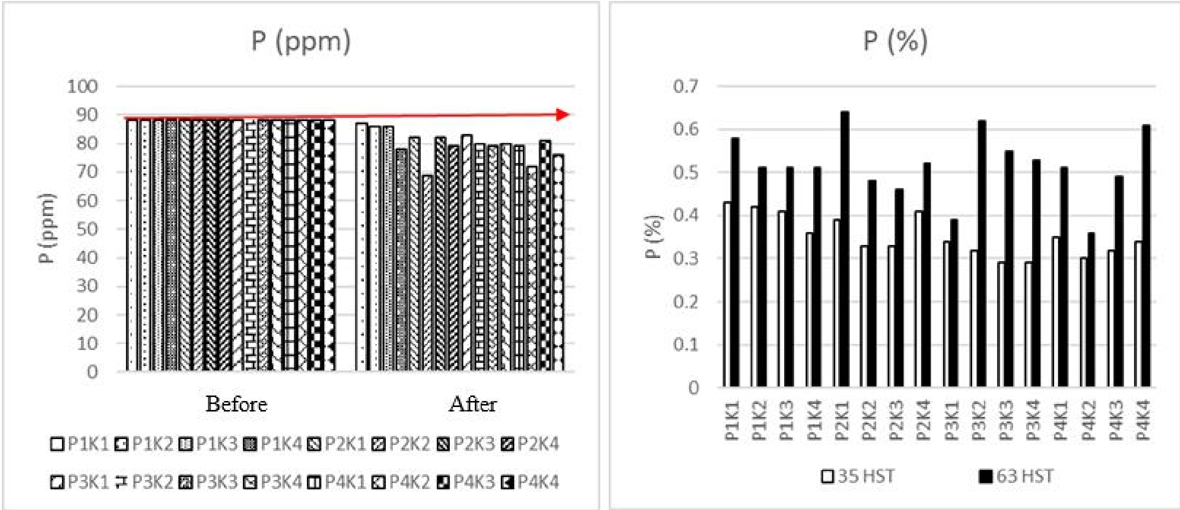
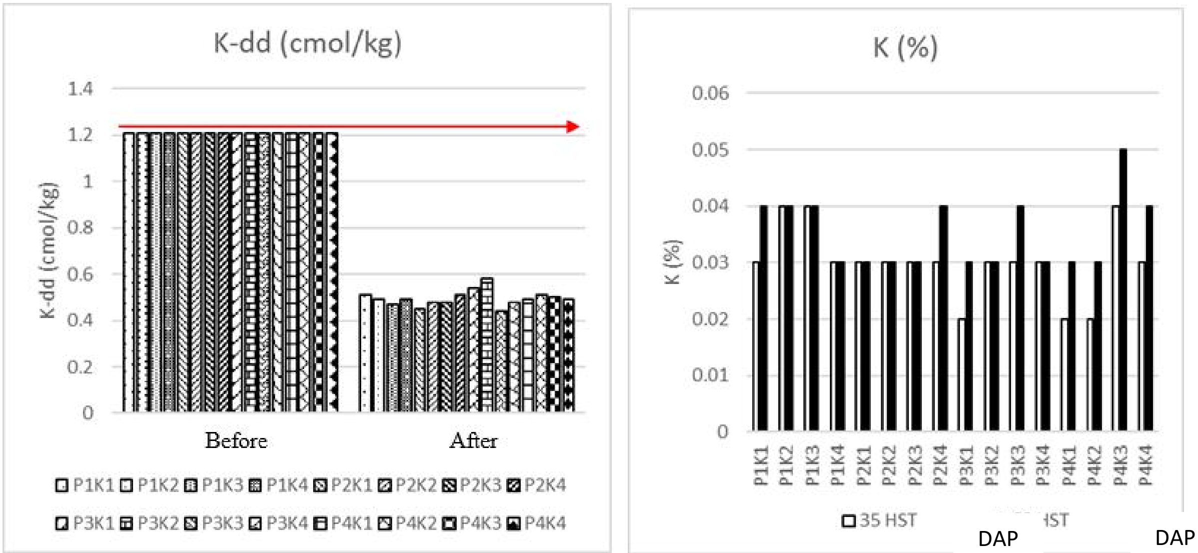


Fig. 2. Diagram of Nitrogen Change in Soil Nutrients (A) and Plant Nutrient Uptake (B)



