Growth Respone of Young Tea Plants on Andisol Soil of Gambung High Land, West Java, Indonesia Mixed With Ameliorants on Zero Point of Charge Status

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Abstract. Andisols, that a variable charge soil, dominates West Java tea plantation land. Soil ameliorant is a substance added to soil that can be both organic and anorganic material such as compost, manure or chemical material and has a function to improve soil quality and plant growth. The study aims to select 10 ameliorants incubated in to the Andisols for 3 months that provided the best response to young tea plants. The ameliorants used were tea pruning litter, weed litter, mucuna cover crop, fluff (waste of tea product), sheep manure, chicken manure, cow manure, biogas waste of cow manure, worm casting, humic acid liquid. Completely Randomized Design was applied consisting 11 treatments including a control with 3 replications. Plant growth measurements namely number of leaves, plant height, stem diameter shown by the best 3 ameliorants that were worm casting, weed compost and sheep manure. The result of this study was in accordance with changes in increase in zero point of soil charge status that support to improve better vegetative growth.

Keywords: tea, andisols, ameliorants, plant growth, zero point of soil charge.

1 Introduction

Andisols, that a variable charge soil, dominates West Java tea plantation land. Andisols are dark black soil, very porous, containing organic and amorphous clay, especially allophane and a little silica and alumina or iron hydroxide [1]. The soil has unique soil properties related to their colloidal fraction. Soil components such as allophane, imogolite and ferrihydrite have a non consistent term such as non crystalline or poorly crystalline. Halloysite usually exist in volcanic regions, furthermore aluminum and iron humus complexes are also part of Andisols with the clay. Those provide their peculiar soil characteristics as andic soil properties [1–5]. Effective soil is soil that can hold plant roots that are able to absorb nutrients and provide nutrients that are easily absorbed by plant roots. Soil has a good level of structure, crumbs and pH according to the needs of tea growth between 4.5-5.5.

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In Indonesia, tea plants cultivated at different heights are lowland (400-800 m above sea level), medium (800-1200 m above sea level), and high (> 1,200 m above sea level) and in some species soil (Andisol, Entisol, Inceptisols and Ultisols). Tea plantation has long planting period because tea plant age is perenial crop, when the management did wrong treatment to the soil, tea land will experience degradation not only soil nutrient but also land capability and productivity, and finally reduce tea quality [6–8]. Several reasons why land use change worse and soil decrease its capabilities, the driving forces can be human activities e.g. deforestation in Iran case [9], severe soil erosion cause nutrient decline [10]. As a result, such degraded agriculture land needs rehabilitation to enhance land sustainability [11].

To overcome the tea land degradation, several actions can be carried out, such as application of NPK fertilizer on the natural vesicular arbuscular mycorrhiza in the root depth [12], soil reconditioning , micronutrient identification, growth regulator application [13], 2017), slow release fertilizer [6].

Furthermore, data analysis of soil and plant required to evaluate its nutrient status [14-15], and then management can get assessment of soil fertility status to increase sustainability of tea plantation [16].

Soil ameliorant is a substance added to soil that can be both organic and anorganic material such as compost, manure or chemical material and has a function to improve soil quality and plant growth [17]. It improves the condition of soil and water performance of agricultural land, such as crop residues to change soil pH under field condition [18], source and sink of plant nutrient using soil organic matter [19]. Improvement total carbon, organic carbon and organic matter of soil affect the cation balance and soil humus properties [20-24].

The study aims to select 10 ameliorants incubated in to the Andisols for 3 months that to expect the soil chemical properties improvement and then provide the best growth response to young tea plants.

2 Materials and Method

2.1. Treatment

The research was setting with a number of 10 ameliorants added 1 control (soil only), thus all treatments were 11 with 3 replications. The ameliorants used were tea pruning litter compost, weed litter compost, mucuna cover crop compost, fluff (waste of tea product) compost, sheep manure, chicken (poultry) manure, cow manure, biogas waste of cow manure, worm casting (vermimanure), humic acid liquid. The ameliorants were analysed pH, % H_2O, % C-org, C/N, % P_2O, % K_2O and % Mg at the RITC Laboratory. Plant growth measurements namely plant height, stem diameter, number of leaves

2.2 Statistical Analysis

Statistical analysis using Completely Randomized Design was applied consisting 11 treatments including a control with 3 replications on data obtained, followed LSD Analysis 5%. Descriptive statistics, correlation and regression analysis of the data were carried out using SPSS.

