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The Effect of NASA Liquid Organic Fertilizer and Chicken Manure on the Growth of Sweet Corn Plants (*Zea mays saccharata* Sturt)

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Abstract: This research aims to determine the effect of a combination of NASA POC and chicken manure on the growth and production of sweet corn (*Zea mays saccharata* Sturt). The research used a Randomized Group Design (RAK) with two treatment factors. The first factor is the administration of NASA Liquid Organic Fertilizer (A) consisting of 4 treatment levels, namely: A0 = 0 ml/liter of water (control), A1 = 2 ml/liter of water, A2 = 4 ml/liter of water and A3 = 6 ml /liter of water. The second factor is the provision of chicken manure (B) consisting of 3 treatment levels, namely: B1 = 2.25 kg/plot (7.5 tons/ha), B2 = 4.50 kg/plot (15 tons/ha) and B3 = 6.75 kg/plot (22.5 tons/ha). The results showed that giving NASA POC up to 6 ml/1 of water significantly increased plant height, ear length, ear weight per plot and total dissolved solids. Providing chicken manure up to 6.75 kg/plot significantly increased plant height, ear length, weight per plot and total soluble solids. The interaction between NASA POC and chicken manure did not significantly affect plant height, ear length, weight per plot, or total dissolved solids.

Keywords: Chicken manure; Growth; NASA POC; Sweet corn

Introduction

Sweet corn (*Zea mays saccharata* Sturt.) is a food crop consumed and is very popular with people in Indonesia (Agustiar et al., 2016; Jumaali et al., 2021). Sweet corn plants have a sweeter taste than regular corn, and their production life is shorter. For farmers, sweet corn is a market business opportunity because of its high selling value; the price of sweet corn in North Sumatra is IDR 5,000/kg (Ardiansyah Haidi, 2019; Sugiarti et al., 2009). Sweet corn, including canned corn, corn jam, sugar, corn noodles, corn milk, corn flavoring, and corn ice cream, is widely used as a processed ingredient to increase economic value (Pribadi et al., 2021).

Demand for sweet corn is increasing; this has encouraged farmers to improve cultivation systems to increase production. Corn production in North Sumatra is 1,557,462.8 tons, with a harvest area of 252.729.2 hectares or an average production of 6.63 tons/hectare (BPS, 2016). Production in 2017 was 1.741.257.4 tonnes, with a harvest area of 281.311.4 hectares or an average production of 6.9 tonnes/hectare (BPS 2017). This production has increased and has high economic value, making it feasible for farmers to cultivate.

One of the important factors in increasing sweet corn production is fertilization. Fertilization is an effort to provide fertilizer to add nutrients plants need to increase growth, production and quality of plant results (Surachman et al., 2020). Fertilization is necessary because the availability of nutrients in the soil is low; there is a loss of nutrients through washing, transportation at harvest time, and the desire to maximize profits (Fauziah et al., 2022; Mohammed et al., 2017; Sofyan et al., 2019).

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Farmers use a lot of inorganic fertilizers; inorganic fertilizers are needed to increase sweet corn production. One type of inorganic fertilizer that is often used is urea fertilizer. Urea fertilizer is a chemical fertilizer that contains about 46% nitrogen (Bertham et al., 2022). Urea inorganic fertilizer is given periodically when plants are of a certain age, so nutrient uptake is more efficient. This is done because releasing nutrients from inorganic fertilizer is faster than organic fertilizer. The amount of fertilizer given to plants will affect the production results that will be obtained. Providing a small amount of fertilizer will not have much effect on plant production while applying too much fertilizer will increase production costs and cause plant poisoning. Continuous application of inorganic fertilizer will affect the quality of the physical, chemical and biological properties of the soil (Iqbal et al., 2019; Zhao et al., 2017).

Fertilizing with organic materials supports efforts to increase land productivity and maintain the availability of organic materials in the soil. Organic fertilizer can improve soil structure, increase soil porosity to increase aerase, improve soil drainage, and increase the activity of soil microorganisms. The organic fertilizers commonly used are liquid organic fertilizers and manure (Ji et al., 2017; Zhao et al., 2017).

