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Application of Bioameliorant and Mycorrhizal Biofertilizers to Increase Growth of Maize-Soybean Intercropping in Suboptimal Land

Wahyu Astiko*, N M L Ernawati andI P Silawibawa
Faculty of Agriculture, University of Mataram,
Indonesia

Abstract:- Application of bioameliorants with various formulations can increase nutrient concentration and growth of maize-soybean intercropping. However, how much increase in nutrient concentration and growth of sandy soil rice has not been revealed. The experimental design used was a randomized block design consisting of five treatments of bioameliorant formulation, namely F0: without bioameliorant, F1: with 10% compost + 10% cattle manure + 10% rice husk charcoal + 70% mycorrhizal biofertilizer, F2: 15% bioameliorant compost+15% cattle manure 15% rice husk charcoal + 55% mycorrhizal biofertilizer, F3 : with bioameliorant 20% compost+20% cattle manure 20% rice husk charcoal + 40% mycorrhizal biofertilizer, F4 : with bioameliorant 25% compost+25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biological fertilizer. The variables observed in this study were: (1) soil nutrient concentration variables and plant nutrient uptake (N and P) at 42 days after planting, (2) growth variables included: plant height and number of leaves at 14, 28, 42 and 56 dap, and weight of wet and dry root and shoot at 42 dap, and (3) mycorrhizal population variables included: number of spores and percentage of root infection at 42 dap. The results showed that the application of bioameliorants with a formulation of 25% compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer in maize-soybean intercropping gave the best soil nutrient concentration, N and P nutrient uptake by plants, mycorrhizal population and growth of maize-soybean intercropping.

Keywords:- *Bioameliorant, maize-soybean,suboptimal land.*

I. INTRODUCTION

Suboptimal land is a future comparative advantage in the West Nusa Tenggara region, because 84% (1.8 million hectares) of its area is suboptimal land that has the potential to be developed into productive agricultural land [1]; [2]. However, the biophysical limiting factor is still considered to be responsible for the low production of food crops in the sub-optimal land of North Lombok. The biophysical limiting factors are low nutrient availability, poor soil organic matter content, and limited water availability for plants ([3]; [4].

On the other hand, the cultivation technology applied is not environmentally friendly which requires large amounts of inorganic fertilizers and fertilizers. artificial pesticides. This has a negative environmental impact and decreases the quality of soil fertility which includes the physical, chemical and biological properties of the soil ([5]; [6]; [7]. The low organic matter content of the soil causes the soil to be susceptible to erosion and decreased soil permeability, and decreased soil microbial population ([8]. Soil quality is naturally capable of producing adequate yields of high-quality plants and protecting human and animal health without destroying natural resources ([9]).

One solution to overcome this problemis substitute the use of inorganic fertilizers with bioameliorants ([10]; [11];[12]. Bioameliorant is a combination of biological resources (biological fertilizers, biological agents) with soil enhancers (ameliorants), especially organic fertilizers (compost, manure, biochar and others) enriched with organic extracts and nutrients to improve soil health and soil fertility continuously. 13;[14]; [15]).

However, the effect of giving several bioameliorant made from raw materials local manure waste, rice husk waste, compost and indigenous which can increase soil nutrient concentration, N and P nutrient uptake by plants, mycorrhizal population and growth in intercropping mize and soybeans on land. suboptimal has not been widely reported. Therefore, this study examines "Effect application of bioameliorant and mycorrhizal biofertilizers to increase soil nutrient concentration, N and P nutrient uptake by plants, mycorrhizal population and growth of maize-soybean intercropping in suboptimal land".

II. MATERIALS AND METHOD

A. Research

materials and tools The materials that will be used in this experiment are mize seed variety “Bisi 18”, soybean variety “Anjasmoro”, mycorrhizal isolates, cow manure, rice husk charcoal, compost, inorganic fertilizer (Urea and Phonska), OrgaNeem, Green Tonic foliar fertilizer, raffia, plastic bags, tissue, label paper, soil samples, root samples, methylene blue, 10% KOH, sucrose, aquades, filter paper, and stationery.

