EFFECTS OF SOIL AMELIORANT COMPOSITION ON SOIL PROPERTIES AND CHILI (*Capsicum annuum* L.) YIELD IN INCEPTISOLS JATINANGOR

PENGARUH KOMPOSISI AMELIORAN TANAH TERHADAP SIFAT TANAH DAN HASIL CABAI (*Capsicum annuum* L.) DI INCEPTISOLS JATINANGOR

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ABSTRAK

Pupuk anorganik meningkatkan produktivitas tanaman cabai, namun penggunaan terus menerus akan menyebabkan kualitas tanah menurun. Penggunaan amelioran diharapkan dapat memperbaiki kualitas tanah. Penelitian ini bertujuan untuk mengetahui pengaruh komposisi dan dosis amelioran terbaik terhadap C organik, pH tanah, populasi bakteri pelarut fosfat, dan hasil tanaman cabai di Inceptisols Jatinangor. Penelitian dilakukan di rumah plastik Fakultas Pertanian Universitas Padjadjaran bulan Januari – Mei 2018 menggunakan rancangan acak kelompok faktorial terdiri dari dua faktor dengan tiga ulangan. Faktor pertama adalah komposisi amelioran yang terdiri dari empat taraf (a_1 = 80% kotoran sapi + 20% biochar batok kelapa; a_2 = 95% komposisi a_1 + 5% dolomit dan guano; a_3 = 90% komposisi a_1 + 10% dolomit dan guano; a_4 = 85% komposisi a_1 + 15% dolomit dan guano), dan faktor kedua adalah dosis amelioran yang terdiri dari empat taraf (t_0 = 0 t ha^{-1} ; t_1 = 2 t ha^{-1} ; t_2 = 4 t ha^{-1} ; t_3= 6 t ha^{-1}). Hasil penelitian menunjukkan bahwa tidak terdapat interaksi antara komposisi dan dosis amelioran terhadap C-organik, pH tanah, populasi BPF, dan hasil cabai pada Inceptisols Jatinangor. Dosis amelioran 4 t ha^{-1} meningkatkan C-organik, pH tanah, populasi BPF, dan meningkatkan hasil tanaman cabai sebesar 44,9%.

Kata Kunci: Amelioran, Bakteri Pelarut Fosfat, Inceptisols, Tanaman Cabai,

ABSTRACT

Inorganic fertilizers have an important role in improving the productivity of chili plants, but continuous use will cause soil quality to decline. The use of ameliorant is expected to improve soil quality. This experiment was aimed to find out the best effect of ameliorant composition

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and dose on organic-C, soil pH, population of phosphate solubilizing bacteria, and yield of chili plant in Inceptisols Jatinangor. The research was conducted in plastic house of Agricultural Faculty of Padjadjaran University on January – Mei 2018. The design experiment was factorial randomizedblock design which consisted of two factors with three replications. The first factor was ameliorant composition consisting of four levels (a_1 = 80% cow manure + 20% Biochar Coconut Shell ; a_2 = 95% Composition a_1 + 5% Dolomite and Guano ; a_3 = 90% Composition a_1 + 10% dolomite and guano; a_4 = 85% composition a_1 + 15% dolomite and guano), and the second factor was ameliorant dose consisting of four levels (t_0 = 0 t ha^{-1} ; t_1 = 2 t ha^{-1} ; t_2 = 4 t ha^{-1} ; t_3= 6 t ha^{-1}). The results showed that there were no interaction between composition and dose of ameliorant to organic-C, soil pH, population of phosphate solubilizing bacteria, and yield of chili on Inceptisols Jatinangor. The 4 t ha^{-1} of ameliorant dose increased organic-C, soil pH, population of phosphate solubilizing bacteria, and yield of chili plant by 44,9%.

Keywords: Ameliorant, Chili Plants, Inceptisols, Phosphate Solubilizing Bacteria

INTRODUCTION

Ameliorant are a substance that aid plant growth primarily by improving the physical condition of the soil**.** Amelioran is a fixer soil, including organic matter and inorganic that can increase soil fertility through improving conditions soil physics and chemistry. Ameliorant is a soil enhancer that can improve soil condition. Ameliorant material can be either organic or inorganic material (Susilawati et al., 2011).

Chili are a member of family *Solanaceae* and are an important crop globally. They are produced in large numbers in Indonesia to meet the high demand (Fadhila et al., 2020). Chili is widely used as a food ingredient in Indonesia, therefore, the need for chili in Indonesia continues to increase every year.

