EFFECT OF THE COMBINATION OF BIOFERTILIZER AND N, P, K FERTILIZER ON C-ORGANIC CONTENT, TOTAL BACTERIA, HUMIC ACID, AND SWEET CORN RESULTS IN JATINANGOR INCEPTISOLS

ABSTRACT

Beneficial microorganisms are found in biofertilizers, which can assist in boosting the soil's availability of N, P, and K and promote plant growth. This study aims to ascertain the impact and optimal combination of biofertilizer and N, P, K fertilizers for sweet corn yields, total bacteria, humic acid, and C-organic yields. With 1 control treatment, 2 doses of N, P, K fertilizer, and 6 combinations of N, P, K fertilizer and biofertilizer, the method used Randomized Completely Block Design (RCBD). Three times each, the treatment was given. The findings indicated that biofertilizer and N, P, K fertilizer significantly differed with control treatment in organic C, total bacteria, humic acid, and sweet corn yields. Combining biofertilizer with N, P, and K fertilizer increased organic C, total bacteria, and humic acid by 1.08%, 124.67×10^7, and 2.74%, respectively. With a dose of 1 liquid biofertilizer and ¾ N, P, K fertilizers, sweet corn can be grown up to 11,80 kg $plot^{-1}$, a 59% increase over the suggested amount of N, P, K fertilizer. The result of this study showed that the best yields of organic C, total bacteria, humic acid, and sweet *corn were obtained with a dose of ¾ N, P, K and 1 biofertilizer, ¾ N, P, K and 1 ½ biofertilizer, and 1 N, P, K and 1 ½ biofertilizer.*

Keywords: *Biofertilizer;* N, P, and K Fertilizers*, Inceptisols Jatinangor*

INTRODUCTION

Fertilization is one of the activities in plant cultivation that aims to increase the nutrient content in the soil (Pangaribuan et al., 2017). Fertilization using inorganic fertilizers or chemical fertilizers in Indonesia has increased since the implementation of the green revolution movement in the 1970s. FAO data for 2017 shows that Indonesia is listed in the 20 countries with the world's largest use of N and P fertilizers (FAO, 2019). Farmers more widely use this inorganic fertilizer because it is easy to obtain, more practical, more efficient application, and can increase plant growth quickly.

Inorganic fertilizers continuously have positive and negative impacts on soil fertility and environmental health. The negative impacts that can be caused are reduced soil organic matter content, damaged soil structure, and decreased soil microbial populations (Herdiyantoro, 2015; Chen et al., 2016;). This is because chemical fertilizers that plants do not absorb can leave residues in the soil and become toxic to the soil and plants if left unchecked. This residue will cause soil compaction and acidity until the soil becomes infertile. Infertile soil will impact decreasing soil microbes, nutrient imbalances, and the emergence of pests and plant diseases (Syamsiah and Abdurofik, 2016). An effort is needed to optimize the use of inorganic fertilizers, one of which is biofertilizers.

Biofertilizers are active biological products consisting of microbes and function in providing nutrients directly or indirectly, breaking down organic matter, increasing fertilization efficiency, and increasing soil fertility and health (Permentan No. 1 of 2019). Biofertilizers can be applied directly to the soil, combined with organic matter, or to seeds (Sriwahyuni and Parmila, 2019). Biofertilizers containing various microbes such as Azospirillum, Azotobacter, Bacillus, Pseudomonas, and BPF applied at 60% recommended doses of N, P, K are known to increase the bacterial population in soil up to 54.9 x 107 cfu/ml; These microbes play a role in breaking down organic matter and increasing the availability of nutrients in the soil (Pangaribuan et al., 2017). The existence of biological fertilizers can increase plant productivity by binding N in the air, dissolving P and K elements, producing growth hormones, decomposition of soil organic waste residues, and controlling plant diseases (Sriwahyuni and Parmila, 2019).

Biofertilizers are also useful for improving soils with low soil fertility, including Inceptisol soil (Kalay et al., 2020). Inceptisol soils generally have low organic matter content, slightly acidic pH, moderate organic-C content, and low N, P, and K nutrients (Widodo and Kusuma, 2018). The application of biological fertilizers is known to increase soil C-organic content, serving as an energy source for microorganisms. Microbes need as much as 88% of carbon compounds for growth and the remaining 12% to produce energy (Spohn et al., 2016). The process of decomposing organic matter carried out by microbes will produce humic acids whose existence can improve soil fertility by improving the soil's physical, chemical, and biological properties and can minimize nutrient loss due to leaching or evaporation (Hartatik and Sarmah, 2013). Biofertilizers are also known to reduce the dosage of recommended N, P, and K applications by as much as 50%. It can increase sweet corn yields by up to 13.85% compared to using inorganic fertilizers alone (Sofatin et al., 2016).

