INDONESIAN MINING JOURNAL Vol. 25, No. 1, April 2022 : 49 - 58

BIO-ORGANO MINERAL EFFECT ON SOIL FERTILITY, NUTRIENT UPTAKE, AND SWEET CORN (*Zea mays L. saccharata*) GROWTH PLANTED IN INCEPTISOLS SOILS

PENGARUH PUPUK BIO-ORGANOMINERAL TERHADAP KESUBURAN TANAH, SERAPAN HARA, DAN PERTUMBUHAN TANAMAN JAGUNG MANIS (Zea mays L. saccharata) PADA TANAH INCEPTISOLS

RESTU WULANSARI[1*], MARYONO[2], DIDIT A. DARMAWAN[2], FARIS N. F. ATHALLAH[1] and FARDIAN K. HAKIM[3]

[1] Research Institute for Tea and Chincona, Gambung, Desa Mekarsari, Kecamatan Pasirjambu, Kabupaten Bandung, 40972 West Java

[2] Research and Development Centre for Mineral and Coal Technology Jalan Jenderal Sudirman 623 Bandung 40211

[3] Soil Chemistry and Plant Nutrition, Faculty of Agriculture, Padjadjaran University, Jatinangor Kabupaten Sumedang, West Java

* Corresponding author's e-mail: restuwulan_sari@yahoo.com

ABSTRACT

Sweet corn (*Zea mays L. saccharata*) is a horticultural product widely consumed by Indonesian people because of its sweetness. Corn requires sufficient nutrients to grow and produce the optimal yield so that the fertilization is a determining factor in corn cultivation. Bio-organomineral fertilizer (BIOM) is a fertilizer that combines mineral, organic, and biological elements (microorganisms). This study aims to examine the effect of BIOM on growth of sweet corn, nutrient uptake, and soil fertility. Experimental design used in this research was Randomized Block Design (RBD) with nine treatments and three replications which consist of treatments control; 1 NPK; ½ BIOM; 1 BIOM; 1 NPK + ½ BIOM; 1 NPK + ¾BIOM; 1 NPK + 1 BIOM; ¾NPK + 1¼BIOM; and ¾NPK + 1½BIOM. Effect of BIOM fertilizer at 100% dosage significantly increased the plant height, stem diameter, and canopy diameter compared to the control. BIOM fertilizer had a significant effect on the N uptake, total N, P-potential, P-available, K-potential, and K- exchangeable. The fertilizer is able to provide positive results on the growth of sweet corn, so it's more effective for the availability of nutrients needed by sweet corn plants.

Keywords: bio-organomineral, nutrient uptake, soil fertility, sweet corn.

ABSTRAK

Tanaman jagung manis (Zea mays L. saccharata) merupakan produk hortikultura yang banyak dikonsumsi sebagai sayuran atau dikonsumsi langsung oleh masyarakat Indonesia karena mempunyai rasa yang lebih manis dibandingkan dengan jagung biasa. Tanaman jagung memerlukan hara yang cukup untuk dapat tumbuh dan berproduksi optimal sehingga pemupukan merupakan faktor penentu keberhasilan budidaya jagung. Pupuk bio-organomineral (BIOM) merupakan pupuk perpaduan antara unsur mineral, organik dan hayati (mikroorganisme). Penelitian ini bertujuan untuk melihat pengaruh pupuk BIOM terhadap pertumbuhan jagung manis, serapan hara dan kesuburan tanah. Rancangan percobaan menggunakan Rancangan Acak Kelompok (RAK) dengan 10 perlakuan dengan 3 ulangan, terdiri dari: kontrol; 1 NPK; ½ BIOM; 1 BIOM; 1 NPK + ½ BIOM; 1 NPK + ¾BIOM; 1 NPK + 1 BIOM; ¾NPK + 1¼BIOM; dan ¾NPK + 1½BIOM. Pengaruh pupuk BIOM dengan 100% dosis dapat meningkatkan hasil tinggi tanaman, diameter batang dan diameter tajuk dengan nyata dibandingkan

Received: 11 February 2022, first revision: 11 May 2022, second revision: 17 May 2022, accepted: 10 June 2022.
DOI: 10.30556/imj.Vol25.No1.2022.1282

dengan kontrol. Pupuk BIOM berpengaruh nyata terhadap serapan N, N total, P-potensial, P-tersedia dan K-dd. Pupuk BIOM mampu memberikan hasil positif terhadap pertumbuhan jagung manis sehingga lebih efektif bagi ketersediaan unsur hara yang dibutuhkan oleh tanaman jagung manis.

Kata kunci: bio-organomineral, serapan hara, kesuburan tanah, jagung manis

INTRODUCTION

Sweet corn is one of the most popular horticultural commodities in Indonesia because its several advantages than that of the ordinary corn. Sweet taste of sweet corn is caused by the high sucrose levels in the endosperm in the corp. So the sweet corn has high in sugar and low in starch. After being picked and stored, the sugars in the kernel turns into starch (Yusuf, 2008). This causes the amount of sugar in sweet corn is twice as much as the ordinary corn. Sweet corn also has a shorter harvest life than that of the ordinary corn and the price is higher, so it is very profitable if cultivated but from productivity point of view, sweet corn in Indonesia is still relatively low.