Liquid organic fertilizer (POC) is a solution resulting from the decomposition of organic materials originating from plant residues and animal and human waste containing more than one nutrient element (Husen et al., 2022; Mahir et al., 2020). The advantages of this organic fertilizer are that it can quickly overcome nutrient deficiencies, has no problems in leaching nutrients, and can provide nutrients quickly. NASA liquid organic fertilizer can be applied to leaves and soil, contains complete macro and micronutrients, and can reduce the use of Urea, SP-36 and KCl + 12.5% - 25%. Nutrient content of liquid organic fertilizer. NASA is N 0.12%, P2O5 0.03%, K 0.31%, Ca 60.4 ppm, Mn 2.46 ppm, Fe 12.89 ppm, Cu 0.03 ppm, Mo 0.2 ppm (Akbar et al., 2022; Ernita et al., 2017; Wanimbo et al., 2020).

One liter of NASA POC is equivalent to giving 1 ton of manure. Recommendations for using NASA POC fertilizer for corn plants are between 20 - 60 ml/10 - 30 l of water/100 m2. In general, NASA fertilizer has a main function and several side functions, such as organic fertilizer, providing nutrient elements (especially micro) that plants need (Hadisuwito, 2012). The results of Gumelar et al. (2022) the research showed that the performance of POC fertilizer had a significant effect on the weight of wet stover in sweet corn plants with the highest average being 177.53 grams. The treatment interaction had a real influence on the number of leaves in the N2A3 treatment with a Nasa POC dose of 30 ml/L and chicken manure fertilizer of 1080 gr/polybag with the highest average being 12.67 pieces. Then in the treatment the number of sweet corn cobs gave the highest average of 3.00 in the N1A3 treatment with a Nasa POC dose of 15 ml/L and chicken manure 1080 gr/polybag. Then there was an observation of the weight of cobs without husks giving an average of 558.67 grams in the treatment dose of N1A2 (NASA POC 15 ml/L and chicken manure 720 grams/polybag).

Chicken manure contains macro and micro elements such as nitrogen (N), phosphate (P), potassium (K), magnesium (Mg) and manganese (Mn), which plants need. It plays a role in maintaining nutrient balance in the soil because manure affects g per period and ats' nutrition (Dhaliwal et al., 2019). This fertilizer has the following nutrient content: 57% water content, 29% organic matter, 1.5% nitrogen, 1.3% P2O5, 0.8% K2O, 4.0% CaO and 9-11% C/N ratio. Chicken manure contains greater nutrients than other types of livestock (Febryani et al., 2022). This is because the solid manure of livestock is mixed with the liquid manure (Dermiyati, 2015). Research by Prasetyo (2019) shows that providing 15 tons/ha of chicken manure + 500 grams of granular organic fertilizer/ha can provide a growth response to plant height and number of leaves. The amount of each type of nutrient contained in chicken manure is still low, so a combination of chemical fertilizers is needed.

The reason the researchers conducted this research was as an effort to increase the production of sweet corn (Zea *mays saccharata* Sturt) to meet the supply of sweet corn on the market, as well as an attempt to increase land productivity by providing organic fertilizer as a primary fertilizer before planting sweet corn plants and after planting. Liquid organic fertilizer. The novelty of this research is that it was conducted to analyze the effect of NASA POC fertilizer and chicken drum fertilizer on the growth and production of corn plants.

Based on the statement above, the author is interested in conducting research by applying chicken manure and NASA POC to see the growth and production of sweet corn.

