# Effect of the Combination of Liquid Biofertilizers and N, P, K Fertilizer on Soil N-Total, N Uptake, N-Fixing Bacteria and Sweet Corn (*Zea mays* L. Saccharata) Results in Fluventic Eutrudepts

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***Abstract—*** *Liquid biofertilizers containing one of the bacteria Azospirillum sp. which plays a role in overcoming soil fertility problems due to excessive use of inorganic fertilizer and provides nutrients to stimulate growth and optimize crop yields. This experiment was conducted to determine the effect combination of liquid biofertilizers with N, P, K fertilizer on various treatments on N-total Soil, N uptake, N fixing bacteria and yield of sweet corn (Zea mays L. saccharata) on Fluventic Eutrudepts. This experiment was carried out using a randomized block design (RBD) consisting of one control treatment or without fertilizer application, 2 treatment of N, P, K fertilizer and 6 combination treatment of liquid biofertilizers with N, P, K fertilizer. Each treatment was repeated three times. The results showed that the application of liquid biofertilizers combined with N, P, K fertilizer had an effect on N-total soil, N uptake, and N-fixing bacteria populations as well as sweet corn yields. The combination dose of 1 liquid biofertilizers (5 L.ha$^{-1}$) with ¾ N, P, K fertilizer (225 kg.ha$^{-1}$ Urea, 112.5 kg.ha$^{-1}$ SP-36, 75 kg.ha$^{-1}$ KCl) gave the best results on N-total soil (1.33%), N uptake (3.46 mg.plant$^{-1}$), N-fixing bacteria (1.33 x 108 CFU.g$^{-1}$) and yield of sweet corn (Weight cob per plot 11.6 kg, cob weight 423.5 g, cob weight without cob 334.7 g, cob diameter 52.79 mm, and cob length 23.9 cm.*

***Keywords— Combination, Liquid Biofertilizers, Sweet Corn, Fluventic Eutrudepts.***

## I. INTRODUCTION

The availability of nutrients in the soil is the main factor to determine the success of plant cultivation. Nutrients have an important role in increasing the yield and quality of plants. The availability of nutrients in the soil is able to maintain a balance of nutrients so that plant productivity is optimal with fertilization (Wulansari et al., 2022).

The main problem in agriculture is the decline in the quality of agricultural soil which causes low agricultural productivity due to degradation of soil fertility. This is due to excessive and uncontrolled use of inorganic fertilizers by farmers. According to Iwuagwu et al. (2016) the continuous use of inorganic fertilizers can result in damage to the physical, chemical and biological properties of the soil so that the level of soil fertility decreases. This is supported by the research of Pangaribuan et al. (2019) that excessive application of inorganic fertilizers to the soil can affect environmental factors, soil quality and cause reactions in the soil such as P fixation, NO3 and N2O volatilization. Inorganic fertilizers can also reduce soil organic matter levels to <2.00% and damage the soil structure.

Solutions to increase the value of agricultural production can be done by preserving agricultural resources, strategies and appropriate efforts such as utilizing biofertilizers. Bio-fertilizers contain symbiotic bacteria (Rhizobium) and non-symbiotic bacteria (Azotobacter and Azospirillum) which correlate with each other in improving soil fertility and increasing crop yields (Fadiluddin, 2019). This is in line with the statement of Setiawati et al. (2020) that the bacterial content in biofertilizers is able to provide nutrients and increase crop yields. Bacteria *Azospirillum* sp. is one of the bacteria that can fix nitrogen and can produce the hormone Indole Acetid Acid (IAA) as a soil aggregate stabilizer and stimulate plant growth (Eckert et al., 2001). The agricultural sector utilizes *Azospirillum* sp. optimally formulated as a special carrier material for biofertilizers in increasing nutrient availability and increasing plant productivity.

Basically, biofertilizers cannot fully optimize the availability of nutrients in the soil, because they are accompanied by the provision of inorganic fertilizers N, P and K in balanced doses so that they have an effect on plant growth and yields. According to Rop et al. (2019) N and P nutrients are needed by plants in the growth process to be precise in the vegetative phase while K nutrients are needed in the generative phase.

This study also used sweet corn (Zea mays L. saccharata) as an indicator in supporting the successful use of a combination of liquid biofertilizers with N, P and K fertilizers. Sweet corn of the Talenta variety is a plant that has a high sugar content of 13-15 obrix while in Ordinary corn has a sugar content of 2-3% (Sukur & Rifianto, 2014). The productivity of sweet corn in Indonesia in 2018 averaged 8.31 t.ha-1 while the yield potential of sweet corn was able to reach 14-18 t.ha-1 (Rinanti et al., 2021). Based on these results indicate that the low productivity of sweet corn is caused by several things, namely the limitations of sweet corn cultivation due to soil fertility problems and pest and disease attacks.

The aim of the study was to determine the effect of a combination of liquid biofertilizers and N, P, K fertilizers on soil N-total, N uptake, N fixing bacteria and sweet corn (Zea mays L. saccharata) yields in Fluventic Eutrudepts.

## II. RESEARCH METHODS

The field experiment was carried out at the Soil Chemistry and Plant Nutrition Laboratory Experimental Garden, Faculty of Agriculture, Padjadjaran University, Jatinangor sub-District, Sumedang Regency 〖(6〗^0 54'56,4"S) and 〖(107〗^0 46'16,9 "E) with an altitude of 794 m above sea level. Initial analysis of soil, biofertilizers, and sweet corn plants was carried out at the Laboratory of Soil Chemistry and Plant Nutrition (KTNT), Department of Soil Science and Land Resources, Faculty of Agriculture, Padjadjaran University, Jatinangor District, Sumedang Regency, West Java. This experiment was conducted from June to September 2022.