The tools used in this experiment are oven, scales, binocular microscope, magnetic stirrer, beaker, tweezers, multilevel sieve, centrifuge, funnel, petri, shovel, hoe, sickle and hand counter.

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B. Location and research design

This research was conducted in TelagaWareng, Pemenang Barat Village, Pemenang District, North Lombok Regency from June to September 2022. The experimental design used was a randomized block design with five treatments of bioameliorant namely F0: without bioameliorant, F1 : bioameliorant formulation 10% compost + 10% cattle manure + 10% rice husk charcoal + 70% mycorrhizal biofertilizer, F2 : bioameliorant 15% compost + 15% cattle manure + 15% rice husk charcoal + 55% mycorrhizal biofertilizer , F3 : bioameliorant 20% compost + 20% cattle manure + 20% rice husk charcoal + 40% mycorrhizal biofertilizer, F4 : bioameliorant 25% compost + 25% cattle manure + 25% rice husk charcoal + 25% fertilizer mycorrhizal life. The treatment was repeated 4 times so that there were 20 experimental plots ([16]. The comparison of the proportion of intercropping used was 3 rows of mize: 3 rows of soybeans.

C. Implementation of the experiment

Soil cultivation was carried out using a tractor to remove weeds from the soil. The soil was then divided into 20 fields measuring 5 mx 5 m. Mize and soybean seeds were planted in a single method. The mize-soybean intercropping pattern used was 3 rows of mize and 3 rows of soybeans. Each hole was filled with 3 seeds with a mize spacing of 60 cm. x 40 cm while the distance between soybeans is 30 cm x 20 cm.

Mycorrhizal isolates were propagated in pot culture using a mize host plant with a mixture of soil and sterile cattle manure (50%:50%) as much as 5 kg. Mycorrhizal inoculation was carried out by using a mixture of soil, roots, spores and mycorrhizal hyphae.Inoculation was carried out using *the funnel method*, namely filter paper foldedisolate was placed$_{MAA}$ and then the host plant was placed on the filter paper. The filter paper was then covered with soil and the plants were allowed to grow ([17]; [18]. After 50 days, the soil in the culture pots was harvested by cutting the plant roots, then blended until smooth. The results of this blender were then mixed homogeneously with the soil of the culture pot media This mixture was then filtered through a 2 mm diameter sieve. This mycorrhizal inoculant was then mixed homogeneously with cattle manure, rice husk charcoal and compost with a percentage ratio according to the treatment being tested. This bioameliorant mixture was then filtered through a 2 mm diameter sieve and the final product was bioameliorant. This is in the form of flour.

The bioameliorant according to the treatment of each bioameliorant is 40 g per hole by inserting it as deep as 5 cm and at a distance of 7 cm from the planting hole, while the application of inorganic fertilizer with a dose of 50% of the recommended dose is Urea and Phonska (mize: Urea). 150 kg/ha and Phonska 100 kg/ha & soybeans: 30 kg/ha Urea and 60 kg/ha Phonska). Bioameliorant days after planting and 50% inorganic fertilizer II was applied at 21 days after planting. Embroidery is done by replanting mize and soybean seeds at the age of 7 days after planting (dap).to replace dead or abnormally growing plants. After the plants grew, thinning was carried out leaving two plants at the age of 14 dap.

Plant maintenance includes weeding the weeds that grow by cleaning them using a sickle after the plants are 10 dap and subsequent weeding is done every 7 day intervals until the plants are 50 days. The provision of water depends on the rainfall in the field, if it is not sufficient, then water is given from the pump well at the age of 30 dap and 50 dap until the soil reaches capacity.

Plant protection is carried out by spraying "OrgaNeem" (an organic pesticide extracted from the Azadirachtin plant) with a concentration of 5 ml of OrgaNeem per liter of water. OrgaNeem was applied from the age of 10 to 40 dap with a spraying interval of 7 days.