Plant growth is influenced by various factors, including soil, temperature, light intensity, and nutrients. Nutrient management plays a crucial role in the yield and quality of sweet corn. Fertilization is one of the efforts to increase soil fertility. Fertilizer is a natural or artificial material added to soil that can increase soil fertility by adding one or more essential nutrients so that plant nutrient needs will be fulfilled and increasing plant production (Suwahyono, 2011).

Several minerals are source of nutrients, including potassium, phosphate, and magnesium. Plant nutrients can be supplied from bio-organo-mineral fertilizers (BIOM). The BIOM is a fertilizer which is a mixture of mineral, organic matter, and biological elements (microorganisms). The fertilizer is produced by the Research and Development Center for Mineral and Coal Technology (*tek*MIRA) and the Research Institute for Tea and Chincona. The minerals that contain potassium (K), magnesium (Mg), and phosphate (P) were taken from Central Java and Lampung, Indonesia. The results of the BIOM fertilizer quality test showed that the fertilizer had N - total of 13.38%, P_2O_5-total of 15.61%, K_2O-total of 11.70%, and moisture content of 13.33%. Such a fertilizer had met the criteria of the Ministry of Agriculture No. 209/KPTS/SR.320/3/2018 (Laboratorium Kimia UNPAD, 2021). This fertilizer has been tested for tea, rice, and sweet corn plants with satisfactory results in terms of growth and production (Pranoto, Saleh and Wulansari, 2018; Wulansari *et al.*, 2021).

This research was conducted on Inceptisol soil from Jatinangor. Inceptisol is one of the most widespread soil types in Indonesia, which is 70.52 million hectares (37.5%) and spread in the lowlands to highlands on the island of Java, Kalimantan, Sumatra, and Papua (Setyastika and Suntari, 2019). The corn plant used in this test is sweet corn, which is a secondary commodity and belongs to the grass family (Gramineae) of the genus Zea and the species *Zea mays L. Saccharate*. This study was intended to provide an overview of the independently treatment effects of BIOM fertilizer or in its combination with N, P, K on sweet corn (*Zea mays L. saccharata* Secada F1) on crop yields, N, P, K nutrient uptakes, and soil fertility.

METHOD

This research was carried out from September 2021 to December 2021 at the Experimental Field of the Laboratory of Soil Chemistry and Plant Nutrition, Faculty of Agriculture, Padjadjaran University, Jatinangor, Sumedang Regency, West Java, which is located at an altitude of 794m above sea level. The seeds of the sweet corn were variety "Secada F1". The soil type in the experimental garden is *Fluventic Eutrudepts* with the Inceptisols order, has the characteristics of volcanic ash as parent material, good soil drainage, and land use is dry land (Table 2).

Table 1. BIOM and NPK fertilizer treatments and dosages for sweet corn

	Treatment	BIOM Fertilizer (kg.ha-1)	NPK Fertilizer (kg.ha-1)		
			Urea	SP-36	KCl
A	Control	0	0	0	0
B	1 NPK (Standard)	0	300	150	100
C	½ BIOM	300	0	0	0
D	1 BIOM	600	0	0	0
E	1 NPK + ½ BIOM	300	300	150	100
F	1 NPK + ¾ BIOM	450	300	150	100
G	1 NPK + 1 BIOM	600	300	150	100
H	¾ NPK + 1¼ BIOM	750	225	112.5	75
I	¾ NPK + 1½ BIOM	900	225	112.5	75

Note: A) Standard N, P, K fertilizers are inorganic fertilizer treatments at local recommended doses for sweet corn (Urea 300 kg, SP-36 150 kg, and KCl 100 kg per hectare).
B) Treatment of the recommended dose of "BIOM" is given in accordance with the recommended dose of 600 $kg.ha^{-1}$,
C) Control treatment is no fertilization.

Table 2. Chemical and physical characteristics of Jatinangor Inceptisols

No	Parameter	Unit	Result	Criteria*
1	pH : H_2O	-	6.25	Acidic Medium
2	pH : KCl 1 N	-	4.49	
3	C-organic	%	2.35	Medium
4	N-total	%	0.23	Medium
5	C/N	-	10	Low
6	P_2O_5 HCl 25%	mg $100g^{-1}$	24.93	Medium
7	P_2O_5 (Bray/Olsen)	$ug.g^{-1}$	9.92	Medium
8	K_2O HCl 25%	mg $100g^{-1}$	23.88	Medium
9	Cations			
	K-exchangeable	$cmol.kg^{-1}$	0.44	Low
	Na-exchangeable	$cmol.kg^{-1}$	0.06	Low
	Ca-exchangeable	$cmol.kg^{-1}$	4.50	Medium
	Mg-exchangeable	$cmol.kg^{-1}$	1.77	Low
10	Soil Texture			
	Sand	%	55	
	Silt	%	34	Clay
	Clay	%	11	

Source: Laboratorium Kimia UNPAD (2021). Criteria * (Balai Penelitian Tanah, 2009).

