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Substitute a half dose of macro fertilizers with liquid organic fertilizers on sweet corn plants (*Zea mays saccharata*) on Inceptisol Soil in Indonesia

Substitua metade da dose macrofertilizantes por fertilizantes orgânicos líquidos em plantas de milho doce (Zea mays saccharata) em Cambissolos na Indonésia

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ABSTRACT

Corn is a promising commodity economically for cultivation. A part from not requiring a long harvest time, sweet corn has a high selling value, without a long post-harvest process. The location of the research was conducted in rice fields in Tawangargo Village, Karangploso District, Malang Regency. Altitude ± 749 m above sea level, Inceptisol soil type and moderate tropical climate. The implementation was carried out from December 2019 to July 2020. The research design was carried out using a Complete Randomized Block Design, with 2 factors. Factor 1, is the recommended fertilizer dosage of 3 doses (0, ½ and 1 dose), the second factor is the dose of liquids fertilizer organic (0, 4, 8, and 12 g / l) with 4 repetitions, with intervals once every 7-10 days. Giving 4 ml / l dose of inorganic fertilizer at an interval of once a week, together with 1 recommended dosage of Macro fertilizer affects the growth and yield of sweet corn plants. The highest production per ha in this treatment was 13,339 kg. The highest RAE value is 325.6% in the recommended 1 dose of NPK treatment plus 4 g / l of "liquids fertilizer organic". The economic approach is by calculating the R/C ratio, the treatment with the highest RAE is the R/C ratio of 8.59 with a net income of Rp. 176,785,041.

KEYWORDS: sweet corn; substitution; organic fertilizer; half doses; macro fertilizer.

RESUMO

O milho é uma *commodity* promissora economicamente para o cultivo. Além de não exigir um longo tempo de colheita, o milho doce tem alto valor de venda, sem um longo processo de pós-colheita. O local da pesquisa foi conduzido em campos de arroz na vila de Tawangargo, distrito de Karangploso, regência de Malang (Indonésia). A altitude é de ±749 m acima do nível do mar, cambissolo e clima tropical moderado. A implementação foi realizada de dezembro de 2019 a julho de 2020. O projeto de pesquisa foi realizado usando um projeto de bloco aleatório completo, com 2 fatores. O fator 1, é a dosagem recomendada de adubo de três doses (0, ½ e 1 dosagem), o segundo fator é a dosagem de adubo líquido orgânico (0, 4, 8 e 12 g/l) com quatro repetições, em intervalos de 7-10 uma vez por dia. Administrar 4 ml/l de fertilizante inorgânico com intervalos de uma vez por semana, juntamente com 1 dose recomendada de Macrofertilizante, afeta o crescimento e rendimento das plantas de milho doce. A maior produção por ha neste tratamento foi de 13.339 kg. O maior valor de RAE é de 325,6% no recomendado 1 dose do tratamento NPK mais 4 g/l de “fertilizante orgânico líquido”. A abordagem econômica é calcular a relação R/C, o tratamento com o RAE mais alto é a relação R/C de 8,59 com um lucro líquido de Rp. 176.785.041.

PALAVRAS-CHAVE: milho doce; substituição; fertilizante orgânico; meias doses; fertilizante macro.

INTRODUCTION

One of the commodities that have an important role in the daily life of the Indonesian people is corn (ALDILLAH 2018). Endosperm Variations Kernel types can shrink into dents *(Zea mays* var. *indentata)*, flint (*Zea mays* var. *indurate)*, flour (*Zea mays* var. *amylacea)*, sweet (*Zea mays* convar. *saccharata)*, pop (*Zea mays everta)*, dan pod (*Zea mays* var. *tunicate)* (LOPES et al. 2009, HAN et al. 2012, SINGH et al. 2014, DARRAH et al. 2019, HALLAUER 2021, WIKIPEDIA 2022 a,b,c,d). Currently, sweet corn (*Zea mays* convar. *saccharata*) is very popular in Indonesia as a vegetable, side dish or snack. Corn (*Zea mays*

L.) production centers in Indonesia include East Java, Central Java, South Sulawesi and East Nusa Tenggara (ARDIANI 2009).

The nutritional content of sweet corn per 100 g contains 360 kJ (86 kcal) of energy, 18.7 g of carbohydrates (5.7 g of starch, 6.26 g of sugar, 2 g of dietary fiber), 1.35 g of fat, 327 g of protein (Leusina 0.348 g, Alanine 0.295 g, Aspartic Acid 0.244 g, Glutamic Acid 0.636 g, Proline 0.292 g, and other proteins with the content below 0.1 g), water 75.96 g, vitamin A 9 µ g, vitamin B1 0.155 mg , vitamin B2 0.055 mg, Vitamin B3 (1.77 mg), Vitamin B5 0.717 mg, Vitamin B6 0.093 mg Vitamin B9 42 µ g, vitamin C 6.8 mg, Fe 0.52 mg, Mg 0.163 mg, Mn 0.163 mg, Phosphorus 89 mg, Potassium 270 mg and Zn 0.46 mg (USDA 2022).

The world market for sweet corn has been entered by Indonesian exporters from Kediri Regency by exporting 40 tons of sweet corn seeds worth US $ 540 thousand or around Rp. 7.5 billion, by PT. Agri Makmur Pertiwi to the destination country of China, 40 tons of corn seeds are transported using container trucks of 4 fleets from its factory in Sambirejo Village, Pare District, Kediri Regency to Surabaya, to then be transported to China by ship ALAMSYAH 2020). Soil can provide sufficient nutrients for cultivated plants with the addition of liquids fertilizer organic (PANGARIBUAN et al. 2018).

