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Assessing Nitrogen Biofertilizer Microbeads Formula and Inorganic Nitrogen Fertilizer on Nitrogen Uptake and Agronomic Traits of Maize

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ABSTRACT: The relatively low fertility of Inceptisols is a limiting factor to increase the growth and yield of maize plants. The application of microbeads nitrogen-fixing biofertilizer can help the availability and efficiency of N for plants. This study aims to assess the effectiveness of microbead N biofertilizer formulations and inorganic nitrogen fertilizers in improving nitrogen uptake, nitrogen fertilizer efficiency, and the agronomic traits of maize. The study used a Factorial Randomized Block Design (RBD) consisting of two factors. The first factor was microbeads consisting of 4 formulations. The second factor is the dose of Urea with four levels: 0% Urea, 40% recommended dose, 80% recommended dose, and 100% recommended dose. The results showed that there was an interaction effect between microbeads and Urea on N-total, total population of nitrogen fixing bacteria, and plant root length, but there was no interaction effect on N uptake and maize plant growth. The combination of microbeads formulation m2 (Alginate 2%, Trehalose 1%, Kaolin 1%, Skim Milk 2%, and Humic Acid 0.5%) and the 80% recommended dose of Urea is the best treatment that can produce N-total by 0.34% and reduce the dose of Urea use by 20%. These results conclude that the application of nitrogen biofertilizers in the form of microbeads could enhance maize growth.

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KEYWORDS: encapsulation, fertilizer efficiency, nitrogen fixing bacteria, sustainable agriculture

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1. INTRODUCTION

Inceptisols are one of the most widespread soil orders in Indonesia, covering an estimated area of 70.5 million hectares (Soil and Agroclimate Research Center, 2006). Despite their promising development potential, there are challenges in utilizing Inceptisols in the field (Kasno, 2009). Typically, soils in drylands exhibit low fertility and organic matter content (Abdurachman et al., 2008). Inceptisols, in particular, have low organic matter content and a pH range from acidic to slightly acidic (pH 4.6-5.5), with a C/N ratio of 5-10. These characteristics result in a low fertility level for Inceptisols.

Maize (*Zea mays* L) is one of the main food sources in Indonesia after rice. It serves as a staple food for several regions, including Java, Madura, Sulawesi, and Nusa Tenggara (Bantacut et al., 2015). According to the Central Bureau of Statistics, the harvested area of maize in 2022 was 4,493,322 hectares, with a productivity rate of 5.6 tons per hectare. Maize is consumed in various forms, including as a staple food, side dish, animal feed, snack, and semi-finished products produced by the industry (Ariani & Pasandaran, 2005). The development of maize cultivation in Inceptisols holds significant promise if accompanied by appropriate soil management techniques (Nursyamsi et al., 2002). However, Inceptisols are characterized by poor chemical properties, with low C-organic content (1.88%) and low total nitrogen (0.15%) (Sudirja et al., 2007). The low organic matter content leads to a deficiency of beneficial microbes, resulting in suboptimal plant growth. To address this fertility issue, farmers often resort to inorganic fertilizers. However, intensive use of these fertilizers can reduce soil permeability, organic matter content, increase erosion susceptibility, and decrease soil microbial populations (Herdiyanto and Setiawan, 2015). Long-term use can also damage soil structure and pollute the environment (Simanjuntak et al., 2013).

The use of biofertilizers offers a viable solution to enhance soil fertility and boost maize productivity (Fitri et al., 2020). Ethno-biofertilizer is produced through the fermentation of plant and animal materials containing beneficial microorganisms that promote plant growth, inhibit disease, dissolve phosphate, and fix nitrogen (Kumar et al., 2017). This type of biofertilizer, also known as Microbial Organic Liquid (MOL), is derived from materials such as compost, Azolla, bamboo roots, banana stalks, organic waste, urine, snails, shrimp shells, and crabs. The fermentation process occurs anaerobically over 4-6 weeks.

Nitrogen-fixing bacteria are microorganisms that convert atmospheric nitrogen into a form usable by plants. Maize growth is highly dependent on nitrogen availability, with nitrogen fertilizer application potentially increasing yields by 30-50%. However, the efficiency of nitrogen fertilizer use by cereal plants is typically less than 50% due to losses from volatilization, leaching, and denitrification. The population and functionality of nitrogen-fixing bacteria can be significantly reduced when directly inoculated into soil under adverse conditions such as drought or salinity. Therefore, microbial packaging methods are essential to ensure their long-term viability (Zhang et al., 2023).