According to the Ministry of Agriculture in 2021, the national production of large red chili was increased become l,k8o1) 1.36 million tons in 2021, this increase was 96.38 thousand tons (7.72%) which is larger than the previous (BPS, 2022) This can occur, among others, due to soil conditions, soil processing, and inappropriate fertilization, so the growth and yield of chili plants are not optimal.

Inceptisols is undeveloped young soil order (Hardjowigeno, 2007) and spread widely in Indonesia, covering around 70.52 million ha or 40% of the total plain (Amisnaipa *et al*., 2014). Inceptisol soils which are quite extensive but have problems with relatively low nitrogen nutrients so that the effort to overcome this is through the addition of organic matter into the soil through organic fertilization or with inorganic fertilizers (Harahap et al., 2021). Decreased levels of organic materials in Inceptisols will indirectly affect the availability of nutrients in the soil, hence fertilization is needed. The application of manure generally more of a improve nature soil, and reduce the negative impact in plant growth and production and application of cattle manure contributed to the increased of total N and available P in soil (Agustini et al., 2017).

Inorganic fertilizer is one of the most common available nutrient source to increase chili productivity. During plant growth, in addition to providing inorganic fertilizers for chili plants, the use of biological/microorganism fertilizers is also essential to increase chili productivity because of its benefit (Priyadi et al, 2022). Inorganic fertilizer can lead to soil quality degradation, this includes physical, chemical, and biological

properties of the soil. This can be mitigated by the addition of ameliorant into the soil to improve the quality and declining soil fertility.

Integrated nutrient management that supports organic fertilization and the use of ameliorant in increasing the availability of nutrients in the soil and in spesially to improve soil physical, chemical and biological fertility (Nurhayati et al., 2013).

According to the Indonesian Agency for Agricultural Research and Development (2011). Ameliorant material can be either organic or inorganic material. Some commonly used ameliorant are manure, biochar, dolomite, and guano (Haryadi et al., 2012). Manure and biochar application in soil can improve soil quality and crop productivity (Muharam & Saefudin, 2016). Dolomite and guano can also increase soil pH, Organic-C, and bacterial activity (Kusbianto et al., 2014; Sudirja et al., 2017). The composition and dose of these ameliorants need further study, especially for chili plant grown in Inceptisols. In this study, the interaction between composition and ameliorant dose towards soil properties and chili yield were studied. The use of ameliorant was expected to improve soil quality. This experiment was aimed to find out the best effect of ameliorant composition and dose on organic-C, soil pH, population of phosphate solubilizing bacteria, and yield of chili plant in Inceptisols Jatinangor

MATERIAL AND METHODE

Soil Samples

Soil sample used in this study was Inceptisol from Ciparanje village, Jatinangor, West Java, Indonesia at January – Mei 2018 . The initial soil compositions were: pH 6.1 (slightly acidic), Organic-C 2.13 % (medium), N 0.21% (medium), C / N 10 (low), P_2O_5 (HCl 25%) 77 high). Location at altitude of place 700 meters above sea level (Analyzed at Soil Chemstry and Plant Nutrition Laboratory, Faculty of Agriculture Padjadjaran University).

Tools and Materials

The materials used consist of Hot Beauty chili seeds, Inceptisol soil media, ameliorant material of Cow manure (CM), Coconut Shell Biochar (CSB), a mixture of 50% dolomite and 50% guano (DG), and materials used in laboratory analysis. The tool used in this research were polybag, label paper, ruler, digital scales, and laboratory equipment for pH analysis, Organic-C, and population of Phosphate Solubilizing Bacteria (PSB) (collection of Microbiology Laboratory Faculty of Agriculture Padjadjaran).

Experimental Design and Data Analysis

This research used Randomized Block Design experiment method with two factors and repeated three times to obtain 48 units of experiment. Analysis of experimental data was done based on linear model from Factorial Randomized Design. The test of difference of influence of mean of treatment was done by F test method at 95% confidence level. If there is a difference in mean treatment significantly, then the test is continued with Duncan's New Multiple Range test at 5% level. Data analysis with SPSS version 16. The observations were made up of Organic-C ((Walkley and Black Metode), Nelson and Sommers,1996)) soil pH (pH meter), population of Phosphate Solubilizing Bacteria (when the first flower were formed), root dry weight, shoot dry weight and chili yields.