The materials used in this experiment include the Inceptisol order soil which belongs to the Fluventic Eutrudepts sub-group. Results of initial soil chemical analysis, results of initial soil biological analysis, and description of Fluventic Eutrudepts), Talenta variety hybrid sweet corn seeds, Liquid biological fertilizer derived from Azospirillum sp. bacteria, Standard N, P, K fertilizer consisting of a single Urea fertilizer (46% N), SP-36 (36% $P_2O_5$), and KCl (60% $K_2O$), $H_2SO_4$, NaOH, distilled water, Conway indicators, chemical and biological materials used for analysis of soil N-total values, N uptake and N-fixing bacteria.

The tools used in this experiment included digital scales, zip plastic, hoes, calipers, stationery, observation diaries, documentation tools, rulers and equipment in the laboratory to analyze soil-total N, N uptake, analysis of N-fixing bacteria.

This experiment was carried out using a Randomized Block Design (RBD), which consisted of 9 treatments, namely: without fertilizer application (A), 2 treatments with N, P, and K fertilizer doses (B and C) with 6 treatments combined with liquid biofertilizers N, P, and K. (D, E. F. G, H. I).

**TABLE 1**
**ARRANGEMENT OF TRIAL TREATMENT**

| Symbol | Treatment | FERTILIZER MEASUREMENT | | | |
|---|---|---|---|---|---|
| | | Organic fertiliser | UREA | SP-36 | KCl |
| | | L.ha$^{-1}$ | kg.plot$^{-1}$ | | |
| A | Control | 0 | 0 | 0 | 0 |
| B | 1 N, P, and K | 0 | 300 | 150 | 100 |
| C | ¾ N, P, and K | 0 | 225 | 112.5 | 75 |
| D | ½ biofertilizers + ¾ N, P, and K | 2.5 | 225 | 112.5 | 75 |
| E | 1 biofertilizers + ¾ N, P, and K | 5 | 225 | 112.5 | 75 |
| F | 1 ½ biofertilizers + ¾ N, P, and K | 7.5 | 225 | 112.5 | 75 |
| G | ½ biofertilizers + 1 N, P, and K | 2.5 | 300 | 150 | 100 |
| H | 1 biofertilizers + 1 N, P, and K | 5 | 300 | 150 | 100 |
| I | 1 ½ biofertilizers + 1 N, P, and K | 7.5 | 300 | 150 | 100 |

***Note:***

- ***Control treatment is treatment without liquid and inorganic N, P and inorganic fertilizers K.***
- ***Dosage Treatment The recommendation for one dose of liquid biofertilizers is 5 L.ha$^{-1}$ which refers to Trinurani Research et al., (2019).***
- ***The recommended N, P, K treatment is the single recommended dose of inorganic fertilizer treatment for Sweet Corn according to the Agricultural Research and Development Katam, 2016 (recommended single dose of fertilizer 300 kg.ha$^{-1}$ Urea, 150 kg.ha$^{-1}$ SP-36, 100 kg.ha$^{-1}$ KCl).***

Data analysis was carried out using variance and follow-up tests with Duncan's Multiple Range Test (DMRT) at 5% significance level.

## III. RESULTS AND DISCUSSION

### 3.1 Supporting Data

#### 3.1.1 Preliminary Soil Analysis

The results of analysis at the Laboratory of Soil Chemistry and Plant Nutrition (2022) showed that the soil in the experimental land had a slightly acidic soil pH of 6.26, medium C-organic content (2.08%), low total N (0.13 %), C/N ratio is low (11), K2O is very high (65,08 mg.100g$^{-1}$), $P_2O_5$ very low (1,07 mg.100g$^{-1}$), KTK moderate (18,11 cmol.kg$^{-1}$) and moderate base saturation (67,47%). Based on this, it shows that Fluventic Eutrudepts soil has very low to moderate soil fertility, so efforts are needed to increase soil fertility.

The results of the analysis of physical properties showed that the soil in the experimental area was classified as clay with a ratio of 8% sand, 20% silt and 72% clay respectively. The results of the analysis of biological properties in the experimental field showed that the content of the bacterium Azotobacter chrococum was 0,38 x $10^8$ CFU.g$^{-1}$, *Azospirillum* 0,21 x $10^8$ CFU.g$^{-1}$, and solubilizing bacteria F of 1,42 x $10^8$ CFU.g$^{-1}$. This shows that the population of *Azospirillum* bacteria belongs to the low category so that efforts are needed to increase the population of *Azospirillum* bacteria, one of which is by administering biofertilizers.

#### 3.1.2 Data on Rainfall, Temperature, Humidity and Sunlight

Weather data is calculated from the start of the month until the end of the study, namely June to September. Rainfall, temperature, humidity and solar radiation data for June - September 2022 can be seen in the table 2.

**TABLE 2**
**RAINFALL, TEMPERATURE, HUMIDITY AND SUNSHINE DATA FOR JUNE - SEPTEMBER 2022**

| Month | Total Rainfall (mm) | Average Temperature (ºC) | Average Humidity (%) | Sunlight (%) |
|---|---|---|---|---|
| June | 169,5 | 22,4 | 91 | 64 |
| July | 62,0 | 22,5 | 89 | 83 |
| August | 26,5 | 22,0 | 86 | 87 |
| September | 48,5 | 22,4 | 87 | 78 |

- ***Source: Padjadjaran University Climatology Station (2022)***

Based on the data in Table 2, the highest average rainfall occurs in June of 169.5 mm while the lowest average rainfall occurs in August of 26.5 mm, the highest average temperature occurs in July of 22,5ºC while the lowest average temperature occurred in August of 22.0ºC, the highest average relative humidity level occurred in June of 91% while the lowest average relative humidity occurred in August of 86%, and the average the highest average solar irradiance occurs in August by 87% while the lowest average solar irradiance occurs in June by 69 mm.