Encapsulation is a technique used to encase bacteria in special materials to maintain their viability and protect them from environmental damage (Sumanti et al., 2017). Encapsulation is considered successful if the encapsulated microbes retain high viability and physiological characteristics similar to those before encapsulation (Triana et al., 2006). Materials that can be used for encapsulation include alginate, skim milk, sugar, humic acid, starch, chitin, chitosan, and mineral clay (Vassilev et al., 2020).
This study aims to assess the effectiveness of microbead N biofertilizer formulations and inorganic nitrogen fertilizers in improving nitrogen uptake, nitrogen fertilizer efficiency, and the agronomic traits of maize.

2. MATERIALS AND METHODS

2.1 Time and Location of Research

The research was conducted from March 2024 to June 2023 at Padjadjaran University. Soil chemical analysis was conducted at the Laboratory of Soil Fertility and Plant Nutrition, Faculty of Agriculture, Padjadjaran University, Jatinangor, West Java.

2.2 Tools and Materials

The tools used in this study include: 1) Scales, 2) Erlenmeyer, 3) Beaker Glass, Injections, 4) Laminar Air Flow (LAF), 5) Autoclave, 6) Digital caliper, 7) Sterile test tube, 8) Vortex, aluminum foil, 9) Plastic wrap, 10) Filter paper, 11) Cotton, 12) Stationery, 13) Label, 14) Petri dish, 15) Ruler, 16) 500 ml plastic cup, 17) Plastic zipper, 18) Envelope, 19) Millimeter paper, 20) Chlorophyllimeter, 21) Scales, 22) Measuring cup, 23) Notebook, 24) Cell phone camera, 25) Polybag, 26) Laboratory equipment for soil microbiology analysis, 27) Laboratory equipment for soil chemistry analysis.

The materials used in this study are: 1) Alginate, 2) Trehalose, 3) Kaolin, 4) Skim milk, 5) Humic acid, 6) Sterile water, 7) 0.2% CaCl solution, 8) BISI-2 variety maize seeds, 9) Selected bacterial isolates from Etno-Biofertilizer, 10) Inceptisols soil, 11) NFB media, 12) 70% alcohol, 13) Physiological NaCl, 14) Urea, 15) Soil microbiology analysis materials, 16) Soil chemical analysis materials.

2.3 Experimental Design

The experimental design used is a Randomized Block Design (RBD) with a factorial pattern employing two treatment factors.

The first factor is the microbeads formulation (m) which consists of four levels:
m0 : 0% alginate, 0% trehalose, 0% kaolin, 0% skim milk, and 0% humic acid
m1 : Alginate 2%, Trehalose 1%, Kaolin 1%, Skim Milk 1%, and Humic Acid 0%
m2 : Alginate 2%, Trehalose 1%, Kaolin 1%, Skim Milk 2%, and Humic Acid 0.5%
m3 : Alginate 2%, Trehalose 1%, Kaolin 1%, Skim Milk 2%, and Humic Acid 1%
The second factor is the dose of Urea (u) which consists of four levels:
u0 : 0 kg ha-1 Urea (0% recommended dose)
u1 : 120 kg ha-1 Urea (40% recommended dose)
u2 : 240 kg ha-1 Urea (80% recommended dose)
u3 : 300 kg ha-1 Urea (100% recommended dosage)
Each treatment was replicated three times, resulting in 48 experimental units. Each experimental unit consisted of 1 plant until the age of 28 HST. The total number of plants is 48 plants.

Table 1. Combination of Microbeads Formulation and Urea Dosage

	Microbeads (M)			
Urea (U)	m_0	m_1	m_2	m_3
u_0	u_0m_0	u_0m_1	u_0m_2	u_0m_3
u_1	u_1m_0	u_1m_1	u_1m_2	u_1m_3
u_2	u_2m_0	u_2m_1	u_2m_2	u_2m_3
u_3	u_3m_0	u_3m_1	u_3m_2	u_3m_3

2.4 Analysis Design

The data from the study were statistically analyzed using a Factorial Randomizes Block Design (RBD) with the SPSS application at 5% significance level. If the test results show significant effects, they will be followed by Duncan's Multiple Range Test (DMRT) at 5% significance level.

3. RESULT AND DISCUSSIONS

3.1 Supporting Observation

3.1.1 Initial Soil Analysis

Soil chemical analysis was conducted on the initial soil analysis. Based on the analysis results, the physical properties of Inceptisols soil have a texture of 10% sand, 62% dust, and 28% clay. Inceptisols soil chemical properties have a pH of 6.37 (slightly acidic), C-organic 2.34% is classified as medium, and N-total 0.17% is classified as low.