Treatments composition of ameliorant were divided into four levels : a1 (80% Cow Manure + 20% Biochar Coconut Shell), a2 (95% composition of a1 + 5 % Dolomit and Guano), a3 (90% composition of a1 + 10 % Dolomit and Guano), a4 (85% composition of a1 + 15 % Dolomit and Guano). The second factor was dose of ameliorant with four levels

: t_0 (0 ton.ha^{-1}), t_1 (2 t ha^{-1}) , t_2 (4 t ha^{-1}), t_4(6 t ha^{-1}).

RESULTS AND DISCUSSION

Soil Properties

Application of ameliorant composition and ameliorant dose have no interaction of Organic-C, Soil pH, and population of Phosphate Solubilizing Bacteria (PSB). However, the application of the composition independently had an effect on the PSB population, whereas the dose application independently had a significant effect on organic-C, soil pH, and PSB population (Table 1). According to Haynes & Mokolobate (2001) the increase in pH due to the administration of ameliorant ingredients is due to the presence of anion decarboxylase of organic acids such as oxalic acid, citric acid and malic acid which are produced in the overhaul of organic matter, consuming H^+ ions and produce CO_2.

The addition of a mixture of dolomite and guano did not significantly increased organic C-and soil pH. a2 ((95% composition of a1 + 5 % Dolomit and Guano) treatment capable of producing PSB population of 10.12 x 10^8 cfu.g^{-1} , higher than a1 which produces only 9.94 x 10^8 cfu.g-^{1} of PSB population. The composition of ameliorant with the addition of a mixture of dolomite and guano increase organic – C conten and soil pH higher than ameliorant composition without mixed dolomite and guano. Higher organic-C and soil pH will increase the activity of bacteria in the soil compared to other treatments. The presence of activity from soil bacteria especially PSB, then can increase the availability of P (Sinaga, et al., 2018). Guano fertilizer has the role of increasing nutrient availability in the soil and cation exchange capacity, and these nutrients include macro nutrients that can be absorbed by plants to optimize photosynthesis as a producer of assimilation so that they can improve the growth of cocoa plants.

Table 1. Independent Effect of Composition and Ameliorant Dose on Soil Properties at 8 MST

Treatment	Organic-C (%)	Soil pH	Population of PSB (x 10^8 cfu/g)
Ameliorant Composition (A)			
a_1 : 80% CM + 20% CSB	3.16 a	6.06 a	9.94 a
a_2 : 95% a_1 + 5% (DG)	3.23 a	6.16 a	10.12 b
a_3 : 90% a_1 + 10% (DG)	3.25 a	6.20a	10.02 ab
a_4 : 85% a_1 + 15% (DG)	3.17 a	6.18a	10.02 ab
Ameliorant Dose (T)			
t_0 : 0 t ha^{-1}	2.04 a	5.89 a	9.85 a
t_1 : 2 t ha^{-1}	3.53 b	6.01 a	10.,08 b
t_2 : 4 t ha^{-1}	3.58 b	6. 22 b	10.08 b
t_3 : 6 t ha^{-1}	3.65 b	6.38 b	10.09 b

Information:
- a_1 = 80% Cow Manure + 20% Coconut Shell Biochar;; CSB = Biochar Coconut Shell; DG = Dolomite and Guano
- The number followe by same letter isnot significant differet according DMRT 5%.

Application of soil ameliorant could improve the biological poperties of soil (Basu et al., 2017). the addition of dolomite and guano has not given a significant effect because the nature of giving organic matter on the soil takes a long time, The response of plants to organic fertilizer is slower, because organic fertilizer is slow release (Chaudhary et al., 2020). Biochar and organic matter can improve soil quality by converting agricultural

waste into soil enhancers that store carbon and make the soil more fertile, applying biochar to agricultural land can increase P, K content, microbial activity, and soil quality and cannhelp reduce nitrogen leaching into water soil and reduce fertilizer costs (Situmeang, 2018).

According to Table 1, the increase of ameliorant dose is directly proportional to the is not increase in organic-C and soil pH. Soil regulators increase the content of available potassium and organic fertilizers significantly increase the organic matter content, it was also found that organic fertilizers significantly increase the pH, potassium (K) and phosphorus (P) contents of the soil (Özyazici et al., 2010). In a study, increasing doses of different organic materials were used, was reported that all application subjects were effective at P <0.01 level on pH. As the level of application increased, the pH value of soil also increased (Alagöz et al., 2006). Soils with low pH (acidity) tend to make some nutrients needed by plants unavailable (Neina, 2021). This is in line with Utami & Handayani's (2003) explanation that the addition of organic matter can increase the soil organic-C, application of organic matter into the soil after decomposition process, can increased The carbon content in the soil is also organic acid derived from weathering organic. Enzyme activities increased along gradients of soil pH, indicating that the influences of inorganic or organic ameliorants on soil enzyme activities were mainly due to the effect on soil pH value (Ai et al., 2015).

