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Utilization of kepok banana peel waste as liquid organic fertilizer for the growth and yield of sweet corn (*Zea mays* saccharata Sturt L.) plants

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ABSTRACT

This study aims to determine the response and appropriate concentration of liquid organic fertilizer from banana peel waste on the growth and yield of sweet corn (*Zea mays* saccharata Sturt L.). The research method was a field experiment using a Randomized Block Design with various concentrations of liquid organic fertilizer from Kepok banana peel waste. The treatments are P0 = 0 ml/litre of water, P1 = 50 ml/litre of water, P2 = 100 ml/litre of water, P3 = 150 ml/litre of water, P4 = 200 ml/litre of water, and P5 = 250 ml/litre of water. Each treatment was repeated four times. The data obtained in this study were analyzed using Analysis of Variance at the 5% error level and followed by the Duncan Multiple Range Test (DMRT). The results showed that the application of various concentrations of organic liquid fertilizer made from Kepok banana peel has a significant effect ($p<0.05$) on plant height, leaf count, stem diameter, cob length without husk, cob diameter without husk, and cob weight without husk. It can be concluded that the treatment with the concentration of Kepok banana peel organic liquid fertilizer at P2 (100 ml/litre of water) yielded the best results for plant height, leaf count, stem diameter, cob length without husk, cob diameter without husk, and cob weight without husk.

Keywords: Concentration, Fluctuation, Fertility, Manggarai, Production. ,

INTRODUCTION

In Indonesia, farmers have long cultivated corn as a primary crop alongside rice. The people of Indonesia in West Java, East Java, Central Java, Madura, Yogyakarta Special Region, East Nusa Tenggara, North Sulawesi, South Sulawesi, and North Maluku are accustomed to making corn as a staple culinary dish. According to data from the Central Bureau of Statistics (BPS) in 2020, the production of superior corn in Indonesia is still deficient, with an average yield of 5,474 tons/ha. Corn production in Manggarai Regency has fluctuated or declined every year between 2019 and 2021, according to data from the East Nusa Tenggara Provincial Statistics Bureau (BPS, 2022), where corn production fell from 13,132 tons/ha in 2020 to 10,316 tons/ha in 2021, and further declined to 4,979 tons/ha in 2022.

The decrease in corn production in Manggarai Regency is due to the continued use of inorganic or chemical fertilizers without being balanced with organic fertilizers, which can reduce soil and plant fertility. Sweet corn has high economic value and is widely used for household consumption and the food industry, making it a potential crop for cultivation. Fius (2016) stated that expanding the harvesting area, increasing production, maintaining production stability, and reducing yield losses boost corn production. Fertilization is one of the methods that can be used to increase sweet corn production.

Applying fertilizer to plants can enhance the quantity and quality of the nutrients plants require for growth, referred to as fertilization. One of the factors influencing the quantity and quality of agricultural yields is fertilization technology. The proper use of fertilizers is expected to achieve financially profitable production levels. Organic fertilizers and inorganic fertilizers are two types of fertilizers but differ in origin. Farmers have traditionally developed their crops by consistently or continuously using inorganic fertilizers. According to Purwanto and Budiyono (2013), excessive or continuous use of inorganic fertilizers over a long period can negatively affect the soil and the surrounding environment, reducing agricultural land productivity.

Using liquid organic fertilizer made from Kepok banana peel is one way to increase the productivity of sweet corn. According to Siboro et al. (2013), using kepok banana peel as liquid organic fertilizer is superior to using manure. This is because liquid organic fertilizer has several advantages, such as being easier to apply, containing nutrients that are easily absorbed by plants, containing many microorganisms, correcting nutrient deficiencies, not having problems with nutrient leaching, and providing nutrients quickly.