Method

This research was conducted on Jl. Market VIII. Simpang Selayang Village, Medan Tuntungan District, Medan, with a height of ± 30 meters above sea level. The research used a Randomized Group Design (RAK) with two treatment factors. The first factor is the administration of NASA Liquid Organic Fertilizer (A) consisting of 4 treatment levels, namely: A0 = 0 ml/liter of water (control), A1 = 2 ml/liter of water, A2 = 4 ml/liter of water and A3 = 6 ml /liter of water. The second factor is the provision of chicken manure (B) consisting of 3 treatment levels, namely: B1 = 2.25 kg/plot (7.5 tonnes/ha), B2 = 4.50 kg/plot (15 tonnes/ha) and B3 = 6.75 kg/plot (22.5 tons/ha). Data analysis used analysis of variance and Duncan's test. The observed variables were plant height, ear length, ear weight per plot and total dissolved solids.

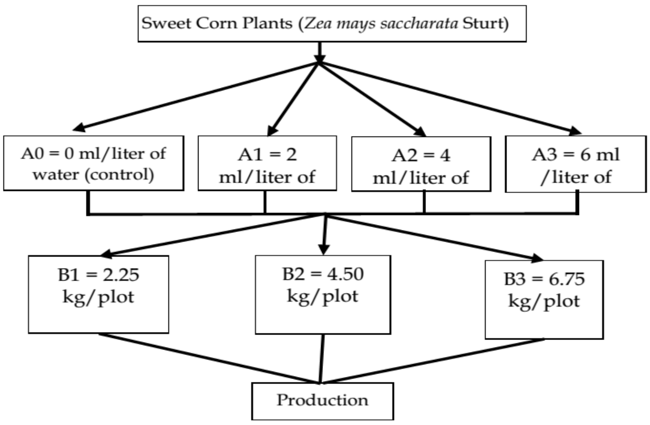

Figure 1. Research flow the effect of NASA liquid organic fertilizer and chicken manure on the growth of sweet corn plants (*Zea Mays Saccharata* sturt)

Result and Discussion

Research Results

Plant Height

Table 1. The Average Height of Sweet Corn Plants Resulting from NASA POC and Chicken Manure at the Ages of 3, 5 and 7 Weeks After Planting (cm)

Treatment	Plant height (cm)		
	3 WAP	5 WAP	7 WAP
A0	40.15	117.97a	182.63a
A1	39.53	124.77b	188.23b
A2	41.06	127.44bc	189.15b
A3	40.50	129.63c	197.57c
B1	39.60	116.44a	179.28a
B2	40.64	125.35b	189.35b
B3	40.69	133.06c	199.56c
A0B1	39.11	105.94	170.72
A0B2	40.84	119.51	184.84
A0B3	40.50	128.44	192.33
A1B1	39.34	116.94	180.00
A1B2	39.11	125.06	187.06
A1B3	40.14	132.31	197.64
A2B1	40.50	121.94	179.94
A2B2	41.11	127.00	187.67
A2B3	41.56	133.39	199.83
A3B1	39.44	120.94	186.44
A3B2	41.50	129.83	197.83
A3B3	40.56	138.11	208.44

Note: Numbers followed by the same letter in the column do not differ at the 5% test level.

The analysis of variance showed that giving NASA POC and chicken manure had no significant effect on sweet corn plant height at 3 WAP but had a significant effect at 5 and 7 WAP. The interaction between the two treatments had no significant effect on plant height at all ages of observation. Table 1 presents the average sweet corn plant height and Duncan's distance difference test due to the influence of NASA POC and chicken manure.

Table 1 shows that when NASA POC was given at 5 WAP, the tallest plants in treatment, A3, were significantly different from A0 and A1 but not significantly different from A2. Plant height in treatment A2 differed significantly from A0 but not significantly from A1. Plant height in treatment A1 was significantly different from A0. At the age of 7 WAP, the tallest plants were found in treatment A3, significantly different from A0, A1 and A2. Plant height in treatments A2 and A1 differed significantly from A0, while plant height in treatment A2 was not significantly different from A1.

The relationship between NASA POC dose and sweet corn plant height at 7 WAP is shown in Figure 2. Figure 2 shows that the higher the NASA POC, the higher the sweet corn plant height increases following a positive linear regression curve.

Table 1 shows that in the chicken manure treatment aged 5 and 7 WAP, the tallest plants were found in treatment B3, which was significantly different from treatments B1 and B2. The height of sweet plants in treatment B2 was significantly different from treatment B1.

