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RESEARCH ARTICLE

GROWTH AND YIELD OF SWEET CORN (ZEA MAYS SACCHARATA) AT VARIOUS NPK FERTILIZERDOSES AND LIQUID ORGANIC FERTILIZERCONCENTRATIONS

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Abstract

Background:The aim of this research was to obtain thebest concentration of liquid organic fertilizer at each dose of NPK fertilizer on the growth and yield of sweet corn.

Methodology: This research was conducted at the Academic Garden, Agriculture Faculty, Tadulako University from August to November 2021.The first factor was the NPK dose consisting of 3 levels, i.e., 200 kg ha^{-1}, 300 kg ha^{-1}, and 400 kg ha^{-1}. The second factor was the concentration of liquid organic fertilizer consisting of 3 levels, i.e.,without POC, 10% POC, and 20% POC. There were 9 combinations of treatments with 3 tests. The data were analyzed using the Analysis of Variance (ANOVA), then followed by the 5% level.

Results : The results showed that 20% POC administration resulted in a larger cob at each dose of NPK. The administration of 400 kg ha^{-1}NPK resulted in a larger cob at each POC concentration. Feeding of 400 kg ha^{-1}NPK achieved better growth and yield characterized by higher plants, larger stems, longer and heavier cobs.

Conclusion : The result showed that 20% liquid organic fertilizers obtained better results characterized by longer and heavier cobs.

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Introduction:-

Sweet corn has long been known and popular in Indonesia because it has a sweeter taste than other types of corn.The production age is shorter (early), so it is very good for cultivation. Central Sulawesi corn production in 2018 reached 540,404 tons with a harvested area of 115,300 hectares and productivity reached 4.69 tons ha^{-1}. Sweet corn production has decreased because the harvested area decreases every year. One of the factors that causes a decrease in sweet corn production is land degradation which results in decreased soil fertility, such as a decrease in nutrient levels, organic matter content, and soil pH. To overcome this problem, fertilization can be applied. The purpose of fertilization is to improve the level of soil fertility, so that plants obtain sufficient nutrients to improve the quality of plant growth [1].

Phonska fertilizer is a fertilizer compound containing the main elements N, P, K with a ratio of 15% N, 15% P_2O_5, 15% K_2O plus 10% sulfur.Protein, vitamin B1, vitamin B3, vitamin B6, manganese, phosphorus and iron which have important roles for plant growth and development [2;3].Nutrient absorption can occur through two processes, i.e., through the soil and leaves. Nutrients in the soil can be absorbed by plants when in contact with plant roots[4].In

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general, the mechanism of nutrients movement from the soil solution to the root surface is grouped into 3 models, i.e., root interception.

The movement of nutrients in the leaves to the vascular tissue (leaf phloem) and then transported out of the leaves can be through 2 pathways, i.e., apoplastic and symplastic. Transport of nutrients from the leaves down through the phloem. Since the leaves can function as nutrient absorbers, fertilization can be performed through the leaves. Foliar fertilization with the spray method has the advantage of fast absorption[5], but the disadvantage is that the supply of nutrients is temporary.Fertilization is one of the efforts made to increase plant production both through the soil and the leaves[6]. Research on Phonska NPK fertilizer and rice water POC was still limited, so researchers were interested in determining the best concentration of liquid organic fertilizer at each consentration of NPK on the development of sweet corn.

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Materials And Methods:-

Description of time and site

The research was conducted at the Academic Garden of the Faculty of Agriculture, Tadulako University, from August to October 2021.The tools used in this study were hand tractors, hoes, scales, meters, calipers, measuring cups and writing utensils. The materials used were sweet corn seeds, phonska NPK fertilizer, and rice washing water (rice water).

This study used a two-factor Randomized Block Design (RBD). The first factor was the NPK dose consisting of 3 levels, i.e., 200 kg ha^{-1} (P1), 300 kg ha^{-1} (P2), and 400 kg ha^{-1} (P3). The second factor was the concentration of liquid organic fertilizer consisting of 3 levels, i.e., without POC (C0), 10% POC (C1), and 20% POC (C2).