The public consumption of kepok banana in various processed foods encourages the author to utilize kepok banana peel waste as liquid organic fertilizer. Banana peel waste will become garbage if not appropriately managed, so it can cause environmental or ecological pollution. Using kepok banana peel waste can be maximized by exploring better technological innovations, one of which is liquid organic fertilizer. Liquid organic kepok banana peel waste has many benefits, one of which is its ability to restore soil fertility by improving the soil's physical, chemical, and biological properties. This condition encourages the author to research "Utilization of Kepok Banana Peel Waste as Liquid Organic Fertilizer on the Growth and Yield of Sweet Corn (*Zea mays* saccharata Sturt L.)".

MATERIALS AND METHODS

Location and design of the experiment

This research was conducted in Satar Luju Village, Satar Mese Barat Subdistrict, Manggarai Regency, from March 2024 to July 2024. The research method was a field experiment arranged using a Randomized Block Design with one treatment factor: various concentrations of liquid organic fertilizer made from kepok banana peel. The treatments used in this study were: P0 = 0 ml/litre of water, P1 = 50 ml/litre of water, P2 = 100 ml/litre of water, P3 = 150 ml/litre of water, P4 = 200 ml/litre of water, P5 = 250 ml/litre of water. The parameters observed in this study include Plant height (cm), number of leaves (blades), bar diameter (mm), length of corn cob without husk (cm), diameter of corn cob without husk (mm), weight of corn without husk (g).

Procedure for making liquid organic fertilizer from kepok banana peels

The steps for making liquid organic fertilizer from kepok banana peels are as follows: (1) In making liquid organic fertilizer from kepok banana peels, it is essential to prepare the necessary tools and materials such as duct tape, scissors, a machete, water pass hose, mineral bottles, a 60 L drum, kepok banana peels, water, 2 kg of brown sugar, and EM4. (2) The pre-prepared kepok banana peels are selected based on quality, characterized by a yellow colour and no signs of rotting. The banana peels are then chopped with a machete into small pieces, totalling 20 kg. (3) Then, 1 litre of EM4 is mixed with water (500 ml of EM4 is added to 10 litres of water). (4) The 2 kg of brown sugar is dissolved in 2 litres of water. (5) Next, the 20 kg of chopped Kepok banana peels are placed into the drum, along with 24 litres of water, the diluted EM4 (20 litres), and the dissolved brown sugar (2 litres). (6) Once everything is added to the drum, it is stirred until well mixed. (7) After thorough mixing, the drum is sealed tightly, and a hole is made in the lid for air circulation by attaching a water pass hose connected to a 1-litre mineral bottle, which is then wrapped with duct tape. (8) Once all is complete, the liquid organic fertilizer is fermented for 2 weeks. The process of making liquid organic fertilizer from kepok banana peels is repeated three times using the same method and quantities as required for the research (Andesta et al., 2022; Saragih, 2021; Munar et al., 2018).

Measurement variables

Plant height is measured on each sample plant by measuring from the base of the stem (ground surface) to the highest leaf after it is straightened. Using a measuring tape, the plant height measurement is performed 6 weeks after planting. The number of leaves is observed on each sample plant by counting all the fully opened leaves. The observation of the number of leaves is also conducted at 6 weeks after planting. Stem diameter measurements are carried out on each sample plant using a digital calliper. The number of corn ears was observed on each sample plant during harvesting. The measurement of corn ear length is conducted on each sample plant at harvesting after removing the husk that wraps the ear. The measurement is done using a ruler from the base to the tip of the ear filled with kernels. The measurement of ear diameter on each sample plant is carried out at harvest using a digital calliper, which measures the middle part of the corn ear, with the husk removed. The weighing of the corn ear with husk is done on each sample plant after harvesting, using an analytical balance to measure the fresh weight of the corn ear.

Statistical analysis

The data obtained in this study were analyzed using an Analysis of Variance at a 5% significance level. If significant differences were found, the analysis was followed by Duncan's Multiple Range Test at a 5% significance level using Microsoft Excel 2016.

