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Application of POC fertilization from organic waste and humic acid on the growth and production of sweet corn (*Zea mays* L. *Saccharata Sturt*)

Nunuk Helilusiatiningsih [1*], Muhammad Alwi Syahara [2]
[1] Department of Agrotechnology, Faculty of Agriculture, Universitas Islam Kadiri, Kediri, Indonesia
[2] Department of Chemistry, Faculty of Agriculture, Universitas Islam Kadiri, Kediri, Indonesia
*Email korespondensi: nunukhelilusi@gmail.com

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ABSTRACT

Introduction: Sweet corn in Indonesia was the main commodity after rice, and it was useful for food, the snack processing industry, semi-finished ingredients, side dishes, and animal feed. Problems with sweet corn farming include limited land, inappropriate cultivation technology, expensive superior seeds, insufficient water availability, fertilizers and pesticides that do not meet needs, as well as expensive and difficult labor, and competition with other commodities. The quality of the corn was that the husk was bright green and slightly moist, the sweet corn tassels were light brown and moist, and the grain texture was dense. The research aimed to analyze the effect of adding humic acid and POC on the growth and yield of sweet corn. **Methods:** The experimental design was RAKF. The first factor was humic acid (A) consisting of 4 levels: control, 5 kg/ha, 10 kg/ha, and 15 kg/ha. The second factor is POC (P) consisting of 5 levels: control, 60 ml/l, 90 ml/l, 120 ml/l, and 150 ml/l so there are 20 experimental combinations. Analysis used the F count test, 5% BNT test, and 5% DMRT test. **Results:** In the analysis of plant height, number of leaves, and weight of corn with and without husks, the best combination was A3P4.The P4 level (150 ml/L) has the highest level of sweetness but is not significantly different, the degree of sweetness was 16.25 brix. Addition of humic acid at a concentration of 15 kg/Ha. Produces a sweetness degree of 18.35 brix. **Conclusion:** The results of the study indicated a significant influence from the combination of treatments, as well as an interaction between the experimental treatments. The most effective combination was A3P4, which involved a humic acid concentration of 15 kg/ha and a POC dose of 150 ml/L. This combination yielded the best results for the tested parameters and sweetness levels.

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INTRODUCTION

The sweet corn farming business was quite profitable and was liked by consumers because it tastes sweet, the selling price is more profitable for farmers, it was widely used as a vegetable, and side dish, and contains good nutritional value, so market demand has increased. It was recorded that the need for corn imports was 1,122 tons in 2017, indicating that there is a large demand for sweet corn in the country, so it is necessary to stimulate the acquisition of sweet corn from local farmers (Agussalim *et al.*, 2022). Sweet corn production can reach 14 tonnes/ha (Syukur & Rifianto, 2013). In 2020, around 71.40% said that corn cultivation was mostly carried out on non-rice fields, and around 36.65% of soybeans were planted on irrigated rice fields (Badan Pusat Statistik, 2020). The research method uses quantitative description. The results of the SWOT analysis of corn plants in Nganjuk Regency are as follows: average corn production and total annual production capacity are 203,402 tons (Astoko & Helilusiatiningsih, 2023). The findings suggest that 50 mM trehalose spray efficiently mitigated the Cr toxicity in maize plants as compared to 25 mM trehalose spray (Razzaq *et al.*, 2024).

Ragheb (2016) stated that many farmers plant sweet corn because it has a short production period is easy to grow, is resistant to pests and diseases, and increases sales value (Ragheb, 2016). Supported by the Ministry of Agriculture (2020), it explains that based on BPS, the need for sweet corn exports in 2020 is around 111 tons, there has been an increase in production compared to 2019, around 91 tons (Kementerian Pertanian,2021). Multiple studies have shown that increasing sweet corn productivity can be achieved by improving both the physical and chemical properties of the soil. This includes providing balanced nutrition through the use of fertilizers, such as plant-activated fertilizers (POC) and others, tailored to the specific needs of the plants. Currently, organic fertilizer has the potential to be used by farmers because it dissolves easily in water and is easily absorbed by plants in the soil (Revilla *et al.*, 2021; Suprapto, 2016).