This research was carried out using the experimental method. The experimental design was a Randomized Block Design consisted of 1 control treatment with doses of Urea, SP-36, and KCl, two treatments with variations of BIOM fertilizer doses, five combination treatments between doses of fertilizer and 1 as a control without fertilizer (Table 3) BIOM with Urea, TSP, and KCl fertilizers. Each treatment was repeated three times so that the total treatment in this research was nine treatments. The application of "BIOM" fertilizer, inorganic fertilizer N (Urea), P (SP-36), and K (KCl) was carried out by immersing ± 5 cm separately on the left and right sides of the plant. The distance between the planting hole and the fertilizer hole is 5 cm, with a depth of ± 5 cm.

The measured growth parameters of corn plants are:

1) Plant growth (plant height, number of leaves, canopy diameter, and stem diameter) were observed every two weeks from 14 DAP to 56 DAP.
2) Nutrient uptakes (N, P, and K). N uptake was determined by Kjeldahl method; P and K uptakes with wet ash method (Eviati, 2012). For plant uptake analysis, the plant part taken was in the form of leaves of sweet corn plants taken from the 4th leaf of 2-3 plants.

Table 3. Effect of BIOM and NPK fertilizer application on sweet corn growth at 56 DAP

	Treatment	Plant Height	Stem Diameter	Canopy Diameter	Number of Leaves
A	Control	173.7 a	25.58 a	194.5 a	10.4 a
B	1 NPK (Standard)	179.3 a	28.76 a	212.5 b	11.0 b
C	½ BIOM	191.6 b	32.67 b	210.5 a	11.3 b
D	1 BIOM	195.2 b	34.02 b	232.1 c	11.0 b
E	1 NPK + ½ BIOM	192.1 b	31.59 b	232.1 c	11.5 c
F	1 NPK + ¾ BIOM	191.1 b	33.39 b	220.4 b	11.1 b
G	1 NPK + 1 BIOM	186.3 b	30.28 b	220.2 b	11.6 c
H	¾ NPK + 1¼ BIOM	192.9 b	33.79 b	214.7 b	11.2 b
I	¾ NPK + 1½ BIOM	189.7 b	30.61 b	213.3 b	11.2 b

Note: Numbers followed by the same letter in the same row and column indicate that the treatment is not significantly different based on Duncan's multiple-distance test with a significance level of 0.05%.

3) Soil chemical properties (Total N - Kjeldahl method), Potential P and K (Extract HCl 25% method) and Available P (Bray method), Exchangeable-K (Extract NH_4Oac 1M, pH 7,0 method) (Eviati, 2012). The soil sample form each plots was taken as much as ±500g and was homogenized first for analysis of soil chemical properties and then analyzed in the laboratory according to the parameters tested.

Plant height, stem diameter, canopy diameter, and number of leaves observations were carried out every two weeks from 14 DAP to 56 DAP. Plant height was measured from the soil surface to the tip of the last leaf. Measurement of the diameter of the stems of corn plants was carried out by measuring the diameter at the center of the stem using a caliper. The number of leaves was carried out by counting the number of leaves of individual plant. Soil sampling for analysis was carried out at the maximum vegetative phase, at the age of 49-52 days after planting (DAP). All statistical analyses were done with the support of SPSS version 21 software with a 95% of confidence level.

RESULTS AND DISCUSSION

Growth of Sweet Corn Plants

1. Plant Height

Based on the results of statistical tests, it was showed that the application of BIOM in or combination with NPK fertilizer had a significant effect on the increase on all parameters (Table 1).

Based on Figure 1, at 28 DAP and 42 DAP, treatment D (1 BIOM) had the highest plant height compared to treatment. Sweet corn plants of 14 DAPs showed the lowest growth due to the new application of fertilizer and plants at 14 DAPs entered the stage of becoming a new plant or were in a slow growth phase, so that in that phase the plant roots had not yet developed and had not optimally absorbed nutrients in the soil but it already needs nutrients in order to grow optimally (Mahdiannoor, Istiqomah and Syarifuddin, 2016).