RESULTS AND DISCUSSION

Description of the research location

Satar Luju Village is one of the villages located in the Satar Mese Barat Subdistrict, Manggarai Regency. Satar Mese Barat Subdistrict is located in the southern part of Manggarai Regency, situated at coordinates 8° North Latitude, 8°, 30 South Latitude, 199° East Longitude, and 120°, 30 West Longitude (Figure 1). The total area of Satar Mese Barat Subdistrict is 27,357 km², consisting of the mainland of Flores Island and Mules Island. The region of Satar Mese Barat Subdistrict generally has a dry climate with uneven rainfall distribution, and it is situated at an altitude of 360 meters above sea level (Manggarai Regency Government, 2015). Manggarai Regency receives an average annual rainfall of 229 mm to 444 mm (BPS of East Nusa Tenggara Province, 2023). The average annual temperature in Manggarai Regency is 20.40°C to 21.17°C (BPS of Manggarai Regency, 2021).

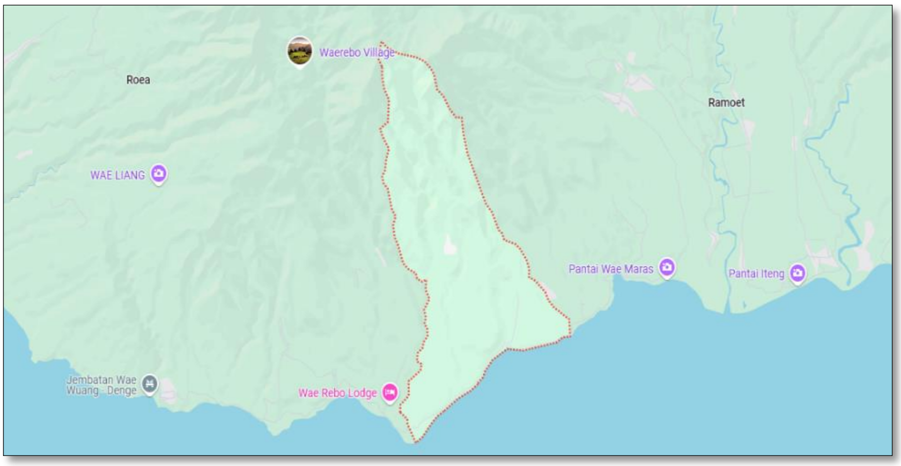

Figure 1. The village where the research took place

The land used in the research was previously unused for cultivating corn plants. Several challenges occurred during the research on sweet corn, such as wilting leaves due to water shortage. To address this issue, the plants were watered once a day. Another challenge was that grasshoppers (Patanga succincta) attacked the sweet corn plants when they were 1 week old and armyworms (Spodoptera litura) when they were 6 weeks old. Grasshoppers have chewing and biting mouthparts, attacking by eating the young leaves, and their attacks can consume the entire leaf, including the veins. The armyworms also have chewing and biting mouthparts similar to grasshoppers, damaging the sweet corn plants by tearing the leaves, leaving holes, and leaving behind sawdust-like frass. The insecticide sidamethrin was used to control the grasshoppers and armyworms, as many pests were found at the research site. The recommended concentration was 1 ml/litre of water for controlling grasshoppers (Patanga succincta) and 4 ml/litre for controlling armyworms (Spodoptera litura). The insecticide was sprayed on the sweet corn plants in the morning. This insecticide contains cypermethrin: 50 g/l, which acts as a contact and stomach poison, forming a yellow concentrate easily soluble in water to control significant pests in corn cultivation. The insecticide was sprayed only twice, once when the sweet corn plants were 1 week old and again at 6 weeks old.

Table 1. Average plant growth with Kepok banana peel liquid organic fertilizer application

Treatment	Plant Height (cm)	Number of leaves (blades)	Stem diameter (mm)
P0 : 0 ml/l water	160.47±5,98 [e]	13,06±0,21 [d]	20,23±1,25 [c]
P1 : 50 ml/l water	189.94±8,05 [b]	15,25±0,64 [b]	23,49±0,36 [a]
P2 : 100 ml/l water	212.25±11,41 [a]	16,44±0,45 [a]	24,25±0,87 [a]
P3 : 150 ml/l water	181.09±6,25 [c]	14,69±0,62 [b]	22,01±0,29 [b]
P4 : 200 ml/l water	177.63±5,19 [cd]	14,63±0,45 [b]	21,62±0,21 [b]
P5 : 250 ml/l water	171.72±5,98 [d]	13,88±0,52 [c]	21,38±0,22 [bc]

Notes: Mean values in the same collum with different superscript letters differ significantly ($p<0.05$).