The problem obtained from the literature review above was that the need for sweet corn exports was increasing and domestic production was limited and required intensive agricultural development and increased production. The current research trend in improving soil quality is using humic acid (Bhatt & Singh, 2022; Wang *et al.*, 2022). Humic acid is an organic compound that plays an important role in improving soil quality (ameliorant), plant growth, and other agronomic factors (Bhatt & Singh, 2022). Humic acid serves to improve chemical, physical, and biological properties (Al-Rawi & Al-Dulaimi, 2021). Humic acid can increase cell membrane permeability nutrients are easily absorbed, chlorophyll production increases, enzyme activity works actively, and increases hormone stimulation (Bhatt & Singh, 2022). Humic acid is also known to increase pH and cation exchange capacity (CEC) (Mollah *et al.*, 2020).

Based on this background, the research aimed to study the effect of humic acid and POC fertilizer applications on the growth and yield of sweet corn. It was thought to produce interactions between treatments in producing growth and production. The parameters analyzed include the vegetative and generative phases of the plant. The targeted results have new data or novelty. The benefit was finding a new formulation regarding added levels of humic acid and POC to increase sweet corn production. This was supported by Tania (2021) explaining that humic acid used in providing nutrition can form humus so it was very good for fertilizing plants. It was hoped that giving POC by spraying it could be absorbed by plants well, thereby speeding up production (Tania, 2021).

METHODS

Tools and materials

In research activities, supporting tools were needed, including pH meters, hygrometers, buckets, hoes, sickles, measuring tapes, watering cans, plot labels, sacks, tarpaulins, scales, and stationery. Materials for field experiments are hybrid sweet corn seeds of the Perkasa F1 variety, kepok banana skin, domestic chicken egg shells, robusta coffee grounds, M-21 decomposer Membramo rice washing water, water, molasses, and humic acid.

Time and place of Implementation

The research was carried out from June to December 2022 in Betet Village, Pesantren Kediri District. Betet Village Astronomical Data Environmental temperature around 29 to 32 degrees Celsius, Betet area 1.6 km2, Pesantren sub-district area 2503 hectares, North village boundary of Gamping Rejo and Gurah sub-districts, East of Gurah and Wates sub-districts, South of Kandat sub-district, West of Kota sub-district, Climate Tropical, soil pH 5.9. The area of rice fields is 1085 Ha, and Tegal Land is 273 Ha. Types of rice, corn, sugar cane, horticultural crops, etc.

Method used

The method used was environmental design using RAKF, using 2 variables and each variable consists of 5 levels and 4 levels of treatment, carried out on dry land. Parameters measured in the vegetative phase aged 14, 21, 28, and 35 HST include plant height and number of leaves. The generative phase measured the weight of the cobs with husks, the weight of the cobs without husks, and the level of sweetness. Observation variables include; growth variables measured starting 28 days after transplanting and then at 1-week intervals; plant height (measured from the base of the stem to the longest tip of the plant per polybag in cm), cob weight was calculated by weighing on a scale after harvest, sweetness level was measured using a refractometer in Bric degrees. The number of leaves was measured for each leaf that had completely opened in units of leaves. The method for making POC was to grind 8 kg of banana peel, 8 kg of egg shells, 4 kg of coffee grounds, and 12 L of water and then put it in a 70L container. The next step was given 24 L of water from memberamo rice, 2 L of molasses, and 96 ml of EM-4 decomposer. The contents of the POC produced were as follows based on laboratory tests at P3GI Jengkol: All ingredients are mixed and stirred until evenly distributed, then fermented for about 2 weeks, stirring every day. The POC content can be seen in Table 1. The result was POC which was fertilized around 8 times with a time interval of 7 days from 7 DAP to 63 HST.

Design used

The research used a factorial randomized block design, with POC concentration treatment consisting of 5 levels: control, 60 ml/l, 90 ml/l, 120 ml/l, 150 ml/l, and humic acid dose with 4 treatment levels: control, 5 kg/ha, 10 kg/ha, 15 kg/ha, Repeat the experiment 3 times so that there are 20 treatment combinations and the total experimental units were 60

Data analysis

The analysis of measurement data was calculated statistically using the F test, followed by the 5% BNT test or 5% DMRT test if there was an influence on the treatment to show differences between treatment combinations.Bagian ini memuat rancangan penelitian meliputi: populasi/sampel penelitian, data dan teknik/ instrumen pengumpulan data, alat analisis dan model yang digunakan. Metode yang sudah umum tidak perlu dituliskan secara detail, tetapi cukup merujuk ke buku acuan (Misal: rumus uji F, uji t). Keterangan simbol pada model dituliskan dalam kalimat.

RESULT AND DISCUSSION

In the experiments that have been carried out, data on the POC content used in this research was obtained as shown in Table 1. The research collaboration involves a laboratory located outside the campus, namely P3GI, located in Ploso Klaten Village, Kediri. The analysis carried out was the nitrogen, phosphorus, and potassium content contained in POC.