The research objective was to determine the effect of a combination of liquid biofertilizers and N, P, K on C-organic, total bacteria, humic acid, and sweet corn yields in Inceptisols Jatinangor.

MATERIALS AND METHODS

This experiment was carried out from July to October 2022 at the Experimental Garden. The Laboratory of Soil Chemistry and Plant Nutrition, Department of Soil Science and Land Resources, Faculty of Agriculture, University of Padjadjaran analyzed liquid and soil biofertilizers.

The materials used were liquid biological fertilizer, urea, SP-36, KCl, and the soil of the Inceptisol order from Jatinangor, F1 hybrid sweet corn seed of the Talenta variety. Various chemicals needed, such as 1 N $K_2Cr_2O_7$, concentrated H_2SO_4, diphenylamine indicator, 0.5 N FeSO4 for C-Organic analysis; nutrient agar (N.A.) for analysis of total bacteria, and a mixture of $Na_2P_2O_7$ and NaOH (10:1), 4 N HCl, 0.1 N H_2SO_4, 96% alcohol for humic acid analysis.

The tools used in this experiment were hoes, analytical balance, caliper, ruler, meter, emrat, stationery, centrifuge, shaker, autoclave, vortex, pH meter, shake the bottle, centrifugation bottle, pipette, test tube, measuring cup, beaker chemistries, and petri dishes.

This experiment was carried out using a Randomized Completely Block Design (RCBD), which consisted of 1 control treatment (without fertilizer application), 2 treatments with N, P, K fertilizer doses, and 6 combination treatments of liquid biological fertilizers with N, P, K fertilizers (Table 1).

Table 1. Arrangement of Trial Treatment

Symbol	Treatment	Fertilizer Measurement			
		Biofertilizers	Urea	SP-36	KCl
		$L.ha^{-1}$	$kg.ha^{-1}$		
A	Control	0	0	0	0
B	1 N, P, K	0	300	150	100

C	¾ N, P, K	0	225	112,5	75
D	¾ N, P, K + ½ biofertilizers	2,5	225	112,5	75
E	¾ N, P, K + 1 biofertilizers	5	225	112,5	75
F	¾ N, P, K + 1 ½ biofertilizers	7,5	225	112,5	75
G	1 N, P, K + ½ biofertilizers	2,5	300	150	100
H	1 N, P, K + 1 biofertilizers	5	300	150	100
I	1 N, P, K + 1 ½ biofertilizers	7,5	300	150	100

Information:

- Control treatment is without liquid biological fertilizers and N, P, and K fertilizers.
- The recommended dose of liquid biofertilizer is 5 L ha-1 which refers to research by Sofyan et al. (2019)
- The recommended N, P, K treatment is a single inorganic fertilizer treatment based on the recommended dose for sweet corn according to the Agricultural Research and Development Word (2016) (recommended single fertilizer dose of 300 kg ha^{-1} urea, 150 kg ha^{-1} SP-36 and 100 kg ha^{-1} KCl.

Experimental data will be processed statistically using Fisher's test at 5% significance level using the SPSS application. If the effect is significant, the test is continued with Duncan's Multiple Range Test at 5% significance level.

The experiment began with minimum tillage and making 27 2 x 3 m plots. Then the initial soil analysis was carried out by taking soil samples diagonally on the experimental land. Preliminary soil analysis aims to determine the actual soil's physical, chemical and biological properties. The spacing of sweet corn used was 75x25 cm, so there were 32 planting holes in each experimental plot. Each planting hole is then filled with two sweet corn seeds.

Urea was applied 14, 28, and 42 days after planting, while SP-36 and KCl were applied 7 and 14 days after planting. Biofertilizers were applied three times at 7, 14, and 28 days after planting. Maintenance includes watering, weeding, replanting, and controlling pests and plant diseases. At 14, 28, 42, and 56 days after planting, plant height (cm) and stem diameter (mm) were observed.

Soil samples for analysis were taken 48 days after planting when the plants reached their maximum vegetative state. Soil samples were taken diagonally around the plant roots in each experimental plot. C-organic analysis was performed using the Walkey-Black method, humic acid extraction using NaOH, and total bacterial counts using the Total Plate Count (TPC) method. Sweet corn is harvested when the plants are 80 days after planting.