#### 3.1.3 Attack of Plant Pest Organisms (OPT)

Based on observations at the time of planting, it was found that pests that attacked sweet corn plants were armyworms (*Spodoptera litura*) and grasshoppers (*Locusta* sp.). Armyworm and grasshopper pest attacks cause damage to some corn crops (mild).

**(a)** **(b)**

**FIGURE 1: Plant Pest Organisms (Pests)**

Based on the results of observations, it was found that weeds that grew when planting sweet corn were weeds and jotang (*Acmella paniculata*) and spinach thorns (*Amaranthus spinosus* L).

**(a)** **(b)**

**FIGURE 2: Plant Disturbing Organisms (Weeds)**

### 3.1.4 Symptoms of Nutrient Deficiency

**(a)** **(b)**

**FIGURE 3: Symptoms of Nutrient Deficiency**

Based on the results of observations in the field, it was found that there were symptoms of N nutrient deficiency in sweet corn plantations, specifically in treatment A (control). Symptoms of this nutrient deficiency are characterized by chlorosis, namely the color of the leaves of the sweet corn plant turns yellow at the tips of the leaves and extends to the leaf veins. These nutrient deficiency symptoms arise due to the low supply of nutrients to the soil used for observation.

The results of the research and analysis can be seen in Table 3 and the histogram of plant height growth can be seen in Figure 4. Observations of plant height during the study showed that there were various differences from the administration of a combination of liquid biofertilizers with inorganic fertilizers N, P and K starting from 14 days after planting (DAP) to 56 DAP.

### 3.1.5 Plant Height

**TABLE 3**
**EFFECT OF COMBINATION OF LIQUID BIOFERTILIZERS WITH INORGANIC FERTILIZERS N, P, AND K ON PLANT HEIGHT**

| Symbol | Treatment | Plant height (cm) | | | |
|---|---|---|---|---|---|
| | | 14 HST | 28 HST | 42 HST | 56 HST |
| A | Control | 28,4 | 43,4 | 106,8 | 130,1 |
| B | 1 N, P, and K | 39,9 | 102,3 | 168,8 | 178,0 |
| C | ¾ N, P, and K | 37,5 | 99,7 | 166,1 | 189,7 |
| D | ½ biofertilizers + ¾ N, P, and K | 37,3 | 98,1 | 164,6 | 192,1 |
| E | 1 biofertilizers + ¾ N, P, and K | 46,6 | 109,9 | 178,9 | 208,9 |
| F | 1 ½ biofertilizers + ¾ N, P, and K | 40,3 | 105,7 | 169,5 | 192,3 |
| G | ½ biofertilizers + 1 N, P, and K | 37,6 | 98,3 | 169,3 | 189,8 |
| H | biofertilizers + 1 N, P, and K | 39,9 | 100,3 | 166,7 | 191,1 |
| I | 1 ½ biofertilizers + 1 N, P, and K | 38,2 | 99,9 | 165,1 | 191,6 |

Based on the data in Table 3, the results showed that the application of a combination of liquid biofertilizers with inorganic fertilizers N, P, and K gave the best results for the growth of the height of sweet corn plants. The highest results in the observation of plant height growth were achieved by treatment E (1 biological fertilizer + ¾ fertilizer N, P, and K) namely 46.6 cm (14 DAP), 109.9 cm (28 DAP), 17891 cm (42 DAP), and 208.9 cm (56 HST). The high growth of sweet corn during the vegetative period is influenced by a balanced nutrient content in the soil (Wahyudin et al., 2019). This is in line with the statement of Setiawati et al. (2021) that the height of the sweet corn plant is said to increase gradually according to the age of the plant with optimal fertilizer application.

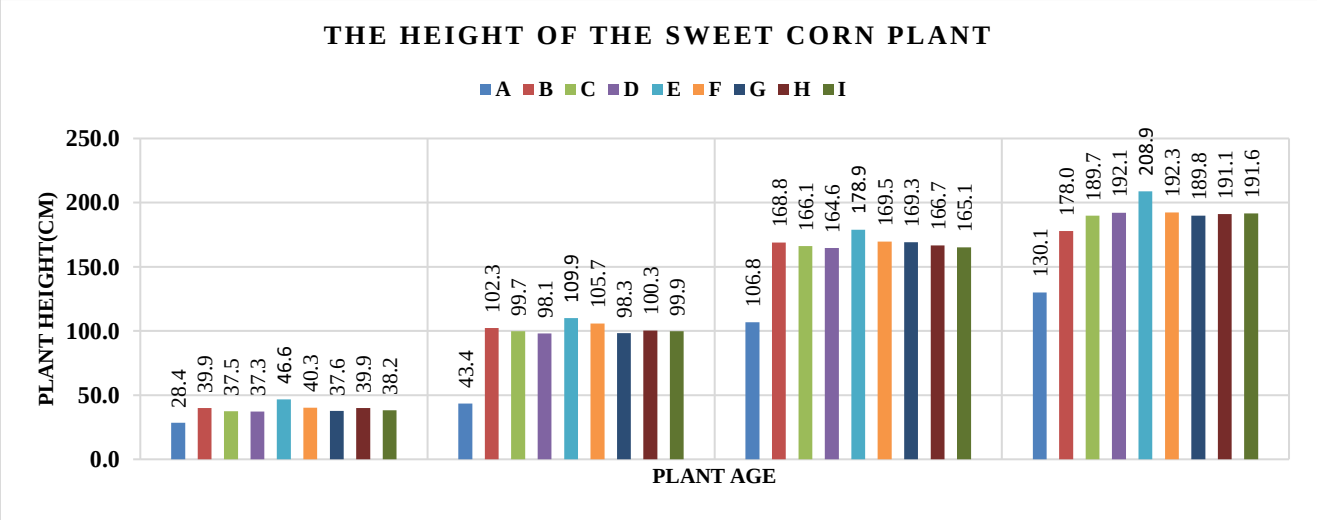


**FIGURE 3: Histogram of Sweet Corn Height Growth**

***Description: Dark blue A (Control), Red B (1 N, P, and K), Light green C (3/4 N, P, and K), purple D (3/4 N, P, and K + ½ biofertilizers), light blue E (3/4 N, P, and K + 1 biofertilizers), orange F (3/4 N, P, and K+ 1½ biofertilizers), navy G (1 N, P, and K + ½ biofertilizers), Dark red H (1 N, P, and K + 1 biofertilizers), and Dark green I (1 N, P, and K + 1½ biofertilizers).***

