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The Influence of a Combination of Cow Manure and Banana Stem on the Growth and the Result of Sweet Potato (Ipomoea Batatas (L) Lamb) in Ancient Planting Method

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Abstract

Indonesian farmers depend on chemical fertilizers. It is necessary to change the planting system to improve soil conditions. This research aimed to determine the influence of a combination of cow manure and banana stem on the growth and the result of sweet potato plants in ancient planting methods. The research was conducted in the rice fields of Sarwadadi Village, Talun District, Cirebon Regency, from May to September 2023. The experimental design used was a Randomized Group Design (RAK), which consisted of 16 treatments, and each factor was repeated twice. The treatment is as follows: (1) A: CM 0 tons/ha and BS 0 tons/ha; (2) B: CM 0 tons/ha and BS 10 tons/ha; (3) C: CM 0 ton/ha and BS 15 tons/ha; (4) D: CM 0 tons/ha and BS 20 tons/ha; (5) E: CM 10 tons/ha and BS 0 tons/ha; (6) F: CM 10 tons/ha and BS 10 tons/ha; (7) G: CM 10 tons/ha and BS 15 tons/ha; (8) H: CM 10 tons/ha and BS 20 tons/ha; (9) I: CM 15 tons/ha and BS 0 tons/ha; (10) A: CM 15 tons/ha and BS 10 tons/ha; (11) K: CM 15 tons/ha and BS 15 tons/ha; (12) L: CM 15 tons/ha and BS 20 tons/ha; (13) M: CM 20 tons/ha and BS 0 tons/ha; (14) N: CM 20 tons/ha and BS 10 tons/ha; (15) O: CM 20 tons/ha and BS 15 tons/ha; (16) P: CM 20 tons/ha and BS 20 tons/ha. The parameters observed in this study were stem length, number of leaves, stem diameter, leaf area index, root volume, root length, tuber diameter, tuber volume, tuber weight per cluster and tuber weight per plot. The resulting data was then analyzed using ANOVA, Scott Knott's advanced test at the 5% level. The results of the research show that (1) the combination of cow manure and banana stem organic matter has a significant effect on leaf area index, root length, tuber weight yield per hill and tuber weight per plot, and (2) the Combination of 20 tons/ha fertilizer treatment and banana stem organic material of 20 tons/ha produced the best effect on tuber weight per plot of 33.53 kg/plot or equivalent to 44.71 tons/ha.

Keywords: *Cow Manure, Organic Materials, Banana Stems, Ancient Planting Methods*

1. Introduction

In Indonesia, sweet potato (Ipomoea batatas L.) is one of the most common types of tuber food. Indonesian sweet potato production in 2017 was 2,092,353; however, in 2018, it declined to 1,914,244 tons (BPS Indonesia, 2019). Sweet potato (Ipomoea batatas L.) is a potential food commodity for development. The existence of sweet potatoes can replace people's need to consume rice as a primary source of carbohydrates. Consuming sweet potatoes can also satisfy human needs for vitamins and minerals. Sweet potatoes are a source of anthocyanins and are useful for being anti-carcinogenic, anti-mutagenic and anti-oxidant (Jiao et al., 2012; El Husna et al., 2013; Hambali et al., 2014; Sukardi et al., 2018; Aningsih et al., 2020).

The increase in crop production, besides increasing the area planted, is also related to increasing soil fertility, which can be done through fertilization (Manure, 2014). Most farmers in developing countries, such as Indonesia, use chemicals to fertilize and control plant diseases (Rinanto, 2015). This causes plant dependence on chemical fertilizer inputs continuously applied to agricultural land, resulting in decreased soil fertility, environmental damage, and soil productivity decreases (Manure, 2014). Another impact of using agricultural chemicals is reducing the population of microorganisms that play a role in soil biogeochemical cycles and reducing the availability of nutrients in the longer term (Rinanto, 2015).