Table 1. Analysis of POC content analyzed in the P3GI laboratory

No	Nitrogen	P2O5	K2O	information
1	0,24 %	0,06%	0,66%	POC (Eggshells, rice washing water, kepok banana peels, coffee grounds)

Statistical tests showed that there was a real interaction between treatment combinations, at the observation age of 35 days after planting, it can be seen in Figure 1. The addition of POC made from kepok banana peel, molasses, leri water, and EM-4 which was fermented for around 21 days gave a response to the addition of plant height because it contains NPK which helps in growing plant height. Humic acid also helps in the process of growing sweet corn plants because it contains organic fertilizer. Sudartini *et al.*'s opinion (2020) stated that leri water obtained from washing rice has 90% carbohydrates, cellulose, protein, glutenin, vitamin B, and starch (Sudartini *et al.*, 2020). Kadir (2016) has also made liquid fertilizer from banana peels and produced NPK content with Nitrogen values ranging from 35,325 mg/L to 78,775 mg/L, Phosphorus 195.83 mg/L to 471 mg/L and Potassium 422.3 mg/L to 2,046 mg/L which is sufficient for use in the agricultural sector (Kadir *et al.*, 2016).

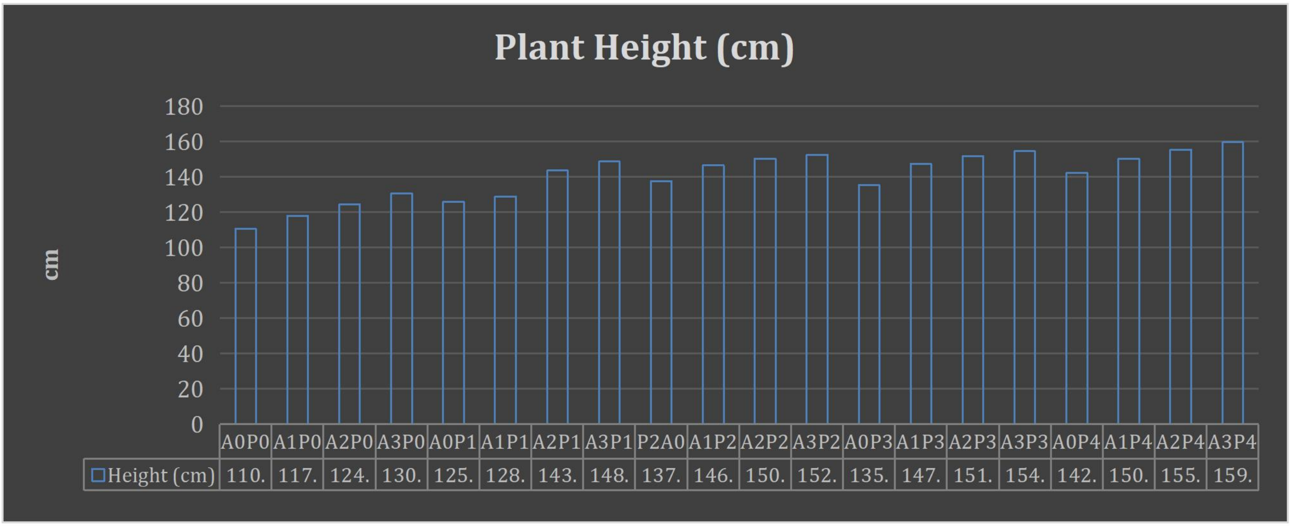

Figure 1. Diagram of sweet corn plant height

Based on data from the results of various plant height tests, the best interaction was the combination A3P4, namely the average plant height reached 159.5 cm as shown in Figure 1, while the shortest, namely A0P0 (control treatment) had a height of 110.5 cm. Researchers Kalay *et al.* (2020) explained the results of observing the highest plant growth from the application of humic acid and POC at the end of the growth phase, namely at the age of 35 days after planting (Kalay *et al.*, 2020). In addition, Eryiğit & Husamalddin have also conducted research that shows that plant height increases with the addition of the dose of humic acid (Eryiğit & Husamalddin, 2023). This is because humic acid contains organic material that can form humus which functions to accelerate plant height. POC contains nutritional ingredients including NPK which suit the needs of plants for vegetative and generative growth. Exudates are a means of communication with surrounding soil organisms. The treatment of adding POC with a concentration of 150 ml/L containing NPK elements has an effect on increasing plant height and functions to improve soil structure as well as the physical, chemical, and biological properties of the soil. Puspadewi *et al.* (2016) explained that NPK fertilizer helps increase plant height (Puspadewi *et al.*, 2016). Sofyan (2023) has also conducted research that shows that the addition of NPK results in increased corn plant height (Sofyan *et al.*, 2023).