RESULTS AND DISCUSSION

A. Supporting Observations

1. Preliminary Soil Analysis

Inceptisol soil has a slightly acidic pH with a value of 6.09. The size of the pH value in the soil can affect plant growth and development. The pH value can indicate the presence of toxic elements in plants, such as Al elements in acid soils (Tarigan et al., 2019). The presence of Al in acid soils will bind phosphorus nutrients making it difficult for plants to make them available.

The nutrient content of N, P, K in Inceptisol soil was 0.20% N-total (low); 46.20 $mg.100g^{-1}$ P_2O_5 (high); 63.16 mg.100 g^{-1} K_2O (very high); 1.81% C-organic (low). C/N is low, with a value of 9. The composition of these soil cations varies from moderate to high, sequentially from the moderate category, namely Na-dd (0.43 $cmol.kg^{-1}$) and Ca-dd (6.93 $cmol.kg^{-1}$), then the high category K-dd (0.89 $cmol.kg^{-1}$) and Mg-dd (4.36 $cmol.kg^{-1}$). Cation Exchange Capacity is in the moderate category, namely 17.87 cmol.kg^{-1}; base saturation showed a high value of 70.56%. Preliminary soil analysis showed that Inceptisols had a clay texture with a composition of 8% sand, 24% silt, and 67% clay. Clay is characterized by being heavier, very sticky, able to form perfect balls, and feels very hard when dry (Mulyono et al., 2019). This soil texture characteristic has more pore space, so its ability to absorb water is quite high (Kusuma and Yulfiah, 2018).

Based on initial soil biological analysis, soil microbial content it included populations of Azotobacter, Azospirillum, and phosphate-solubilizing bacteria. Successively starting from the population of Azotobacter 0.38x108 CFU.g^{-1}, 0.21x108 CFU.g^{-1}, to phosphate solvent bacteria 1.42x108 CFU.g^{-1}. The presence of these soil microbes can help improve soil fertility and increase the availability of nutrients. The number of Inceptisol soil microbes can be increased by applying biofertilizers.

2. Data on Temperature, Humidity, Rainfall, and Sunlight

The Padjadjaran University Climatology Station observed the climatic conditions during the trial period. Climatic conditions that can be monitored include temperature, humidity, rainfall, and sunlight intensity. The average monthly temperature in Jatinangor from July to October ranges from 22°-22.7°C (Table 2). This temperature range corresponds to the temperature required for corn plants to grow optimally, which ranges from 21°-34°C (Agricultural Technology Assessment Agency, 2009).

The temperature factor can affect the availability of water in the soil, which assists the process of photosynthesis and plant respiration (Herlina and Prasetyorini, 2020).

Table 2 shows that the highest humidity throughout the corn planting period was in July, with 89% humidity, and the lowest was in August, with 86% humidity. This humidity value meets corn growth requirements, which require humidity between 80-90%. Monthly rainfall from July to September ranges from 26.5-62 mm/month. This value does not meet the optimal sweet corn plant growth requirements, ranging from 100-140 mm $month^{-1}$ (Agricultural Technology Assessment Agency, 2009).

Table 2. Data on temperature, humidity, rainfall, and sunshine for July - October 2022

Bulan	Temperature (°C)	Rainfall (mm)	Humidity (%)	Sunlight (%)
July	22,5	62	89	83
August	22,0	26,5	86	87
September	22,4	48,5	87	78
October	22,7	360	91	58

Source: Padjadjaran University Climatology Station (2022)

3. Attack of Plant Pest Organisms (OPT)

Plant-disturbing organisms (OPT) are animals or plants whose existence disturbs, inhibits, or even kills cultivated plants. OPT attacks are divided into pests, diseases, and weeds. According to Megasari and Nuriyadi (2019), pests and diseases are the main factors that hinder the stability of crop production in tropical and subtropical regions. Weeds in cultivated plants can interfere with plant growth and production through competition for water, light, and nutrients (Padang et al., 2017).

Field observations showed that there were pest attacks caused by locusts (*Locusta migratoria*) and armyworms (*Spodoptera frugiperda*) (Figure 1). Grasshoppers are polyphagous pests that have many host plants. This allows locusts to live in a variety of vegetation and growing periods. The presence of locusts on sweet corn plants will cause damage, namely, the edges of the leaf blade with holes. Leaf damage will impact reducing leaf surface area and disrupt the physiological functions of the attacked plants (Nelly, 2022). The level of damage caused by locusts during the planting period of sweet corn is relatively mild and can still be controlled by taking and then throwing the locusts elsewhere. Control is also carried out by clearing the planting area of weeds because weeds can be a food source for the locusts to survive (Sudewi et al., 2020).