Biological analysis was also carried out in the initial soil analysis. The biological properties of Inceptisols soil used in this study obtained a population of nitrogen-fixing bacteria of 45 x 107 CFU g-1. The low population of nitrogen-fixing bacteria is thought to be caused by low levels of organic matter in the soil. Nitrogen-fixing bacteria use organic matter as a carbon source for metabolism.

Based on the results of the initial soil analysis, pH H_2O with a value of 6.37 is very suitable for maize plants (Harniati, 2000). Based on the results of the initial soil analysis, total nitrogen was 0.17%, categorized as low. Nitrogen, an abundant element in the atmosphere, is often the most deficient nutrient in agricultural land, but is important for protein formation in plants (Ibrahim and Kasno, 2008). Nitrogen deficiency in maize causes stunted growth and leaf necrosis. Therefore, balanced fertilization combining biofertilizers and inorganic fertilizers is needed to improve soil fertility and maize yield..

3.1.2 Observation of Plant Pest and Diseases

Observations of pests in this experiment were in the form of pests that attacked maize plants, namely locusts. Locusts (Locusta migratoria) attacked maize plants at the age of 21 HST. Locusts attack the leaves of maize plants by leaving bite marks in the form of irregular tears. Locust attacks on maize plants can result in suboptimal production (Ningsih et al., 2018).

3.2 Main Observations

3.2.1 Plant Height

The results of the analysis of variance showed that there was no interaction between microbeads and urea so that it showed an independent effect on plant height. The m1 treatment showed significantly different compared to the control with the highest average plant height of 48 cm but not significantly different from the m3 treatment. Nitrogen-fixing bacteria in microbeads are able to fix free nitrogen from the air, making it available to plants and affecting their growth. Research by Pangaribuan et al. (2017) showed that biofertilizers significantly increased maize vegetative growth, such as plant height, by increasing the decomposition process and nutrient availability.

Table 2. Independent Effects of Microbeads (m) and Urea (u) on Maize Plant Height at 28 Days After Planting

Treatment	Crop Height (cm)
Microbeads (m)	
m0	43,4 a
m1	48,0 c
m2	45,0 ab
m3	46,8 bc
Urea (u)	
u0	43.4 a
u1	44.6 a
u2	46.2 a
u3	49.0 b

Notes: Mean values followed by the same letter are not significantly different according to Duncan's Further Test at the 0.05 level of significance.

The increase in plant height depends on the availability of nutrient supply and the ability to absorb nutrients in each plant. The u3 treatment was significantly different compared to uo, u1, and u2 with the highest average plant height of 49 cm. The higher the dose of fertilizer, the development of plant organs such as roots becomes faster, so that plants can absorb more nutrients and affect the height of maize (Rahmah et al., 2014). Yanti et al. (2014) stated that the optimal dose of Urea increases maximum plant growth, but excessive fertilizer application can reduce soil fertility, make fertilization inefficient, and cause nitrogen pollution (Good & Beatty, 2011).

3.2.2 Stem Diameter

Stem diameter is a parameter that is often used to see plant growth. Measurement of stem diameter was carried out up to 28 HST using a caliper. The results of the analysis of variance showed that there was no interaction between microbeads and urea so that it showed an independent effect on stem diameter. The average value of stem diameter increased from 5.29 in the m0 treatment to 5.85 in the m3 treatment, but the difference was not significant. Microbeads are thought to work slower or not as effective as Urea in providing nitrogen, because microorganisms need time to decompose organic matter into a form that can be absorbed by plants, which affects the diameter of maize stalks. Stem diameter depends on the availability of nutrients, especially nitrogen, which supports plant growth and yield (Kresnatita, 2012).

Table 3. Independent Effects of Microbeads (m) and Urea (u) on Stem Diameter at 28 Days After Planting

Treatment	Stem Diameter (mm)
Microbeads (m)	
m0	5.29 ab
m1	5.64 b
m2	4.75 a
m3	5.85 b
Urea (u)	
u0	4.83 a
u1	5.51 b
u2	5.65 b
u3	5.54 b

Notes: Mean values followed by the same letter are not significantly different according to Duncan's Further Test at the 0.05 level of significance

Urea can increase the availability of nitrogen needed by plants quickly, thus helping in the photosynthesis process which has an impact on the growth of maize plants. The u1, u2, and u3 treatments were significantly different from the u0 treatment. The treatment with the highest stem diameter was m2 with a stem diameter of 5.65 mm. This is thought to be because Urea is more quickly available and absorbed by plants. Urea contains high nitrogen, which is very important for plant growth. The availability of nitrogen can increase the formation of chlorophyll which will increase the rate of photosynthesis. The increase in photosynthesis rate causes an increase in stem circumference (Puspadewi et al., 2016).