D. Variable observations

The variablesobserved in this study were: (1) growth variables including: plant height and number of leaves at 14, 28, and 42 days after planting, (2) soil nutrient concentration variables and plant N and P nutrient uptake [19] ; [20]; [21] at 42 dap, root and shoot dry and wet weight at 42 dap, and (3) mycorrhizal population variables included: number of spores and percentage of root infection [22]; [23]; [24]; [25]at 42 dap.

E. Data analysis

Data analysis Observational data were analyzed using analysis of variance followed by the Least Significant Difference (LSD) test at a significance level of 5% using the Costat for Windows program.

III. RESULTS AND DISCUSSION

A. Height and number of leaves

The results of the diversity analysis showed that the application of a bioameliorant 25% compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer had a significant effect on plant height and number of leaves compared to the control (without bioameliorant) when the plants were 14-42 dap (Table 1). The highest plant height and number of leaves was obtained in the treatment of 25% compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biological fertilizer (F4).

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Bioameliorant Formulation	Plant Height (cm)			Number of leaves (strands)		
	14	28	42	14	28	42
Mize Plant						
F0	48.85^{c}	96.86^{d}	201.51^{d}	12.02^{c}	18.02^{e}	20.06^{d}
F1	49.48^{b}	116.49^{c}	232.26^{c}	12.27^{b}	18.75^{d}	22.01^{c}
F2	49.60^{b}	128.24^{ab}	249.51^{b}	13.69^{ab}	19.20^{c}	23.01^{c}
F3	49.85^{b}	130.61^{a}	254.01^{b}	13.77^{a}	19.77^{b}	23.26^{b}
F4	52.60^{a}	130.64^{a}	268.01^{a}	13.79^{a}	20.77^{a}	24.26^{a}
LSD 5%	0, 56	10.74	10.69	1.17	0.72	1.02
Soybean Plants						
F0	30.73^{e}	40.24^{c}	55.52^{c}	8.26^{e}	16.01^{d}	27.52^{e}
F1	34.73^{d}	47, 86^{b}	63.77^{d}	9.76^{d}	18.51^{c}	29.26^{d}
F2	35.73^{c}	53.74^{b}	68.27^{b}	18.71^{c}	31.26^{c}	11.01^{c}
F3	36.10^{b}	55, 56^{b}	70.52^{a}	11.51^{b}	23.76^{b}	32.01^{b}
F4	42.73^{a}	60.86^{a}	77.02^{a}	11.76^{a}	24.26^{a}	33.51^{a}
LSD 5%	3.52	7 ,60	7,67	0,25	2,12	1,29

Table 1: The mean height and number of leaves of mize-soybean plants (dap)

The mean values followed by the same letter in the same column are not significantly different according to the LSD 5 test %. F0: without bioameliorant, F1: bioameliorant formulation 10% compost + 10% cattle manure + 10% rice husk charcoal + 70% mycorrhizal biofertilizer, F2: bioameliorant 15% compost + 15% cattle manure + 15% rice husk charcoal + 55 % mycorrhizal biofertilizer, F3: bioameliorant 20% compost + 20% cattle manure + 20% rice husk charcoal + 40% mycorrhizal biofertilizer, F4: bioameliorant 25% compost + 25% cattle manure + 25% rice husk charcoal + 25 % mycorrhizal biofertilizer.