The armyworm is a leaf-eating polyphagous pest and one of the main pests of sweet corn. Symptoms of armyworm attack found during the planting period of sweet corn were randomly perforated leaves. This pest can cause up to 85% damage to corn plants and even crop failure (Muliani et al., 2022). Control of this pest attack is done manually (technically) by taking caterpillars that are in the leaves and stems. This is because the attack intensity is <5%, so it is not too detrimental (Sofyan et al., 2019)

(a) Belalang (*Locusta migratoria*)

(b) Ulat Grayak (*Spodoptera frugiperda*)

Figure 1. Plant Pest Organisms (Pests)

Weeds that grew a lot during the planting period of sweet corn were thorn amaranth (*Amaranthus spinosus*) and bribil (*Galinsoga parviflora*) (Figure 2). Efforts to control weeds are carried out by pulling weeds manually or using cored and then immersing them back into the soil as green manure. Weeding is mainly carried out during the critical period of the corn crop, which is 21-28 days after planting, so that plant growth is not disturbed (Padang et al., 2017).

(a) Bayam Duri (*Amaranthus spinosus*) (b) Bribil (*Galinsoga parvifora*)

Figure 2. Weeds on Sweet Corn Plants

4. Nutrient Deficiency Symptoms

Deficiency symptoms seen in corn plants are symptoms of nitrogen deficiency. This symptom is indicated by the yellowing of the leaves, forming a V shape (Figure 3). Symptoms of nitrogen deficiency were found in corn plants that were not given N, P, K, or biological fertilizers (control). A lack of nutrients in the soil causes deficiency symptoms. N nutrient deficiency can cause slow growth and stunted plants (Andita et al., 2019).

5. Plant height

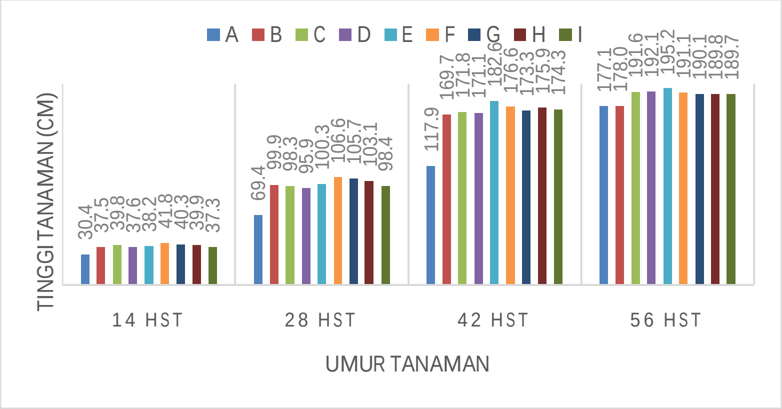
Plant height is often observed because it relates to plant genetics, plant adaptability, soil nutrients, and other growth factors (Oktaviani et al., 2020). The availability of optimal nutrients in the soil affects plant height so that plants do not grow stunted.

Sweet corn plant height increased from 14 to 56 days after planting in all treatments. Figure 4 shows that fertilization can increase plant height compared to the control treatment (without fertilization). The supply of nutrients not obtained by control treatment resulted in insufficient availability of nutrients in the soil for plant growth. In the vegetative phase of plants, nutrient N is needed and has an important role in increasing plant height (Sofyan et al., 2019).

At 14 days after planting, the ¾ N, P, K, and 1 ½ biofertilizers treatments had the highest plants, 41.8 cm. SP-36 and KCl applied 7 days after planting were sufficient for plant growth because the elements P and K play a more important role in the generative phase of the plant. Growth in plant height 14 days after planting in all treatments was relatively uniform and began to vary 28 days after planting. At 14 days after planting, corn plants are still in the vegetative phase (10-18 days after planting) and only have seminal roots, so nutrients are absorbed in small amounts (Subekti et al., 2008).

Sweet corn plants treated with ¾ N, P, K fertilizer and 1 ½ biofertilizers also showed the highest plant height at 28 days after planting, 106.6 cm. Sweet corn will absorb nutrients in large quantities in this vegetative phase (18-35 days after planting) (Subekti et al., 2008). The high dose of biofertilizers can help provide more nutrients than other biofertilizers. Treatment of ¾ N, P, K, and ½ biofertilizers at 28 days after planting showed lower plant height than applying N, P, and K fertilizers. This was because the biofertilizers given in low doses could not meet the nutrient requirements plants need.