Liquid organic fertilizers contain many macro, micro, hormone and amino acid nutrients that plants need. In addition, in liquid organic fertilizers, there are microorganisms that will improve soil fertility so that they can support plant growth and development. The combination of liquid organic fertilizers and inorganic fertilizers (Urea, SP-36, and K Cl) of 20% recommendation can be an alternative fertilizer for sweet corn that is more economical because its growth and production are the same as recommended inorganic fertilizers (PANGARIBUAN et al. 2018). Fertilization recommendations according to POLII &TUMBELAKA (2012) for inorganic Nitrogen, Phosphor, and Potassium fertilizers are (200 kg N ha-1, 150 kg P2O5 ha-1, and 150 kg K2O ha-1), but according to JUMINI et al. (2011), fertilization with 500 kg Urea + 350 kg SP36 and 300 kg K Cl gave the best effect on the growth and yield of sweet corn. Inorganic fertilizers with a recommended dose of 100%: Urea 300 kg ha-1, SP-36 150 kg ha-1, and K Cl 100 kg ha-1 (MURNI et al. 2018). Fertilization carried out by ALFIAN & PURNAMAWATI (2019) is manure (5000 kg ha-1) and Dolomite fertilizer (1000 kg ha-1). The basic fertilizers used are Urea (300 kg ha-1) and SP-36 (200 kg ha-1). Fertilization with inorganic Phonska fertilizer at a dose of 300 kg ha-1 provides the highest ear production of cob without husk (SETYORINI et al. 2023).

Liquid fertilizer organic a type of liquid organic fertilizer. The results of fertilizer testing were carried out by the Soil, Plant, Fertilizer and Water Laboratory, East Java AIAT. The test results showed that the fertilizer had a pH of 5.8, contained C-Organic 11.29%, total nitrogen content 0.56%, P2O5 content 1.79%, K2O content 0.83%, Organic nitrogen content 0.51%, total Fe content 94.47 ppm, Mn content 25, 59 ppm, Zn level 59.63 ppm. Negative in Escherichia coli and Salmonella contaminants (PRAYITNO 2021). Testing the effectiveness of this fertilizer is guided by the Minister of Agriculture Regulation No. 36/PERMENTAN/SR/10/2017. This test is based on a letter from Directorate General of Agricultural Infrastructure and Facilities No. 395.OL/SR.310/B.5.4/4/2019, December 11, 2019 (BPTP JAWA TIMUR 2020). Field testing is needed to determine the effect of fertilizers "Organic Fertilizer"is about the growth and yield of Sweet Corn.

The purpose of this study was to determine the effectiveness of liquid organic fertilizer on the growth and yield of sweet corn plants. In addition, it is also to determine the economic effectiveness of the fertilizer on sweet corn farming.

MATERIAL AND METHODS

The materials used in this research consisted of sweet corn seeds of Talenta variety, Urea fertilizer, Phonska (NPK) fertilizer, insecticide, liquid fertilizer organic (Cakra Tani WKG), and fungicide. The fertilizer content of is in Table 1 below. Macro Fertilizer in Laboratory of Soil, Plant, Fertilizer and Water Testing, East Java AIAT, C-Organic, by-products, heavy metals As, Hg, Pb, Cd, Cr, Ni, pH, macro nutrients, Nitrogen levels total, P2O5 levels, K2O levels, total N + P2O5 + K2O, Organic Nitrogen levels, microbial contaminants: Escherichia coli, Salmonella sp., Micro nutrients: Total Fe levels, Mn levels, Zn levels.

The research design was carried out using a completely randomized block design, 2 factors. Treat based on previous research, which produces the best production. Factor 1, the recommended fertilizer dosage of 3 doses (0, ½ and 1 dose) (POLII & TUMBELAKA 2012, KRESNATITA et al. 2013, KRISWANTO et al. 2016, ALATAS et al. 2019, WIDOWATI et al. 2021, ARIFIN et al. 2022), the second factor is the dose of fertilizer (0, 4, 8 and 12 g / l) (POLII & TUMBELAKA 2012, PUSPADEWI et al. 2016, MULYANI et al. 2019), with four repetitions, with intervals of 7-10 once a day.

The location of the research was carried out in rice fields in *Tawangargo* Village, *Karangploso* District, *Malang* Regency, Indonesia, with an area of ±0,1 ha, with type of soil *Inceptisol*, and moderate climate type. The cropping patterns of the research location were always planted with vegetables, namely: mustard greens, celery, cabbage, green onions or vegetables. Altitude ± 749 m above sea level. The implementation was carried out from December 2019 to July 2020.

Table 1. Results of Analysis of Liquid Organic Fertilizer by the East Java AIAT Testing Laboratory.

No	Parameter	Value	Unit	Method
1.	C-Organic	11,29	%	Walkey and Black Method
2.	Bonding Materials (Plastic, glass, gravel)	0	%	973.03 Method, Sorting *)
	Heavy metal			
	- As	0	ppm	ICP-MS ***)
	- Hg	0	ppm	ICP-MS ***)
3.	- Pb	0	ppm	ICP-MS ***)
	- Cd	0	ppm	ICP-MS ***)
	- Cr	0	ppm	ICP-MS ***)
	Ni	0	ppm	ICP-MS ***)
4.	pH	5,8	-	994.18 Method, pH Meter *)
	pH	6,8	-	994.19 Method, pH Meter *)
5	Macro Elements			
	Total Nitrogen Levels	0,56	%	Kjeldahl, Titrimetry
	P2O5 levels	1,79	%	Wet oxidation (HNO3+HClO4), molibdovanadat, Spektrofotometry
	K2O levels	0,83	%	Wet oxidation (HNO3+HClO4), AAS
	Total (N+P2O5+K2O)	3,18	%	
6.	Organic Nitrogen Levels	0,51	%	Kjeldahl, Titrimetry
	Microbial Contaminants:			
7.	- *Escherichia coli*	Negative	cfu/g	MPN **)
	- *Salmonella sp.*	Negative	cfu/g	Pour Plate **)
	Micro Nutrients:			
8.	Total Fe content	94,47	ppm	Wet oxidation (HNO3 + HClO4), AAS
	Mn	25,59	ppm	957.02 Method & 965.09, AAS *)
	Zn levels	59,63	ppm	957.02 Method & 965.09, AAS *)

(PRAYITNO 2022).