Application bioameliorant 25% compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer gave a significant effect on plant height and number of leaves compared to control. This fact indicates the importance of applying ameliorant in the management of sandy soils. Bioameliorants or "soil enhancers" can improve the root to support plant growth.formulationbioameliorant consisting of 25% compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer is thought to be able to meet the K needs of mize and soybeans, because the K content in this formulation is very high. Potassium plays a very important role in the early growth of mize and soybeans, especially in meristem tissue, which is a tissue that actively divides at the tip. That the element K plays a greater role in plant vegetative growth, especially in the tip meristem (shoot), and is also higher in these tissues compared to older parts [26]. Elemental K plays a role in supporting plant growth, which plays a role in plant photosynthesis which produces carbohydrates, proteins and other organic compounds [27]. The compounds produced are used in the process of division and enlargement or differentiation of plant cells, so that it will stimulate growth in plant shoots and will encourage the increase in height and number of plant leaves. The application of bioameliorants with this formulation can also meet the needs of micro nutrients in sandy soils such as Cu and Zn which play a role in the formation of cell walls which causes an increase in plant height and number of leaves.formulationBioameliorant 20% chicken cattle manure + 20% agricultural weed + 20% purun rat + 20% mineral soil + 20% dolomite with a dose of 15 tons ha^{-1} gave the best effect on plant height and number of leaves [28].

B. Soil nutrient concentration and plant nutrient uptake.

The results of the diversity analysis showed that the application of 25 % compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer had a significant effect compared to other formulations on soil nutrient concentrations. and nutrient uptake by plants (Table 2 and Table 3).

Bioameliorant formulation	total N (g kg^{-1})		P available (mg kg^{-1})	
	Mize	Soybean	Mize	Soybean
F0	1.30^{d}	1.23^{d}	12.07^{d}	12.85^{e}
F1	1.44^{c}	1.28^{c}	16, 80^{c}	15.22^{d}
F2	1.44^{c}	1.33^{b}	20.83^{b}	17.67^{c}
F3	1.58^{b}	1.47^{a}	23.57^{b}	20.80^{b}
F4	1.92^{a}	1.47^{a}	37 ,41^{a}	24,31^{a}
LSD 5%	0.12	0.05	3.59	2.35

Table 2: Average nutrient concentrations of N and P in the mize-soybean intercropping rhizosphere in the treatment of several bioameliorant aged 42 DAP

Average value followed by the same letter in the same column were not significantly different according to the 5% LSD test. Description of treatment see Table 1.

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The results of the LSD test at the 5% level showed that the application of a bioameliorant 25% compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer could increase the concentration of total N and P available in the soil and nutrient uptake of N. and plant P at 42 dap. The highest and significantly different increase occurred in the application of 25 % compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer (F4).

Bioameliorant Formulation	N Absorption (g kg^{-1})		P Uptake (g kg^{-1})	
	Mize	Soybean	Mize	Soybean
F0	29.09^{d}	35.50^{e}	1.95^{e}	1.97^{d}
F1	29.71^{c}	36.41^{d}	2, 24^{d}	2.11^{c}
F2	31.30^{b}	40.05^{c}	2.95^{c}	2.12^{bc}
F3	31.58^{b}	45.02^{b}	3.05^{b}	2.23^{b}
F4	32.24^{a}	46.98^{a}	3 ,88^{a}	2.35^{a}
LSD 5%	0.59	0.89	0.27	0.12

Tabe 3: Average N and P uptake of mize-soybean intercropping in the treatment of several bioameliorant aged 42 dap

The mean value followed by the letterthe same column in the same column was not significantly different according to the 5% LSD test. Description of treatment see Table 1

Application of bioameliorant25% compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer 25 tons ha^{-1} showed the concentration of N and P nutrients in the soil and NP uptake in plants showed significant differences, both in the soil and shoot. Application bioameliorant can improve the chemical and physical properties of sandy soil [29]. Improvement of chemical properties through improvement of nutrient availability status improves soil pH. Improvement of physical properties, one of which is by decreasing total porosity and increasing lump density in sandy soils can have an impact on nutrient uptake, especially P [30]; [31]. An increase in soil pH also affects P uptake by plant roots. P uptake will be disturbed at low pH conditions because P is not mobile. This condition also causes impaired root growth and function. The application of P both from inorganic fertilizers and bioameliorants can increase the uptake of N and P in maize [32].Application 20 ton ha^{-1}bioameliorant with a formulation of 80% chicken manure + 20% dolomite gave the highest NPK nutrient uptake. This condition is thought to be due to the bioameliorant with this composition is more able to increase the concentration of available P in the soil solution, so that its availability in the soil increases. In addition, the nutrients contained in bioameliorant are released slowly (*slow release*) so that they are available continuously so that they can be used by plants [33].