The fulfillment of the need for essential nutrients in photosynthesis impacts the process of cell elongation, cell division, and cell differentiation (Sugiono and Sugiarto, 2021). Applying ¾ N, P, K, and 1 biofertilizers 42 and 56 days after planting resulted in the highest plant stands of 182.6 cm and 192.5 cm, respectively. Research by Sofyan et al. (2019) showed that plants treated with ¾ N, P, K, and 1 biofertilizers had higher stands than the combination of the same doses of N, P, K with a lower dose of biofertilizers. At 42 days after planting, the sweet corn plants reached the maximum vegetative phase, so there was no significant increase in plant height at 56 days after planting.



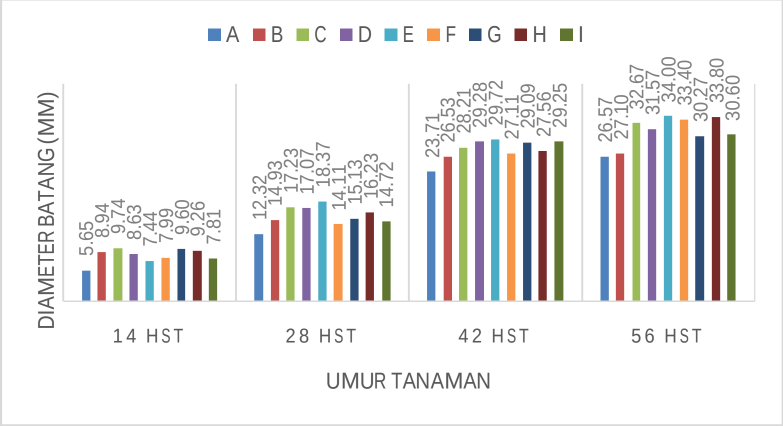
Keterangan: Perlakuan A (control); B (1 N, P, K); C (¾ N, P, K); D (¾ N, P, K + ½ biofertilizers); E (¾ N, P, K + 1 biofertilizers); F (¾ N, P, K + 1 ½ biofertilizers); G (1 N, P, K + ½ biofertilizers); H (1 N, P, K + 1 biofertilizers); I (1 N, P, K + 1 ½ biofertilizers).

Figure 4. Histogram of Sweet Corn Height Growth

The combination of N, P, K fertilizers and biofertilizers with appropriate doses can create optimal conditions for plant growth. The application of N, P, K fertilizers serves to add nutrients to the soil in large quantities, while biofertilizers can help increase the availability of nutrients and produce plant growth hormones such as auxin and gibberellins through the activity of microorganisms (Fitriatin et al., 2021; Kalay et al., 2020). This hormone can affect plant growth by increasing nutrient absorption through the roots so that the process of photosynthesis can run well. Research by Syamsiah and Abdurofik (2016) shows that a combination of N, P, K fertilizers and biofertilizers can increase plant height growth compared to the application of N, P, K or biofertilizers alone.

6. Stem Diameter

Stems in plants serve as a place for attachment of plant parts as well as a place for the passage of water and nutrients from roots to leaves or vice versa. Growth in stem diameter requires adequate nutrition so that the process of transporting nutrients can be carried out optimally. Sturdy and large stems will help the plant not to be easily knocked over by strong winds.



Keterangan: Perlakuan A (control); B (1 N, P, K); C (¾ N, P, K); D (¾ N, P, K + ½ biofertilizers); E (¾ N, P, K + 1 biofertilizers); F (¾ N, P, K + 1 ½ biofertilizers); G (1 N, P, K + ½ biofertilizers); H (1 N, P, K + 1 biofertilizers); I (1 N, P, K + 1 ½ biofertilizers).

Figure 5. Histogram of Sweet Corn Stem Diameter Growth

Nutrients are factors that influence plant growth. In the early vegetative phase, nutrients are used for plant growth; in the late vegetative phase, they are used for stem diameter growth (Puspadewi et al., 2016). The results showed that stems with the highest diameter values 14 days after planting were found in the ¾ N, P, K treatment. At 28, 42, and 56 days after planting, the combination treatments of ¾ N, P, K, and 1 biofertilizer were combined. Applying KCl fertilizer helps meet the needs of the element potassium in the soil, which forms sturdy and large stems (Mutaqin et al., 2021). The control treatment without applying N, P, K, and biofertilizers showed the lowest stem diameter growth in all observational data.

Growth in stem diameter can affect the corn cobs produced, starting from the cobs' length, diameter, and weight (Puspadewi et al., 2016). This is because the size of the stem diameter affects the transport of nutrients in plants. In line with the research of Yassen et al. (2019), the combination of ¾ N, P, K and biofertilizers produced the highest diameter (2.4 cm) and the highest cob weight (211.58 g) compared to doses of ¼ N, P, K + biofertilizers and ½ N, P, K + biofertilizers respectively (2.11 cm, 187.70 g) and (2.22 cm, 197.33 g). It was strengthened by Sofyan et al. (2019) that the size of the stem diameter is directly proportional to the cross-section of the nutrient transport network, so the larger the stem diameter, the better the translocation rate of nutrients.