3.2.3 Chlorophyll Content

The results of the analysis of variance showed that there was no interaction between microbeads and Urea, this showing an independent effect on chlorophyll content. Giving microbeads with the appropriate formulation can increase the chlorophyll content of plants, but not significantly different between microbeads formulations. The average value of chlorophyll content produced by microbeads treatment tends not to differ significantly, namely 5.33, 5.44, 5.64, and 5.89 for treatments m0, m1, m1, and m3. This indicates that the microbeads treatment did not significantly affect the chlorophyll content of the plants.

Table 4. Independent Effects of Microbeads (m) and Urea (u) on Chlorophyll Content

Treatment	Chlorophyll Content
Microbeads (m)	
m0	5.33 a
m1	5.44 a
m2	5.64 a
m3	5.89 a
Urea (u)	
u0	4.09 a
u1	5.11 b
u2	5.85 b
u3	7.26 c

Notes: Mean values followed by the same letter are not significantly different according to Duncan's Further Test at the 0.05 level of significance

Nitrogen nutrients can increase the amount of chlorophyll, which supports an increase in the rate of photosynthesis, so that photosynthate production in plants will increase (Kresnatita et al., 2012). The u3 treatment was significantly different from the u0, u1, and u2 treatments. The average value of chlorophyll content produced by Urea treatment (u) increased from 4.09 for u0 treatment to 7.26 for u3 treatment. This shows that the higher the dose of Urea given, the higher the chlorophyll content possessed by the plants. This occurs because Urea has a higher nitrogen content and contains nutrients that are more quickly available, thus having a direct impact on the chlorophyll content of maize plants.

3.2.4 Crown Dry Weight

Dry weight reflects the accumulation of plant organic compounds, indicates nutritional status, and is an important indicator for assessing plant growth and development, and is related to nutrient availability (Sitorus et al., 2014). The results of the analysis of variance showed that there was no interaction between microbeads and Urea so that an independent effect on crown dry weight was shown. The m1 treatment was significantly different from m0 and produced the highest crown dry weight of 1.03 g, but not significantly different when compared to the m2 treatment. The independent effect of Urea treatment also significantly affects the crown dry weight. The u1 treatment was significantly different from the control and showed the highest dry weight of 1.08 g, but not significantly different from the u2 treatment.

Table 5. Independent Effects of Microbeads (m) and Urea (u) on Crown Dry Weight

Treatment	Crown Dry Weight (g)
Microbeads (m)	
m0	0,83 a
m1	1,03 b
m2	0,74 a
m3	0,98 b
Urea (u)	
u0	0,67 a
u1	0,87 b
u2	0,96 bc
u3	1,08 c

Notes: Mean values followed by the same letter are not significantly different according to Duncan's Further Test at the 0.05 level of significance

Nutrients absorbed by plants support physiological and metabolic functions. Physiological symptoms of fertilization can be observed through dry weight (Supriadi and Soeharsono, 2003). Crown dry weight is linearly correlated with crown fresh weight. Adequate nitrogen availability increases vegetative growth, leaf number, and photosynthetic yields, so that crown dry weight increases with nitrogen dosage (Rachmawati et al., 2010). Nitrogen is important for plants for the synthesis of proteins, chlorophyll, and nucleic acids, which regulate biochemical reactions (Nazira, 2023).

3.2.5 Root Length

The results of the analysis of variance showed that there was an interaction between microbeads and Urea on root length. The application of u2m2 treatment resulted in a root length of 59.7 cm. The combination of microbeads BPN formulation m2 with 80% of the recommended dose of Urea increased the root length by 41.1% compared to the control. In line with the research of Widiyawati et al. (2014) showed that the use of nitrogen fixing bacteria can reduce dependence on inorganic N fertilizer up to 25% of the recommended dose. Bacteria in the growing medium increase nitrogen availability because they function as nitrogen fixers..