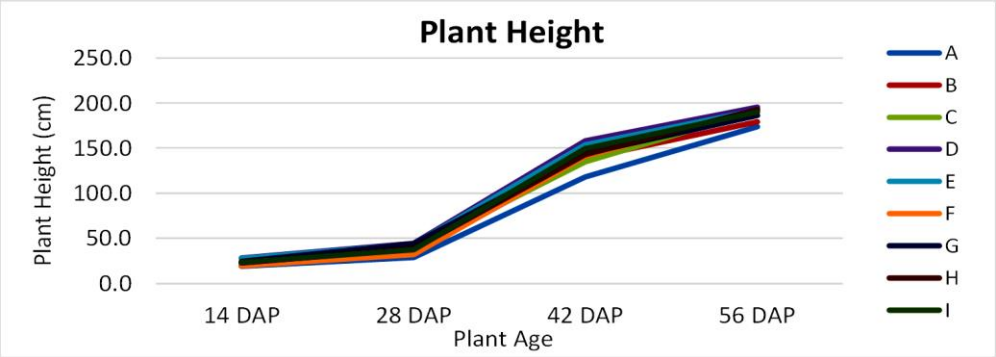

Figure 1. Effect of BIOM and NPK fertilizer on the height of the sweet corn plant at 14, 28, 42 and 56 DAP

The highest growth rate was indicated by treatment D (1 BIOM) at 14 DAPs to 56 DAPs, while control (A) showed the lowest growth rate among other treatments. At 56 DAP growth, 100% dose of BIOM gave the highest average value of 195.2 cm (Treatment D) and the lowest was 173.7 cm (Control). BIOM fertilizer contained mineral elements in the form of N, P, and K in addition to organic and biological elements. Organic matter acts as a soil amendment that can improve the physical, chemical, and biological properties of the soil (Roidah, 2013). Good soil physical properties allow plant roots to easily absorb nutrients in the soil so that the absorbed nutrients can be utilized properly by plants during the growth phase (Dermiyati *et al.*, 2016).

2. Stem Diameter
   Based on the results of ANOVA, it showed a significant difference in stem diameter at 56 DAPs (Table 1). Overall increasing the dose of BIOM fertilizer had a better increase in stem diameter than that of the control. The stem is one part of the plant that functions as a place for transporting nutrients which are then translocated by the phloem from the leaves to all plant tissues. The increase in the volume of stem diameter in sweet corn plants has begun to look different at the age of plants from 14 DAPs to 56 DAPs. Treatment 1 (¾ NPK + 1½ BIOM) gave the best results on the number of branches at the age of 42 DAPs with the highest average value of 29.7 mm and the lowest being 23.7 mm (control) at the age of 56 DAPs. The highest stem diameter by treatment D (1 BIOM) which was 34.02 mm. BIOM fertilizer contains complete N, P, and K. It is suspected that the availability of potassium elements can function for plants to strengthen stems and circulate carbohydrates in plants, accelerate the metabolism of nitrogen, and prevent flowers and fruit from falling easily (Ibrahim and Kasno, 2008). The results of the research by Puspadewi, Sutari and Kusumiyati (2016); N, P, K fertilizers are needed for plant growth, especially in stimulating the formation of plant height and enlargement of stem diameter.

3. Canopy Diameter
   Based on the results of statistical tests with a 95% confidence level, it showed that there was significant difference in the canopy diameter on all treatments (Table 1). The growth of the canopy diameter of sweet corn in each treatment had a different pattern (Figure 3). The diameter of the canopy increased with increasing from 14 DAP to 56 DAP. The control treatment at the age of 56 DAP had the lowest canopy diameter among other treatments was 194.5 mm, while the highest canopy diameter results were treatment D (1 BIOM) and treatment E (1 NPK + BIOM) which was 232.1 cm. The application of BIOM fertilizer single or in combination with NPK fertilizer was able to increase the canopy diameter.

   According to Rop *et al.* (2019), the growth of the canopy diameter is related to the availability of nitrogen (N). Nitrogen absorption by corn plants takes place during its growth, therefore the N is needed in large quantities at each stage of its growth, especially at the vegetative growth stage, such as shoot formation or stem and leaf development (Wirayuda and Koesriharti, 2020).

4. Number of Leaves
   Application of BIOM fertilizer caused a significant effect on the number of leaves parameters on all treatments at 14 DAP to 56 DAP (Table 1). The highest number of leaves was in the treatment G (1 NPK + 1 BIOM) was 11.6 leaves and the least number of leaves was in the control treatment was 10.4 leaves at the age of 56 DAP. This is in line with the yield of plant height, stem diameter, and canopy diameter. Application of BIOM fertilizer was able to show the highest number of leaves due to the availability of important macro-mineral elements (N, P, and K) needed by the plants.

   The stress of nutrient requirements for the growth of the sweet corn is nitrogen which is important in increasing plant vegetative growth (Pane, Sabrina and Lubis, 2018). An overview of the development of the growth of the number of leaves can be seen in Figure 4. The application of various doses of BIOM fertilizer and the application of single N, P, K fertilizer independently showed the number of leaves of corn plants was more than the treatment without fertilizer application (control). According to Soegito (2003), the

greater the amount of available nitrogen, the greater the number of photosynthetic yields to the optimum which in turn will affect the number of plant leaves. Good leaf growth certainly supports the growth and yield of sweet corn plants (Puspadewi, Sutari and Kusumiyati, 2016).