Sweet potatoes need nutrients to stimulate their growth. Nutrients to increase the growth of sweet potatoes can be obtained by breaking down organic material by applying compost (Naqib et al., 2016; Boru, 2019; Navarro et al., 2020). Several types of compost that have been studied as being able to influence the growth of sweet potatoes are goat manure (Sarwanto & Tuswati, 2020), rice straw (Syahputra et al., 2017), cow manure (Herliana et al., 2021), fish bones and legume residues. (Novianantya et al., 2017), And cogon grass (Michael, 2020).

The utilization of the remaining banana harvest in Indonesia still needs to be improved. This causes banana stems to only be thrown away as agricultural waste. Therefore, one alternative is to process it into useful liquid organic fertilizer (LOF). Banana stems are reported to have a Ca content of 16.2%, P of 30.05%, and K of 21.5% with the addition of optimum distilled water of 600 ml and stirring for 15 minutes (Suprihatin, 2011). With fermentation times of 6 and 12 days, as well as the addition of bioactivators, banana stem LOF could produce the highest NPK content (Sari & Alfianita, 2018). Using banana stem, LOF has been tested on several commodities, including tomatoes (Manurung & Walida, 2015; Laginda et al., 2017) and mustard greens (Fitriani et al., 2019).

The ancient planting method is a newly developed method to realize healthy and environmentally friendly agriculture. In its cultivation, no land processing (TOT) is carried out; only weeding is done around the land to be planted, using organic materials, fertilizers, and vegetable pesticides. The difference between conventional agriculture and ancient planting methods is that the cultivation of plants uses the LMO (Local Microorganisms) consortium. LMO is a type of microorganism found around the plant's environment. These local microorganisms usually comprise bacteria, fungi and algae, which can help regulate the balance of the ecosystem around the plant (Suryanto, 2016). The LMO Consortium is a collection of dozens of types of microorganisms that live together, maintain and support each other and have the role of breaking down natural organic materials (waste) into organic materials that are originally from nature (environmentally friendly) (Alfaridzi 2022). The main ingredients of LMO comprise several components, namely carbohydrates, glucose and a source of microorganisms (Selly et al., 2015).

Based on the explanation above, it is necessary to increase sweet potato production using ancient methods through a combination of cow manure and organic banana stem material. Apart from efforts to increase production, this is also done to improve soil aggregates by adding organic material. Hopefully, this will change farmers' views on using organic fertilizer or compost.

The specific objectives of this research include:

1. To find out the influence between bananas stems and cow manure on the growth and result of sweet potato plants using ancient planting methods.

2. To find out how many doses of cow manure for sweet potato (Ipomoea batatas (L) Lamb) are in ancient planting methods appropriately.

2. Methods

The research was carried out in the rice fields of Sarwadadi Village, Talun District, Cirebon Regency. The research location is at an altitude of ± 190 m above sea level (asl). The soil type is in the Red Podzolic soil category and the soil pH is around 5.61. The experiment time in the field was carried out for 4 months, from May 2023 to September 2023. Based on Schmidt and Ferguson's classification, the climate conditions in Cirebon Regency include types C and D. The characteristics of areas in this category are tropical climate, with a minimum temperature of 24℃ and the average temperature is 28℃ and the relative humidity is 70% to 90%.

The experimental design used was a Randomized Block Design (RBD) comprising 16 treatments of each factor (cow manure (CM) and banana stem (BS)) which was then repeated twice, so that in total there were 32 experimental units. The following is a description of the treatment that will be carried out in the field:

A: CM 0 ton/ha and BS 0 ton/ha

B: CM 0 tons/ha and BS 10 tons/ha

C: CM 0 ton/ha and BS 15 tons/ha

D: CM 0 ton/ha and BS 20 tons/ha

E: CM 10 tons/ha and BS 0 tons/ha

F: CM 10 tons/ha and BS 10 tons/ha

G: CM 10 tons/ha and BS 15 tons/ha

H: CM 10 tons/ha and BOBP 20 tons/ha

I: CM 15 tons/ha and BS 0 tons/ha

A: CM 15 tons/ha and BS 10 tons/ha

K: CM 15 tons/ha and BS 15 tons/ha

L: CM 15 tons/ha and BS 20 tons/ha

M: CM 20 tons/ha and BS 0 tons/ha

N: CM 20 tons/ha and BS 10 tons/ha

O: CM 20 tons/ha and BS 15 tons/ha

P: CM 20 tons/ha and BS 20 tons/ha

The observation data is processed using statistical model tests as follows:

$Yij = \mu + r + ti + Ɛij$

Description:

Yij = The observation results of treatment i

μ = Average

r = The effect of repetition

ti = The effect of treatment i

Ɛij = The effect of experimental error

(Kemas Ali Hanafiah, 2011)

Table 1. List of Variance

Source of variance	DB	JK	KT	F^{count}	F0.05
Repetition (r)	2	∑Xij2/p-X…2/rp	JKu/DBu	KTu/KTg	3.443
Treatment (p)	11	∑Xij2/p-X…2/rp	JKp/DBp	KTp/KTg	2,259
Error (g)	22	JKT – JKr – JKp	JKg/DBg		
Total (T)	35	∑Xij2 - X.. 2/rp			

Source: Kemas Ali Hanafiah (2011)

If the results of the variance test show that there is a real effect, data analysis continues using the Scott Knott Cluster Test at a significance level of 5%.

3. Results And Discussions

3.1 Growth Observation

Based on the results of analysis of variance on observations of stem length (cm) aged 4, 5, 6, 7, 8, and 9 WAP, it shows that there is a real effect of the combination treatment of cow manure and banana stem organic material on sweet potato plants. Then the P treatment (CM 20 tons/ha and BS 20 tons/ha) showed significantly different results from the other treatments, with an average plant height of 4 MST 50.20 cm, 5 MST 97.8 cm, 6 MST 146, 7 cm, 7 MST 198.8 cm, 8 MST 272.6 cm and 9 MST 339.7 cm. This is thought to be because cow manure has a relatively complete nutrient composition, namely: pH 7.6, C-organic 8.99%, organic matter 15.49%, C/N-ratio 10.22, N-total 0, 88 %, P-total 0.33 % and K-total 0.56 % (Melsasail et al., 2019). Single application of cow manure has a significant effect on the length of the tendrils of sweet potato plants (Chairil Ezward et al., 2019).

Table 2. The Observation Results of Stem Length (cm) Age 4, 5, 6, 7, 8 and 9 MST

No	Treatment	4 MST	5 MST	6 MST	7 MST	8 MST	9 MST
1.	A	29.70 a	58.2 a	107.1 a	153.9 a	227.7 a	294.8 a
2.	B	33.90 a	67.2 a	116.1 a	162.9 a	236.7 a	303.8 a
3.	C	26.90 a	53.8 a	102.7 a	149.5 a	223.3 a	290.4 a
4.	D	31.05 a	62.5 a	111.4 a	158.2 a	232.0 a	299.1 a
5.	E	21.20 a	42.7 a	91.6 a	138.4 a	212.2 a	279.3 a
6.	F	31.30 a	62.7 a	111.6 a	158.4 a	232.2 a	299.3 a
7.	G	25.00 a	50.1 a	99.0 a	145.8 a	219.6 a	286.7 a
8.	H	29.10 a	58.5 a	107.4 a	154.2 a	228.0 a	295.1 a
9.	I	31.60 a	63.5 a	112.4 a	159.2 a	233.0 a	300.1 a
10.	J	28.30 a	56.2 a	105.1 a	151.9 a	225.7 a	292.8 a
11.	K	28.00 a	56.9 a	105.8 a	152.6 a	226.4 a	293.5 a
12.	L	34.60 a	69.1 a	118.0 a	164.8 a	238.6 a	305.7 a
13.	M	27.80 a	55.2 a	104.1 a	150.9 a	224.7 a	291.8 a
14.	N	34.50 a	68.5 a	117.4 a	164.2 a	238.0 a	305.1 a
15.	O	32.60 a	65.4 a	114.3 a	161.1 a	234.9 a	302.0 a
16.	P	**50.20 b**	**97.8 b**	**146.7 b**	**198.8 b**	**272.6 b**	**339.7 b**