Main Observations

The results of the research on the effect of a combination of liquid biofertilizers and N, P, and K fertilizers on C-organic content, total bacteria, and humic acid levels are presented in Table 3.

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Table 3. Effect of Combination of Liquid Biofertilizer and N, P, K Fertilizer on Soil C-Organic Content, Total Bacteria and Humic Acid Levels

Symbol	Treatment	C-Organik (%)	Total Bakteria (CFU.g^{-1})	Humic Acid (%)
A	Control	1,23 a	11,00 x 10^7 a	2,09 a
B	1 N, P, K	1,67 ab	18,33 x 10^7 ab	2,46 ab
C	¾ N, P, K	1,70 ab	16,00 x 10^7 ab	2,35 ab
D	¾ N, P, K + ½ biofertilizers	1,75 b	58,33 x 10^7 bc	3,27 abc
E	¾ N, P, K + 1 biofertilizers	2,31 c	70,67 x 10^7 c	3,81 cd
F	¾ N, P, K + 1 ½ biofertilizers	1,91 bc	135,67 x 10^7 d	4,83 d
G	1 N, P, K + ½ biofertilizers	1,76 b	64,67 x 10^7 c	3,50 bc
H	1 N, P, K + 1 biofertilizers	1,74 b	72,00 x 10^7 c	3,15 abc
I	1 N, P, K + 1 ½ biofertilizers	1,84 bc	77,33 x 10^7 c	3,56 bc

Note: The mean number followed by the same letter in each column is not significantly different based on Duncan's Multiple Range Test at the 5% level.

1. C-organic

The results showed that applying N, P, K fertilizers and biofertilizers increased soil organic C content compared to control treatments and N, P, K fertilizers alone. Table 3 shows the application of ¾ N, P, K, and 1 biofertilizers was significantly different from the control and N, P, K treatment but not significantly different from the ¾ N, P, K, and 1 ½ biofertilizers applications and 1 N, P, K and 1 ½ biofertilizers. The C-organic content in the ¾ N, P, K, and 1 biofertilizers treatment was 2.31%; this value was higher than the control treatment, which only had 1.23% organic-C content. The absence of microorganisms added from biofertilizers in the control treatment resulted in the minimal activity of microorganisms in the soil, affecting C-organic levels. The organic matter in the soil will be used as a food source for the heterotrophic microorganisms in it so that the C-organic content in the soil without fertilizer application will be lower (Setiawati et al., 2020).

N, P, K fertilizers combined with biofertilizers can increase the C-organic value to 0.64% of a single N, P, K fertilizer application. This increase in C-organic levels will positively affect soil fertility (Setiawati et al., 2020). Adding biofertilizers to the soil helps to increase the number of microorganisms so that the process of decomposing organic matter in the soil will increase. In line with the research of Setiawati et al. (2020) application of biofertilizers can increase C-organic levels by up to 0.8% from the treatment of N, P, and K fertilizers alone.

The application of ¾ N, P, K with 1 ½ biofertilizers and 1 N, P, K with 1 ½ biofertilizers showed a lower C-organic value than the application of ¾ N, P, K and 1 biofertilizers. Combining ¾ N, P, K with 1 ½ biofertilizers and 1 N, P, K with 1 ½ biofertilizers had C-Organic content of 1.91% and 1.84%, respectively, respectively. This low C-organic value can be caused by the presence of microorganisms around the rhizosphere, which have higher activity, so carbon absorption is also higher (Setiawati et al., 2020). Another factor that causes a low C value in the soil is the process of plant respiration (Astari et al., 2016).

2. Total Bacteria

The statistical analysis results showed that the application of ¾ N, P, K, and 1 biofertilizers had a significantly different effect on the total bacterial population of all treatments. Applying N, P, K and biofertilizers can increase the total bacterial population to 135.67x107 CFU.g^{-1}. The higher the dose of biofertilizers given, the total bacterial population will increase. In line with the research of Gou et al. (2020) that the application of biological fertilizers can increase the number and biodiversity of bacteria in the soil.

