

Composition and Dose of Ameliorant Against C/N Ratio, Soil pH, Plant Phosphate Content on Potato Plants

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ABSTRACT

This research aimed to study the addition of ameliorant material in the soil to increase fertility rates, especially for potato plants grown at the height of 750 m above sea level. The experiments were conducted on medium plains 750 m above sea level in the Jatiningor area, Indonesia, with land type Incepticol. The composition of ameliorant consists of Cattle manure, biochar from coconut shells, and dolomite. The seeds of the potatoes used are relatively good varietal when cultivated in a medium plain. The design of the environment used is the group's random draft repeated three times, the treatment design consists of K₀: control; K₁: Cattle manure 10 Mg ha⁻¹; K₂: Cattle manure 20 Mg ha⁻¹; K₃: Cattle manure 8 Mg ha⁻¹, dolomite 1 Mg ha⁻¹, 1 Mg ha⁻¹ biochar; K₄: Cattle manure 16 Mg ha⁻¹, dolomite 2 Mg ha⁻¹, 2-Mg biochar ha⁻¹; K₅: Cattle manure 8 Mg ha⁻¹, dolomite 2 Mg ha⁻¹; K₆: Cattle manure 16 Mg ha⁻¹, dolomite 4 Mg ha⁻¹; K₇: Cattle manure 8 Mg ha⁻¹, biochar 2 Mg ha⁻¹; K₈: Cattle manure 16 Mg ha⁻¹, biochar 4 Mg ha⁻¹. Results showed that the composition and dose of ameliorant could increase the value of soil pH but have not improved the C/N ratio and absorption of phosphorus plants. The best result was obtained from the composition treatment of 16 Mg ha⁻¹ Cattle manure, 2 Mg ha⁻¹ dolomite, and 2 Mg ha⁻¹ biochar. Soil pH is capable of increased by 16.83%, and the size of the potato bulbs of Class L (450-550 mm) amounted to 35, 11%, size M (350-450 mm) by 25.89%, and size S (200-350 mm) amounting to 34.37% when compared with controls.

Keywords: Ameliorant composition, soil nutrient contents and potato yield

INTRODUCTION

Potato production in 2020 amounted to 1.26 million Mg, although it showed a decrease in the production of 2.42% compared to 2019. However, the value of potato exports rose by 81.38% compared to 2019 (Sumartini *et al.* 2021); this shows the potential that is quite promising for the potato production business. Potato plants are plants planted on a plateau, but potato production is decreasing. Potato plants are plants grown in the highlands causing land damage due to the continuous use of chemical fertilizers and erosion so that it becomes one of the factors of declining potato production (Pawelzik and Moller 2014; Braman *et al.* 2016; Das *et al.* 2017). Planting potato crops in the middle plains is one of the efforts to keep the potatoes production, and it can also reduce environmental damage.

Ameliorant is an organic material that can improve soil fertility. The addition of ameliorant can increase C available (Dariah and Susanti 2015). Ameliorants that can be added to the land include manure, biochar, and dolomite. Biochar is a solid carbon-rich material derived from partial combustion biomass under oxygen-limited conditions (Li *et al.* 2016). Excess use of biochar can reduce residue due to herbicide use (Rittenhouse *et al.* 2014). On soil contaminated use of biochar indicates a tendency to reduce the accumulated heavy metals (Tan *et al.* 2015; Bøendová *et al.* 2016; Gwenzi *et al.* 2016).

Similarly, cattle manure is added with biochar to reduce the accumulation of heavy metal content (Kiran *et al.* 2017). A very little availability of dolomite (Mew 2016), so that the addition of dolomite on the ground can be added in a small amount. The addition of dolomite plays a role in the supply of phosphate elements, wherein the 75:25 ratio of compost and Rock phosphate shows the maximum soluble P and finds higher plant growth (Yadav *et al.* 2017).

The composition of ameliorant Cattle manure, biochar from coconut shell, and dolomite is expected to reduce soil damage and give good results on plant potatoes planted on medium plains.