(Trial Data Source, 2023)

Cow manure is an alternative for increasing soil fertility. Apart from fertilizing the land, farmers can also easily obtain it in large quantities. One adult cow can produce 30 kg of manure every day (Fathurrohman et al., 2015). Cow manure contains the elements N, P and K needed by plants. Apart from that, it can also improve the physical properties of the soil, including aggregate stability, total pore space, and water holding capacity (Riyani, Islami and Sumarni, 2015). Applying 5t/ha and 10t/ha of cow manure significantly increased soil organic matter more than other treatments (Vrahara & Jamil, 2021). Based on the results of Vrahara & Jamil's research in 2021, the increase in soil organic matter due to the use of cow dung is caused by the potential for organic waste to fertilize soil organic matter.

Table 3. The Observation Results of Number of Leaves (Strands) Age 4, 5, 6, 7, 8 and 9 MST

No	Treatment	4 MST	5 MST	6 MST	7 MST	8 MST	9 MST
1.	A	39.2a	76.9a	159.7a	255.5a	304.2a	362.1a
2.	B	35.1a	69.6a	152.4a	242.5a	291.2a	349.1a
3.	C	27.4a	55.1a	137.9a	226.9a	275.6a	333.5a
4.	D	23.8a	47.7a	130.5a	222.2a	270.9a	328.8a
5.	E	20.9a	42.0a	124.8a	215.2a	263.9a	321.8a
6.	F	27.1a	54.1a	136.9a	225.7a	274.4a	332.3a
7.	G	20.6a	41.5a	124.3a	212.3a	261.0a	318.9a
8.	H	26.5a	53.0a	135.8a	223.4a	272.1a	330.0a
9.	I	29.1a	57.5a	140.3a	235.3a	284.0a	341.9a
10.	J	26.3a	52.2a	135.0a	218.9a	267.6a	325.5a
11.	K	26.8a	54.3a	137.1a	228.0a	276.7a	334.6a
12.	L	39.9a	78.0a	160.8a	246.9a	295.6a	353.5a
13.	M	27.1a	54.6a	137.4a	228.0a	276.7a	334.6a
14.	N	21.5a	44.1a	126.9a	217.0a	265.7a	323.6a
15.	O	31.5a	63.1a	145.9a	233.9a	282.6a	340.5a
16.	P	27.0a	54.1a	136.9a	227.9a	276.6a	334.5a

(Trial Data Source, 2023)

Table 3 is the result of analysis of variance when observing the number of leaves aged 4, 5, 6, 7, 8 and 9 MST. It shows homogeneous results so that all combination treatments of cow manure and banana stem organic matter are not significantly different. Giving different doses of organic fertilizer produces relatively the same number of leaves up to 6 MST (Harti et al., 2020). This effect is caused by the narrow space for leaf formation and is accompanied by relatively small differences in nutrient availability and sufficient nutrient availability in the experimental field to cause the same number of leaves to form so that the assimilate produced through the photosynthesis process is also relatively the same. Genetic factors influence the rate of assimilation in the form of photosynthesis in plants because the intensity of sunlight influences the activity of light-capturing genes, so that each plant's response to sunlight is no different and does not affect the rate of assimilation (Anni et al., 2013). Apart from that, the process of leaf growth and development is influenced by the genetic factors of the plant itself (Muhammad Yasir and Erlida Ariani, 2017).