Treatment with fertilizer doses of ¾ N, P, K, and 1 ½ biofertilizers had a higher total bacterial population than other treatments. Combining the two gave the best effect by producing a total bacterial population of 135.67x107 CFU.g^{-1}. The lowest total bacterial population of 11x107 CFU.g^{-1} was found in the control treatment without fertilizer application. The absence of nutrient intake from N, P, and K fertilizers and microorganisms from biofertilizers is a factor in the low total bacterial population in the control treatment. This aligns with Cahyani et al. (2021), stating that microorganisms will compete with plants for nutrients without nutrients.

The data in Table 3 shows that the application of various doses of N, P, and K, either in combination with or without biofertilizers, gave a higher total bacterial population than the control. Pangaribuan et al. (2017) stated that the application of inorganic fertilizers affects the growth and yield of sweet corn and microbial activity. Applying biofertilizers with the highest doses has a total bacterial population superior to other biofertilizers. The density of microbial cells from the applied biofertilizers will affect the viability and competitiveness of natural microbes (Subandi et al., 2016).

3. Humic Acid

Application of N, P, K, and biofertilizers can increase humic acid levels in the soil. Statistical analysis showed a significant difference between ¾ N, P, K and 1 ½ biofertilizers with humic acid levels in the control treatment and N, P, K fertilizers but not significantly different from ¾ N, P, K and 1 biofertilizer. The presence of humic acids in the soil can help increase soil fertility so crop production can occur optimally.

Table 3 shows that applying N, P, and K fertilizer alone or combined with biofertilizers has higher levels of humic acid than the control treatment (without fertilizer application). Combining N, P, K, and biofertilizers can increase humic acid levels to 2.74% of the control treatment. Adding 1 ½ biofertilizers at a dose of ¾ N, P, K has a humic acid content of 4.83%. This value is higher than the application of ¾ N, P, K, which only has a humic acid content of 2.35%. The combination of various doses of N, P, K with 1 ½ biofertilizers had higher humic acid levels than the combination with lower biofertilizer doses; respectively, the humic acid levels were ¾ N, P, K with 1 ½ biofertilizers and 1 N, P, K with 1 ½ biofertilizers, namely 4.83% and 3.56%.

The performance of microorganisms in the decomposition process of organic matter influences the high content of humic acid in the soil. In line with Lestari and Sukri (2020), humic acid in the soil results from overhauling living things in the form of plants or animals carried out by microorganisms. Humic acid in treatment 1 biofertilizer with 1 N, P, K showed a lower value than the other combination doses of biofertilizers and N, P, K. Humic acids in the soil are known to be lost through washing processes or degraded into compounds with lower molecular weights such as fulvic acid (Hartatik and Sarmah, 2013).

Fertilization not only provides nutrient intake but can also increase soil organic matter content (Andita et al., 2019). A comparison of 1 N, P, K, and ½ biofertilizers with ¾ N, P, K, and ½ biofertilizers shows that the application of 1 N, P, K, and ½ biofertilizers has higher levels of humic acid. The application of urea as a single nitrogen fertilizer can increase plant biomass. Plant biomass will affect the increase in soil organic matter so that humic acid levels will increase. Furthermore, Andita et al. (2019) showed that the applied urea fertilizer increased the humic acid content in the soil by up to 5.34%.

The presence of humic acid in the soil is also influenced by other soil chemical properties such as C-organic, pH, and total N (Mulyani et al., 2021). C-organic soil has an important role because the weathering of organic matter will produce humus (Setiawati et al., 2020). The biggest component of the humus is a humic compound consisting of fulvic acid, humic acid, and humin (Firdausi et al., 2016). Humic acids in the soil can improve soil fertility, increase plant growth, and reduce the solubility of Fe^{2+} (Lestari and Sukri, 2020).

4. Yield Components of Sweet Corn Plants

Plant cultivation results in an accumulation of various factors, such as seeds, soil, and applied fertilizers. Sweet corn with a large cob weight and full seeds is a criterion for sweet corn in great demand. The results of the sweet corn plants observed in this study included cob weight, cob weight with husk and without husk, cob length, and cob diameter, which can be seen in Table 4.