MATERIALS AND METHODS

Study Sites and Materials

The experiments were conducted on medium plains 750 m above sea level in Jatinangor area, Indonesia, with land type Incepticol. Seeds of potatoes used are varieties of Medians Second Generation. The composition of ameliorant consists of Cattle manure, biochar from coconut shells, and dolomite. The seeds of the potatoes used are relatively good varietal when cultivated in a medium plain.

Research Design

The design of the environment used is the group's random draft repeated three times, the treatment design consists of K_0 : control; K_1 : Cattle manure 10 Mg ha⁻¹; K_2 : Cattle manure 20 Mg ha⁻¹; K_3 : Cattle manure 8 Mg ha⁻¹, dolomite 1 Mg ha⁻¹, 1 Mg ha⁻¹ biochar; K_4 : Cattle manure 16 Mg ha⁻¹, dolomite 2 Mg ha⁻¹, 2-Mg biochar ha⁻¹; K_5 : Cattle manure 8 Mg ha⁻¹, dolomite 2 Mg ha⁻¹; K_6 : Cattle manure 16 Mg ha⁻¹, dolomite 4 Mg ha⁻¹; K_7 : Cattle manure 8 Mg ha⁻¹, biochar 2 Mg ha⁻¹; K_8 : Cattle manure 16 Mg ha⁻¹, biochar 4 Mg ha⁻¹. Advanced analysis using a 5% Duncan test, each treatment is given NPK base fertilizer according to the recommended dosage.

Soil Analysis

Observations of C, N, soil pH were made at the time of harvest (110 DAP/Day After Planting), measurement of C-organic by Walkley and Black method, N-total with Kjeldahl method, and pH

(H₂O) with Electrometry method. P levels in plants are carried out at the end of the vegetative period in destructive sling plants aged 44 ADP by the wet oxidation method.

RESULTS AND DISCUSSION

Effect of Ameliorant on Soil Chemical

The results of the analysis showed that Cattle manure used to have N total of 1.48. 18.2% C; C/N ratio 12.29; 1.93% P₂O₅; 1.04% K₂O; pH 7.98. Biochar Coconut Shell content has N total 0.52; 40% C; C/N ratio 77.75; 0.80% P₂O₅; 1.85% K₂O and pH 10.81. Dolomite contains 0.99% MgO and 52.48% CaO.

The provision of composition and the dose of ameliorant effect does not impact the C/N ratio of soil and absorption P plants. The carbon content of biochar produced is affected by the original material by the content of lignin origin material (Lee *et al.* 2013; Rehrah *et al.* 2014; Sun *et al.* 2017). The cattle manure has an organic-C value of 18.2% and total N content of 1.48. However, the soil C/N ratio did not increase, even though it has been administered up to a dose of 20. The absorption of P plants is not impacted because each treatment is given the chemical fertilizer NPK recommended dose so that each treatment receives the same phosphate levels. However, administered ameliorant containing phosphate-appropriate treatment but the phosphate content of very low ameliorant is 1.93% P₂O₅ for Cattle manure and 0.80% P₂O₅ for biochar of coconut shell shells. Adding biochar to the ground has good agricultural environment potential due to long-term carbon absorption capacity and the ability to increase crop productivity (Kolton *et al.* 2011).

The administration of composition and doses of ameliorant is a tangible impact on the soil pH value (presented in Table 1). The ameliorants given

Table 1. Composition and dose of ameliorant against organic-C, soi-NI, soil pH, and absorption P by plant.

Treatment	Organic-C (%)	Total-N (%)	C/N	Soil pH (H ₂ O)	P Absorption
k0	1.87 a	0.206 a	9.03 a	5.88 a	13.83 a
k1	1.663 a	0.19 a	8.84 a	6.33 a	21.2 a
k2	1.88 a	0.216 a	8.78 a	6.22 a	21.72 a
k3	1.693 a	0.213 a	8.25 a	6.33 a	17.83 a
k4	1.853 a	0.216 a	8.83 a	6.87 b	19.97 a
k5	1.83 a	0.226 a	8.06 a	6.82 b	18.56 a
k6	2.07 a	0.27 a	7.78 a	7.02 b	23.03 a
k7	1.846 a	0.25 a	7.48 a	5.8 a	16.34 a
k8	1.853 a	0.216 a	8.66 a	5.86 a	18.29 a

Table 2. Composition and dosage of Amelioran to total tuber size L, M and S.