Research Implementation

Tillage was performed twice using a hand tractor,then followed by harrowing. 27 plots were made with a size of 4 x 2 meters.Before planting, the seeds were soaked first, then the planting wasperformed individually by planting three seeds per plant clump with a spacing of 75 cm x 40 cm.Maintenance of corn plants included watering, weeding, pest and disease control, and thinning.Embroidery wasapplied when there were plants that did not grow. Weeding wasperformedin 7 days after planting (DAP) by pulling weeds around the plants. Control of grasshoppers and leaf caterpillars was applied using Dangke and Furadan pesticides for controlling cob caterpillars. Thinning was performed 2 weeks after planting (WAP) by leaving one plant per clump.

Fertilization

NPK fertilization was administeredtwice according to the dose. First at 14 DAP of 1/3 dose and 2/3 dose at 35 DAP, with three different treatments, i.e., 200 kg ha^{-1} equivalent to 120 g plot^{-1} (first administration of 1/3 dose was 40 g and second administration of 2/ 3 dose was 80 g), 300 kg ha^{-1} equivalent to 180 g plot^{-1} (first administration of 1/3 dose was 60 g and second of 2/3 dose was 120 g), and 400 kg ha^{-1} equivalent to 240 g plot^{-1} (first administration of 1/3 dose was 80 g and second of 2/3 dose was 160 g). Then,Liquid Organic Fertilizer used the concentration with a dose of 600 liters ha^{-1}. The first administration at 14 DAP was 100 litersha^{-1} equivalent to 60 ml plot^{-1}, the second administration at 28 DAP was 200 litersha-1 equivalent to 120 ml plot^{-1}, the third administration at 42 DAP was 300 litersha^{-1} equivalent to 180 ml plot^{-1}.

Results And Discussion:-

Plant height.

The results of showed that the dose of NPK and POC concentration had an effect. The average plant height is presented in Figure 1. The results of HSD test (Figure 1) showed that the administration of NPK 400 kg ha^{-1} resulted in higher plants that were different from other treatments. This was presumably because the administration of NPK 400 kg ha^{-1} has fulfilled the nitrogen requirement of plants. This was in agreement with [7]that vegetative growth of corn plants requires nitrogen. Nitrogen functions to increase plant height, stimulate shoots and increase protein content. Phosphorus functions to improve root development, especially lateral and secondary roots. Potassium functions to be more resistant to disease[8].Table 1 also shows that the administration of POC at a concentration of 10% produced taller plants, different from a concentration of 20%, but it was not significantly different from without POC. Plant growth does not always respond well to additional nutrition as in the vegetative growth period.

Figure 1:- Average Plant Height at Various NPK Doses and POC Concentrations.

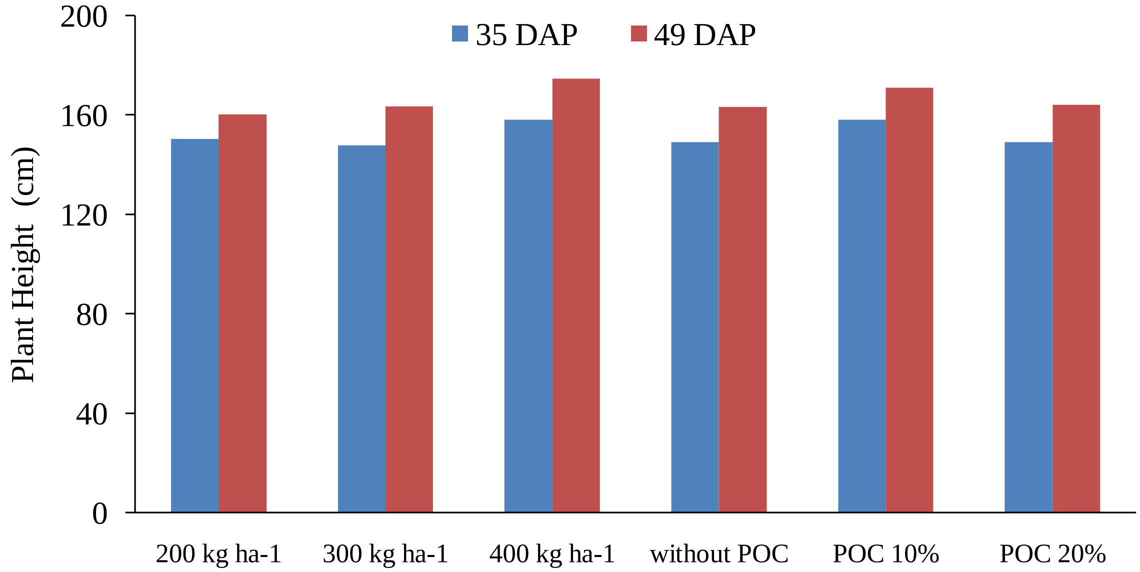

Table 1:- Parameters at various NPK doses and POC concentrations.