Based on the data in Figure 4, the observation of the height of sweet corn plants aged 14 DAP in each treatment was relatively diverse. The difference in plant height can be seen at the age of the plant entering 28 HST. The average results of plant height growth at plant age 56 HST included, treatment E (1 biological fertilizer + ¾ N, P, and K fertilizer) showed the best average yield of plant height growth of 208.9 cm and treatment A (Control ) showed the lowest average yield of plant height, namely

120.4 cm. A gradual increase in plant height occurs when the application of fertilizers containing N, P and K nutrients in the soil at the beginning of planting is included in the low category and is not available to plants. This is in line with the statement of Wahyudin et al. (2019) that the increase in plant height is due to the nutrient content in biological and inorganic fertilizers N, P and K being able to meet nutrient needs for plants, stimulate plant height growth and enlarge plant stems.

### 3.1.6 Stem Diameter

The results of the average stem diameter observations can be seen in Table 4 and the histogram of the stem diameter of the sweet corn plants can be seen in Figure 5. Observations were made when the sweet corn plants were 14, 28, 42, and 56 HST.

**TABLE 4**
**EFFECT OF COMBINATION OF LIQUID BIOFERTILIZERS WITH INORGANIC FERTILIZERS N, P, AND K ON STEM DIAMETER**

| Symbol | Treatment | Stem Diameter (cm) | | | |
|---|---|---|---|---|---|
| | | 14 HST | 28 HST | 42 HST | 56 HST |
| A | Control | 5,45 | 9,10 | 14,91 | 20,07 |
| B | 1 N, P, and K | 9,06 | 14,05 | 26,91 | 30,65 |
| C | ¾ N, P, and K | 7,69 | 12,57 | 25,77 | 28,16 |
| D | ½ biofertilizers + ¾ N, P, and K | 9,26 | 15,57 | 27,56 | 32,75 |
| E | 1 biofertilizers + ¾ N, P, and K | 9,81 | 18,77 | 32,15 | 36,29 |
| F | 1 ½ biofertilizers + ¾ N, P, and K | 8,81 | 15,02 | 29,28 | 32,53 |
| G | ½ biofertilizers + 1 N, P, and K | 9,54 | 15,79 | 29,25 | 31,02 |
| H | 1 biofertilizers + 1 N, P, and K | 8,46 | 13,85 | 28,21 | 32,80 |
| I | 1 ½ biofertilizers + 1 N, P, and K | 7,11 | 14,13 | 26,53 | 31,08 |

Based on the data in Table 4, the application of a combination of liquid biofertilizers with inorganic fertilizers N, P, and K gave the best results for the growth of sweet corn stem diameter. The highest results on stem diameter growth observations were achieved by treatment E (1 biofertilizers + ¾ N, P, and K fertilizer) namely 9,81 mm (14 HST), 18,77 mm (28 HST), 32,15 mm (42 HST), and 36,29 mm (56 HST).

The size of the stem diameter is influenced by the transport of nutrients by plants. This is in line with the statement of Trinurani et al. (2019) that stem growth indicates the cross-sectional area of the nutrient transport network in plants, the greater the stem diameter, the greater the cross-section of the nutrient transport network so that the nutrient translocation rate is better.

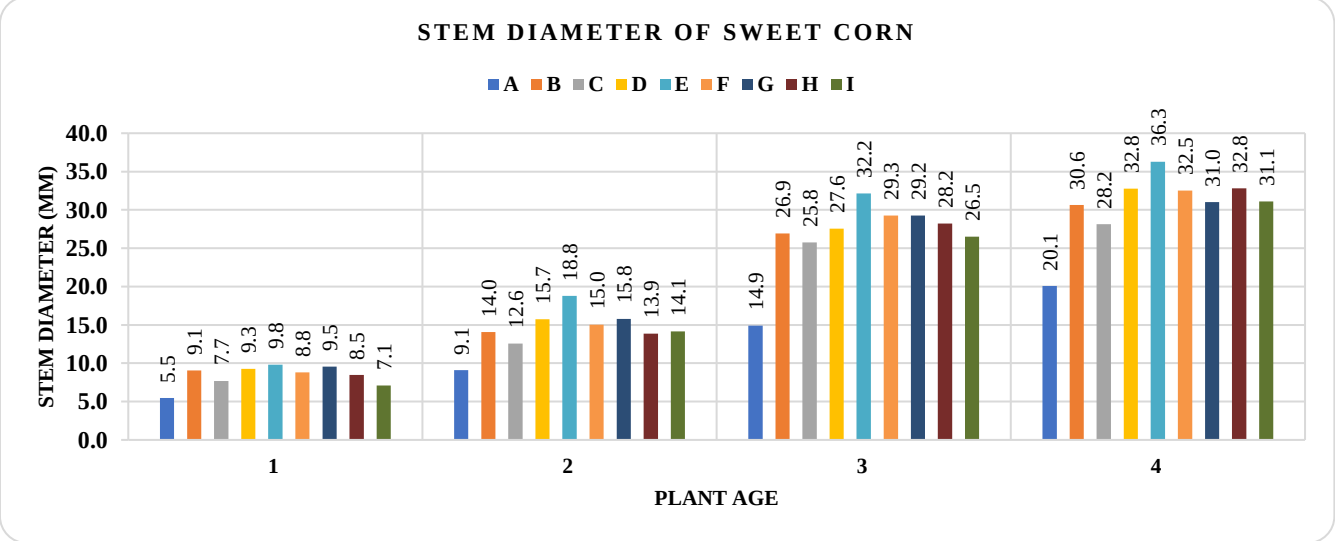


**FIGURE 5. Histogram of Sweet Corn Stem Diameter**

***Description: Dark blue A (Control), Red B (1 N, P, and K), Light green C (34 N, P, and K), purple D (4 N, P, and K + ½ biofertilizers), light blue E (4 N, P, and K + 1 biofertilizers), orange F (34 N, P, and K+ 1½ biofertilizers), navy G (1 N, P, and K + ½ biofertilizers), Dark red H (1 N, P, and K + 1 biofertilizers), and Dark green I (1 N, P, and K + 1½ biofertilizers).***