C. Development of Mycorrhizae

The results of the diversity analysis show the effect of treatment with 25 % compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizermake a real impactaccording to the LSD test 5% compared with bioameliorant on the parameters of the number of mycorrhizal spores and the percentage of root colonization at 42 dap (Table 4). The value of the number of spores and the highest percentage of colonization was found in the treatment with compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer.

Bioameliorant Formulation	Spores on Mize	Spores on Soybean	%-colonization of Mize	%-colonization of Soybean
F0	102.67^{d}	100.01^{d}	25.01^{c}	20.34^{d}
F1	726.67^{c}	606.67^{c}	53.01^{b}	43.34^{c}
F2	966.01^{c}	818.67^{bc}	62.67^{ab}	51.67^{bc}
F3	1651.34^{b}	994.67^{b}	68.34^{a}	58.34$_{ab}$
F4	2612.67^{a}	1888.67^{a}	76.67^{a}	63.34^{a}
LSD 5%	386.65	226.86	19.68	8.96

Table 4: Average number of spores (per 100 g of soil) and root colonization (%) of maize-soybean intercropping in the treatment of several bioameliorant aged 42 dap

Value the mean followed by the same letter in the same column was not significantly different according to the 5% LSD test. For treatment information, see Table 1.

Application bioameliorant into the soil can increase soil fertility in terms of physics, chemistry and soil biology. Organic matter can provide nutrients for plants, has macro and micro pores so that air circulation is quite good and has high water absorption [34]. Application of bioameliorant formulation of 25% compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer (F4) as basic fertilizer was able to increase the activity and population of mycorrhizae in the rhizosphere. Mycorrhizal activity in the soil is one of the most useful activities in providing P available to plants. Mycorrhizae in carrying out their activities and development require energy and organic matter derived from bioameliorant is a source of energy for these mycorrhizae to develop [35]. The provision of bioameliorants

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that contain lots of organic matter is closely related to the increase in organic C and mycorrhizal activity in the soil ([36]. The availability of sufficient organic matter in the soil acts as an energy source for mycorrhizal development because it can provide important elements needed by mycorrhizae). to thrive ([37].formulation bioameliorant has a role in the soil to increase soil fertility. Because the organic matter contained in it can play a role in increasing the activity of mycorrhizae in the soil, storing and releasing nutrients for plants. Decomposition of organic matter is very useful for providing nutrients for the development of microorganisms (mycorrhizae) in the soil [38]. The main benefit of the symbiosis between mycorrhizae and plants is its ability to increase the absorption of phosphorus nutrients and improve plant growth. Mycorrhizae can help improve plant nutrition, increase plant growth and yield ([39].

D. Wet and dry biomass weight

The results of the diversity analysis showed bioameliorant consisting of 25% compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer had a significant effect on increasing the wet and dry biomass weight of roots and shoots compared to without bioameliorant (Table 5).The results of the LSD test at 5% level showed that the application of bioameliorant 25% compost + 25% cattle manure cow25% rice husk charcoal + 25% mycorrhizal biofertilizer compared to control (without bioameliorant) can significantly increase the weight of wet and dry biomass of roots and plant shoots.The highest increase in wet and dry biomass weight of roots and plant crowns occurred in the application of bioameliorant 25% compost+ 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer (F4).