The C-organic content in the combination treatment of ameliorant was also higher on average compared to control. Fahriansyah *et al.* (2015) also showed that the increase in organic matter doses is proportional to the increase in organic-C and soil pH. Increased organic-C and soil pH due to the addition of ameliorant with various doses will increase energy source and improve the environment to increase the activity of bacteria in the soil. Biochar as ameliorant can contribute to soil fertility, increase yields, help closing nutrient cycles (Beusch et al., 2021). The higher the dose application, the higher the organic C content of the soil, of course this can be understood because the contribution of carbon from biochar increases soil organic C related to the presence of recalcitrant C (Salawati, 2016) in biochar as a result of the increased aromatic degree possessed by biochar.

The application of ameliorant to the soil can improve the biophysical and chemical properties of the soil and the supply of nutrients to plants. Biochar can increase the soil's ability to increase carbon (C) storage in the soil by reducing natural degradation and improve soil fertility and other ecological functions (Lehmann et al., 2006).

The addition of organic matter can improve the chemical properties of the soil, it can also improve the physical and biological properties of the soil. The application of organic matter stabilizes soil aggregates against destruction by water, increases the ability of soil to hold water, increases soil permeability (Organic soil ameliorant (OSA) improved soil nutrients, such as available phosphorous, potassium and C-organic but not the total nitrogen (Jaya et al., 2021).

YIELD OF CHILI PLANT

Compotition treatment and dose of ameliorant give real influence to the weight of dry root and weight of dry shoot (Table 2). Application of compotition ameliorant encreased root dry weight and shoot dry weight at treatment a3 (90 % a1 (80% Cow manure + 20 % Coconut Shell Biochar) + 10% Dolomit and Guano) hieghest than treatment else.

Application of dose of ameliorant increases root dry weight and shoot dry weight significantly than non application of

ameliorant, where 4 t ha^{-1} treatment is enough to increase root dry weight and shoot dry weight compared to treatment without ameliorant.

Table 2. Independent Effect of Composition and Ameliorant Dose on root dry Weight and shoot dry weight of Chili

Treatment	Root Dry Weight (g)	Shoot Dry Weigth (g)
Ameliorant Composition (A)		
a_1 : 80% CM + 20% CSB	2.61a	11.60 a
a_2 : 95% a_1 + 5% (DG)	4.11 b	13.78 b
a_3 : 90% a_1 + 10% (DG)	5.51 c	18.27 d
a_4 : 85% a_1 + 15% (DG)	4.64 bc	15.81 c
Ameliorant dose (T)		
t_0 : 0 t ha^{-1}	2.76a	10.12 a
t_1 : 2 t ha^{-1}	4.21 b	12.84 b
t_2 : 4 t ha^{-1}	4.55 b	16.30 c
t_3 : 6 t ha^{-1}	4.55 b	17.19 c

Information:

- a_1 = 80% Cow Manure + 20% Coconut Shell Biochar;; CSB= Coconut Shell Biochar; DG = Dolomite and Guano- The number followe by same letter isnot significant differet according DMRT 5%.

The increase in the growth of chili plants is not too high and slow but still higher compared to without ameliorant, this occurs because the application of ameliorant has an effect on increasing soil microbial activity (Purwani et al., 2014). In line with the research of Kusbianto et al. (2014), that the application of ameliorant in the soil can increase the population of azotobacter sp and the activity of phosphate solubilizing bacteria thereby increasing the availability of N and P in the soil.

The activity and the biodiversity of microbe in rhizosphere correlated with the roots growth and supply of organic carbon or roots exudate. Moreover, the domination and high activity or biodiversity of N-fixer or PSB as biofertilizers or as plant growth promoting rhizobacteria (PGPR) in soils will improve the nutrients status and phytohormone production for supporting the plant growth (Simarmata et al., 2019).