Table 2. Dosage treatment of macro fertilizer and Cakra Tani WKG fertilizer on Sweet Corn, MH 2019 planting season from Desember 2019 until May 2020, Inceptisol soil type and moderate tropical climate.

Treatment	Recommended Dosage (kg)		Recommended nutrient dosage (kg)			Cakra Tani WKG Dosage (ml / l)
	Urea	Phonska (NPK)	N (Nitrogen/N)	P_2O_5 (Phosphor/P)	K_2O (Potassium/K)	
A	0	0	0	0	0	0
B	0	0	0	0	0	4
C	0	0	0	0	0	8
D	0	0	0	0	0	12
E	125	150	80	22,5	22,5	0
F	125	150	80	22,5	22,5	4
G	125	150	80	22,5	22,5	8
H	125	150	80	22,5	22,5	12
I	250	300	160	45	45	0

J	250	300	160	45	45	4
K	250	300	160	45	45	8
L	250	300	160	45	45	12

The activity location has a moderate climate with climate data in Table 3. After the soil is processed, soil samples are taken, and then soil analysis is carried out. The results of soil analysis showed in Table 4. Table 4 shows that the land used for the study was classified as medium fertility, had neutral soil reactions (pH 7.06), total N was low, C-organic was low, available P was high, K dd was high (0.83)/100 me/g soil), high CEC (20.25 me/100 g soil) and clay texture. Based on the results of soil analysis, the land is suitable for fertilizer research because of its low organic matter content and N content, which are the minimum land requirements for fertilizer research.

Table 3. Tables of rainfall, humidity, temperature, irradiation duration, and wind speed at the location (Moderate Tropical Climate).

Month	Tavg (°C)	RH_avg (°C)	RR (mm)	ss (jam)	ff_avg (m/s)
Dec-19	25,32	79,23	318,8	6,54	1,16
Jan-20	24,66	82,16	327,3	5,13	1,42
Feb-20	24,22	84,72	502,40	4,80	1,14
Mar-20	24,54	82,84	238,80	5,42	1,35
Apr-20	24,95	79,50	154,20	6,42	1,27
May-20	24,65	80,23	135,70	6,28	1,58
Jun-20	23,72	75,30	3,20	7,56	1,90
Jul-20	23,02	75,94	17,40	7,68	2,00

Souce: meteorological and geophysical agency.
Tavg = temperature average; RHavg = humidity average; RR = rainfall; ss = irradiation duration; ffavg = wind speed average.

Table 4. Results of Soil Analysis Research Sites, Tawangargo Village, Karangploso, Malang (Inceptisol Soil Type).

No	Parameter	Value	Unit	Method
1.	Water content	7,76	%	Gravimetry
2.	pH H_2O	7,06	-	(1:5), Elektrometri, pH Meter
	pH KCl	5,41	-	(1:5), Elektrometri, pH Meter
3.	C-Organic	1,11	%	Walkley & Black; Spektrofotometer
4.	Total Nitrogen	0,14	%	Kjeldahl, Titrimetri
5.	P2O5 is available	170,96	ppm	Olsen, Spektrofotometer
6.	Cation Exchange Rate can be exchanged / dd			
	- K dd	0,83	me.100 g-1	NH4Oac 1 M, pH7, AAS
	- Ca dd	20,34	me.100 g-1	NH4Oac 1 M, pH7, AAS
	- Mg dd	5,60	me.100 g-1	NH4Oac 1 M, pH7, AAS
	- Na dd	0,36	me.100 g-1	NH4Oac 1 M, pH7, AAS
7.	Cation Exchange Capacity	20,25	me.100 g-1	NH4Oac 1 M, pH7, Titrimetry, Hydrometer
8.	Texture			
	- Sand	27	%	
	- Dust	24	%	
	- Clay	49	%	
	Criteria	Clay		Texture Triangle (USDA)

Implementation of Activities

a) Land preparation

Before conducting the research, soil samples were taken to analyze soil nutrient status and soil chemical properties. The analysis includes water content, soil pH, C-organic, total N content, available P_2O_5 levels, soil alkaline cations, cation exchange capacity, and soil texture, carried out at the East Java AIAT Laboratory.

b) Seed preparation

The *Talenta* variety of Sweet Corn seeds has a higher selling price than other varieties (HANIFAH 2018). Minimum seed viability of 85%, and uniform.

c) Preparation for planting

The soil is processed using hoes and formed beds with a size of 3 x 4 m, with a water channel limited to 25-30 cm deep with a width of 50 cm. Sweet corn seeds are sown first in a nursery medium. *Talenta* sweet corn seeds have a low growth percentage, when planted directly in the field. However, this seed is preferred by farmers because of market preference. Seeds are planted with a spacing of 50x40 cm (MULYANI et al. 2019). The location of the research is paddy field agro-ecosystem with a total area of ± 0.1 ha.

d) Fertilization

Fertilization I, when the plants are 7-10 days old after planting with 1/4 dosage NPK 15-15-15 and urea. Fertilization II is given when the plants are 30-35 days after planting as much as 1/2 part of Urea and compound NPK 15-15-15 (N; P_2O_5; K_2O). Fertilization III is given when the plants are 45-50 days after planting with ¼ part Urea and compound NPK 15-15-15 fertilization. The "Cakra Tani WKG" fertilizer is dissolved in water according to the dosage, and is given by spraying on plant leaves at intervals of 1x a week.

e) Filling

Weeding is done on the edge of the beds that are not covered with mulch by removing them according to field conditions. Usually done before fertilization.

f) Pest and Disease Control

Disease control is carried out intensively according to the attack, especially *Cercospora sp*. Prevention is carried out by spraying fungicides and bactericides 1 week 1.

g) Observations

The observation variables were planting height at 14 days, 28 days, 48 days and 56 days, the number of plant leaves aged 14 days, 28 days, 48 days and 56 days, the length of plant leaves aged 14 days, 28 days, 48 days and 56 days, leaf width aged 14 days, 28 days, 48 days and 56 days, number of ears per plant, ear diameter, ear length, production per ha.

h) Harvest and Post-harvest

Harvesting is done when the cobs are full of corn kernels. Data were taken from an average of five sample plants and not peripheral plants.