A B

Fig. 3. Diagram of Phosphorus Changes in Soil Nutrients (A) and Plant Nutrient Uptake (B)



A B

Fig. 4. Diagram of Potassium Changes in Soil Nutrients (A) and Plant Nutrient Uptake (B)

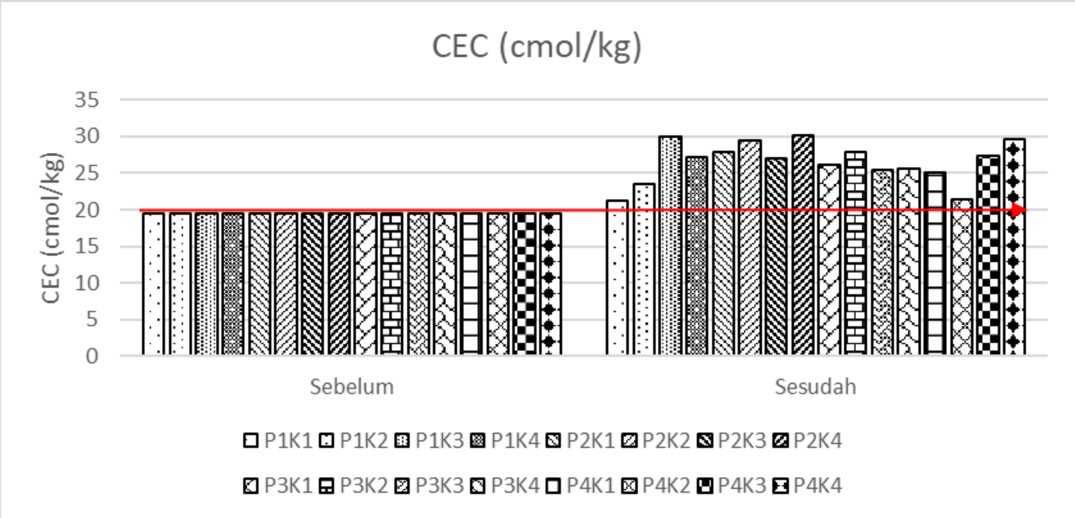


Fig. 5. Diagram of Changes in Soil Nutrients Cation Exchange Capacity

Overall, the relationship between nutrient uptake by plants and nutrient content in soil can be explained through the interaction between the physiological needs of plants, the chemical properties of nutrients, and the effect of fertilizers applied. Increased uptake of nitrogen, phosphorus and potassium by plants leads to a decrease in nitrogen and potassium content in the soil, indicating that plants utilize these nutrients intensively to support their growth and development. This phenomenon confirms the importance of a combination of organic and inorganic fertilizers in supporting plant growth while maintaining soil fertility. The use of chicken manure in this study contributed to the initial availability of N, P and K in the soil. Zhang *et al*. (2020) explained that organic fertilizers such as manure can increase nutrient availability in the short term through nutrient mineralization by soil microbes. However, after one crop growth cycle, the nutrient content in the soil decreases due to uptake by plants and losses through leaching and fixation. Therefore,a sustainable fertilization strategy is needed to maintain soil nutrient balance and support optimal growth of sweet corn plants in the next growing season.

Then, the increase in plant nutrient uptake at 35 DAP to 63 DAP shows the importance of nutrient availability during the active growth phase of sweet corn. Chicken manure plays a role in increasing the organic matter content of the soil, which supports nutrient retention, while KNO_3 fertilizer provides nitrogen in a form that is easily absorbed by plants to support vegetative and generative development. Both contribute to an increase in leaf area, which maximizes the photosynthesis process, and supports biomass accumulation, as seen from the increase in the dry weight and fresh weight of the plants. The decrease in nutrients in the soil during this period shows that the plants are actively utilizing the available nutrients to support their optimal growth. This is supported by several growth data that will be presented in the table below.

Leaf Area ($cm^2.tan^{-1}$)

Based on the data in Table 1, at the observation age of 63 DAP, the treatment of 12 $tons.ha^{-1}$ chicken manure with the use of 50 $kg.ha^{-1}$ KNO_3 fertilizer is considered to produce a higher leaf area among others with a leaf area value of 8255.78. According to Fitriyah *et al*. (2024), this is due to increased nutrient availability and improved soil physical properties by chicken manure, as well as the supply of potassium from KNO_3 which supports leaf cell division and elongation. Potassium also plays a role in stomatal

regulation, increasing water use efficiency and photosynthesis, which contributes to the increase in leaf area. In addition, this combination can increase the activity of soil microorganisms, accelerate the decomposition of organic matter, and increase nutrient availability to plants.The increase in leaf area has implications for increasing photosynthetic area, which in turn can increase corn yield.