Plant growth takes place slowly compared to the application of inorganic fertilizers which takes place quickly, even though the composition of the nutrients contained in biofertilizers is more complete (Nurahmi et al., 2011). Application of ameliorant composition with ameliorant dose did not show the interaction of the increase of yield of five times of chili crop harvest, either amount or weight of fruit. Further test results of ameliorant composition and ameliorant dose can be independently seen in Table 3. The application of ameliorant composition does not have a significant effect on the increase in the number and total weight of the fruit per plant.

The addition of dolomite and guano had no significant effect on the resultant component because the amount of addition of dolomite and guano was added a little, so it could not give the improvement of the different component of the result with the ameliorant composition without the addition of dolomite and guano.

Guano fertilizer has the role of increasing nutrient availability in the soil and cation exchange capacity, and these nutrients include macro nutrients that can be absorbed by plants to optimize photosynthesis as a producer of assimilation so that they can

improve the growth of chili plants (Lindawati et al., 2000 *in* Tarigan et al., 2020).

Effect of ameliorant dose application independently gives a real effect on the amount of fruit. Ameliorant dose 4 t ha^{-1} can yield 10 fruit with total weight 44,10 g, with an increase of 66,7% and 44,9% respectively compared to ameliorant dose 0 t ha^{-1} yielding 6 fruit with total weight 30,44 g. This is thought to occur because the application of ameliorant can increase the resistance of chili plants to the disease so it can produce more fruit than the control plants. Chili endurance increased by allegedly due to increased rhizobacteria population due to ameliorant addition. Research by Taufik *et al*. (2010) also showed that increased rhizobacteria may reduce disease attacks on chili plants.

Table 3 Independent Effect of Composition and Ameliorant Dose on the Number and Weight of Chili Fruit from 5 Harvest Times

Treatment	Amount of Fruit/ Plant	Weight of Fruit/ Plant (g)
Ameliorant Composition (A)		
a_1 : 80% CM + 20% CSB	9 a	40.37 a
a_2 : 95% a_1 + 5% (DG)	9 a	38.06 a
a_3 : 90% a_1 + 10% (DG)	9 a	41.74 a
a_4 : 85% a_1 + 15% (DG)	9 a	38.38 a
Ameliorant dose (T)		
t_0 : 0 t ha^{-1}	6 a	30.44
t_1 : 2 t ha^{-1}	9 b	41.01
t_2 : 4 t ha^{-1}	10 b	44.10
t_3 : 6 t ha^{-1}	10 b	43.00

Information:

- a_1 = 80% Cow Manure + 20% Coconut Shell Biochar;; CSB= Coconut Shell Biochar; DG = Dolomite and Guano- The number followe by same letter isnot significant differet according DMRT 5%.

The effect of ameliorant dose has no significant effect on the weight of fruit suspected to occur because of the nutrient content in the low ameliorant material so that it can not increase the availability of nutrients in the soil significantly. According to Soelaeman (2008), Dariah *et al*. (2015), and Pahmiansyah *et al*. (2013), cow manure, coconut shell biochar, and guano contain NPK content (0.55%, 0.12%, 0.3%), (0.15%, 0.02%, 0, 04%), and (2%, 28%, 2.5%) so as not to increase the availability of NPK nutrients in the soil and increase the weight of chili plants significantly.

The application of ameliorant to the soil increases the availability of cations, especially Nitrogen and Phosphorus and cation exchange capacity (Saputra, 2012). the effect of ameliorant application increases nutrient retention in addition to changes in soil microbial dynamics. Improvement of soil biology is closely related to the role of ameliorant as a source of carbon and energy for microorganisms.

Application of organic ameliorants significantly improved some soil biological properties (population of phosphate solubilizing microbes, N-fixing bacteria and phosphatase activity) and increased some soil chemical properties such as total N, available P, organic C and cation exchange capacity (Fitratin et al., 2021).

Soil ameliorant amendment is a way to improve soil fertility and thereby enhance

plant growth. Both organic and inorganic ameliorants are considered as non-conventional fertilizers for better plant yield (Hindarsah et al., 2022).

CONCLUSIONS

Based on the results of testing the ameliorant composition with ameliorant dose can be concluded that:

1. The composition and dose of ameliorant have no interaction effect on soil organic-C, soil pH, population of phosphate solubilizing bacteria, and chili plant yield in Inceptisols. However independently, the application of ameliorant dose significantly affected the soil organic-C, soil pH, population of phosphate solubilizing bacteria, and chili plant yield.
2. Application of ameliorant dose 4 t ha^{-1} significantly increased organic-C, soil pH, population of phosphate solubilizing bacteria, and increased the yield of chili plant by 44,9%.

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