Observation

Parameters observed included: plant height at 14 days, 28 days, 48 days and 56 days. The number of plant leaves aged 14 days, 28 days, 48 days and 56 days. Leaf length of the plant was 14 days, 28 days, 48 days and 56 days. Leaf width at 14 days, 28 days, 48 days and 56 days. Yield parameters include production per ha, ear diameter, ear length, weight per ear and number of rows in ear.

Data analysis

Analysis of variance ANOVA F test, further tests with DMRT 5% (GOMEZ & GOMEZ 1993), and using the SAS / GenStat 2015 program. RAE analysis is used to calculate the Relative Agronomic Effectiveness value, namely the comparison between the increase in yield due to the use of fertilizer and the increase in yield using standard fertilizers multiplied by 100% (MACKAY et al. 1984). With the formula:

$$RAE = \frac{The\ yield\ of\ the\ tested\ fertilizers - The\ yield\ withoutfertilizers}{The\ yield\ from\ standard\ fertilizers - The\ yield\ without\ fertilizer}$$

Farming analysis R / C ratio is used to calculate the feasibility of using fertilizers economically, with the formula:

$$R/C\ ratio = \frac{Total\ income}{Total\ cost} X100$$

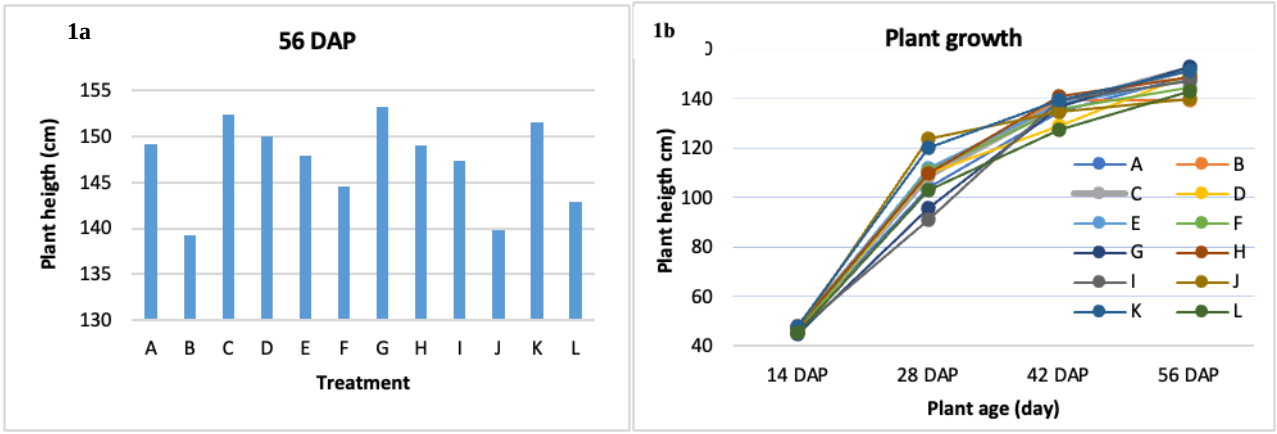
RESULTS AND DISCUSSION

Plant height

Initial growth of plant diversity is quite high, namely 26%, because the plants are still in the adaptation period from the nursery to open land. After the plants are 56 days after planting, there are differences in the recommended macro-fertilized plant treatment with 0 or ½ dose + fertilizer at a dose of 8 ml per liter, different from the recommended dose of 0 or ½ dose of macro fertilized plants + fertilizer as much as 4 ml / liter.

Plants fertilized with at a dose of 8 mL/liter of water with a recommended macro fertilizer dose of 0 or ½ dose, have a plant height of 153.15 cm and 152.4 cm. If the plants are not fertilized with macro, the recommendation is the addition of fertilizer 4 mL / liter has a plant height of 139.5 cm and the addition of fertilizer treatment is 8 ml / liter of water. This is because the micro-element content in Liquid fertilizer organic based on Table 1 is able to provide the needs of plant micro nutrients, so that it can increase plant growth (RONEN 2008, CALVO et al. 2014, LI et al. 2015, DE FREITAS ALVES et al. 2017, BANA et al. 2022).

The detected microelement content was Fe, Zn, Mn. Macronutrients are consumed by plants in large amounts, while micronutrients are consumed by plants in small amounts. Although absorbed in small amounts, micronutrients play an important role in plant metabolic processes, especially to support the work of enzymes. A lack of micronutrients will disrupt the work of enzymes, The role of essential micronutrients is very important to increase crop yields and crop quality in agriculture (SERAN 2017). Manganese (Mn) is a nutrient required in small amounts by plants for proper development, with a critical deficiency threshold between 10 and 20 mg kg^{-1} , this nutrient is also involved in several metabolic processes acting as an enzyme cofactor, e. g. superoxide dismutase (MnSOD) and RNA polymerases, in protein synthesis, enzyme activation, and the biosynthesis of secondary metabolites such as flavonoids and lignin Excess Mn can also lead to a reduction of chlorophyll content, foliar chlorosis and necrosis, lower ATP content, enzymatic malfunctioning, biomass decrease nutritional imbalances, as Mn can compete with other divalent cations, such as Mg2+ and Fe2+ for uptake, translocation and physiological activity (DE OLIVEIRA et al. 2022).



The numbers followed by the same letter in the same column are not significantly different in Duncan's 5% test; ns = not real. (A = No NPK fertilizer; B = No NPK fertilizer + 4 g / l Organic Fertilizer, C = without NPK fertilizer + 8 g / l Organic Fertilizer; D = without NPK fertilizer + 12 g / l Organic Fertilizer; E = ½ recommended dosage of NPK fertilizer; F = ½recommended dosage of Macro fertilizer + 4 g / l Organic Fertilizer; G = ½recommended dosage of Macro fertilizer + 8 g / l Organic Fertilizer; H = ½recommended dosage of Macro fertilizer + 12 g / l Organic Fertilizer; I = 1recommended dosage of Macro fertilizer; J = 1recommended dosage of Macro fertilizer + 4 g / l Organic Fertilizer; K = 1recommended dosage of Macro fertilizer + 8 g / l Organic Fertilizer; L = 1recommended dosage of Macro fertilizer + 12 g / l Organic Fertilizer)

Figure 1. a) High Growth of Sweet Corn Plants with Fertilizer Treatment at 56 Days After Planting. b) High Development of Sweet Corn Plants in the Treatment of Organic Fertilizer, starting at the age of 14 - 59 days after planting.