Plant height (cm)

Based on the data in Table 1, the treatment with various concentrations of liquid organic fertilizer made from kepok banana peels showed that the highest sweet corn plant height at 6 weeks after planting was 212.25 cm in the P2 treatment, while the lowest was 160.47 cm in the P0 treatment. This suggests that the nutrient content in the liquid organic fertilizer made from kepok banana peels may enhance the growth of sweet corn plants. This aligns with Buhaerah's (2021) statement that Kepok bananas contain nitrogen (N), which can influence plant height.

The primary function of N is to support overall plant growth, particularly in stems, branches, and leaves. Adding organic materials containing N will affect the total N content, help activate plant cells, and maintain photosynthesis processes, resulting in increased plant height. The increase in plant height is due to cell division and elongation, primarily occurring at the plant's shoot tips. According to Marsono and Sigit (2010) and Arif (2021), nitrogen is crucial for producing amino acids, proteins, and cell protoplasm, which can drive plant growth.

The application of liquid organic fertilizer from banana peel waste at treatment P1 is higher than treatments P3, P4, and P5. This is suspected to be because the concentration of the liquid organic fertilizer from banana peels given was too high, potentially causing the soil medium to become more acidic. This is in line with the opinion of Andesta et al. (2022), who state that excessive liquid organic fertilizer from banana peels can increase soil acidity, thereby inhibiting the activity of microorganisms in providing available nutrients. If the nutrients plants require are too high or too low, it can impede plant growth.

Number of leaves (blades)

The treatment with the highest number of leaves 6 weeks after planting, with a concentration of liquid organic fertilizer from banana peel waste, is 16.44 in treatment P2, while the lowest number of leaves is 13.06 in treatment P0 (Table 1). This suggests that sweet corn plants can produce more leaves due to the nutrient content in the liquid organic fertilizer from banana peels. According to Hidayat (2013), total nitrogen (N-total) is required for protein production used in cell and chlorophyll formation. Chlorophyll, in turn, aids in photosynthesis, which is then broken down through respiration to produce the energy cells need for cell division, allowing for additional leaf growth. Thus, sweet corn plants are suspected to produce more leaves due to the nutrient content in the liquid organic fertilizer from banana peels. According to Hakim et al. (1986), as cited in Hidayat (2013), total nitrogen is required for protein production used in cell and chlorophyll formation. Chlorophyll assists in photosynthesis, and the results are then separated through the respiration cycle, producing the energy cells need for cell division and allowing for increased leaf growth.

Lubis et al. (2022) state that nitrogen (N) is an essential component of proteins and enhances the nutritional value of vegetative plant growth. Vegetative plant growth, such as height and the number of leaves, is influenced by the increased use of nitrogen. Nitrogen aids in shoot growth rather than root growth, affecting plant height. According to Nyakpa et al. (1988) and Hidayat (2013), phosphorus (P) plays a crucial role in respiration and photosynthesis to promote plant growth or leaf number. The banana peel liquid organic fertilizer application at the P2 treatment showed a higher leaf number than the P1, P3, P4, and P5 treatments. This suggests that the concentration of the liquid organic fertilizer from banana peels given may not align with the plant's growth requirements. Lingga and Marsono (2013) argue that satisfactory plant development is achieved when the growing medium has an adequate supply of nutrients, balancing the plant's needs. However, insufficient or excessive amounts of nutrients can disrupt plant growth and production, including the generative phase.