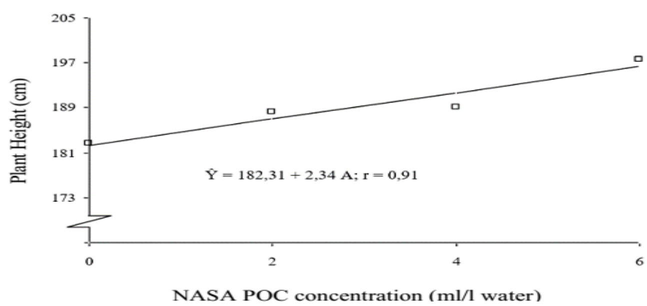

Figure 2. Effect of NASA POC on sweet corn plant height at 7 WAP

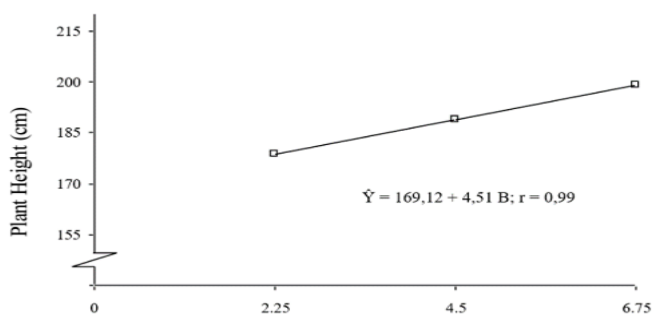

Figure 3. Effect of providing chicken manure on sweet corn plant height at 7 WAP

The relationship between giving chicken manure and sweet corn plant height at 7 WAP is shown in Figure 3. Figure 3 shows that the higher the application of chicken manure, the higher the sweet corn plant increases, following a positive linear regression curve.

Cob Length

The analysis of variance showed that the administration of NASA POC and chicken manure significantly affected sweet corn cob length. In contrast, the interaction between the two treatments had no significant effect on cob length. Table 2 presents the average length of sweet corn cobs and Duncan's distance difference test due to the influence of NASA POC and chicken manure.

Table 2. Average Length of Sweet Corn Cobs Due to Application of NASA POC and Chicken Manure (cm)

Treatment	Cob Length (cm)
A0	26.98a
A1	27.96a
A2	29.57b
A3	29.89b
B1	27.00a
B2	28.93b
B3	29.88c
A0B1	25.56
A0B2	27,28
A0B3	28.11
A1B1	26,22
A1B2	27.78
A1B3	29.89
A2B1	28.00
A2B2	30.28
A2B3	30.44
A3B1	28.22
A3B2	30.39
A3B3	31.06

Note: Numbers followed by the same letter in the column do not differ at the 5% test level

Table 2 shows that when given NASA POC, the longest sweet corn cobs found in treatment, A3 differed significantly from treatments A0 and A1 but not significantly from treatment A2. The length of sweet corn cobs in treatment A2 was significantly different from treatments A0 and A1, while the length of sweet corn cobs in treatment A1 was not significantly different from treatment A0.

The relationship between NASA POC dose and sweet corn cob length is shown in Figure 4. Figure 4 shows that the higher the NASA POC, the longer the sweet corn cobs increase, following a positive linear regression curve.

Table 2 shows that in the chicken manure treatment, the longest sweet corn cob length was found in treatment B3, which was significantly different from treatments B1 and B2. The length of sweet corn cobs in treatment B2 was significantly different from B1.