In the observations carried out to count the number of leaves during the growing period, the results obtained were that there was an interaction between the two experimental treatments and they had a significant influence on each other. In Figure 2 you can see the results of statistical analysis. Leaf growth was influenced by the addition of humic acid and POC. The nutritional content absorbed was quite optimal because it suited the needs of plants in carrying out the growth and development process.

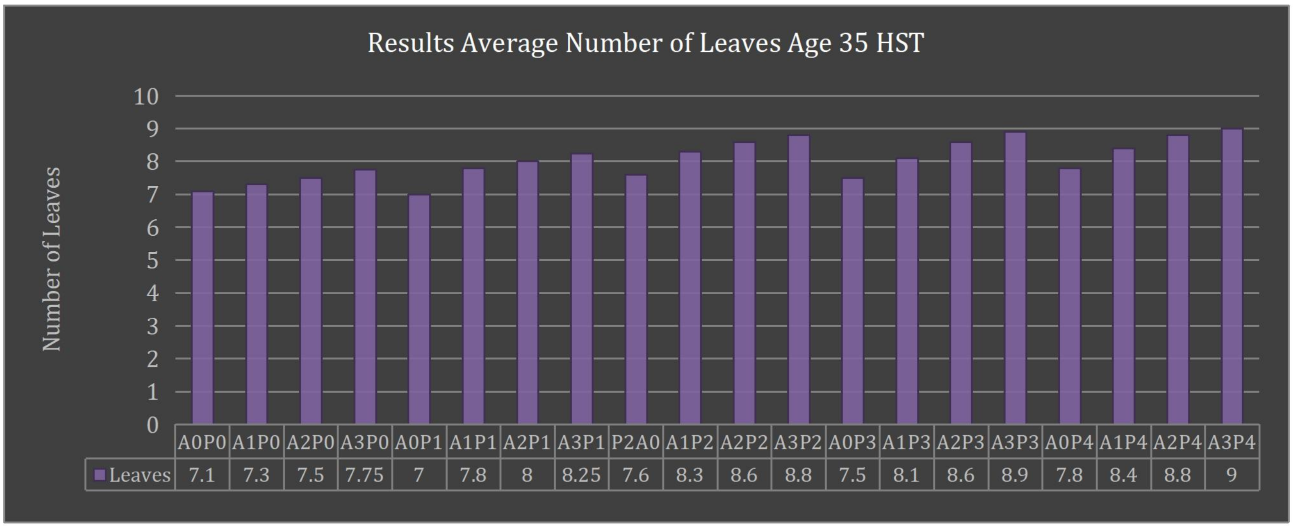

Figure 2. Average number of leaves

Observing the highest number of leaves was the A3P4 combination which had 9 leaves and the lowest was the A0P0 control which produced 7 leaves. Lestari and Sukri (2020) explained that humic acid contains the growth phytohormone IAA (Indole Acetic Acid), the ZPT auxin group, which plays a role in the formation and vegetative growth of plants (Lestari & Sukri, 2020). The results of this study are in line with Eyrighit's research which shows that the use of 180 kg/ha of humic acid can produce 12 leaves (Eryiğit & Husamalddin, 2023). Victolika *et al.* (2014) explained that a humic acid dose of 7.5 cm/ml was effective and the NPK fertilizer dose could be reduced by 25% in increasing the number of leaves on tomato plants (Victolika *et al.*, 2014). The number of leaves is influenced by the availability of Nitrogen (N), humic acid is known to increase the amount of N absorbed by plants, thereby increasing chlorophyll in the leaves. The increase in chlorophyll will increase the rate of photosynthesis which affects the number of leaves formed in corn plants (Mollah *et al.*, 2020).

Based on the F test, calculate the weight of the cob with an interaction between the two treatments as shown in Figure 3. Based on this data, it shows that the combination of treatments that produces the heaviest weight with husks was A3P4 with a humic acid concentration of 15 kg/Ha and a POC of 150ml/L The weight of the fruit with the peel was 360.9 grams, while the lowest weight in the A0P0 treatment was 188.30 grams. This was thought to require the development of corn with balanced fertilizer levels to produce maximum production. Setiaaji *et al.* (2017) ordinary corn needs nitrogen around 70 kg/ha, while sweet corn needs around 150 ± 300 kg/ha (Setiaaji *et al.*, 2017).