Bar diameter (mm)

The various concentrations of liquid organic fertilizer from Kepok banana peel waste significantly affect the diameter of sweet corn plant stems. The largest stem diameter observed was 24.25 mm in treatment P2, while the smallest was 20.23 mm in treatment P0 (Table 1). This effect is suspected to be due to the liquid organic fertilizer from banana peels containing essential nutrients the plants need. Lingga and Marsono (2013) state that plants require macro-nutrients such as nitrogen, phosphorus, and potassium from fertilizers, with nitrogen being particularly crucial for vegetative growth, including the development of stems and foliage.

According to Handayani (2007), as cited in Balgis et al. (2021), banana peel (particularly the Kepok variety) contains 68.90% water (H2O), 18.50% nitrogen (N), 715 mg calcium (Ca), 15% potassium (K), 12% phosphorus (P), and other compounds that can be used as fertilizer for plant growth and development. Rambitan and Mirna (2013) state that Kepok banana peel waste contains macronutrients N, P, and K, which are essential for the growth of fruits and stems. According to Tania (2002), as cited in Putri (2022), banana peel liquid organic fertilizer contains only 0.18% of the nitrogen sweet corn needs to stimulate stem diameter growth. Applying liquid organic fertilizer from Kepok banana peel at concentrations P1 and P2 resulted in larger stem diameters than treatments P3, P4, and P5. This is suspected to be due to the concentrations of the banana peel fertilizer not being suitable for the plant's growth needs. This is consistent with the opinion of Salisbury and Ross (1995), as cited in Hidayat (2013), which states that if optimal conditions have been achieved to address plant problems, increasing the dose will not significantly improve plant growth and yield.

Length of corn cob without husk (cm)

Based on the data in Table 2, the treatment with the highest concentration of organic liquid fertilizer from banana peel waste resulted in the longest cob without husk at 21.94 cm for treatment P2. The shortest cob without husk was 18.71 cm in treatment P0. This is suspected to be due to the nutrient content in the organic liquid fertilizer from banana peels, which is believed to enhance the cob length without husk. This is supported by the research of Meiriana et al. (2014), which shows that the nutrient content in the banana peel liquid fertilizer includes 0.55% Organic C, 0.18% Total N, 0.043% P2O5, 1.137% K2O, and a C/N ratio of 3.06%. During the generative phase of the plant, these nutrients play a crucial role in plant physiology. The generative phase of maize is significantly influenced by macronutrients, particularly K and P. Due to the availability of P, plants can allocate more photosynthetic energy to the cob and seeds, resulting in larger fruit, uniform seed growth, and higher seed quality (Ainiya et al., 2019).

According to Nurhayati and Sebayang (2022), the parameter of ear length is related to the translocation of photosynthates to the ear-forming organs, resulting in more prominent ears. In addition to nitrogen (N), ear size is also influenced by phosphorus (P). Hanifah and Sudiarso (2022) explain that N, P, and potassium (K) can affect corn ears, allowing them to develop and produce longer ears according to their potential. In the P1 treatment, the ear length without husk was longer compared to the P3, P4, and P5 treatments. This is suspected to be due to the concentration of liquid organic fertilizer from banana peel waste being less suitable, which could lead to poor plant development. This is also consistent with Saputra et al. (2020), who state that insufficient or excessive fertilization can affect plant growth because plants require both macro and micronutrients in adequate amounts; however, excessive nutrients can inhibit plant growth.

Table 2. Average corn yield with Kepok banana peel liquid organic fertilizer application

Treatment	Length of corn cob without husk (cm)	Diameter of corn cob without husk (mm)	Weight of corn without husk (g)
P0 : 0 ml/l water	18,71±0,46 e	48,58±1,17 d	196,63±15,84 c
P1 : 50 ml/l water	21,24±21,24 b	52,75±0,90 b	263,11±5,90 a
P2 : 100 ml/l water	21,94±21,94 a	54,34±0,37 a	281,44±12,25 a
P3 : 150 ml/l water	20,54±20,54 c	51,03±0,76 c	242,16±3,63 b
P4 : 200 ml/l water	20,34±20,34 cd	50,69±1,06 c	236,96±4,88 b
P5 : 250 ml/l water	19,88±19,88 d	50,51±1,03 c	227,22±12,61 b

Notes: Mean values in the same collum with different superscript letters differ significantly (p<0.05).