Based on the data in Figure 5, at the age of 14 DAP to 56 HST the plants gave various responses to the diameter of the sweet corn stalks. The results of the average growth of stem diameter at plant age 56 DAP included, treatment E (1 biological fertilizer + ¾ fertilizer N, P, and K) showed the best average yield of stem diameter growth of 36.3 mm and treatment A (Control ) showed the lowest average growth in stem diameter, namely 20.07 mm. The enlargement of stem diameter occurs due to the activity of cell division and enlargement of cells in the lateral meristem tissue (Klau et al., 2019). This is in line with the statement of Pasta et al. (2017) that the use of inorganic fertilizers N, P, and K with liquid biofertilizers can produce a stem diameter of sweet corn plants reaching 23.5% greater than the control or without fertilizer application.

### 3.2 Main Data

#### 3.2.1 N-total of soil

The results showed that the sweet corn plants which were given a combination of liquid biofertilizers with inorganic fertilizers N, P, and K had a significant effect on the total N-content of the soil. Data from observations of N-total Fluventic Eutrudepts soil can be seen in Table 5.

**TABLE 5**
**EFFECT OF LIQUID BIOFERTILIZERS WITH INORGANIC FERTILIZERS N, P, AND K ON N-TOTAL SOIL IN FLUVENTIC EUTRUDEPTS JATINANGOR**

| Symbol | Treatment | N-total (%) |
|---|---|---|
| A | Control (no fertilizer application) | 0,11 a |
| B | 1 N, P, and K | 0,23 b |
| C | ¾ N, P, and K | 0,21 a |
| D | ½ biofertilizers + ¾ N, P, and K | 0,24 b |
| E | 1 biofertilizers + ¾ N, P, and K | 0,32 c |
| F | 1 ½ biofertilizers + ¾ N, P, and K | 0,26 b |
| G | ½ biofertilizers + 1 N, P, and K | 0,22 b |
| H | 1 biofertilizers + 1 N, P, and K | 0,23 b |
| I | 1 ½ biofertilizers + 1 N, P, and K | 0,22 a |

***Note: Numbers followed by the same letters do not show significant differences according to the Duncan's Multiple Range Test 5%.***

The results of Fluventic Eutrudepts initial soil analysis on the N-total soil content showed 0.13% and became 0.11% in treatment A (Control). The total N-content in Fluventic Eutrudepts soil has decreased due to root activity. Roots release root exudates in the soil, but roots do not correspond with soil organisms so that roots do not change the structure of the rhizosphere and nutrients in the soil decrease. Giving doses of inorganic fertilizers that contain large amounts of N nutrients will increase the total N content so that the N nutrients that enter the soil will be higher (Bachtiar et al., 2019). This is in line with the statement of Setiawati et al. (2021) that taking nutrients bound to soil colloids is more optimal in increasing total nitrogen levels in the soil so that plant growth will be good and can increase productivity.

Based on the data in Table 5, it can be seen that each treatment showed different total nitrogen in the soil. The difference in the total N-content of soil in each treatment could be due to differences in the percentage of application of biofertilizers with inorganic fertilizers N, P and K. Treatment E (1 biological fertilizer + ¾ N, P, and K fertilizers) showed the highest level of soil N-total fertilizer, namely 0.32% and treatment A (Control) showed the treatment with the lowest total N-content in the soil, namely 0.11%. An increase in the total N-content of soil occurs in line with an increase in the population of N-fixing bacteria which play a role in forming a food network and maintaining the continuity of the N cycle in the soil (Bachtiar et al., 2017). The mechanism of N-fixing bacteria in providing N in the soil occurs due to bacterial nitrogenase activity in reducing N2 in the air to NH3- and increasing total N in the soil (Setiawati et al., 2021).

According to Gardner et al. (2008) the ability of N-fixing bacteria found in biofertilizers to fix nitrogen nutrients and provide available nitrogen nutrients for plants. $N_2$ fixation activity by bacteria is one of the things in maintaining the balance of nitrogen elements as a whole because fixed nitrogen elements can continuously be lost due to denitrification (Pamungkas & Prasetya, 2017). Based on this, it shows that the application of biofertilizers in excess amounts cannot increase the total N-content due to the denitrification process. The denitrification process is the process of converting nitrite (NO3) into nitrogen gas (N2) which

is released into the atmosphere. The process of denitrification through the reduction reaction of nitrogen compounds that have been oxidized by bacteria. The denitrification reaction can be described in the following reaction.

$$2NO_3^- + 10e^- + 12H^+ \text{----} > N_2 + 6H_2O$$

The level of nitrogen content in the soil is also influenced by the amount of intake of nitrogen nutrients that enter the soil and loss of nitrogen nutrients due to evaporation and leaching processes (Khalif et al., 2014). This indicates that nitrogen in the soil is easily lost due to volatilization, leaching and denitrification processes. In line with the statement of Widiana et al. (2020) that the leaching and erosion processes that occur can result in leaching of basic anions and cations which play an important role in meeting the needs of plant nutrients.