Number of Leaves

The number of leaves in the NPK elemental macro fertilizer dose treatment indicated that the initial growth did not show any difference. After 42- and 56-days old plants showed differences, in control plants without the addition of macro fertilizer N, P and K with fertilizer had a higher number of leaves compared to the ½ dose of NPK macro fertilizer added with fertilizer 4 ml / liter and treatment with 1 dose of NPK macro fertilizer added with fertilizer 12 ml / liter (Table 5). This does not show consistency between the fertilizer treatments used, presumably due to hormonal stimulation, leaf formation is influenced by hormonal stimulation. his may be related to the effect of high levels of nutrients in reducing the degree of apical dominance, thereby releasing the axillary bud from inhibition by the active shoot apex (KULASEGARAM & KATHIRAVETPILLAI 1972). Reinforced by ALI et al. (2020) which states that Leaves are the primary organs responsible for photosynthesis and photo perception, and play a key role in plant growth. Their development starts from the shoot apical meristem (SAM), which have a central zone (CZ) that houses pluripotent cells, and a peripheral zone (PZ), responsible for the leaf initiation and their development into a flattened structure.

Leaf width

Leaf width at the beginning of growth until the age of the plant 42 days after planting showed that the plants that were not fertilized had small leaf width, but after 56 days after planting almost all treatments showed the same leaf width (Table 6), because the organic fertilizers used contain little nitrogen, while the vegetative growth of the plants is strongly influenced by the element nitrogen. This is supported by studies on barley and wheat plants that produce broader leaf area through the application of nitrogen fertilizer (REBETZKE et al. 2004). Nitrogen fertilizer is universally accepted as a key component to high yield and optimum economic return as it plays a very important role in crop productivity, leaf area influence interception and utilization of solar radiation of maize crop canopies and consequently maize dry matter accumulation and grain yield. Leaf area and number are important factors in the estimation of canopy photosynthesis in crop growth simulation models that compute dry matter accumulation from temporal integration of canopies photosynthesis (AMANULLAH et al. 2009). Nitrogen should be available in sufficient quantity so the growth and production of plants will be in optimum condition (WIDARYANTO & FIRDA 2016).

Table 5. Number of sweet corn leaves in the dose treatment of macro NPK fertilizer with liquid organic fertilizer Organic Fertilizer.

Treatment	Number of leaves (strands)			
	14 daps	28 daps	42 daps	56 daps
A	5,1 ns	8,5 Ns	9,7 c	11,45 a
B	5,2 ns	8,7 Ns	9,7 c	10,5 c
C	5,25 ns	8,9 Ns	9,65 c	11,25 ab
D	5,35 ns	8,45 Ns	9,85 abc	10,85 abc
E	5,4 ns	8,9 Ns	9,75 bc	11,05 abc
F	5,35 ns	9 Ns	10,45 ab	10,75 bc
G	5,1 ns	8,45 Ns	9,75 bc	11,1 abc
H	5,25 ns	8,95 Ns	10,1 abc	10,9 abc
I	5,3 ns	8,7 Ns	10,55 a	10,85 abc
J	5,4 ns	8,8 Ns	10 abc	11 abc
K	5,35 ns	8,6 Ns	9,75 bc	11,2 ab
L	5,1 ns	8,65 Ns	9,45 c	10,65 bc

The numbers followed by the same letter in the same column are not significantly different in Duncan's 5% test; ns = not real. (A = No NPK fertilizer; B = No NPK fertilizer + 4 g / l Organic Fertilizer, C = without NPK fertilizer + 8 g / l Organic Fertilizer; D = without NPK fertilizer + 12 g / l Organic Fertilizer; E = ½ recommended dosage of NPK fertilizer; F = ½recommended dosage of Macro fertilizer + 4 g / l Organic Fertilizer; G = ½recommended dosage of Macro fertilizer + 8 g / l Organic Fertilizer; H = ½recommended dosage of Macro fertilizer + 12 g / l Organic Fertilizer; I = 1recommended dosage of Macro fertilizer; J = 1recommended dosage of Macro fertilizer + 4 g / l Organic Fertilizer; K = 1recommended dosage of Macro fertilizer + 8 g / l Organic Fertilizer; L = 1recommended dosage of Macro fertilizer + 12 g / l Organic Fertilizer)

Table 6. Leaf width of sweet corn on the dosage treatment of macro NPK fertilizer with Organic Fertilizer liquid organic fertilizer.

Treatment	Leaf width (cm)			
	14 DAP	28 DAP	42 DAP	56 DAP
A	1,46 e	3,51 D	9,43 c	10,85 b
B	1,53 ed	3,96 C	10,30 abc	10,73 b
C	1,54 cde	4,30 c	9,80 abc	15,75 a
D	1,51 e	4,82 bc	9,65 bc	10,43 b
E	1,60 bcd	5,15 ab	10,70 a	10,85 b
F	1,61 abc	5,14 ab	10,25 abc	10,75 b
G	1,62 abc	5,28 a	9,83 abc	10,57 b
H	1,69 a	5,14 ab	10,25 abc	10,58 b
I	1,61 abc	5,24 ab	10,50 ab	10,63 b
J	1,61 abc	5,23 ab	10,15 abc	10,63 b
K	1,62 abc	5,36 a	10,08 abc	11,05 b
L	1,67 ab	5,33 a	9,95 abc	10,20 b

The numbers followed by the same letter in the same column are not significantly different in Duncan's 5% test; ns = not real. (A = No NPK fertilizer; B = No NPK fertilizer + 4 g / l Organic Fertilizer, C = without NPK fertilizer + 8 g / l Organic

Fertilizer; D = without NPK fertilizer + 12 g / l Organic Fertilizer; E = ½ recommended dosage of NPK fertilizer; F = ½recommended dosage of Macro fertilizer + 4 g / l Organic Fertilizer; G = ½recommended dosage of Macro fertilizer + 8 g / l Organic Fertilizer; H = ½recommended dosage of Macro fertilizer + 12 g / l Organic Fertilizer; I = 1recommended dosage of Macro fertilizer; J = 1recommended dosage of Macro fertilizer + 4 g / l Organic Fertilizer; K = 1recommended dosage of Macro fertilizer + 8 g / l Organic Fertilizer; L = 1recommended dosage of Macro fertilizer + 12 g / l Organic Fertilizer).