Table 4. The Observation Results of Stem Diameter (mm) Age 4, 5, 6, 7, 8 and 9 WAP

No	Treatment	4 MST	5 MST	6 MST	7 MST	8 MST	9 MST
1.	A	4.5a	5.1a	5.6a	6.1a	6.7a	7.2a
2.	B	4.4a	5.0a	5.6a	6.0a	6.6a	7.1a
3.	C	3.9a	4.5a	5.0a	5.5a	6.0a	6.6a
4.	D	4.1a	4.7a	5.2a	5.7a	6.2a	6.8a
5.	E	4.1a	4.7a	5.2a	5.7a	6.2a	6.7a
6.	F	4.1a	4.7a	5.2a	5.7a	6.2a	6.7a

7.	G	4.0a	4.6a	5.1a	5.6a	6.2a	6.7a
8.	H	4.2a	4.8a	5.3a	5.8a	6.3a	6.8a
9.	I	4.8a	5.3a	5.9a	6.4a	6.9a	7.4a
10.	J	4.3a	4.9a	5.4a	5.9a	6.5a	7.0a
11.	K	3.8a	4.4a	4.9a	5.4a	6.0a	6.5a
12.	L	5.1a	5.6a	6.2a	6.7a	7.2a	7.7a
13.	M	4.8a	5.3a	5.9a	6.3a	6.9a	7.4a
14.	N	3.8a	4.3a	4.9a	5.4a	5.9a	6.4a
15.	O	4.7a	5.3a	5.9a	6.3a	6.9a	7.4a
16.	P	4.3a	4.9a	5.5a	5.9a	6.5a	7.0a

(Trial Data Source, 2023)

Table 4 is the result of analysis of variance on observations of stem diameters aged 4, 5, 6, 7, 8 and 9 MST. It shows homogeneous results so that all combination treatments of cow manure and banana stem organic matter are not significantly different. This means that it is in line with observations of the number of leaves. The same size of tuber diameter can be understood because it is related to the same number of leaves where leaves are an indication of the plant's ability to produce assimilate because leaves function as organs for the photosynthesis process (Apriliani, 2022). Leaves are one of the organs that receive direct influence from the environment, especially from solar radiation. Direct sunlight is used by leaves for the photosynthesis process (Rasyid et al., 2017).

Table 5 is the result of analysis of variance in observations of Leaf Area Index (LAI), root volume (ml) and root length (cm) at the age of 60 HST. Observation of root volume showed homogeneous results, so that all combination treatments of cow manure and banana stem organic matter were not significantly different. Meanwhile, observations of LAI and root length (cm) showed significant differences. Treatment J (CM 15 tons/ha and BS 10 tons/ha) was significantly different from the other treatments in LAI observations. Then the P treatment (CM 20 tons/ha and BS 20 tons/ha) was significantly different from the other treatments in observing root length.

Table 5. Observation of Leaf Area Index (LAI), Root Volume (ml) and Root Length

No	Treatment	LAI	Root Vol (ml)	Root Length (cm)
1.	A	0.035 b	3.00a	34.00 c
2.	B	0.030 a	2.00a	20.75 b
3.	C	0.035 b	2.50a	19.50 b
4.	D	0.030 a	2.00a	29.50 c
5.	E	0.030 a	1.50a	18.25 a
6.	F	0.040 c	2.00a	18.00 a
7.	G	0.040 c	3.50a	27.00 c
8.	H	0.030 a	2.00a	24.00 b
9.	I	0.040 c	2.00a	27.25 c
10.	J	**0.045 d**	3.50a	26.00 c
11.	K	0.030 a	2.50a	20.50 b
12.	L	0.035 b	2.00a	24.00 b

13.	M	0.030 a	2.00a	25.50 c
14.	N	0.030 a	1.50a	18.25 a
15.	O	0.035 b	3.00a	29.50 c
16.	P	0.035 b	3.00a	**39.25 d**

(Trial Data Source, 2023)

Several types of compost that have been studied as being able to influence the growth of sweet potatoes are cow dung (Herliana et al., 2021). Banana stems are reported to have a Ca content of 16.2%, P of 30.05%, and K of 21.5% with the addition of optimum distilled water of 600 ml and stirring for 15 minutes (Suprihatin 2011). With fermentation times of 6 and 12 days, as well as the addition of bioactivators, banana stem LOF was able to produce the highest NPK content (Sari and Alfianita 2018). So, the treatment of cow manure and banana stem can influence LAI and plant root length. Providing different amounts of cow dung manure had a positive effect ($P<0.05$) on the number of branches, long leaves, leaf area and vine length compared to the control (Umaru Mohamed Gassama et al., 2022).