BioameliorantFormulation	Mize		Soybean	
	Roots	Shoot	Roots	Shoot
Wet Biomass				
F0	Wet^{a}	89.91^{e}	0.41^{e}	1.73^{e}
F1	57.56^{d}	123.95^{d}	0.73^{d}	4.24^{d}
F2	68.36^{cd}	146, 02^{c}	0.91^{c}	5.63^{c}
F3	81.09^{b}	261.87^{b}	1.25^{b}	8.55^{b}
F4	140.01^{a}	365.21^{a}	1.61^{a}	13.49^{a}
LSD 5%	20.43	32.08	0.32	2.51
Dry biomass				
F0	13.59^{d}	15.75^{d}	0.31^{d}	0.58^{d}
F1	29.44^{c}	25.73^{c}	0.34^{c}	1.62^{c}
F2	42.44^{b}	26.28^{c}	0.36^{c}	2.06^{bc}
F3	42.82^{b}	87.24^{b}	0.65^{b}	2.82^{b}
F4	89.22^{a}	108.48^{a}	0.66^{a}	4.56^{a}
LSD 5%	15 ,76	9.29	0.03	1.04

Table 5: Average wet and dry biomass weight of roots and shoots (g/plant) of mize-soybean intercropping in the treatment of several bioameliorant aged 42 dap

The mean value followed by the same letter in the same column were not significantly different according to the 5% LSD test. Description of the treatment see Table 1.

The results showed that the wet and dry biomass weights of roots and plant crowns were the highest and significantly different in the treatment formulation bioameliorant25% compost + 25% cattle manure + 25% rice husk charcoal + 25% biological fertilizer (F4).formulation bioameliorant thought to provide a better growing environment than the F4 formulation bioameliorant 10% compost + 10% cattle manure + 10% rice husk charcoal + 70% mycorrhizal biofertilizer (F1), bioameliorant 15% compost + 15% cattle manure + 15% rice husk charcoal + 55% mycorrhizal biofertilizer (F2) and the formulation of bioameliorant 20% compost + 20% cattle manure + 20% rice husk charcoal + 40% mycorrhizal biological fertilizer (F3), especially the availability of N and P in the soil. Mize plants generally require higher N and P than soybeans ([40]. Improvements in the availability of N and P elements in the soil will also balance the availability of nutrients in the soil.In order for plants to grow well, it is necessary to balance the amount of nutrients in the soil according to plant needs [41]. Nutrients will be used by plants to stimulate the process of photosynthesis. The results of photosynthesis will be translocated to all parts of the plant to stimulate vegetative and generative development of plants. In addition, the bioameliorant F4 formulation was able to provide N and P in sufficient proportions to support plant growth. As the availability of N and P in the soil increases, the wet and dry weights of roots and shoots also increase. On the other hand, the application of bioameliorants into the soil can improve soil structure and increase the availability of nutrients for plants. Root development can occur because the absorption of nutrients by plant roots goes better. The absorption of nutrients by the roots can also run more broadly, so that the nutrients absorbed by the roots can also meet the nutrient needs of plants. In addition, root elongation occurs due to root interception, where the growth of these formed roots can reach unreached planting media, resulting in increased nutrient uptake by plant roots.Better availability of nutrients leads to better plant growth and easier absorption of nutrients so that mize and soybeans will form new roots and shoots well [42]. Furthermore, improvements in plant nutrient absorption will support metabolic processes so that plants will actively form new roots and branches [43].

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IV. CONCLUSION AND SUGGESTIONS

Formulation of bioameliorant 25% compost + 25% cattle manure + 25% rice rice husk charcoal + 25% mycorrhizal biofertilizer can increase soil nutrient concentration (total N and P available), plant nutrient uptake (N and P), growth mycorrhizae (number of mycorrhizal spores and percentage of root colonization) and plant growth (plant height, number of leaves, wet and dry weight of roots and shoots). Formulation Bioameliorant 25% compost + 25% cattle manure + 25% rice husk charcoal + 25% mycorrhizal biofertilizer (F4) was the best in increasing soil nutrient concentration, nutrient uptake by plants, mycorrhizal development and plant growth.

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