### 3.2.2 Plant N Uptake

The results showed that sweet corn plants treated with a combination of liquid biofertilizers with inorganic fertilizers N, P, and K had a significant effect on N uptake. Observations on N uptake of sweet corn plants can be seen in Table 6.

**TABLE 6**
**EFFECT OF LIQUID BIOFERTILIZERS WITH INORGANIC FERTILIZERS N, P, K ON PLANT N UPTAKE IN FLUVENTIC EUTRUDEPTS JATINANGOR**

| Symbol | Treatment | Plant N Absorption (mg.plant $^{-1}$) |
|---|---|---|
| A | Control (no fertilizer application) | 1,99 a |
| B | 1 N, P, and K | 3,04 b |
| C | ¾ N, P, and K | 2,94 b |
| D | ½ biofertilizers + ¾ N, P, and K | 3,12 b |
| E | 1 biofertilizers + ¾ N, P, and K | 3,46 c |
| F | 1 ½ biofertilizers + ¾ N, P, and K | 3,12 b |
| G | ½ biofertilizers + 1 N, P, and K | 3,30 b |
| H | 1 biofertilizers + 1 N, P, and K | 3,13 b |
| I | 1 ½ biofertilizers + 1 N, P, and K | 3,04 b |

***Note: Numbers followed by the same letters do not show significant differences according to the Duncan's Multiple Range Test 5%.***

Based on the data in Table 6, it shows the absorption level of the sweet corn plants varies in each treatment plot. The difference in the level of nutrient uptake is influenced by the availability of nutrients in the soil. Treatment E (1 biological fertilizer + ¾ fertilizer N, P, and K) showed the treatment with the highest absorption rate of 3.46 mg.plant-1 and treatment A (control) showed the treatment with the lowest nutrient absorption rate of 1.99 mg .plant-1. This shows that the application of biofertilizers with inorganic fertilizers N, P, and K has an effect on increasing N uptake through bacterial activity. In line with the statement of Yuniarti et al. (2020) that the absorption of N nutrients by plants affects the N content of plants.

The application of fertilizers containing N nutrients is not only a source of nutrients for plants, but can play a role in releasing ammonium ions in the soil which are absorbed by plants through a mass flow mechanism so that these ions will be available to plants (Agsari et al., 2020). This is in line with Khairul's statement (2022) that applying very high N fertilizers can increase the concentration of N in the soil in the form of NH4+, so that Ca2+, Mg2+, Fe3+, Mn2+ and Na+ ions will be replaced by NH4+ in soil colloids. Increased plant N uptake correlated with increased plant dry weight, plant root development, and increased soil N availability (Wahyudin *et al*., 2019).

High levels of N absorbed by plants can increase the weight of sweet corn plant biomass. According to Anjasmara (2019) the increased weight of sweet corn cobs is due to the plant's ability to absorb available nutrients. The high cob weight value indicates that the ability of the plant to absorb nutrients is also high. Plant nutrient uptake basically depends on the concentration of nutrients in the soil in the process of plant body formation. The amount of nitrogen absorbed by plants has increased so that it correlates with plant growth in active meristematic tissue, especially in the growth of plant height and stem diameter (Febrianna et al., 2018). This is in accordance with the statement of Pamungkas & Prasetya (2017) that the growth of plant height and stem diameter correlates with the results of photosynthesis as a food reserve, resulting in heavier cob weight.

Element N is needed by plants which are supplied from the decomposition of organic matter, nitrogen fixing bacteria, organic fertilizers, and the allocation of nitrogen fertilizers in agricultural cultivation (Febrianna et al., 2018). Fulfillment of plant N

nutrient needs can not only be through the provision of organic fertilizers, but can also be through the fertilization of biofertilizers. Bacteria contained in biofertilizers help to increase the N content of plants through diazotrophy or biological fixation of atmospheric nitrogen so that a qualitative increase in plant nutrition does not immediately show changes in root morphology because the bacteria are not directly related to the soil itself (Setiawati & Suryatmana, 2022). This is in line with the statement of Setiawati et al. (2020) that the role of bacteria found in biofertilizers correlates with nitrogen metabolism in plants using bacterial urease in increasing nitrogen uptake.

### 3.2.3 N-Fixation Bacteria

The results showed that the sweet corn plants treated with a combination of liquid biofertilizers with inorganic fertilizers N, P, and K had a significant effect on the population of N-fixing bacteria. The observational data for sweet corn N-fixing bacteria can be seen in Table 7.

**TABLE 7**
**EFFECT OF LIQUID BIO FERTILIZERS AND N, P, K FERTILIZERS ON POPULATIONS OF N-FIXING BACTERIA**

| Symbol | Treatment | Population of BPN (CFU.g$^{-1}$) |
|---|---|---|
| A | Control (no fertilizer application) | 0,21 x $10^8$ a |
| B | 1 N, P, and K | 0.47 x $10^8$ a |
| C | ¾ N, P, and K | 0,77 x $10^8$ b |
| D | ½ biofertilizers + ¾ N, P, and K | 0,78 x $10^8$ b |
| E | 1 biofertilizers + ¾ N, P, and K | 1,33 x $10^8$ c |
| F | 1 ½ biofertilizers + ¾ N, P, and K | 1,15 x $10^8$ b |
| G | ½ biofertilizers + 1 N, P, and K | 0.81 x $10^8$ b |
| H | 1 biofertilizers + 1 N, P, and K | 0,85 x $10^8$ b |
| I | 1 ½ biofertilizers + 1 N, P, and K | 0,91 x $10^8$ b |

***Note: Numbers followed by the same letters do not show significant differences according to the Duncan's Multiple Range Test 5%.***

Based on Table 7, it shows that each treatment has a different total population of N-fixing bacteria. Treatment E (1 biological fertilizer + ¾ N, P, and K fertilizer) showed the highest population of N-fixing bacteria, namely 1,33 x $10^8$ CFU.g$^{-1}$ and treatment A (Control) showed the lowest population of N-fixing bacteria, ie 0,21 x $10^8$ CFU.g$^{-1}$. The density of N-fixing bacterial cells in this liquid biofertilizers complies with the quality standard of the Ministry of Agriculture number 70/Permentan/SR.140/10/2016 namely above $10^7$ CFU.g$^{-1}$. This is in line with the statement of Danapriatna & Simarmata (2011) that cell density is included in the optimal standard category in increasing the root surface area by $10^7$ CFU.g$^{-1}$ per plant.