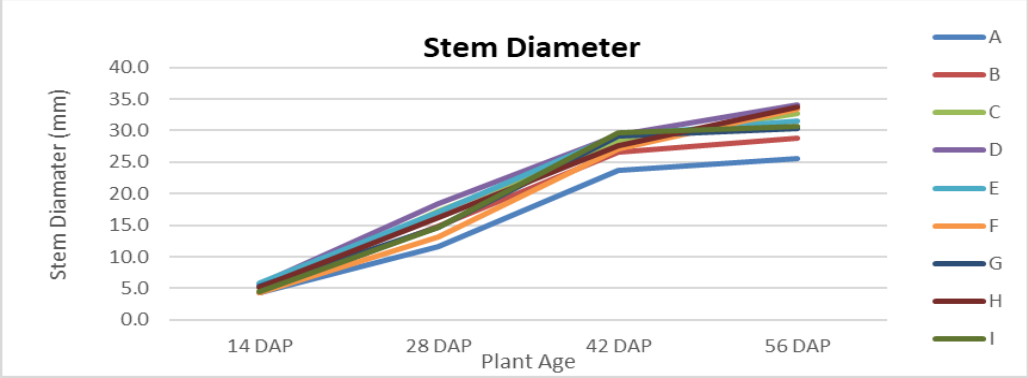

Figure 2. Effect of BIOM and NPK fertilizer on sweet corn stem diameter at 14, 28, 42 and 56 DAP

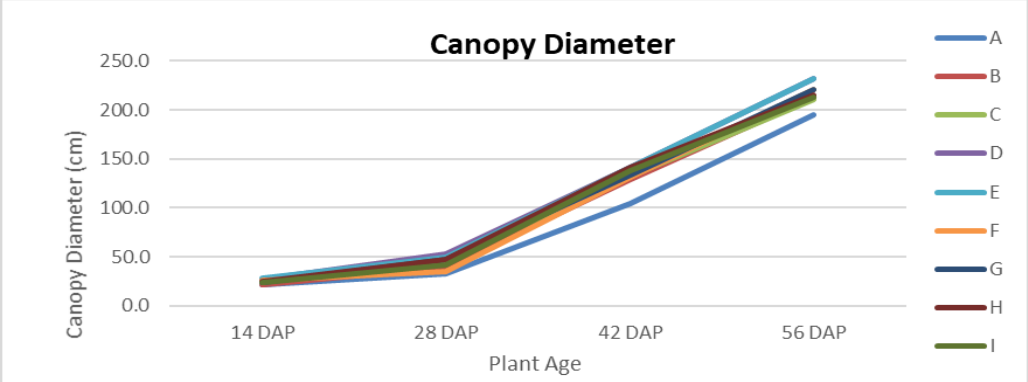

Figure 3. Effect of BIOM and NPK fertilizer on sweet corn canopy diameter at 14, 28, 42 and 56 DAP

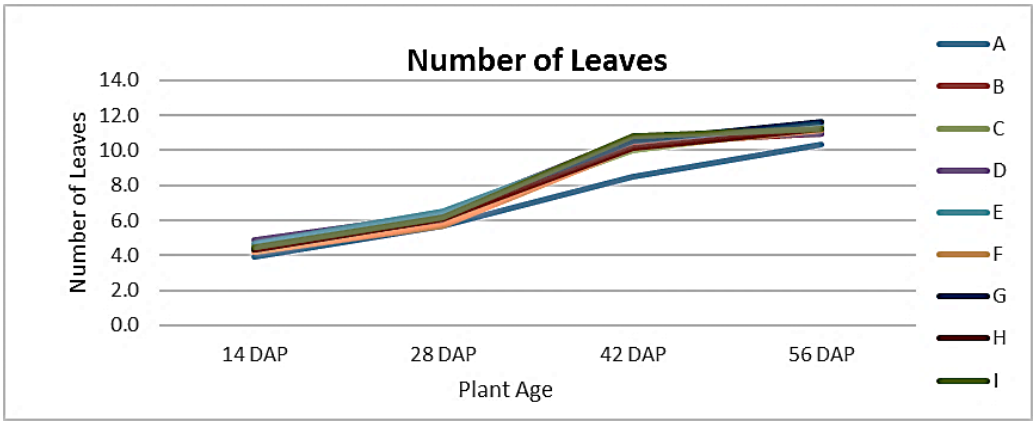

Figure 4. Effect of BIOM and NPK fertilizer on sweet corn number of leaves at 14, 28, 42 and 56 DAP

Nutrient Uptakes of N, P, and K

The experimental results showed that plants received inorganic fertilizers containing the elements N, P, and K had an effect on nutrient uptake of nitrogen, phosphorus, and potassium per plant (Table 4). Plant uptake analysis was carried out to see the effectiveness of BIOM fertilizer in providing nutrients to be absorbed by sweet corn plants through the roots.

Based on the data in Table 4, results of statistical analysis showed that there was no difference in the effect of treatment on P and K plant uptake. The application of BIOM increased the yield of N nutrient uptake by sweet corn plants. The highest N nutrient uptake is in treatment E (1 NPK + ½BIOM) of 3.33 gr plant^{-1}. This is caused the organomineral fertilizers with organic and biological additions showed superior results than the single fertilizers in increasing N, P, K, Ca, so that it is easily available to plants compared to the fertilizers that are easily leached from single fertilizer (Ipinmoroti, Adeoye and Iremiren, 2007).