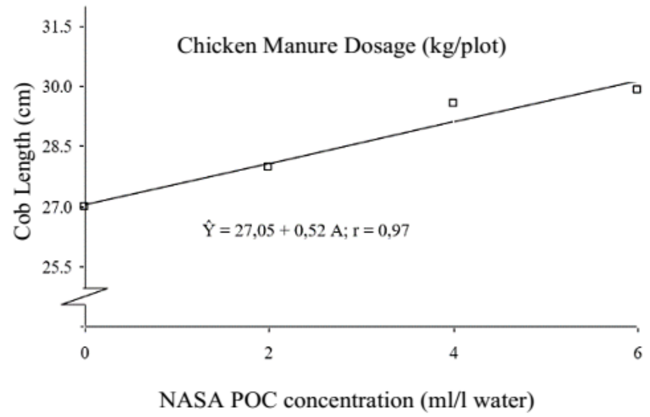

Figure 4. Effect of NASA POC on sweet corn cob length

The relationship between the provision of chicken manure and the length of sweet corn cobs is shown in Figure 5. From Figure 5, it can be seen that the higher the application of chicken manure, the longer the sweet corn cobs increase following a positive linear regression curve.

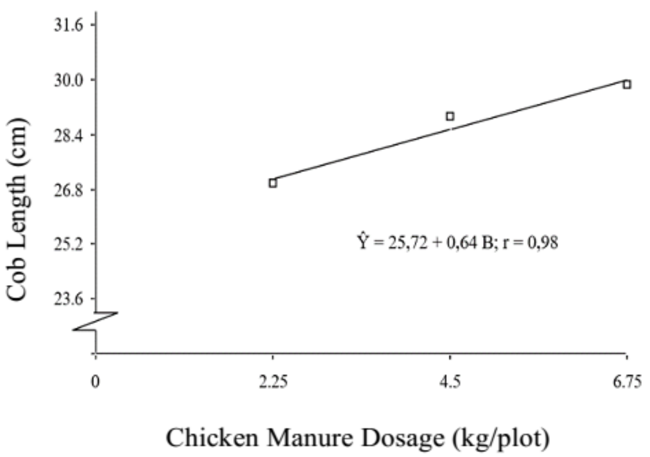

Figure 5. Effect of fertilizer application pen chicken to long sweet corn cobs

Cob Weight per Plot

The analysis of variance showed that giving NASA POC and chicken manure significantly affected cob weight per plot. In contrast, the interaction between NASA POC and chicken manure did not significantly affect cob weight per plot. Table 3 presents the average cob weight per sweet corn plot and Duncan's distance difference test due to the influence of NASA POC and chicken manure.

Table 3 shows that when giving NASA POC the heaviest cob weight per plot of sweet corn in treatment, A3 was significantly different from A0 but not significantly different from A1 and A2. Cob weight per sweet corn plot in treatment A2 differed significantly from A0 but not from A1. The ear weight per plot in treatment A1 was not significantly different from A0. The relationship between NASA POC dose and cob weight per plot is shown in Figure 6.

Table 3. Average Cob Weight per Plot Due to Application of NASA POC and Chicken Manure (kg)

Treatment	Cob Weight per Plot (kg)
A0	5.14a
A1	5.67b
A2	5.96b
A3	5.98b
B1	4.96a
B2	5.78b
B3	6.33c
A0B1	4.33
A0B2	5.47
A0B3	5.63
A1B1	4.97
A1B2	5.73
A1B3	6.30
A2B1	5.27
A2B2	5.83
A2B3	6.77
A3B1	5.27
A3B2	6.07
A3B3	6.60

Note: Numbers followed by the same letter in the column do not differ at the 5% test level.

Figure 6 shows that the higher the NASA POC, the more the cob weight per sweet corn plot increases following a positive linear regression curve. The table above shows that in the chicken manure treatment, the heaviest cob weight per plot in the B3 treatment was significantly different from the B1 and B2 treatments. The cob weight per plot in treatment B2 was significantly different from B1. The relationship between giving chicken manure and cob weight per plot is shown in Figure 7.