Parameters	Treatments	200 kg ha^{-1}	300 kg ha^{-1}	400 kg ha^{-1}
Number of leaves	Non POC	11.16±0.19	11.89±0.38	11.72±0.19
	10%	12.11±0.44	11.5±0.75	11.78±0.34
	20%	12.17±0.35	12.22±1.29	12.39±2.95
	Average	11.59a	11.80b	12.26c
	HSD 5%		0.16	
Cob Length (cm)	Non POC	15.58±0.19	17.42±0.87	19.29±0.75
	10%	16.71±1,15	18..17±0.57	19.5±1.12
	20%	17.5±0.62	18.17±0.91	20.08±4.65
	Average	16.60a	17.92b	19.63c
	HSD 5%		0.78	
Cob Diameter (mm)	Non POC	45.40±2.02^{a}	44.53±1.15^{a}	49.02±6.32^{a}
	10%	47.47±2.38^{ab}	48.85±1.14^{b}	49.72±0.45^{a}
	20%	50.11±0.59$_{b}$	49.65±1.84$_{b}$	50.97±6.31$_{a}$
	HSD 5%		3.03	
Fresh Cob Weight (g)	Non POC	212±3	251±2	293±2
	10%	224±2	262.33±1	290±2
	20%	250.33±1	278.33±2	315±3
	Average	228.89a	263.89b	299.56c
	HSD 5%		12.04	
Fresh Cob Weight Per hectare (tons)	Non POC	7.06±0.2	8.07±0.1	9.77±0.2
	10%	7.49±0.2	8.45±0.2	9.69±0.2
	20%	8.34±0.1	9.28±0.2	10.5±0.2
	Average	7.63a	8.60b	9.99c
	HSD 5%	0.52		

Note: same letter in the same column were not significantly different at the 5% HSD test level.

Number of Leaves

ANOVA revealed that the dose of NPK had an effect, while the concentration of POC and the interaction between the two treatments had no significant effect (Table 1).The results of HSD test (Table 1) showed that the administration of NPK 400 kg ha^{-1} produced more leaves, which was different from the treatments of 200 kg ha^{-1} and 300 kg ha^{-1}.The provision of N elements, plants will contain a lot of green leaf matter which is important in the photosynthesis process, accelerates growth and plant height.This development is influenced by the availability of nutrients including nitrogen, phosphorus, and potassium. A plant is deficient in N elements, it will result in pale green plant leaves and small leaf sizes. Meanwhile, if there is a lack of P, the plants will become stunted and fall quickly, sometimes even the leaves will turn dark red. If the plant lacks K elements, it will result in necrosis of the old leaves on the edges.

Cob Length

ANOVA revealed that the dose of NPK and POC concentration had an effect, while the interaction between the two treatments had no significant effect.Table 1 showed that the administration of NPK 400 kg ha^{-1} resulted in longer cobs that were different from other treatments. This waslikely due to nutrient needs for plants have been met by the administration of NPK 400 kg ha^{-1}.The dose of NPK given longer cobs produced. Availability of N, P and K elements causes more photosynthate allocated to corn cobs, so that the size of the cobs becomes longer.Plant metabolism will also be more active,in which the elongation process, cell division and differentiation will be better.Therefore, an increase in cob weight, length and diameter occurs.Table 1also shows that the administration of POC with a concentration of 20% resulted in longer cobs compared to without POC, but it was not different with a concentration of 10%. This was presumably because macro and micro nutrients are available to plants, so that they can lengthen the cobs. The plant lacks N and P, it will cause abnormal development of cobs and seeds. If there is a lack of K, the resulting cob is small and has a tapered tip.