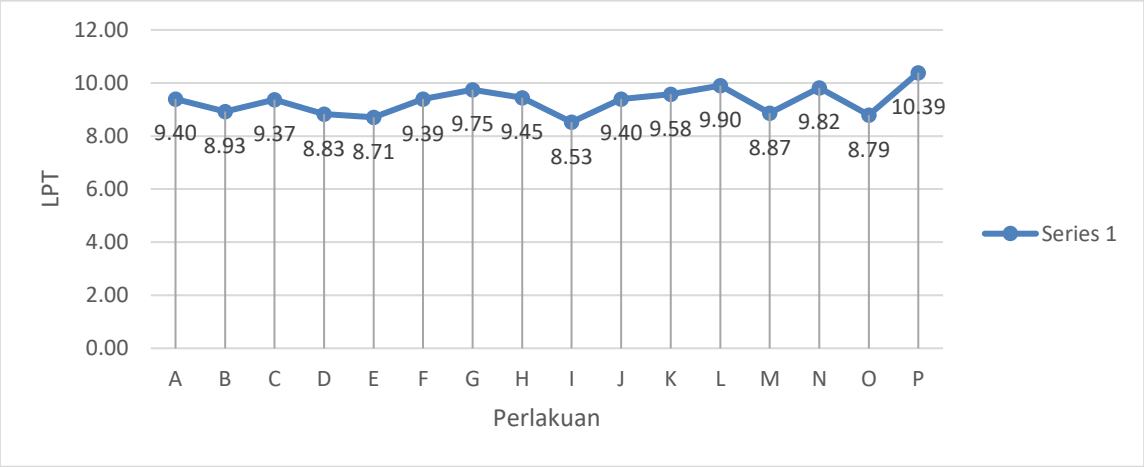

Figure 1. Plant growth rate graph aged 60 HST – 90 HST

Based on Figure 1, it can be seen that the highest plant growth rate was the P treatment (CM 20 tons/ha and BS 20 tons/ha) with an LPT value of 10.39. This shows that the addition of cow manure and organic material from banana stems can increase the growth rate significantly due to adequate supply of plant nutrients. Cow manure has a relatively complete nutrient composition, namely: pH 7.6, C-organic 8.99%, organic matter 15.49%, C/N-ratio 10.22, N-total 0.88%, P -total 0.33% and K-total 0.56% (Melsasail et al., 2019). In addition, organic material from cow manure contains microorganisms that can increase the mineralization process of soil organic N into N available for plants (Rahman et al., 2013). Banana stems are reported to have a Ca content of 16.2%, P of 30.05%, and K of 21.5% with the addition of optimum distilled water of 600 ml and stirring for 15 minutes (Suprihatin 2011). With fermentation times of 6 and 12 days, as well as the addition of bioactivators, banana stem LOF was able to produce the highest NPK content (Sari and Alfianita 2018).