Treatment	Number of bulbs of L size (size 450-550 mm)	Number of bulbs size M (size 350-450 mm)	Number of bulbs of size S (size 200-350 mm)
K0	0.803 a	1.178 a	2.179 a
k1	0.743 a	1.575 b	2.909 b
k2	0.824 a	1.555 b	2.811 ab
k3	0.847 a	1.395 b	2.687 ab
k4	1.085 b	1.483 b	2.928 b
k5	0.989 a	1.551 b	1.820 a
k6	1.101 b	1.500 b	2.409 a
k7	0.743 a	1.502 b	2.636 ab
k8	0.984 a	1.595 b	2.416 a

have an alkaline pH value of 7.89 for cattle manure and 10.81 for the coconut shell biochar. The results are in line with Windeatt *et al.* (2014); most biochars are slightly alkaline, ranging from pH 6.1 to 11.6. Treatment with composition K₄: Cattle manure 16 Mg ha⁻¹, dolomite 2 Mg ha⁻¹, 2-Mg biochar ha⁻¹, K₅: Cattle manure 8 Mg ha⁻¹, dolomite 2 Mg ha⁻¹; K₆: Cattle manure 16 Mg ha⁻¹, dolomite 4 Mg ha⁻¹ shows the best influence in increasing the pH value of the soil when compared to the control. Soil pH is a critical determinant of the composition and diversity of bacterial communities. Ameliorants (biochar, lime, and organic fertilizer) altered soil notification by changing the abundance of nitrifying bacteria, diversity, and composition, caused by soil pH change (Zhang *et al.* 2017).

Bulb Size of Potato

Composition and dose of ameliorant with a treatment of K₄: Cattle manure 16 Mg ha⁻¹, dolomite 2 Mg ha⁻¹, 2 Mg Biochar ha⁻¹ represents the best number of bulbs in size L, M and S. This is because the treatment of K₄ has a composition consisting of Cattle manure, biochar, and dolomite so that at a dose of 20 Mg Ha⁻¹ can give the best results. Soil management approaches based on biochar and biochar compost increase total soil organic carbon, soil nutrient status, and groundwater content (Agegnehu *et al.* 2016). Biochar is shown to effectively improve soil quality and improve soil microbial biomass where Biochar participates in microbial extracellular respiration (Yu *et al.* 2016).

Compost filling in both single and combined with chemical fertilizers able to reduce the loss of N and P due to mineralization (Bedada *et al.* 2016), N Fertilizer Delivery at 375 kg Ha⁻¹ can produce potatoes in the supergroup (Hosseini *et al.* 2017), Fertilizer P significantly impact on tuber

results (Debaba *et al.* 2019) Additionally higher levels of chemical fertilization are beneficial for microbial respiration and potato yield (Zabee and AL-Maliki 2019).

Medium-Plain potato weaver will undoubtedly give a difference to the potato yield compared with the medium plains planted. Temperature rise can lower the productivity of the potato plant (Dua *et al.* 2016). The provision of fertilizer NPK and Amelioran is recommended because it accumulates C organic high soil and can have fewer losses loss of organic C due to temperature rise (Ghosh *et al.* 2016). The addition of temperature at the time of flowering and when the formation of bulbs can improve potato yield (Lizana *et al.* 2017), Extended photoperiod able to increase the yield of potato crop (Shankar *et al.* 2016), for large size bulbs, indicating the dilution effect P, resulting from the excessive growth of the tubers to the number of accumulation P (Potarzycki and Grzebisz 2019).

CONCLUSIONS

Results showed that the composition and dose of ameliorant could increase the value of soil pH but have not improved the C/N ratio and absorption of phosphorus plants. The best result obtained the treatment from composition of Cattle manure 16 Mg ha⁻¹, dolomite 2 Mg ha⁻¹, 2 Mg ha⁻¹ biochar and composition of Cattle manure 16 Mg ha⁻¹, dolomite 4 Mg ha⁻¹. Soil pH can increase by 16.83%, and the size of the potato bulbs of Class L (450-550 mm) amounted to 35, 11%, and size S (200-350 mm) amounting to 34.37% when compared with controls.

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