Table 1. The Value of Leaf Area Due to Interaction in the Treatment of Chicken Manure and KNO_3 Fertilizer at the Age of Observation 63 DAP

Leaf Area ($cm^2.tan^{-1}$)						
Chicken Manure ($tons.ha^{-1}$)	**KNO_3 fertilizer ($kg.ha^{-1}$)**				**HSD AP (5%)**	**CV AP (5%)**
	0	**25**	**50**	**75**		
0	7221,46 a A	7560,04 a A	8071,92 a B	7453,41 a A		
4	7883,22 a AB	7242,24 a A	6984,93 a A	7387,02 a A		
8	8328,37 a AB	8055,69 a A	7929,67 a AB	7643,47 a AB	1279,15	5,29
12	7980,23 a AB	7943,27 a A	8255,78 a B	8539,69 a B		
HSD PU (%)	992,08					
CV PU (%)	11,33					

Description:

Numbers accompanied by the same lowercase letter indicate not significantly different in rows, while numbers followed by the same uppercase letter indicate not significantly different in columns, based on the 5% HSD test, DAP = Days after Planting, CV = Coefficient of Variance.

Dry Weight ($g.tan^{-1}$)

Table 2. Dry Weight Value Due to Interaction in the Treatment of Chicken Manure and KNO_3 Fertilizer at 63 DAP Observation Age

Dry Weight ($g.tan^{-1}$)						
Chicken Manure ($tons.ha^{-1}$)	**KNO_3 fertilizer ($kg.ha^{-1}$)**				**HSD AP (5%)**	**CV AP (5%)**
	0	**25**	**50**	**75**		
0	62,45 a A	60,89 a AB	61,68 a A	60,59 a A		
4	60,79 a A	62,98 a B	61,00 a A	61,34 a A	4,57	1,84
8	60,74 a A	61,29 a AB	63,38 a A	63,02 a B		
12	62.16 ab A	58,30 a A	63,10 b A	62.33 ab A		
HSD PU (%)	3,95					
CV PU (%)	3,40					

Description:

Numbers accompanied by the same lowercase letter indicate not significantly different in rows, while numbers followed by the same uppercase letter indicate not significantly different in columns, based on the 5% HSD test, DAP = Days after Planting, CV = Coefficient of Variance.

Based on the data in Table 2, at the observation age of 63 DAP, the treatment of 12 tons.ha^{-1} chicken manure with 50 kg.ha^{-1} KNO_3 fertilizer treatment was considered to produce higher dry weight compared to the other treatments. This was proven by the dry weight value of 63.10 g.tan^{-1}. According to Prasetya *et al*. (2021), higher plant dry weight indicates better nutrient absorption efficiency, especially nitrogen (N) and potassium (K), which play an important role in protein synthesis and regulation of plant cell osmotic pressure. Chicken manure can increase the availability of macro and micro nutrients in the soil, thus supporting plant biomass growth. In addition, potassium in KNO_3 plays a role in strengthening cell walls and increasing photosynthate transport efficiency, which has an impact on increasing plant dry weight (Cendana *et al*., 2021). The interaction between chicken manure and KNO_3 can also increase the activity of soil microorganisms, which helps in the mineralization of nutrients (Pangaribuan *et al.*, 2017).

Fresh Weight of Cob with Husk (tons.ha^{-1})

The results of the analysis of variance showed that there was an interaction at the observation age of 71 DAP between the treatment of chicken manure and KNO_3 fertilizer on the observation of the fresh weight of the cob with the cob of sweet corn plants. Separately, the treatment of chicken manure and KNO_3 fertilizer treatment gave a significant effect at the observation age of 71 DAP. The value of Fresh Weight of Cobs with Cobs due to the interaction on the treatment of manure and KNO_3 fertilizer at the age of 71 DAP is presented in Table 3.