Agsari *et al.* (2020) stated that the application of fertilizers containing N elements is not only a source of N nutrients for plants, but it can play a role in releasing ions in the soil. Soil has bound minerals which when released can become available nutrients for plants. The application of high N fertilizers can increase the concentration of N in the soil in the form of NH_4^+, so that Ca^{2+}, Mg^{2+}, Fe^{3+}, Mn^{2+}, and Na^+ ions will be replaced with NH^{4-} in soil colloids. The release of these ions from the soil colloid, it will be available and can be absorbed by plants through a mass flow mechanism. Mass flow process is a process of movement of nutrients in the soil to the surface of plant roots through mass movement of water, nutrient uptake of N occurs through a mass flow process because N nutrients have mobile properties that are easy to move. Nutrient N is absorbed by roots in the form of NO^{3-} , the amount of NO^{3-} movement in mass flow is influenced by several factors, including soil water content and potential, soil porosity, and transpiration (Dermiyati *et al.*, 2016).

Treatment A (control) obtained the lowest N, P, and K nutrient uptake compared to the other treatments with N uptake of 2.73 gr. plant$^{-1,}$ P-uptake of 0.18 gr.plant^{-1} and K-uptake of 1,60 g.plant^{-1}. Corn plant growth that is not optimal can be due to lack of nutrient absorption, resulting in nutrient deficiency, yellow leaves due to lack of chlorophyll, non-optimal fruit development, stunted root, and abnormal seed development (Kaya, 2012).

Soil Fertility

The treatment of various doses of BIOM fertilizer significantly affected the total N, P-potential, P-available, K-potential, and K-exchangeable in the soil compared to the control (Table 5). Nutrients that are needed in large quantities (macro nutrients) include elements of N, P, and K. The BIOM treatment caused differences in the percentage of N, P, and K content in the soil. The balanced fertilization is very important to get the maximum results, both on plant and soil quality (Lahay, Sipayung and Sabrina, 2019).

Table 4. Effect of BIOM and NPK fertilizer on N, P, and K nutrient uptakes in the sweet corn

Treatments		N Uptake	P Uptake	K Uptake
			gr/plant	
A	Control	2.73 a	0.18 a	1.60 a
B	1 NPK (Standard)	3.24 b	0.20 a	1.74 a
C	½ BIOM	3.31 b	0.20 a	1.70 a
D	1 BIOM	3.30 b	0.21 a	2.09 b
E	1 NPK + ½ BIOM	3.33 b	0.21 a	1.70 a
F	1 NPK + ¾ BIOM	3.08 a	0.20 a	1.98 a
G	1 NPK + 1 BIOM	3.18 b	0.21 a	1.87 a
H	¾ NPK + 1¼ BIOM	3.08 a	0.20 a	1.84 a
I	¾ NPK + 1½ BIOM	3.21 b	0.20 a	1.89 a

Note: Numbers followed by the same letter in the same row and column indicate that the treatment is not significantly different based on Duncan's multiple-distance test with a significance level of 0.05%.

Tabel 5. Effect of BIOM and NPK fertilizer on soil chemical analysis

Treatment		Soil Chemical Analysis				
		Total-N (%)	P-potential ($mg.100g^{-1}$)	P-available (ppm)	K-potential ($mg/100g^{-1}$)	K-exchangeable ($cmol.kg^{-1}$)
A	Control	0.13 a	32.38 a	4.86 a	27.33 a	0.34 a
B	1 NPK (Standard)	0.15 a	52.80 a	6.32 a	31.50 a	0.40 a
C	½ BIOM	0.15 a	45.23 a	8.99 a	35.13 a	0.38 a
D	1 BIOM	0.18 b	52.65 a	12.45 b	55.44 b	0.72 b
E	1 NPK + ½ BIOM	0.19 b	46.70 a	11.94 b	39.41 a	0.49 a
F	1 NPK + ¾ BIOM	0.16 a	56.75 b	10.34 b	41.34 b	0.40 a
G	1 NPK + 1 BIOM	0.19 b	57.70 b	11.37 b	56.39 b	0.57 a
H	¾ NPK + 1¼ BIOM	0.18 b	56.01 b	11.25 b	53.41 b	0.59 b
I	¾ NPK + 1½ BIOM	0.16 a	42.90 a	11.32 b	39.91 a	0.45 a

Note: Numbers followed by the same letter in the same row and column indicate that the treatment is not significantly different based on Duncan's multiple-distance test with a significance level of 0.05%

Effect of BIOM fertilizer on soil fertility can be seen in Table 5. The plant control were without BIOM, Urea, SP-36 or KCl fertilizers, so that the sweet corn plants in the plots absorbed nutrients in the soil and no additional nutrients were added. According to Mahdiannoor, Istiqomah and Syarifuddin (2016) roots of corn at the age of 14-28 days after planting (DAT) began to develop and absorbed nutrients in the soil in the early vegetative phase. Other factors that can reduce N in the soil are denitrification, volatilization, leaching, and soil surface erosion (Tando, 2019).