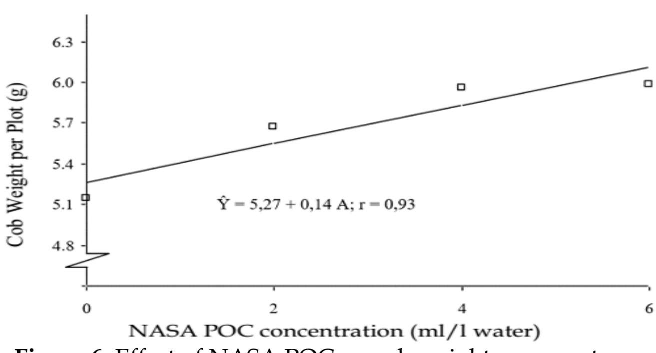

Figure 6. Effect of NASA POC on cob weight per sweet corn plot

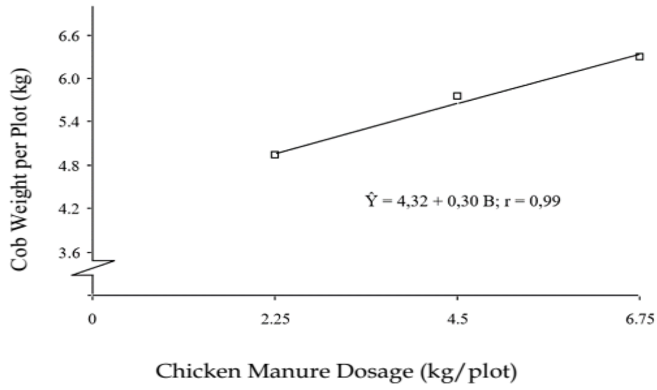

Figure 7. Effect of providing chicken manure on cob weight per sweet corn plot

Figure 7 shows that the higher the application of chicken manure, the higher the cob weight per sweet corn plot, following a positive linear regression curve.

Total Dissolved Solids (PTT)

The analysis of variance showed that the treatment of NASA POC and chicken manure significantly affected the total soluble solids of sweet corn. In contrast, the interaction between the treatment of NASA POC and chicken manure had no significant effect on the total soluble solids of sweet corn. Table 4 presents the average soluble solids of sweet corn and Duncan's distance difference test due to the influence of NASA POC and chicken manure.

Table 4. Average Total Dissolved Solids of Sweet Corn Due to Application of NASA POC and Chicken Manure (°Brix)

Treatment	Total Dissolved Solids (°Brix)
A0	26.98a
A1	27.96a
A2	29.57b
A3	29.89b
B1	27.00a
B2	28.93b
B3	29.88c
A0B1	25.56
A0B2	27,28
A0B3	28.11
A1B1	26,22
A1B2	27.78
A1B3	29.89
A2B1	28.00
A2B2	30.28
A2B3	30.44
A3B1	28.22
A3B2	30.39
A3B3	31.06

Note: Numbers followed by the same letter in the column do not differ at the 5% test level

Table 4 shows that when given NASA POC, the highest total soluble solids of sweet corn were found in treatment A3, which was significantly different from A0 but not significantly different from A1 and A2. The total soluble solids of sweet corn in treatment A2 were significantly different from A0 but not significantly different from A1. The total dissolved solids of sweet corn in treatment A1 were not significantly different from A0.

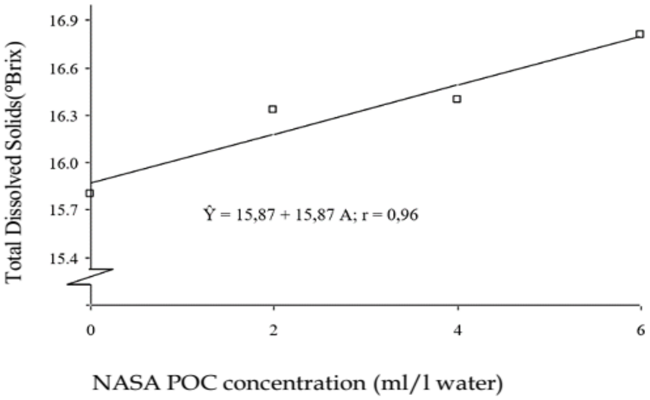

Figure 8. Effect of NASA POC on total dissolved solids of sweet corn

The relationship between NASA POC dose and total dissolved solids of sweet corn is shown in Figure 8. Figure 8 shows that the higher the NASA POC, the more the total soluble solids of sweet corn increase following a positive linear regression curve.