The increase in the average population of N-fixing bacteria in the soil is influenced by the amount of biofertilizers given and the growing environment of the planting medium (Ariflandha & Setiawati, 2018). The high population of bacteria can help meet the supply of nitrogen in secreting growth hormone during the vegetative phase, so as to produce the photosynthate needed in the generative phase. According to Alin & Setiawati (2017) populations of N-fixing bacteria are produced from bacterial culture ratios as carriers for biofertilizers which can increase energy and nutrient sources for bacteria. This is in line with the statement of Danapriatna & Simarmata (2011) that the addition of nutrients to each carrier formulation is due to the availability of energy sources for bacteria in the form of sucrose and glucose so as to increase microbial viability in biofertilizers.

N-fixing bacteria are able to develop and survive in new environments with stressed conditions, such as acidic soil pH and the ability to compete with other indigenous bacteria (Setiawati et al., 2020). According to Sofatin et al. (2017) several factors that affect the population of N-fixing bacteria include soil type, environmental conditions, agricultural practices carried out and previous land conditions. N-fixing bacteria can grow well in soils with a neutral pH, namely 6,00 - 8,00 (Kantikowati & Firmansyah, 2019).

Bacteria Azospirillum sp. is one of the N-fixing bacteria that acts as a biological fertilizer. Mechanism of *Azospirillum* sp. as a biological fertilizer, namely through nitrogen fixation in the atmosphere and stimulating plant growth through the synthesis of substances that support plant growth (Rosmalia, 2019). This is in line with the statement of Pamungkas & Prasetya (2017) that the use of Azosfirillum sp. It is capable of donating nitrogen and balancing nitrogen in the soil through the process of nitrogen fixation. The availability of oxygen is able to provide lower IAA production than under microaerobic conditions, so

*Azospirillum* sp. has great potential to produce auxin. Based on this, the bacteria *Azospirillum* sp. which is used as a raw material for the manufacture of liquid biofertilizers is an isolate that is superior in fixing N and IAA (auxin) production.

### 3.2.4 Yield Components of Sweet Corn

The components of sweet corn yield observed included cob weight per plot, cob weight with husks, cob weight peeled, cob diameter, and cob length. The results showed that the sweet corn plants that were given liquid biofertilizers and inorganic fertilizers N, P, and K had a significant effect on the yield components of sweet corn. Data from observations of the sweet corn yield components can be seen in Table 8.

**TABLE 8**
**THE EFFECT OF INORGANIC FERTILIZERS N, P, AND K WITH LIQUID BIO FERTILIZERS ON SWEET CORN YIELDS**

| Symbol | Treatment | BTPP (kg) | BTB (g) | BTK (g) | DT (mm) | PT (cm) |
|---|---|---|---|---|---|---|
| A | Control (no fertilizer application) | 4,7 a | 309,4 a | 201,3 a | 43,56 a | 19,7 a |
| B | 1 N, P, and K | 8,8 b | 384,4 b | 276,1 a | 47,80 b | 19,8 a |
| C | ¾ N, P, and K | 8,3 b | 369,3 b | 242,7 a | 47,04 b | 19,8 a |
| D | ½ biofertilizers + ¾ N, P, and K | 8,1 b | 394,5 b | 280,1 a | 48,57 b | 19,9 a |
| E | 1 biofertilizers + ¾ N, P, and K | 11,6 c | 423,5 c | 334,7 b | 52,79 c | 23,9 c |
| F | 1 ½ biofertilizers + ¾ N, P, and K | 8,7 b | 388,9 b | 280,6 a | 49,11 b | 20,3 b |
| G | ½ biofertilizers + 1 N, P, and K | 10,2 b | 396,7 b | 285,3 a | 49,56 b | 20,5 b |
| H | 1 biofertilizers + 1 N, P, and K | 9,3 b | 395,7 b | 283,8 a | 49,27 b | 20,4 b |
| I | 1 ½ biofertilizers + 1 N, P, and K | 7,51 b | 397,3 b | 285,3 a | 49,68 b | 19,8 a |

***Note: Numbers followed by the same letters do not show significant differences according to the Duncan's Multiple Range Test 5%. BTPP = Cob Weight Per Plot, BTB = Cob Weight, BTK = Cob Weight, DT = Cob Diameter, PT = Cob Length***

Based on the research results in Table 8, the use of liquid biofertilizers with inorganic fertilizers N, P and K has a significant effect on the yield component of sweet corn. Treatment E (1 Biofertilizers + ¾ N, P and K Fertilizer) showed the highest sweet corn yield component compared to other treatments with the order of treatment including cob weight per plot (BTPP) of 11.6 Kg, cob weight (BTB) of 423.5 g, peeled cob weight (BTK) of 334.7 g, cob diameter (DT) of 52.79 cm, and cob length (PT) of 23.9 mm and treatment A (control) showed the yield component of sweet corn lowest compared to all treatments in the order of cob weight per plot (BTPP) of 4.7 kg, cob weight (BTB) of 309.4 g, peeled cob weight (BTK) of 201.3 g, cob diameter (DT) of 43.56 cm, and cob length (PT) of 19.7 mm. According to Indiarto et al. (2022) the increase in the yield component of sweet corn is influenced by plant growth such as plant height and stem diameter.