The application of BIOM fertilizer with 100% dosage tends to increase the total N, P-potential, P-available, K-potential, and K-exchangeable content in the soil. This is due to the addition of nitrogen, phosphorus, and potassium nutrients to the soil due to the application of fertilizers containing these elements, but the addition of too high N fertilizers does not increase the yields but actually reduces the efficiency of N fertilizer (Hartatik and Adiningsih, 2003).

Phosphorus (P) is the second essential element after N which plays an important role in photosynthesis and root development (Ginting, Saraswati and Husen, 2006). Phosphorus is absorbed in the form of H_2PO^{4-} ions and is mobile in plants. Element P is not like element N which is easily lost in the soil, the element P is an element that is not mobile so that the presence of a fertilizer coating does not have much effect on phosphorus coating. Taufiq and Sundari (2012) stated that the phosphorus loss generally occurs in acid soils that have high Fe and Al content due to the fixation. In some circumstances, elemental P is also rapidly converted in the form of P-organic by soil microbial activity (Hebbar *et al.*, 2004).

Nutrient K is a macro nutrient for plants that is needed in large quantities after N and P. Potassium has a role in plant metabolic processes. The element is often lost due to leaching and is in an unavailable form because it is bound by clay minerals. Therefore, it is expected that the availability of K nutrients will always be available in the soil so that later it will be absorbed by plants in the form of K^+ ions.

CONCLUSION

Based on the results of the research on the application of BIOM fertilizer to sweet corn (*Zea mays* L. *saccharata*) it can be concluded that the application of BIOM showed that the effect of giving BIOM at 100% dose could significantly increase sweet corn yields compared to controls. The contribution of N nutrient uptake to increase sweet corn yield was more than P_2O_5 and K_2O nutrients at 3.33 g/plant. BIOM fertilizer had a significant effect on the total N, P-potential, P-available, K-potential and K- exchangeable in the soil. The application of BIOM fertilizer is able to provide significant results so that it is more effective for the availability of nutrients needed by sweet corn plants.

ACKNOWLEDGMENT

The authors would like to thank the Research and Development Centre for Mineral and Coal Technology for the funds given to this research projects.

REFERENCES

Agsari, D., Utomo, M., Hidayat, K. F. and Niswati, A. (2020) 'Respon serapan hara makro-mikro dan produksi tanaman jagung (Zea mays L.) terhadap pemupukan nitrogen dan praktik olah tanah jangka panjang', *Journal of Tropical Upland Resources (J. Trop. Upland Res.)*, 2(1), pp. 46–59. doi: 10.23960/jtur.vol2no1.2020.78.

Balai Penelitian Tanah (2009) *Petunjuk teknis: Analisis kimia tanah, tanaman, air dan pupuk*. 2nd edn. Balai Besar Litbang Sumber Daya Lahan Pertanian.

Dermiyati, Utomo, S. D., Hidayat, K. F., Lumbanraja, J., Triyono, S., Ismono, H., Ratna, N. E., Putri, N. T. and Taisa, R. (2016) 'Pengujian pupuk organonitrofos plus pada jagung manis (Zea mays saccharata. L) dan perubahan sifat kimia tanah ultisols', *Journal of Tropical Soils*, 21(1), pp. 9–17.

Eviati, S. (2012) *Analisis kimia tanah, tanaman, air dan pupuk*. 2nd edn. Jakarta: Badan Penelitian dan Pengembangan Pertanian.

Ginting, R. C. B., Saraswati, R. and Husen, E. (2006) 'Mikroorganisme pelarut fosfat', in Simanungkalit, R. . D. M. et al. (eds) *Pupuk Organik dan Pupuk Hayati*. Bogor: Balai Besar Litbang Sumberdaya Lahan Pertanian, pp. 141–158.

Hartatik, W. and Adiningsih, J. S. (2003) 'Evaluasi rekomendasi pemupukan NPK pada lahan yang mengalami pelandaian produktivitas (levelling off)', in *Prosiding Seminar Nasional Inovasi Teknologi Sumberdaya Tanah dan Iklim*. Bogor: Pusat Penelitian dan pengambangan Tanah dan Agroklimat, pp. 17–36.

Hebbar, S. ., Ramachandrappa, B. ., Nanjappa, H. . and Prabhakar, M. (2004) 'Studies on NPK drip fertigation in field grown tomato (Lycopersicon esculentum Mill.)', *European Journal of Agronomy*, 21(1), pp. 117–127. doi: 10.1016/S1161-0301(03)00091-1.

Ibrahim and Kasno, A. (2008) 'Interaksi pemberian kapur pada pemupukan urea terhadap kadar N tanah dan serapan N tanaman jagung (Zea mays. L)', in *Jagung: Teknik Produksi dan Pengembangan*. Semarang: Balai Penelitian Tanaman Pangan, pp. 313–327.