Table 4 shows that in the chicken manure treatment, the highest total soluble solids of sweet corn were found in treatment B3, which was significantly different from treatment B1 but not significantly different from treatment B2. The total soluble solids of sweet corn in treatment B2 were significantly different from B1.

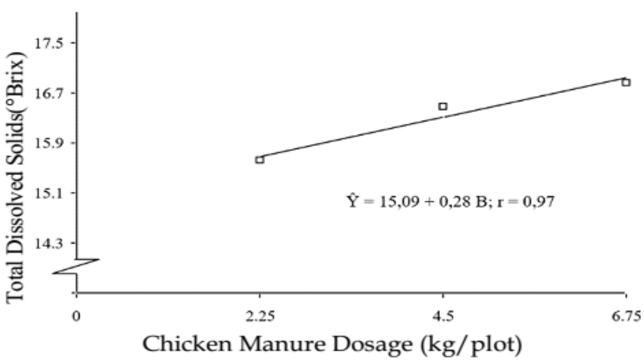

Figure 9. Effect of giving chicken manure on total dissolved solids of sweet corn

The relationship between chicken manure and the total soluble solids of sweet corn is shown in Figure 9. Figure 9 shows that the higher the application of chicken manure, the more the total soluble solids of sweet corn increase following a positive linear regression curve.

Discussion

Effect of NASA POC on Sweet Corn Growth and Production

The research showed that giving NASA POC 4 and 6 g/plant increased plant height growth. Giving NASA POC 6 ml/l of water resulted in an average plant height of 197.57 cm, while giving four g/plant resulted in an average plant height of 189.15 cm.

Providing NASA POC with up to 6 ml/l of water can increase the vegetative growth of tall plants. This is because NASA POC can increase the supply of nutrients and microelements for plants. The increasing supply of nitrogen will increase the rate of photosynthesis in plants, where nitrogen is the main ingredient in the photosynthesis process (Hayati et al., 2023). An increase in the rate of photosynthesis will produce photosynthesis, which is then translocated into plant growth and the formation of new plant leaves. Sweet corn plants require large amounts of nitrogen nutrients at the beginning of vegetative growth (Jafarikouhini et al., 2020; Stewart et al., 2020).

The results showed that giving 6 g NASA POC/plant increased cob length by 29.89 cm. This is because plants can quickly use the application of liquid organics for the photosynthesis process. The higher the concentration given, the higher the nutrient content received by the plant (Bahua et al., 2020; Wasis et al., 2019). Research by Fahrurrozi et al. (2019) and Wijaya et al. (2023) shows that applying liquid organic fertilizer provides growth and yield of sweet corn plants.

The research showed that the higher the concentration of NASA liquid organic fertilizer, the more the total dissolved sweet corn solids increased. Low total dissolved solids are caused by plants lacking nitrogen and phosphorus nutrients. Sudding et al. (2021), Sukor et al. (2023) and Yasin (2023) stated that the nitrogen and phosphorus nutrients contained in liquid organic fertilizer can increase the development of sweet corn seeds and metabolic processes, increasing the total dissolved solids in the seeds. According to Krismawati et al. (2022) the increase in cob weight with husks is closely related to the results of photosynthate, which is translocated to the corn cob. The greater the photosynthate that is translocated to the cob, the greater the fresh weight of the cob. The development of better sweet corn yields is thought to be due to providing nutrients in optimal and balanced quantities. Applying N, P, and K fertilizers and liquid organic fertilizers has provided a balance between macro and micronutrients in the plants. Plants will not produce maximum results if the required nutrients are not available. Fertilization can increase growth and crop yields qualitatively and quantitatively (Fajar et al., 2023; Syamsurizal et al., 2023).