Table 3. Value of Fresh Weight of Cob with Lint as a Result of Interaction on the Treatment of Chicken Manure and KNO_3 Fertilizer at 71 DAP Observation Age (ton.ha^{-1})

Fresh Weight of Cob with Husk (tons.ha^{-1})						
Chicken Manure (tons.ha^{-1})	**KNO_3 fertilizer (kg.ha^{-1})**				**HSD AP (5%)**	**CV AP (5%)**
	0	**25**	**50**	**75**		
0	12,25 a	13.82 bc	14,42 c	13,45 b		
	A	A	A	A		
4	13,29 a	14,52 b	15,18 b	13,57 a		
	B	B	B	A	0,70	2,10
8	14,02 a	15,04 b	13,96 a	14,34 a		
	C	BC	A	B		
12	15,12 a	15.55 ab	15,94 b	15.34 ab		
	D	C	C	C		
HSD PU (%)				0,67		
CV PU (%)				2,36		

Description:

Numbers accompanied by the same lowercase letter indicate not significantly different in rows, while numbers followed by the same uppercase letter indicate not significantly different in columns, based on the 5% HSD test, DAP = Days after Planting, CV = Coefficient of Variance.

Based on the data in Table 3, at the observation age of 71 DAP, the Fresh Weight of Cobs with cob both in grams and tons, 12 tons.ha^{-1} chicken manure treatment with 25 kg.ha^{-1} and 50 kg.ha^{-1} KNO_3 fertilizer treatment is considered to produce higher fresh weight on the cob. This is evidenced by the higher yields of sweet corn at 15.55 and 15.94 kg.ha^{-1} with more efficient use of KNO_3 fertilizer. The increase in fresh weight of cob with kelobot in sweet corn is influenced by the optimal availability of nutrients during the generative phase. Chicken manure contributes to improving soil fertility by providing nitrogen (N), phosphorus (P), and potassium (K) in a form that is easily absorbed by plants. The results showed that the combination of 12 tons.ha^{-1} of chicken manure with 25-50 kg.ha^{-1} of KNO_3 produced the highest cob fresh weight. Potassium in KNO_3 supports the translocation of photosynthates from leaves to cobs, which increases the size and weight of sweet corn cobs (Fitriyah *et al*., 2024). In addition, according to Agustina *et al*. (2020), chicken manure can increase the activity of soil microorganisms, improve soil aeration, and increase nutrient availability, which contributes to the formation of larger cobs. This interaction between organic and inorganic fertilizers increases the efficiency of nutrient uptake, resulting in increased yields (Pangaribuan *et al*., 2017).

From supporting data the research results, it is proven that there is interaction between the application of chicken manure and KNO_3 fertilizer. The application of chicken manure and KNO_3 fertilizer shows a relationship between the absorption of macro nutrients (nitrogen, phosphorus, and potassium) by sweet corn plants at 35 days after planting (DAP) and 63 DAP with changes in nutrient content in the soil after planting. Based on the results of N, P and K absorption, it can be seen that the absorption of nitrogen (N), phosphorus (P), and potassium (K) by plants increased significantly from 35 DAP to 63 DAP. Meanwhile, the nitrogen, phosphorus and potassium content in the soil decreased after planting. This pattern shows a close relationship between the physiological needs of plants in various growth phases and the dynamics of nutrients in the soil due to the influence of the fertilizer used, namely a combination of chicken manure and KNO3. This is evidenced by the results of the analysis presented in the following explanation of interaction and efficiency