Diameter of corn cob without husk (mm)

The highest diameter of the cob without the husk was 54.34 mm with the P2 treatment, while the most minor diameter of the cob without the husk was 48.58 cm with the P0 treatment (Table 2). This is suspected to be due to the nutrient content in the liquid organic fertilizer made from banana peel waste, which is sufficient for the needs of sweet corn plants. This is also supported by Apriliani (2016), who states that plants can fully absorb these nutrients and grow optimally when they receive adequate nutrients. The research by Kasniari and Supadma (2007) cited in Rahman et al. (2023) shows that potassium (K) plays a crucial role in increasing turgor, improving lignin content, cellulose, and acting as an enzyme activator, and is essential for enhancing the size and weight of seeds.

Soetoro et al. (1988) and Ayunda (2014) state that the nutrients absorbed and utilized in the photosynthesis process affect the weight of the cob, particularly the seeds. This is because the nutrients absorbed by the plant are used to form proteins, carbohydrates, and fats, which are then stored in the seeds, increasing the weight, diameter, and length of the cob. This is supported by Silalahi and Karyawati (2020), who assert that the correct dose of organic fertilizer results in better cob diameter, cob length, fresh weight of the cob (both with and without husks), and overall yield. In treatment P1, the diameter of the cob without husks is more significant compared to treatments P3, P4, and P5. This is suspected to be due to the inappropriate concentration of liquid organic fertilizer from banana peel waste, which may lead to poor plant development. According to Salisbury and Ross (1995) and Hidayat (2013), increasing the dosage will not significantly improve plant growth and yield once the plant's needs are optimally met.

Weight of corn without husk (g)

The highest weight of cobs without husks is 281.44 g in the P2 treatment, while the lowest weight of cobs without husks is 196.63 g in the P0 treatment (Table 2). This suggests that the organic liquid fertilizer made from banana peel waste likely contains nutrients that meet the plant's needs. This is supported by Apriliani (2016), who states that plants will achieve optimal growth if their nutrient requirements are met. According to Rahayu (2021), organic liquid fertilizer from banana peels contains various components such as phosphorus, potassium, magnesium, sodium, protein, and zinc. Each component plays a role in plant growth and development, ultimately enhancing productivity.

This is also consistent with the opinion of Della et al. (2022), who state that the availability of sufficient nutrients in the soil can improve the vegetative phase, create a balance in the leaf ratio, and stimulate plant growth, especially during the generative phase. The roots absorb nutrients distributed throughout the plant tissues more quickly if the soil contains adequate nutrients. According to Manalu et al. (2022), the nitrogen content in natural materials or organic fertilizers plays a crucial role in protein synthesis during the formation of ears and seeds. Practical protein synthesis will positively correlate with the increase in the ears' size, length, weight, and diameter. Phosphorus also plays an essential role in increasing the size of corn ears and the nitrogen nutrients found in organic fertilizers.

In treatments P1 and P2, the weight of the ears without husks was heavier compared to treatments P3, P4, and P5. This is suspected to be due to the concentration of the liquid organic fertilizer made from kepok banana peels being less than optimal, which affected plant development. According to Agustina (2004) in Toisuta (2018), if the nutrient content in liquid organic fertilizers is provided in amounts that are either too high or too low, it can reduce plant production. This happens because the imbalance in nutrient concentrations in the soil does not match the proportions the plants need. Inadequate nutrient proportions can limit the production of a plant.

CONCLUSION

The application of various concentrations of liquid organic fertilizer from kepok banana peel significantly affects plant height, number of leaves, stem diameter, length of the cob without husk, the diameter of the cob without husk, and weight of the cob without husk. The treatment with a concentration of liquid organic fertilizer from kepok banana peel at P2 (100 ml/litre of water) showed the best results for plant height, number of leaves, stem diameter, length of the cob without husk, the diameter of the cob without husk, and weight of the cob without husk.

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