The research results show that giving NASA POC 4 and 6 g/plant increased the total dissolved solids. Giving NASA POC 6 ml/l of water produced an average total dissolved solids of 16.81 °Brix, while giving four g/plant produced an average total of 16.40 °Brix. This shows that the higher the NASA POC, the more the dissolved solids increase. This is because giving POC can increase the supply of nutrients, especially nitrogen and phosphorus, in forming carbohydrates, especially simple sugars. An increase in simple sugars in seeds will further increase total dissolved solids. Soluble solids content is one of the quality attributes of sweet corn. The drastic reduction in total dissolved solids means that the sweet taste of corn is reduced and even gradually disappears. The reduction in sweetness is caused by uncontrolled metabolic processes, which result in chemical changes in the product. Stored food reserves such as carbohydrates in fruit as a supply of energy (Brown et al., 2022).

Effect of Chicken Manure on the Growth and Production of Sweet Corn

The research showed that giving chicken manure at a dose of 6.75 kg/plot could increase plant height growth. Providing chicken manure at a dose of 6.75 kg/plot resulted in an average plant height of 199.56 cm.

Providing chicken manure at a dose of up to 6.25 kg/plot can increase the vegetative growth of tall sweet corn plants. This is because chicken coops contain nitrogen elements, which are the main source in the plant growth process, so increasing doses will increase the rate of photosynthesis, where photosynthesis will be used in cell enlargement and elongation so that the plants get taller and the number of leaves also increases. According to Saryanto et al. (2021) and Tarigan (2024), plants that receive sufficient N supply will form broad leaf blades with high chlorophyll content so that plants can assimilate in sufficient quantities to support vegetative growth.

The research results show that providing chicken coops with up to 6.25 kg/plot can increase the production of sweet corn plants with an average cob weight per plot of 6.33 kg. This is because chicken manure decomposes easily, so it can quickly stimulate plant growth. According to Putri et al. (2023) and Waskito et al. (2022), chicken manure is a high-quality organic material that decomposes quickly or is quickly available to plants compared to organic fertilizer from cows or other animals. The quality of organic material is determined by the lignin and polyphenol content and the C/N ratio. It is correlated with the speed of decomposition and mineralization of the organic material. Chicken manure has a relatively low C/N ratio, namely 1.92, meaning that chicken manure quickly decomposes into the nutrients needed by plants so that it will stimulate plant growth and crop production.

The research showed that giving chicken manure at a dose of 4.5 kg/plot and 6.75 kg/plot increased total dissolved solids. Providing 6.75 kg of manure/plot produces an average total dissolved solids of 16.88 °Brix, while applying four g/plant produces an average total of 16.50 °Brix. This shows that the higher the chicken manure dose, the more dissolved solids are increased. Low total dissolved solids are caused by plants lacking nitrogen and phosphorus nutrients. Chicken manure contains the nutrients nitrogen and phosphorus, so increasing the dose of manure will increase the supply of nitrogen and phosphorus to plants. According to Revilla et al. (2021), nitrogen and phosphorus nutrients for plants can increase the development of sweet corn seeds and metabolic processes, increasing the total dissolved solids in the seeds.

Interaction between Giving NASA POC and Chicken Manure on the Growth and Production of Sweet Corn

The results of variance analysis showed that the interaction between NASA POC and chicken manure had no significant effect on plant height, ear length, ear weight per plot and total dissolved solids. This is because the two types of fertilizer used have nutrient values that are not as high as inorganic fertilizers.

Conclusion

Providing NASA POC with up to 6 ml/l of water significantly increased plant height, ear length, ear weight per plot, and total dissolved solids. Providing chicken manure up to 6.75 kg/plot increased considerably plant height, ear length, ear weight per plot, and total soluble solids. The interaction between NASA POC and chicken manure had no significant effect on plant height, ear length, ear weight per plot, and total dissolved solids.

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Author Contributions

The main autors Efbertias Sitorus and Lince Romauli Panataria: designing research, conducting research, collecting data, and writing research articles. the authors Parsaoran Sihombing and Meylin Kristina Saragih, helped prepare the report and research instruments and conducted data analysis.

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Conflicts of Interest
The author declares that all authors have no conflict of interest.

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