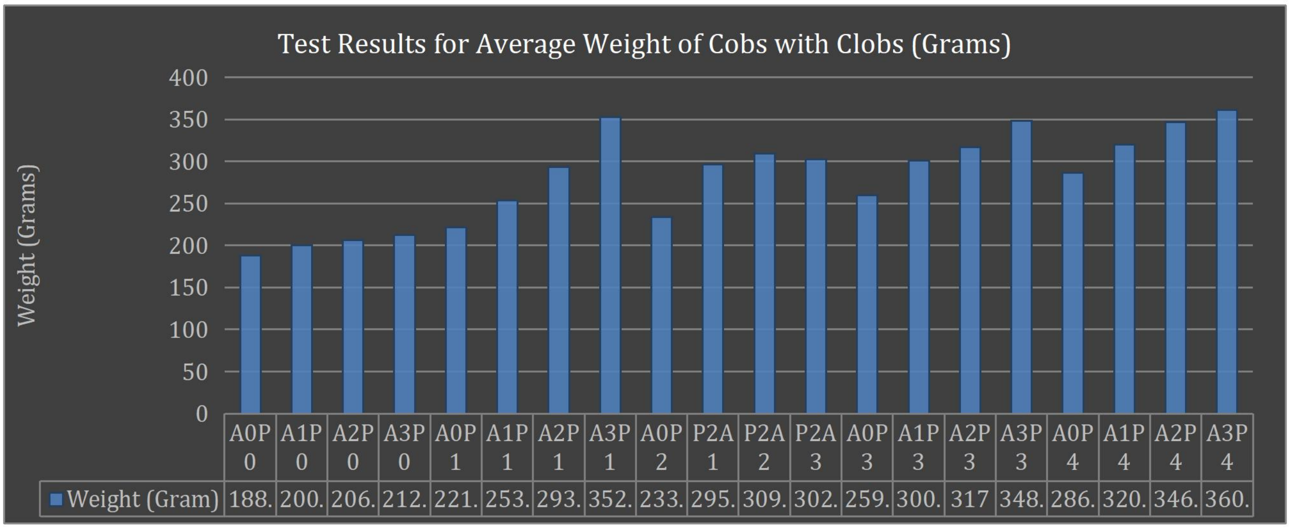

Figure 3. Bar diagram of corn weight with husks

This was thought to require the development of corn with balanced fertilizer levels to produce maximum production. Setiaaji *et al.* (2017) explained that sweet corn was a plant that was greedy for nutrients, especially nitrogen, around 150 ± 300 kg/ha compared to ordinary corn, which is only 70 kg/ha (Setiaaji *et al.*, 2017). According to Nurlaeli *et al.* (2022), the potential of nitrogen and phosphorus nutrients is to help in the formation of sweet corn seeds to produce more production. Explained that the nutrients nitrogen and phosphorus can increase the growth of sweet corn seeds (Nurlaeli *et al.*, 2022). Supported by the opinion of Lestari and Sukri (2020), opinion is that the role of roots and optimal root absorption capacity can influence the increase in cob weight during plant development (Lestari & Sukri, 2020).

The weight of the cobs without husks that had been weighed and tested F calculated, there was a significant interaction. Based on Figure 4, it can be seen that there is an interaction between humic acid and the POC given and the best treatment was A3P4, namely adding 15 kg/Ha of humic acid and giving 150 ml/L of POC. The results of the treatment produced the highest weight of corn without husks, which was 260.60 grams. The treatment that produced the lowest weight was A0P0, around 115.90 grams. This shows similar results to the results of the Al-Rawi & Al-Dulaimi, Eryiğit & Husamalddin study that adding a dose of humic acid can increase the weight of corn seeds (Al-Rawi & Al-Dulaimi, 2021; Eryiğit & Husamalddin, 2023). This was because the addition of humic acid contains nutrients that suit plant needs and the addition of POC which has a balanced NPK can stimulate the development and production of sweet corn.