Table 6. Effect of Interaction of Microbeads (m) with Urea (u) on Root Length of Maize Plants at 28 Days After Planting

Microbeads (m)	Urea (u) u0		u1		u2		u3	
m0	42.30 A	a	49.60 B	b	51.03 B	b	52.00 B	a
m1	51.97 B	c	43.77 A	a	46.63 A	ab	52.37 B	a
m2	45.00 A	ab	46.23 A	ab	59.70 C	c	52.57 B	a

m3	49.57 B	bc	50.37 B	b	44.37 A	a	51.27 B	

Notes:

- Mean values followed by the same letter are not significantly different according to Duncan's Further Test at the real level of 0.05.
- Lowercase letters read vertical direction, comparing between 2 Microbeads on the same Urea.
- Capital letters read horizontal direction, comparing between 2 Ureas on the same Microbeads.

3.2.3 Soil Total Nitrogen

Nitrogen is one of the macro nutrients that are very important for plant growth and development (Pudjiwati, 2022). The results of the analysis of variance showed that there was an interaction between microbeads and Urea on total soil nitrogen.

Table 7. Effect of Interaction of Microbeads (m) with Urea (u) on Total Soil Nitrogen

Microbeads (m)	Urea (u) u0		u1		u2		u3	
m0	0.19 A	a	0.25 B	b	0.27 B	b	0.22 A	ab
m1	0.20 A	a	0.21 A	a	0.22 A	a	0.19 A	ab
m2	0.25 B	b	0.21 A	a	0.34 C	c	0.18 A	a
m3	0.21 A	a	0.25 B	b	0.23 AB	a	0.22 AB	b

Notes:

- Mean values followed by the same letter are not significantly different according to Duncan's Further Test at the real level of 0.05.
- Lowercase letters read vertical direction, comparing between 2 Microbeads on the same Urea.
- Capital letters read horizontal direction, comparing between 2 Ureas on the same Microbeads.

The u2m2 treatment, which is a combination of m2 microbeads and 80% of the recommended dose of Urea, produced the highest N-total of 0.34%. Nitrogen fixing bacteria in microbeads can increase soil N-total through nitrogen fixation, converting unavailable atmospheric nitrogen into nitrogen compounds that plants can utilize, such as ammonium (NH_4^+) and nitrate (NO_3-). Nitrogen fixed by bacteria becomes available to plants and is used as an essential nutrient for protein synthesis (Sapalina et al., 2022).

3.2.4 Plant Nitrogen Uptake

Plant nutrient uptake is one of the important indicators in achieving the expected harvest quality. Nutrient uptake is an indicator of adequate plant nutrient requirements. The results of the analysis of variance showed that there was no interaction between microbeads and Urea so that it showed an independent effect on plant nitrogen uptake.

Table 8. Independent Effects of Microbeads (m) and Urea (u) on Nitrogen Uptake

Treatment	Nitrogen Uptake
Microbeads (m)	
m0	0.96 a
m1	0.90 a
m2	0.98 a
m3	0.95 a
Urea (u)	
u0	0.88 a
u1	0.90 a
u2	1.03 b
u3	0.97 ab

Notes: Mean values followed by the same letter are not significantly different according to Duncan's Further Test at the 0.05 level of significance

The amount of nutrients absorbed by plants affects plant production and the achievement of desired quality. The more nutrients absorbed, the better the growth and development of plants in accordance with their growth phase. Plants that grow and develop optimally will produce maximum harvest, both in terms of quantity and quality (Bhaskoro et al., 2015). Treatments m1, m2, and m3 did not show significant differences compared to m0. The average value of nitrogen uptake from microbeads increased, but the difference was not significant. This is thought to be because nitrogen-fixing bacteria take longer to provide nitrogen than Urea, which immediately provides nitrogen that can be absorbed by plants. Biofertilizers containing nitrogen-fixing bacteria often take longer to show an increase in plant yield (Wiludjeng, 2020). The u2 treatment was significantly different from the control but not significantly different from u3. The increase in Urea dose is in line with the increase in nitrogen uptake. The higher the dose of Urea, the higher the uptake of nitrogen in plants until it reaches a dose of 80%, because the nutrients in Urea are quickly available and absorbed, which supports the formation of chlorophyll and green leaves. Suwardi (2009) stated that N uptake in maize is influenced by plant age, application conditions, and photosynthesis.

3.2.3 Population of Nitrogen Fixing Bacteria

Nitrogen-fixing bacteria are biological agents that provide nitrogen to plants. Microbial populations in soil are affected by environmental factors such as temperature and humidity. Microbial encapsulation technology can protect against environmental stress, increase cell viability, and increase the effectiveness of microbial application (Rojas-Sánchez et al., 2022). The result of analysis of variance showed that there was no interaction between microbeads and Urea, thus showing an independent effect on the population of nitrogen-fixing bacteria.