Number of Rows of Seeds Per Cob

The results of ANOVA showed that the NPK dose, POC concentrationhad no effect. This was presumably because all the nutrients needed for sweet corn of P and K have not been achieved in the formation of seeds. The formation of corn cobs is strongly influenced by P elements[9]. P elements can stimule the seed flowers and corn cobs. The availability of sufficient P nutrients will produce sufficient energy for fruit growth. Furthermore, the element P is needed by corn plants in the generative phase. In addition to the element P, the availability of K which also comes from NPK fertilizer is very important in improving the quality of cobs.

Cob Diameter

The results revelaed that dose of NPK, POC concentration had an effect. Table 1 showed that the effect of POC concentrations was different at each dose of NPK, except at the NPK dose of 400 kg ha^{-1}.At a dose of 200 kg ha^{-1}, 20% POC produced larger cobs that were different from other concentrations.Meanwhile, at a dose of NPK 300 kg ha^{-1}with 20% POC produced larger cobs, different from without POC, but not significantly different from POC 10%. At each dose of NPK, administrationof 20% POC resulted in larger cobs, in which the higher concentration of POCresults in greater cobs produced. This was presumably due to the application of NPK fertilizer at the same time as POC which contains macro and micro nutrients, so as to meet the nutrient needs required by plants. The availability of phosphorus that can be absorbed by corn plants in sufficient quantities will make the photosynthate allocated to the cobs more.Therefore, the diameter and size of the fruit are larger. In addition, The element K can function to strengthen plant vigor and will affect the length, size of the cobs, and the diameter of corn cobs. Based on the observed changes in yield components, maize productivity was more influenced by the length and diameter of the cob than the weight of 100 seeds.

Table 2 also shows NPK dose was different fromwithout POC, but not different at 10% and 20% of POC concentrations. At each concentration of POC administration of 400 kg ha^{-1} of NPK resulted in larger cobs. This was presumably because the nutrient content is available in optimal quantities, so that the application of NPK fertilizer is able to provide a balance of macronutrients in plants. The availability of sufficient nitrogen causes a balance ratio between leaves and roots, then vegetative growth is manual and perfect[10]. This condition will affect the plant to enter the generative growth phase.

Fresh Cob Weight

The results of HSD test (Table 1) showed that the administration of NPK 400 kg ha^{-1} resulted in heavier fresh cobs compared to other treatments. This was presumably because plant nutrient needs have been fulfilled. P nutrient is needed for the development of plant roots[11]. Faster growing roots will allow for the absorption of more nutrients. The increased uptake of N, P, and K elements and the amount of chlorophyll can increase the rate of photosynthesis which in turn will increase crop yields.

Table 1 also shows that the administrationof 20% POC resulted in heavier fresh cobs compared to other treatments. This wasapparently because POC contains nutrients needed for plant growth, both vegetative and generative. Rice washing water contains a phosphorus compound that is useful for increasing yields[12]. Therefore, the fruit ripening process is strongly influenced by the phosphorus level absorbed by plants from the soil. The important roles of phosphorus are to promote the growth of shoots, plant roots, increase the activity of other nutrients such as nitrogen and potassium which are balanced for plant needs.The nutrient content in rice water is able to stimulate root growth, so that roots can optimally absorb nutrients to support plant growth and development[13].

Fresh Cob Weight Per Hectare

Table 1 showed the application of NPK 400 kg ha^{-1} resulted in heavier cobs per hectare, different from other treatments. The better development of sweet corn yields is because of the provision of nutrients that are available in optimal and balanced quantities.Therefore, the application of NPK and liquid organic fertilizers has been able to provide balance between macro and micronutrients in plants.Table 1 also shows that the administrationof 20% POC resulted in heavier cobs per hectare compared to other treatments. This wasapparently because POC contains nutrients needed for the generative phase. Plant nutrients causes metabolism to run optimally[14].

Stem Diameter

The results of ANOVA showed that the dose of NPK had an effect, while the concentration of POC and the interaction between the two treatments had no significant effect. The average stem diameter is presented in Table 2.The results of HSD test (Table 2) showed that the administration of NPK 400 kg ha^{-1} resulted in larger stems, different from other treatments. This was presumably because the application of NPK fertilizer at a dose of 400 kg ha^{-1} has fulfilled the plant needs. The K nutrient contained in the fertilizer plays a role in stem formation. NPK fertilizer is needed to stimulate stem enlargement and root formation which will support the establishment of plants accompanied by the formation of plant height during the aging or harvesting period. N, P, K nutrients are needed for plant growth, especially in stimulating the formation of plant height and stem enlargement.