Leaf Length

The initial leaf length of growth was influenced by a combination of NPK Macro fertilizer and liquid organic fertilizer "Organic Fertilizer". This is because the initial plant growth is a period of plant adaptation after transplanting, so the effect of the NPK macro fertilizer dose given greatly affects the initial growth of the plant (Table 7). Where plants that are not fertilized with NPK macro and the dose of fertilizer ½ dose of NPK without the addition of fertilizer have shorter leaf lengths. This is in line with the results of research conducted by KHAIRIYAH et al. (2017), where the N fertilizer dose can affect leaf size. However, after the plants are 42 - 56 days after planting, the length of the leaves is not affected by the combination of this fertilizer treatment, because after that age macro fertilizer is not added, only the application of liquid organic fertilizer through leaf spraying, where the N content in liquid organic fertilizer is very small.

The use of nitrogen fertilizer is a major factor in the profitable production of most crops in temperate environments, because it affects dry matter production by influencing leaf area development and maintenance, as well as photosynthetic efficiency, nitrogen fertilizer can affect both vegetative and reproductive development of crops, while nitrogen deficiency delays both vegetative and reproductive phonological development, as well as reduces leaf emergence rate, yield, and yield components (JU et al. 2022).

Table 7. Length of Sweet Corn Leaves in Combination Treatment of NPK Macro Fertilizer and Liquid Organic Fertilizer Organic Fertilizer.

Treatment	Leaf Length (cm)			
	14 daps	28 daps	42 daps	56 daps
A	12,50 e	36,60 f	74,88 ns	77,75 ns
B	14,33 d	38,75 f	73,28 ns	75,55 ns
C	15,58 bc	41,45 e	79,00 ns	82,05 ns
D	15,55 bc	41,90 e	77,15 ns	76,50 ns
E	15,43 c	47,35 d	74,65 ns	75,65 ns
F	16,23 abc	49,95 c	72,98 ns	76,65 ns
G	16,55 ab	51,85 abc	75,08 ns	76,10 ns
H	17,20 a	50,35 bc	79,05 ns	80,55 ns
I	17,05 a	52,75 ab	77,95 ns	77,15 ns
J	16,25 abc	52,15 abc	76,55 ns	77,93 ns
K	16,70 a	51,20 abc	77,75 ns	80,25 ns
L	17,10 a	53,20 a	74,20 ns	77,10 ns

The numbers followed by the same letter in the same column are not significantly different in Duncan's 5% test; ns = not real. (A = No NPK fertilizer; B = No NPK fertilizer + 4 g / l Organic Fertilizer, C = without NPK fertilizer + 8 g / l Organic Fertilizer; D = without NPK fertilizer + 12 g / l Organic Fertilizer; E = ½ recommended dosage of NPK fertilizer; F = ½recommended dosage of Macro fertilizer + 4 g / l Organic Fertilizer; G = ½recommended dosage of Macro fertilizer + 8 g / l Organic Fertilizer; H = ½recommended dosage of Macro fertilizer + 12 g / l Organic Fertilizer; I = 1recommended dosage of Macro fertilizer; J = 1recommended dosage of Macro fertilizer + 4 g / l Organic Fertilizer; K = 1recommended dosage of Macro fertilizer + 8 g / l Organic Fertilizer; L = 1recommended dosage of Macro fertilizer + 12 g / l Organic Fertilizer) daps = day after planting.

Stem Diameter

Stem diameter showed a difference at the beginning of growth 14 days after transplanting, control and treatment plants 1 dose of recommended macro NPK plus liquid fertilizer 12 ml/liter, showing the smallest diameter, namely 9.54 mm and 9.58 cm. This shows that the plants that are not fertilized with recommended NPK macro and fertilizer have the smallest stem growth compared to other treatments. Fertilization treatment 1 dose of recommended NPK macro fertilizer added with fertilizer 12 ml / liter indicates a smaller stem diameter due to the provision of liquid organic fertilizer which contains quite a lot of micro elements (Table 1.), if given in large quantities it will be toxic to plants, the element of Fe at this dose reaches 1,133 ppm and the element of Zn reaches 715 ppm, while the need for the element of corn Fe is at least 200 ppm and the element of Zn is 15 ppm (SYAFRUDDIN et al. 2012).

The stem and rod diameter is strongly influenced by the macro elements in the soil (Table 8), also MONTENEGRO et al. (2019) report significant increases in plant height, basal stem diameter, number of branches, and a respective seed yield of 1,475 kg ha-1 per year following the application of 80-80-80 kg ha^{-1} N-P_2O_5-K_2O. In Thailand, a significant increase in seed yield up to 1,559 kg ha^{-1} per year was achieved in plants of 75 cm height and fertilized with 15-15-15 N-P_2O_5-K_2O at a rate of 312.5 kg ha^{-1}.

Table 8. Rod diameter of Sweet Corn Leaves in Combination Treatment of NPK Macro Fertilizer and Liquid Organic Fertilizer Organic Fertilizer.