Table 9. Effect of Microbeads Interaction (m) with Urea (u) on Total Population of Nitrogen Fixing Bacteria

	Total Population of Nitrogen Fixing Bacteria (10^9)			
Microbeads (m)	Urea (u)			
	u0	u1	u2	u3
m0	1,14 a A	1,23 a A	1,37 a B	1,48 a B
m1	1,36 b A	1,28 b A	1,38 a A	1,65 b B
m2	1,40 b A	1,39 b A	2,06 c C	1,72 b B
m3	1,30 ab A	1,52 c B	1,57 b B	1,63 b B

Notes:

- Mean values followed by the same letter are not significantly different according to Duncan's Further Test at the real level of 0.05.
- Lowercase letters read vertical direction, comparing between 2 Microbeads on the same Urea
- Capital letters read horizontal direction, comparing between 2 Ureas on the same Microbeads.

The u2m2 treatment, a combination of microbeads formulation m2 and 80% of the recommended dose of Urea, produced the highest population of nitrogen-fixing bacteria at 2.06 x 109 CFU g-1, an increase compared to the control which had the lowest population of nitrogen-fixing bacteria. The population of nitrogen-fixing bacteria in the soil increased in all microbeads treatments. The interaction between microbeads and Urea increased the total population of nitrogen-fixing bacteria because these bacteria fix free nitrogen from the air which is then absorbed by plants. Urea also provides nitrogen in the form of ammonium ($NH4^+$) which accelerates plant growth and increases soil fertility. In line with the research of Erlanda et al. (2021) showed that the interaction of Azotobacter and Urea increased the overall population of nitrogen-fixing bacteria, which in turn increased nitrogen uptake by plants.

3.2.4 N Fertilization Efficiency

Nitrogen is one of the nutrients that is easily lost through processes such as evaporation, leaching, erosion, and denitrification, which affects nitrogen uptake efficiency. Nitrogen uptake efficiency measures the ratio between the amount of nitrogen absorbed by plants and the amount of nitrogen applied through fertilizer. Biofertilizers have the potential to reduce the use of inorganic fertilizers and increase nutrient uptake by plants. Nitrogen-fixing bacteria can improve nitrogen uptake by increasing the population of nitrogen-fixing microbes in the soil, thereby increasing the amount of available nitrogen. In maize plants, 60% of absorbed nitrogen comes from the soil, while the other 38% comes from fertilization (Xiaobin et al., 2001).

Table 10. N Uptake Efficiency in Various Treatments

Treatment	N Fertilization Efficiency %
u0m0	0.00
u0m1	0.00
u0m2	0.00
u0m3	0.00
u1m0	0,89
u1m1	0,86
u1m2	0,92
u1m3	0,84
u2m0	0,99
u2m1	0,92
u2m2	1,14
u2m3	1,03
u3m0	1,05
u3m1	0,89
u3m2	0,92
u3m3	0,98

The highest nitrogen uptake efficiency was obtained from the combination of m2 formulated microbeads and 80% recommended dose of Urea, which amounted to 1.14%. Although nitrogen uptake efficiency was generally low, this combination showed better efficiency compared to 100% Urea application. The application of microbeads into the soil can protect microbes that convert nitrogen into a form that can be used by plants. Nitrogen uptake efficiency is influenced by factors such as the type of fertilizer and its application method. Although Urea contains high nitrogen, its fast dissolving and easily leached nature makes it less able to provide nitrogen in a sustainable manner, so it can reduce maize plant production (Bhaskoro et al., 2015).

4. CONCLUSION

1. There was an interaction between the application of Nitrogen Fixing Bacteria inoculant from Etno-Biofertilizer in the form of microbeads (encapsulation) and Urea on N-total, total population of nitrogen fixing bacteria, and root length of maize plants, but there was no interaction between on N uptake and growth of maize plants on Inceptisols soil. The independent effect of microbeads had a significant effect on plant height, stem diameter, and crown dry weight. The independent effect of Urea had a significant effect on plant height, stem diameter, chlorophyll content, crown dry weight, and N uptake.
2. The treatment of microbeads formulation m2 and Urea 80% of the recommended fertilizer is the best treatment that can produce N-total of 0.34% and can reduce the dose of Urea use by 20%.

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