Table 2:- Average Stem Diameter at Various NPK Doses and POC Concentrations.

Treatment	Stem Diameter (mm)	
	35 DAP	49 DAP
200 $kgha^{-1}$	20.45±0.11a	30.19±0.23a
300 $kgha^{-1}$	20.52±0.15a	30.57±.012a
400 $kgha^{-1}$	22.27±0.11b	32.19±0.21b
HSD 5%	1.31	0.97

Note: Numbers followed by the same letter in the same column were not significantly different at the 5% HSD test level.

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Conclusion:-

This study revealed thatthe administration of 20% POC resulted in larger cobs at each dose of NPK. Meanwhile, the administration of NPK 400 kg ha^{-1}generated greater cobs at each concentration of POC. The application of NPK 400 kg ha^{-1} resulted in better growth and yields characterized by taller plants, larger stems, longer and heavier cobs. The administration of 20% POC showed better results which were indicated by longer and heavier cobs.

References:-

1. Karrimi, A. S., Reddy, A. P. K., Babazoi, F. & Kohistani, T. Growth , yield and post-harvest soil available nutrients in sweet corn (Zea mays L .) as influenced by zinc and iron nutrition. J. Pharmacogn. Phytochem.7, 2372–2374 (2018).
2. Rivera-hernández, B., Carrillo-ávila, E., Obrador-olán, J. J., Juárez-lópez, J. F. & Aceves-navarro, L. A. Morphological quality of sweet corn (Zea mays L .) ears as response to soil moisture tension and phosphate fertilization in Campeche , Mexico. 97, 1365–1374 (2010).
3. Xiao, Y. et al. Genome-wide association study of vitamin E in sweet corn kernels. Crop J.8, 341–350 (2019).

4. Barberon, M. & Geldner, N. Radial Transport of Nutrients : The Plant Root as a. Plant Physiol.166, 528–537 (2014).
5. Shio, B. J., Guo, S., Zhang, R., Tanveer, S. K. & Hai, J. Diverse Planting Density-Driven Nutrient and Yield Enhancement of Sweet Corn by Zinc and Selenium Foliar Application. Sustainability14, 1–16 (2022).
6. Yousaf, M. et al. Effects of fertilization on crop production and nutrient-supplying capacity under rice-oilseed rape rotation system. Sci. Rep.7, 1–9 (2017).
7. Walker, R. L., Burns, I. G. & Moorby, J. Responses of plant growth rate to nitrogen supply: A comparison of relative addition and N interruption treatments. J. Exp. Bot.52, 309–317 (2001).
8. Gul, S., Khan, M. H., Khanday, B. A. & Nabi, S. Effect of Sowing Methods and NPK Levels on Growth and Yield of Rainfed Maize (Zea mays L.) . Scientifica (Cairo).2015, 1–6 (2015).
9. Setiani, V., Priastuti, U. & Yuniarta, D. P. Improvement of Soil Chemichal Properties using Corn Cob Biochar (BTJ). J. Presipitasi Media Komun. dan Pengemb. Tek. Lingkung.18, 1–9 (2021).
10. Chen, G. et al. Improving rice tolerance to potassium deficiency by enhancing OsHAK16p : WOX11 -controlled root development. Plant Biotechnol. J.13, 833–848 (2015).
11. Ahmad, A. A., Fares, A., Paramasivam, S., Elrashidi, M. A. & Savabi, R. M. Biomass and nutrient concentration of sweet corn roots and shoots under organic amendments application. J. Environ. Sci. Heal. - Part B Pestic. Food Contam. Agric. Wastes44, 742–754 (2009).
12. Nabayi, A. et al. Chemical and Microbial Characterization of Washed Rice Water Waste to Assess Its Potential as Plant Fertilizer and for Increasing Soil Health. Agronomy11, 1–21 (2021).
13. Li, X., Zeng, R. & Liao, H. Improving crop nutrient efficiency through root architecture modifications. J. Integr. Plant Biol.58, 193–202 (2016).
14. Xu, X. et al. Effects of Potassium Levels on Plant Growth , Accumulation and Distribution of Carbon , and Nitrate Metabolism in Apple Dwarf Rootstock Seedlings. Front. Plant Sci.11, 1–13 (2020).