Treatment	Rod Diameter (mm)			
	14 daps	28 daps	42 daps	56 daps
A	9,54 c	12,77 ns	29,59 ab	31,86 ns
B	9,74 abc	13,85 ns	29,40 ab	31,85 ns
C	9,78 abc	14,89 ns	27,10 b	31,11 ns
D	9,84 ab	15,75 ns	28,92 ab	30,57 ns
E	9,64 abc	16,44 ns	29,71 ab	31,71 ns
F	9,88 a	16,20 ns	26,61 b	29,67 ns
G	9,89 a	16,33 ns	27,94 ab	30,24 ns
H	9,85 ab	16,17 ns	27,81 ab	31,68 ns
I	9,89 a	15,91 ns	27,99 ab	31,71 ns
J	9,87 a	16,08 ns	28,51 ab	29,93 ns
K	9,68 abc	16,43 ns	30,99 a	32,15 ns
L	9,58 bc	16,47 ns	30,23 ab	30,33 ns

The numbers followed by the same letter in the same column are not significantly different in Duncan's 5% test; ns = not significant. (A = No NPK fertilizer; B = No NPK fertilizer + 4 g / l Organic Fertilizer, C = without NPK fertilizer + 8 g / l Organic Fertilizer; D = without NPK fertilizer + 12 g / l Organic Fertilizer; E = ½ recommended dosage of NPK fertilizer; F = ½recommended dosage of Macro fertilizer + 4 g / l Organic Fertilizer; G = ½recommended dosage of Macro fertilizer + 8 g / l Organic Fertilizer; H = ½recommended dosage of Macro fertilizer + 12 g / l Organic Fertilizer; I = 1recommended dosage of Macro fertilizer; J = 1recommended dosage of Macro fertilizer + 4 g / l Organic Fertilizer; K = 1recommended dosage of Macro fertilizer + 8 g / l Organic Fertilizer; L = 1recommended dosage of Macro fertilizer + 12 g / l Organic Fertilizer)

Cob Weight, ear diameter, ear length and the number of seed rows in cob.

On the parameters of ear weight, ear diameter, and the number of rows of seeds in the ear, treatment 1 recommended dosage of macro fertilizer added with 4 ml / l of liquid organic fertilizer "Organic Fertilizer", showed the highest yields, namely 507 g, 50.82 mm and 15.05. line. Its because of fertilization able to provide and supply nutrients to plants.

Table 9. Cob weight, cob diameter, cob length and row of seeds in the cob of recommended compound NPK fertilizer treatment and "Liquids organic fertilizer ".

Treatment	Seed Row (row)	Cob Weight (g)	Cob Diameter (mm)	Cob Length (cm)
A	14,25 ab	417.50 c	50,77 ab	19,00 ns
B	14,10 ab	427.00 bc	50,47 ab	18,89 ns
C	14,65 ab	472.00 abc	52,22 a	20,08 ns
D	14,35 ab	458.50 abc	50,84 ab	18,47 ns
E	13,60 b	449.00 abc	48,78 b	18,26 ns
F	14,10 ab	501.00 a	52,57 a	19,65 ns
G	14,75 ab	473.00 abc	52,13 ab	20,00 ns
H	14,10 ab	465.50 abc	52,51 a	19,50 ns
I	14,05 ab	486.50 ab	51,85 ab	20,10 ns
J	15,05 a	507.00 a	53,31 a	19,83 ns
K	14,30 ab	455.50 abc	50,82 ab	18,29 ns
L	14,55 ab	462.50 abc	50,65 ab	19,38 ns

The numbers followed by the same letter in the same column are not significantly different in Duncan's 5% test; ns = not real. (A = No compound NPK fertilizer; B = No compound NPK fertilizer + 4 g / l Liquids fertilizer organic, C = without compound NPK fertilizer + 8 g / l Liquids fertilizer organic ; D = without NPK fertilizer + 12 g / l Liquids fertilizer organic ; E = ½ recommended dosage of compound NPK fertilizer; F = ½recommended dosage of Macro fertilizer + 4 g / l Liquids fertilizer organic ; G = ½recommended dosage of Macro fertilizer + 8 g / l Liquids fertilizer organic ; H = ½recommended dosage of Macro fertilizer + 12 g / l Liquids fertilizer organic ; I = 1recommended dosage of Macro fertilizer; J = 1recommended dosage of Macro fertilizer + 4 g / l Liquids fertilizer organic ; K = 1recommended dosage of Macro

fertilizer + 8 g / l Liquids fertilizer organic ; L = 1recommended dosage of Macro fertilizer + 12 g / l Liquids fertilizer organic).

Inorganic fertilizers commonly used by farmers are NPK fertilizers in the forms of Urea, SP-36, and KCl, respectively. N, P, and K are essential nutrients for plants, they should always be available in soil. Often farmers provide excessive amounts of inorganic fertilizers that can cause physical, chemical, and biological soil damages, thus decreasing the soil fertility. An effort that can be made to reduce the impact of inorganic fertilizer use is the application of organic fertilizer that can improves soil properties and increases the nutrient content of the soil (SOFYAN et al. 2019). The application of organic and inorganic fertilizers showed great benefits not only for the increase of N uptake by plants and available N in soil, but also for the improvement of maize yield. The extent to which organic fertilizers could increase the efficiency of applied inorganic fertilizers in soil and crop productivity has not received much attention for research. However, the combined use of organic and inorganic fertilizers increases crop yields more than the use of single fertilizer (ENGEL et al. 2010).

Production Per Ha, RAE Value and R / C Ratio

The highest production is shown in plants fertilized with recommended 1 dose of compound NPK macro fertilizer plus liquid organic fertilizer at a dose of 4 ml / liter, which is 13,339 kg / ha, in contrast to the recommended compound NPK macro fertilizer plus liquid organic fertilizer "Organic Fertilizer "The dose of 4 ml / liter is 11,660 kg / ha. This occurs because the production of maize is strongly influenced by compound NPK macro fertilizer because it is needed in large quantities (SYAFRUDDIN et al. 2012), but when coupled with the provision of liquid organic fertilizers, which are complete fertilizers containing small amounts of macro and micro nutrients, with a dose according to the needs of the plant, it will increasingly be able to increase the photosynthetic process of the plant, and result in increased production. According to the results of research conducted by PUSPADEWI et al. (2016), one recommended dose of single N, P, K fertilizer with a combination of several concentrations of Liquid Organic Fertilizer provides better plant growth and yield.