Sweet corn plants provide optimal results if the supply of nutrients is sufficient for plant growth. This is in line with the statement of Pasta et al. (2015) that the yield of sweet corn plants is said to be optimal if one of the conditions is met, such as the availability of sufficient nutrients. This is also supported by the statement of Darwin et al. (2017) that the need for sufficient nutrients absorbed by plants, both macro and micro elements will provide plant growth and productivity will increase. Sweet corn plants require nitrogen elements throughout their growth and are very effective in using ammonium even though most of it is taken in the form of nitrate (Sudirdja et al., 2020). Based on this, the element nitrogen in the soil can increase plant growth such as the number of leaves, stem diameter, cob length so that the weight of sweet corn cobs will be higher.

Element P has a role as a constituent of compounds to store and transfer energy from photosynthesis in the generative phase. According to Pasta et al. (2015) the role of element P in the generative phase is allocated to the process of forming plant seeds or fruit. This is in line with the statement of Puspadewi et al. (2019) that nutrient P has a function as an energy source in various plant metabolic reactions and plays an important role in increasing yields and providing lots of photosynthate which is distributed into the seeds so that the yield of corn plant seeds increases. Based on this, it shows that the harvest index describes the amount of photosynthate correlated with the formation of seeds originating from the plant canopy.

Observation of cob diameter and cob length is an overview of the results of the process of filling sweet corn kernels. The process of filling the seeds cannot be separated from the role of nutrients absorbed by plants. According to Khairul (2022) the absorbed nutrients will be accumulated in the leaves into proteins that can form seeds. This is in line with the statement of Trinurani et al. (2017) that the fulfillment of plant nutrient needs causes metabolism to run optimally so that the formation of

proteins, carbohydrates and starch is not hampered, as a result the accumulation of materials resulting from metabolism in seed formation will increase so that the seeds formed have maximum size and weight.

The formation of sugar in sweet corn cobs is related to the maturity level of sweet corn cobs. According to Puspadewi et al. (2019) the developmental stages of sweet corn maturation include the pre-milk, milk and dough levels. The pre-milk level is characterized by a sweet taste with a sugar content of 6.3%, starch content of 3.3%, rather small seeds and rather clear seed endosperm. The milk level shows a sweeter taste but the seeds have become older and bigger than pre-milk and the seed endosperm looks like milk while the dough level is marked by the rapid change of seeds that look wrinkled. The low total dissolved solids is caused by a lack of nitrogen and phosphorus nutrients in plants. According to Haerani (2019) nitrogen and phosphorus nutrients for plants can increase the development of sweet corn seeds and also increase metabolic processes so that there is an increase in total dissolved solids in the seeds. This is in line with the statement of Mubarok et al. (2022) that the formation of protein in sweet corn kernels is influenced by the availability of N nutrients, so that absorption of N. The addition of the weight of the sweet corn cobs transported to the sweet corn cobs increases the weight of the sweet corn cobs.

Bio-fertilizers contain microbes that are capable of producing active compounds that play a role in breaking down nutrients in the soil (Setiawati et al., 2020). This is in line with the statement of Setiawati et al. (2021) that the activity of microorganisms can increase the ability of soil to store water, so that nutrients are more easily absorbed by plants. Hardjowigeno (2015) explained, the application of biofertilizers has a very important influence in improving the chemical and physical properties of the soil, one of which is providing nutrients for plants and helping to increase the soil's ability to hold water. The availability of nutrients can be provided through fertilization until they reach the ideal for plant growth and will increase the productivity of plants according to their genetic maximum conditions (Wulansari et al., 2022).

Biofertilizers play a role in increasing soil fertility through the application of microorganisms in providing nutrients and increasing plant productivity. According to Setiawati & Suryatmana (2022) the availability of available nutrients is due to the application of inorganic fertilizers and microorganisms contained in biofertilizers that can make the growth process and the results of photosynthesis accumulate in the assimilate storage organs and the final result is reflected through an increase in the yield component. The presence of microbes at the beginning of application and increased from day to day caused these microbes to be able to decompose soil organic matter and at the level of uptake of inorganic fertilizers by plants to be more optimal. According to Kalay et al. (2020) the use of *Azozpirillum* sp. as a nitrogen fixing bacteria (N2) it reaches 40-80% and produces IAA phytohormones which play a role in increasing plant growth and yields, especially in accelerating flowering and ripening of the fruit produced, so as to improve the quality of the yield components of sweet corn plants. Based on this, the use of biofertilizers can increase the yield component of sweet corn and reduce the dosage of inorganic fertilizers.

## IV. CONCLUSIONS AND RECOMMENDATIONS

### 4.1 Conclusion

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

1. The combination of liquid biofertilizers with N, P, K fertilizers has an effect on N-total soil, N uptake, N fixing bacteria and sweet corn yield (cob weight per plot, cob weight with husk, cob weight without cob, cob diameter and cob length).
2. Dose combination of 1 liquid biofertilizers (5 $L.ha^{-1}$) with ¾ fertilizer N, P, and K (225 $kg.ha^{-1}$ Urea, 112.5 $kg.ha^{-1}$ SP-36, 75 $kg.ha^{-1}$ KCl) is the treatment dose that gives the best results on N-total soil (0.32%), N uptake (3,46 $mg.crop^{-1}$), N fixing bacteria (1,33 x $10^8$ $CFU.g^{-1}$) and sweet corn yields consisting of cob weight per plot (11.6 kg), cob weight with husks (423.5 g), cob weight without husks (334.7 g), cob diameter (52.79 mm), and length cob (23,9 cm).

### 4.2 Suggestion

Further research is needed with different soil orders, and it is necessary to carry out a consortium analysis of combinations of liquid biofertilizers containing several symbiotic and non-symbiotic bacteria with compound fertilizers.

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