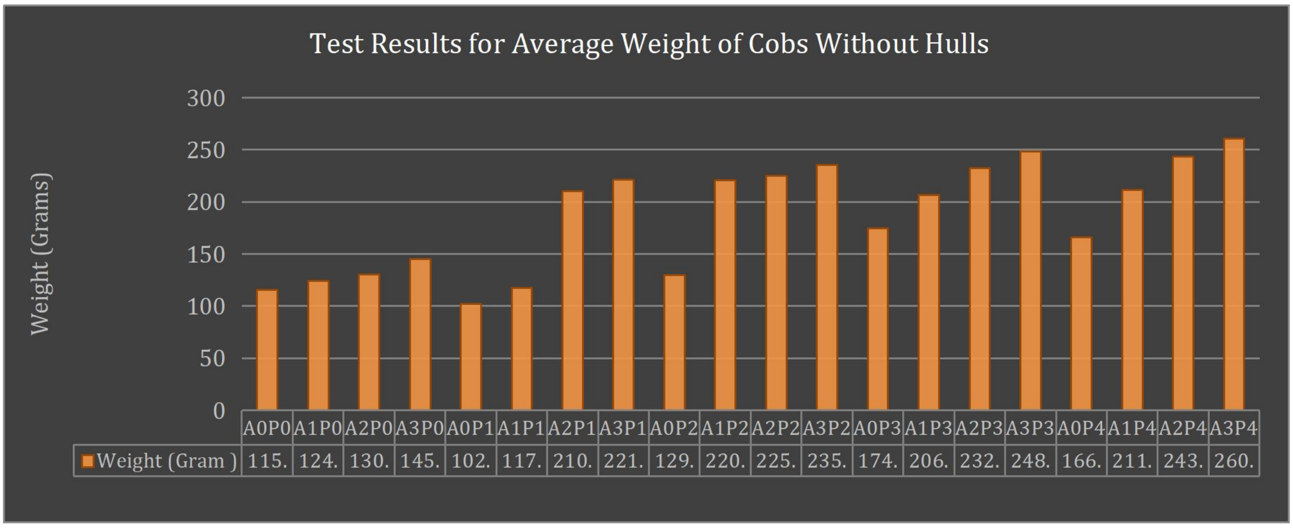

Figure 4. Weight diagram of sweet corn without husks

This shows that the nutrient requirements provided for the growth and development of sweet corn are balanced and production can be maximized. Another factor is that photosynthesis and metabolism processes run well due to the climate. The use of organic matter, such as humic acid, increases the availability of nitrogen and other micro and macronutrients in the soil, thereby increasing crop yields and improving seed quality. Furthermore, higher yields per plant can be attributed to the addition of organic chemicals that enhance cell development, control enzymes, and initiate photosynthesis by increasing chlorophyll concentration, light absorption, and chloroplast fine structure (Bhatt & Singh, 2022; Eryiğit & Husamalddin, 2023; Sofyan *et al.*, 2023).

The results of the sweetness test using Brix degrees can be seen in Table 2. There was no interaction. The type of experimental treatment has a role in the metabolic process so it influences the process of forming the sweet taste of sweet corn. The nutrients provided include humic acid and POC which have different sweetness values. The P4 level (150 ml/L) has the highest level of sweetness but is not significantly different, the degree of sweetness was 16.25 brix. Addition of humic acid at a concentration of 15 kg/Ha. Produces a sweetness degree of 18.35 brix.

Table 2. Sweetness level test data

Treatment	Sweetness level (Brix)
P0	$15.75^{a} \pm 0.25$
P1	$15.75^{a} \pm 0.15$
P2	$16.00^{a} \pm 0.30$
P3	$16.12^{a} \pm 0.20$
P4	$16.25^{a} \pm 0.15$
BNT 5 %	0.997
A0	$15.40^{a} \pm 0.17$
A1	$16.30^{b} \pm 0.15$
A2	$17.40^{c} \pm 0.12$
A3	$18.35^{d} \pm 0.10$
BNT 5%	0.892

Table 2. above was a calculated F test showing data that do not interact, however, A3 (humic acid 15kg/ha) has the highest value, namely 18.35 brix. Agussalim's research results also show that the use of *Pupuk Organik Cair* (POC) can

increase the brix level of sweet corn (Agussalim *et al.*, 2022). It is suspected that the added humic acid contains organic material which can increase the CEC of the soil which was related to increasing the sweetness of the fruit due to biochemical processes in the plant. Wijayanti and Soedradjad (2019) stated that the element potassium can increase the amount of sugar in plants (Wijiyanti & Soedradjad, 2019).

CONCLUSION

The results of analysis from research with the addition of humic acid and POC influenced the growth and yield of sweet corn plants, and there was an interaction between the two treatments. The best combination, namely A3P4 (Humic acid concentration of 15 kg/Ha and POC content of 150 ml/L), can increase vegetative and generative development.

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