Response of Interaction Effect of Chicken Manure and KNO_3

Based on the data in tables 1,2,3 the application of chicken manure and KNO_3 showed a significant interaction on the growth and yield of sweet corn. This combination increases nutrient availability, improves soil structure, and optimizes plant growth. Chicken manure increases cation exchange capacity (CEC) and water retention, while KNO_3 provides nitrogen (NO_3) and potassium (K) that support photosynthesis and growth (Singh *et al.*, 2020). The results showed that a dose of 12 $ton.ha^{-1}$ chicken manure with 25 and 50 $kg.ha^{-1}$ KNO_3 produced optimal yields of about 15.55 $ton.ha^{-1}$ and 15.94 $ton.ha^{-1}$. In contrast, too high doses (>12 $tons.ha^{-1}$) and high KNO_3 (75 $kg.ha^{-1}$) caused nutrient saturation, which inhibited plant growth (Fageria, 2016). The interaction of these two fertilizers had an impact on leaf area at 63 DAP, suggesting that this combination supports plant canopy development. Chicken manure increases water retention and nutrient availability, while KNO_3 with its potassium and nitrogen content accelerates photosynthesis and cell division (Taiz *et al*., 2015). At 35 and 63 DAP, plant dry weight increased due to optimization of photosynthesis and plant metabolism (Marschner, 2012). In the generative phase, fertilizer interactions had an impact on cob diameter and fresh weight at 71 DAP. Potassium availability increases the translocation of photosynthetic products to the cob, which contributes to cob size and weight (Singh *et al*., 2020). The relationship between leaf area, wet weight and cob fresh weight showed continuity from vegetative to generative phase. Optimal leaf area at 63 DAP increases photosynthesis, which supports carbohydrate accumulation and dry biomass formation *(*Manogaran *et al*., 2022). Phosphorus from chicken manure helps ATP synthesis for seed filling, while potassium from KNO_3 maintains water balance and supports photosynthate translocation (Kumar *et al*., 2018). Thus, the combination of chicken manure and KNO_3 not only enhances vegetative growth, but also maximizes sweet corn yield.

From the interaction of the two, chicken manure and KNO_3 have a good effect on plants. From the data presented, chicken manure can be said to be able to make the use of KNO_3 fertilizer more efficient. The simultaneous use of chicken manure and KNO_3 fertilizer has a significant effect on the growth and yield of sweet corn.

Efficiency Response of Using Chicken Manure in Optimizing KNO_3 Fertilizer

The simultaneous use of chicken manure and KNO_3 fertilizer had a significant effect on the growth and yield of sweet corn. Chicken manure improves soil structure, increases cation exchange capacity (CEC), and provides macronutrients such as slow-release organic nitrogen, phosphorus, and potassium. Meanwhile, KNO_3 fertilizer provides nitrogen in the form of nitrate (NO_3) and potassium needed to accelerate plant metabolism. This combination increases the efficiency of chemical fertilizers because the organic matter in chicken manure retains and distributes nutrients from KNO_3 fertilizer more stably (Sakdan *et al*., 2022). The study showed that the optimal dose to achieve the highest yield was the combination of 12 $ton.ha^{-1}$ chicken manure with 25 $kg.ha^{-1}$ KNO_3 fertilizer, which resulted in a yield of about 15.55 $ton.ha^{-1}$. In this combination, chicken manure improved soil conditions and increased nutrient uptake from KNO_3 fertilizer. In contrast, too low a dose of chicken manure (<8 $ton.ha^{-1}$) inhibits growth due to nutrient limitation, while too high a dose (> 12 $ton.ha^{-1}$) can cause nutrient saturation in the soil and inhibit nutrient uptake, especially when combined with a high dose of KNO_3 (75 $kg.ha^{-1}$) (Irawan *et al*., 2023). The combination of chicken manure with KNO_3 fertilizer increases nutrient uptake efficiency, supports vegetative growth, and increases yield. The application of KNO_3 fertilizer in a low dose (25 $kg.ha^{-1}$) with chicken manure 8-12 $ton.ha^{-1}$ is sufficient to increase yield compared to the use of KNO_3 without organic fertilizer. This efficiency occurs because organic matter prolongs nutrient availability, reduces *leaching*, and maintains nutrients throughout the plant growth cycle (Sakdan *et al*., 2022). Integrated application of chicken manure with KNO_3 fertilizer has been shown to increase sweet corn productivity. This combination reduces dependence on chemical fertilizers, reduces production costs, and supports sustainable agriculture (Irawan *et al*., 2023). Therefore, the combination of chicken manure and KNO_3 is an effective and environmentally friendly solution to increase crop yields and maintain land quality.

IV. CONCLUSION

The results showed a significant interaction between the application of chicken manure and KNO_3 fertilizer at different doses on the growth and yield of sweet corn, especially in the final phase of growth. The combination of chicken manure dose of 12 $tons.ha^{-1}$ with KNO_3 fertilizer of 25 $kg.ha^{-1}$ produced higher cob fresh weight with and without cob than the other treatments, showing better effectiveness in supporting vegetative growth and yield. The efficient use of chicken manure was also shown to reduce KNO_3 fertilizer requirement without reducing crop yield, thereby improving fertilizer efficiency and supporting sustainable agricultural practices. In addition, chicken manure contributes to the improvement of soil structure and increases the availability of essential nutrients for plants.

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