3.2 Observation of Results

Table 6. Tuber Diameter (mm) and Tuber Volume (ml)

No	Treatment	Tuber Diameter (mm)	Tuber Vol (ml)
1.	A	52.97a	180.00a
2.	B	53.07a	154.00a
3.	C	52.16a	155.00a

4.	D	54.33a	185.00a
5.	E	54.23a	175.00a
6.	F	55.91a	175.00a
7.	G	52.56a	155.00a
8.	H	53.48a	165.00a
9.	I	55.20a	160.00a
10.	J	56.88a	165.00a
11.	K	52.74a	140.00a
12.	L	53.12a	180.00a
13.	M	54.01a	155.00a
14.	N	58.97a	165.00a
15.	O	57.72a	160.00a
16.	P	58.33a	160.00a

(Trial Data Source, 2023)

Based on observations of plant results in Table 6, namely tuber diameter and tuber volume, the analysis of variance results is homogeneous. This shows that all combination treatments of cow manure fertilizer and banana stem organic material were not significantly different. Application of cow manure significantly increased the number of marketable tubers, tuber diameter, and tuber length per plant compared to without manure ($P<0.05$) (Darwis Suleman et al., 2021). The shape of the tuber is greatly influenced by plant genetic factors so that the diameter and volume of the tuber in plant varieties will not be significantly different. Variety determines the genetic characteristics of the plant. Sweet potatoes have good environmental adaptability, but some varieties have poor adaptation. Planting appropriate varieties supports vegetative growth and plant yields (Muhammad et al., 2017). Then, the root volume will be influenced by the spread of the roots. The distribution of sweet potato roots is influenced by the nature of the variety, soil type and age of harvest (Muhammad et al., 2017).

Table 7. The Results of Tuber Weights per Clump, Per Plot, and Productivity (tons/ha)

No	Treatment	Per Clump (gram)	Per Plot (kg)	Productivity (ton/ha)
1.	A	301.21 a	8.35 a	11.13 a
2.	B	556.00 d	15.56 d	20.74 d
3.	C	396.63 b	11.10 b	14.79 b
4.	D	361.11 b	10.10 b	13.47 b
5.	E	440.29 c	12.32 c	16.43 c
6.	F	752.53 e	21.06 e	28.08 e
7.	G	774.74 e	21.68 e	28.91 e
8.	H	883.03 f	24.71 f	32.95 f
9.	I	382.13 b	10.69 b	14.25 b
10.	J	490.93 c	13.74 c	18.31 c
11.	K	970.17 g	27.16 g	36.21 g
12.	L	1019.17 g	28.53 g	38.04 g

13.	M	834.30 f	23.36 f	31.14 f
14.	N	875.93 f	24.52 f	32.69 f
15.	O	995.52 g	27.92 g	37.22 g
16.	P	**1197.75 h**	**33.53 h**	**44.71 h**

(Field Data Source, 2023)

Table 7 shows significantly different results in observing the weight of tubers per clump, per plot and the productivity value of sweet potato plants. The P treatment (CM 20 tonnes/ha and BS 20 tonnes/ha) showed the highest yield compared to the other treatments with a weight value per hill of 1,197.75 grams, per plot of 33.53 kg/plot and productivity of 44.71 tonnes/ha. This is because manure contains complete nutrients, namely macro and micro, compared to without manure. Manure application increases the availability of P, Ca, and CEC on marginal land (Mutammimah et al., 2020), and banana stem LOF can produce the highest NPK content (Sari & Alfianita, 2018). Manure also increases the soil's capacity to hold water (Khairuddin et al., 2018), soil organic C, infiltration, and improves aeration, making the tuber development process more flexible. Apart from that, applying manure also improves soil biological activity. Providing 20 tons per ha of goat, buffalo, cow and chicken manure increases sweet potato yields (Lestari et al., 2021). Providing organic fertilizer increases the availability of nutrients, especially P and K, which are essential for tuber formation, and increases the activity of enzymes and bacteria in the soil (Shang et al., 2020).

4. Conclusion

Based on the results of the research, it can be concluded as follows:

1. The combination of cow manure and banana stem organic matter has a significant effect on leaf area index, root length, tuber weight yield per hill and tuber weight per plot.

2. Combination of 20 tons/ha fertilizer treatment and banana stem organic material of 20 tons/ha produced the best effect on tuber weight per plot of 33.53 kg/plot or equivalent to 44.71 tons/ha

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