The technical / agronomic effectiveness of the inorganic fertilizer is approached by calculating the value of Relative Agronomic Effectiveness (RAE). RAE analysis showed that fertilizing 1 dose of compound NPK Recommendation + 4 g / l had the highest RAE value, namely 325%. The second highest RAE was ½ the recommended compound NPK dose + 4 g / l "Liquid fertilizer organic ", the RAE value was 231%, (Table 9). Therefore, the provision of fertilizer technically / agronomically can increase yields if accompanied by a recommendation of compound NPK macro fertilizer (Table 10).

Table 10. Sweet corn production per ha and RAE value in several liquid fertilizer organic treatments.

Treatment	Production per ha (kg/ha)	Value RAE (%)
A= Without fertilizer	12.411 ab	-
B= Without fertilizer; 4 g/l Liquids fertilizer organic	11.660 b	-262,5
C= Without fertilizer; 8 g/l Liquids fertilizer organic	12.964 ab	193,7
D= Without fertilizer; 12 g/l Liquids fertilizer organic	12.749 ab	118,7
E= ½ recommended dosage of Macro fertilizer;	12.178 ab	-81,2
F= ½ recommended dosage of Macro fertilizer; 4 g/l Liquid fertilizer organic	13.071 ab	231,2
G= ½ recommended dosage of Macro fertilizer; 8 g/l Liquid fertilizer organic	12.821 ab	143,8
H= ½ recommended dosage of Macro fertilizer; 12 g/l Liquid fertilizer organic	12.607 ab	68,8
I= 1 recommended dosage of Macro fertilizer;	12.696 ab	100,0
J= 1 recommended dosage of Macro fertilizer; 4 g/l Liquid fertilizer organic	13.339 a	325,0
K= 1 recommended dosage of Macro fertilizer; 8 g/l Liquid fertilizer organic	12.893 ab	168,7
L= 1 recommended dosage of Macro fertilizer;12 g/l Liquid fertilizer organic	12.143 ab	-93,7

The numbers followed by the same letter in the same column are not significantly different in Duncan's 5% test; ns = not real. (A = No compound NPK fertilizer; B = No compound NPK fertilizer + 4 g / l Liquid fertilizer organic, C = without compound NPK fertilizer + 8 g / l Liquid fertilizer organic ; D = without compound NPK fertilizer + 12 g / l Liquid fertilizer organic ; E = ½ recommended dosage of compound NPK fertilizer; F = ½recommended dosage of Macro fertilizer + 4 g / l Liquid fertilizer organic ; G = ½recommended dosage of Macro fertilizer + 8 g / l Liquid fertilizer organic ; H = ½recommended dosage of Macro fertilizer + 12 g / l Liquid fertilizer organic ; I = 1recommended dosage of Macro fertilizer; J = 1recommended dosage of Macro fertilizer + 4 g / l Liquid fertilizer organic ; K = 1recommended dosage of

Macro fertilizer + 8 g / l Liquid fertilizer organic ; L = 1recommended dosage of Macro fertilizer + 12 g / l Liquid fertilizer organic)

Farming analysis using R / C ratio farming analysis. The calculation result of R / C from treatment with the highest RAE is ½ the recommended compound NPK dose with the addition of 4 ml / l fertilizer with 8 applications with an R / C ratio of 8.65. Net income of IDR 173,404,213 (Table 11). Meanwhile, treatment with 1 recommended dosage of macro fertilizer + liquid organic fertilizer 4 g / l, earning a net income of Rp. 176,785,041 with R / C Ratio of 8.59. The results of the calculation of the farm analysis can be seen in Table 11.

Table 11. Results of R / C Treatment Ratio Analysis 1 recommended dosage of Macro fertilizer + 4 ml / l and ½recommended dosage of Macro fertilizer + 4 ml / l "Liquid fertilizer organic ".

Description	1 recommended dosage of Macro fertilizer + 4 ml/l (treatment J)				1/2 recommended dosage of Macro fertilizer + 4 ml/l (treatment F)			
	volume	Unit	Unit price	total cost	volume	Unit	Unit price	total cost
Seeds	8	kg/ha	292.000	2.336.000	8	kg/ha	292.000	2.336.000
Urea	250	kg/ha	2.008	502.052	125	kg/ha	2.008	251.026
Phonska	300	kg/ha	2.588	776.292	150	kg/ha	2.588	388.146
Manure	1.000	kg/ha	500	500.000	1.000	kg/ha	500	500.000
Liquid fertilizer organic	182.857	ml/ha	60	10.971.429	182.857	ml/ha	60	10.971.429
Liquid Pesticides	1.429	ml/ha	262	374.500	1.429	ml/ha	262	374.500
Furadan	15	kg/ha	12.063	175.511	15	kg/ha	12.063	175.511
Transportation costs		Rp		860.009		Rp		860.009
Labor cost	134	person/ha	50.000	6.712.500	134	person/ha	50.000	6.712.500
Land Tax		Rp		91.667		Rp		91.667
Total cost		Rp		23.299.959		Rp		22.660.787
Cash Receipts	13339	kg/ha	15000	200.085.000	13071	kg/ha	15000	196.065.000
R / C ratio				8,59				8,65
Net income				176.785.041				173.404.213

CONCLUSION

The liquid fertilizer organic effected the growth and yield of sweet corn. One dose of Inorganic Macro Nitrogen, Phosphorus and Potassium Fertilizers + 4 ml liquid fertilizer organic at one week interval, affects the growth and yield of sweet corn plants. The highest production per ha in this treatment was 13,339 kg. The highest RAE value is 325.6% at 1recommended dosage of Macro fertilizer plus 4 g / l "Liquid fertilizer organic ". The economic approach by calculating the R / C ratio, the treatment with the highest RAE is the R / C Ratio 8.59 with a net income of Rp 176.785.041,-.

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