Ipinmoroti, R. R., Adeoye, G. O. and Iremiren, G. O. (2007) 'Soil nutrient dynamics as influenced by organomineral fertilizers and tea seedlings nutrient uptake in Nigeria', *International Journal of Tea Science*, 6(3), pp. 25–29.

Kaya, E. (2012) 'Pengaruh pemberian bokashi ela sagu dan pupuk ABG bunga-buah terhadap N-tersedia, serapan-N, serta hasil tanaman jagung (Zea mays L.) pada inceptisol', *Jurnal Budidaya Pertanian*, 8(2), pp. 89–94.

Laboratorium Kimia UNPAD (2021) *Analisis kimia di Laboratorium Kesuburan Tanah dan Nutrisi Tanaman*. Bandung.

Lahay, R. R., Sipayung, R. and Sabrina, T. (2019) 'The growth and yield of sweet corn (Zea mays saccharata Sturt.) with anorganic and organo-bio fertilizer', *IOP Conference Series: Earth and Environmental Science*, 260(1), p. 012156. doi: 10.1088/1755-1315/260/1/012156.

Mahdiannoor, Istiqomah, N. and Syarifuddin (2016) 'Aplikasi pupuk organik cair terhadap pertumbuhan dan hasil tanaman jagung manis', *Ziraa'ah*, 41(1), pp. 1–10.

Pane, I. E., Sabrina, T. and Lubis, A. (2018) 'Perbaikan sifat kimia tanah inceptisol serta pertumbuhan kedelai akibat pemberian kompos diperkaya cangkang telur dan zeolit', *Jurnal Agroekoteknologi*, 6(2), pp. 379–388.

Pranoto, E., Saleh, R. and Wulansari, R. (2018) 'The influence of mineral-based compound fertilizer (CFC) on the health and production of tea plant clone GMB 7', *AGRIVITA Journal of Agricultural Science*, 40(2), pp. 338–349. doi: 10.17503/agrivita.v40i2.709.

Puspadewi, S., Sutari, W. and Kusumiyati, K. (2016) 'Pengaruh konsentrasi pupuk organik cair (POC) dan dosis pupuk N, P, K terhadap pertumbuhan dan hasil tanaman jagung manis (Zea mays L. var Rugosa Bonaf) kultivar talenta', *Kultivasi*, 15(3), pp. 208–216. doi: 10.24198/kultivasi.v15i3.11764.

Roidah, I. S. (2013) 'Manfaat penggunaan pupuk organik untuk kesuburan tanah', *Jurnal Universitas Tulungagung BONOROWO*, 1(1), pp. 30–42.

Rop, K., Karuku, G. N., Mbui, D., Njomo, N. and Michira, I. (2019) 'Evaluating the effects of formulated nano-NPK slow release fertilizer composite on the performance and yield of maize, kale and capsicum',

Annals of Agricultural Sciences, 64(1), pp. 9–19. doi: 10.1016/j.aoas.2019.05.010.

Setyastika, U. S. and Suntari, R. (2019) 'Pengaruh aplikasi bokashi terhadap dinamika ketersediaan N, P, dan S pada inceptisol Karangploso, Malang', *Jurnal Tanah dan Sumberdaya Lahan*, 6(2), pp. 1291–1299. doi: 10.21776/ub.jtsl.2019.006.2.10.

Soegito (2003) *Teknik bercocok tanam jagung*. Yogyakarta: Kanisius.

Suwahyono, U. (2011) *Petunjuk praktis penggunaan pupuk organik secara efektif dan efisien*. Jakarta: Penebar Swadaya.

Tando, E. (2019) 'Upaya efisiensi dan peningkatan ketersediaan nitrogen dalam tanah serta serapan nitrogen pada tanaman padi sawah (Oryza sativa L.)', *Buana Sains*, 18(2), pp. 171–180. doi: 10.33366/bs.v18i2.1190.

Taufiq, A. and Sundari, T. (2012) 'Respons tanaman kedelai terhadap lingkungan tumbuh', *Buletin Palawija*, (23), pp. 13–26.

Wirayuda, B. and Koesriharti (2020) 'Pengaruh pemberian pupuk organik dan pupuk anorganik terhadap pertumbuhan dan hasil tanaman jagung manis (Zea mays L. var. saccharata)', *Jurnal Produksi Tanaman*, 8(2), pp. 201–209.

Wulansari, R., Athallah, F. N. F., Pranoto, E., Maryono, Darmawan, D. A. and Supriyanto, B. A. (2021) 'Growth and production of tea plant (Camellia sinensis (L.) O Kuntze) after pruning with bio-organomineral ameliorant', *Indonesian Mining Journal*, 24(2), pp. 85–92. doi: 10.30556/imj.Vol24.No2.2021.1235.

Yusuf, K. (2008) *Studi segregasi warna dan bentuk biji pada jagung manis melalui hibridisasi silang tunggal*. Universitas Lampung.