Table 4. Effect of Combination of Liquid Biofertilizer and N, P, K Fertilizer on Yield Components of Sweet Corn Plan

Symbol	**Treatment**	Cob weight (kg/plot)	Cob weight with husk **(g)**	Cob weight without husk **(g)**	Cob Length (cm)	Cob Diameter (mm)
A	Control	4,74a	316,13a	201,3a	19,10 a	43,56a
B	1 N, P, K	7,41b	369,27b	236,00b	19,77ab	46,37b
C	¾ N, P, K	6,84ab	371,07b	250,10bc	19,83ab	46,47b
D	¾ N, P, K + ½ biofertilizers	8,28bc	397,27bc	263,10cd	19,93ab	49,23c
E	¾ N, P, K + 1 biofertilizers	11,80d	419,20c	283,10d	21,77c	50,03c
F	¾ N, P, K + 1 ½ biofertilizers	10,23cd	409,07bc	268,90cd	20,53b	49,56c
G	1 N, P, K + ½ biofertilizers	9,33bc	396,73bc	266,40cd	19,87ab	49,27c
H	1 N, P, K + 1 biofertilizers	8,74bc	394,47bc	272,00cd	20,33b	49,60c
I	1 N, P, K + 1 ½ biofertilizers	8,85bc	404,27bc	267,60cd	20,37b	49,11c

Note: The mean number followed by the same letter in each column is not significantly different based on Duncan's Multiple Range Test at the 5% level.

Table 4 shows the combination of N, P, and K fertilizers and various doses of biofertilizers that can increase cob weight per plot, cob weight, peeled cob weight, cob length, and cob diameter. The highest values for all parameters were found in applying ¾ N, P, K, and 1 biofertilizers. Based on the statistical analysis results, ¾ N, P, K, and 1 biofertilizers had a significantly different effect on cob weight per plot but not significantly different from the application of ¾ N, P, K, and 1 ½ biofertilizers. The control treatment without applying N, P, K, and biofertilizers showed the lowest values for all parameters observed.

The cob weight per plot in the treatment without applying N, P, K, and biofertilizers only weighed 4.74 kg, while the highest cob weight per plot was in the application of ¾ N, P, K, and 1 biofertilizers with a weight of 11.80 kg. Biological fertilizers containing beneficial microorganisms can help increase the availability of nutrients so plants can absorb them (Supriyono et al., 2022). The use of biofertilizers containing *Azotobacter* can produce growth hormones such as auxin and gibberellin. In contrast, *Azospirillum* can produce IAA hormones that stimulate root and root hair growth to expand nutrient absorption (Subandi et al., 2016).

The availability of nutrients N, P, and K in the soil also affects plant metabolic processes. The formation of proteins, carbohydrates, and starch from plant metabolism in forming seeds will increase the maximum size and weight (Puspadewi et al., 2016). Table 4 shows the application of various doses of biofertilizers has a significant effect on the weight of the cob husks and the weights of the cobs. The highest cob weight and peeled cobs were found in the combination of ¾ N, P, K, and 1 biofertilizers, respectively, 419.20 grams and 283.1 grams. At lower doses of biofertilizers, the combination of 1 N, P, K with ½ biofertilizers showed a 3.3 grams cob weight higher than the combination of ¾ N, P, K, and ½ biofertilizers.

The size of the cob weight of corn husks can be affected by the increase in cob length, which allows the formation of more corn kernels. In line with the study's results, the highest cob weight was found in ¾ N, P, K, and 1 biofertilizers, with the highest cob length being 21.77 cm. Applying ¾ N, P, K and 1 of this biofertilizer also had a significantly different cob length compared to other treatments. Various dose combinations of N, P, K, and biofertilizers showed higher cob length and weight than control and single N, P, K fertilizers. This is because the process of filling the seeds on the cobs is strongly influenced by the nutrients absorbed by the plants (Puspadewi et al., 2016). Nutrients absorbed by plants will accumulate in the leaves to form proteins that produce seeds.

Cob diameter and cob length were greater in the treatment of ¾ N, P, K, and 1 biofertilizers with cob diameter values of 50.03 mm and cob length of 21.77 cm. Cob diameter and length increase due to applying N, P, and K fertilizers and biofertilizers. Based on the statistical analysis, biofertilizers at various doses significantly affected cob diameter compared to the control treatment and N, P, and K fertilizers alone. The results showed that biofertilizers could reduce the use of N, P, and K fertilizers by up to 25%. In line with the research of Arifin et al. (2021) that the combination of inorganic fertilizers and biofertilizers can increase fertilization efficiency by up to 14.86%.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on the results of the research, the following conclusions can be drawn:

1. Combining biofertilizers and N, P, K fertilizers can increase C-organic, total bacteria, humic acid, and sweet corn yields in Inceptisols Jatinangor.
2. Doses of 1-1 ½ biofertilizers and ¾ N, P, K and 1 biofertilizer and 1 N, P, K are best for increasing C-organic, total bacteria, humic acid, and sweet corn yields in Inceptisols Jatinangor.

Suggestion

Organic fertilizers should accompany the application of biofertilizers to increase the total bacterial population in the soil. Adding organic matter is expected to increase carbon as an energy source for microbes and increase C-organic, which affects the availability of humic acid.

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