3 Results and Discussion

3.1 Ameliorants (Compost and Manure) analysis

Before treatment application and starting incubation, the ameliorants was analysed at the RITC Gambung Laboratory. The C/N Ratio is one of parameter to determine the ameliorant

Table 1. Ameliorant Analysis at RITC Lab

No	Ameliorants	Test Parameters							
		pH	% H_2O	% C-org	% N	C/N	% P_2O_5	% K_2O	% Mg
K1	Tea Pruning Litter Compost	6,9	53,8	22,5	1,02	22,1	0,357	0,660	0,206
K2	Weed Litter Compost	8,1	59,3	19,5	1,99	9,80	1,04	2,22	0,312
K3	Mucuna Cover Crop Compost	6,8	62,2	24,8	0,876	28,3	0,234	0,465	0,369
K4	Fluff (waste of tea product) Compost	5,7	68,6	26,0	0,900	28,9	0,241	1,36	0,157
K5	Sheep manure	8,9	55,6	19,8	0,527	37,6	0,461	1,05	0,325
K6	Chicken manure	8,6	39,7	22,4	0,789	28,4	1,13	1,13	0,234
K7	Cow manure	6,8	52,4	18,6	0,217	85,7	0,252	1,30	0,201
K8	Biogas waste of cow manure	7,3	51,1	21,0	0,595	35,3	0,933	0,270	0,328
K9	Worm Casting (Vermimanure)	6,3	61,1	20,7	0,331	62,5	0,325	0,145	0,155
K10	Humic acid liquid								

Notes: K10. Humic acid liquid was not analysis at RITC Lab. K11 Control.

quality, the lower the C/N value, the better the ameliorant quality. In the Table 1 showed that K2 had the highest N, and the C/N Ratio was the lowest one (9,80)

Furthermore, Tabel 2, 3 and 4 provided the measurements of plant height, stem diameter, and number of leaves after 90 days of ameliorant incubation.

3.2 Plant Height after 90 days of ameliorant incubation

Table 2. Plant Height after 90 days of ameliorant incubation

Plant Height after 90 days of ameliorant incubation							
	K7	3	26,6667				
	K11	3	28,6667	28,6667			
	K10	3	35,6667	35,6667	35,6667		
	K3	3		40,3333	40,3333		
	K8	3		41,6667	41,6667		
Duncan[a]	K4	3			44,3333	44,3333	
	K6	3			45,0000	45,0000	
	K1	3			48,0000	48,0000	
	K5	3			48,3333	48,3333	
	K2	3				56,3333	56,3333
	K9	3					68,0000

3.3 Stem Diameter after 90 days of ameliorant incubation

Table 3. Stem Diameter after 90 days of ameliorant incubation

Stem Diameter after 90 days of ameliorant incubation					
	K11	3	5,4067		
	K10	3	5,5100	5,5100	
	K7	3	6,0567	6,0567	6,0567
	K3	3	6,1367	6,1367	6,1367
	K8	3	6,1767	6,1767	6,1767
Duncan[a]	K4	3	6,2600	6,2600	6,2600
	K6	3		6,4533	6,4533
	K5	3		6,4767	6,4767
	K1	3			6,5800
	K2	3			6,6067
	K9	3			6,9167

3.4 Number of Leaves after 90 days of ameliorant incubation

Table 4. Stem Diameter after 90 days of ameliorant incubation

Number of Leaves after 90 days of ameliorant incubation						
Duncan[a]	K11	3	17,0000			
	K6	3	17,3333			
	K7	3	25,0000	25,0000		
	K3	3	25,0000	25,0000		
	K8	3	27,6667	27,6667	27,6667	
	K10	3		28,6667	28,6667	
	K4	3		34,6667	34,6667	34,6667
	K1	3		35,3333	35,3333	35,3333
	K2	3			38,0000	38,0000
	K5	3				40,6667
	K9	3				45,0000
	Sig.		,060	,071	,068	,068

3.5 Discussion

Previously, the study of zero point of charge status of Andisol soil mixed with ameliorants at the Gambung Tea Plantation. The zero point of charge was measured for 3 x 30 days of incubation. Based on ZPC data of 4 (four) soil sample collections, finally worm casting was selected as the best ameliorant based on highest ZPC value rather than the initial control ZPC that was 3,40 (+0,05) and provided that negative charge of nutrient was increased. Then followed by weed litter compost and sheep manure (Table 5 below).

Furthermore, Table 6 provided summary of growth indicator after 90 days of ameliorant incubation.

Table 5. Zero point of Charge Values after 90 days of incubation

	Perlakuan	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	K11. Control: soil	3	3,4800	
	K7. cow manure	3	3,6600	
	K8. biogas waste of cow manure	3	3,7067	
	K3. mucuna cover crop compost	3	3,8000	3,8000
	K6. chicken manure	3	3,9567	3,9567
	K1. tea pruning litter compost	3	4,5200	4,5200
	K4. fluff (waste of tea) compost	3	4,5800	4,5800

K10. humic acid liquid	3	4,6033	4,6033
K5. sheep manure	3		5,5133
K2. weed litter compost	3		5,5833
K9. worm casting (Vermimanure)	3		5,5933

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3,000.

Table 6. Summary of growth indicator after 90 days of ameliorant incubation.

	Plant Height	Stem Diameter	Number of Leaves
Duncan[a]	K7	K11	K11
	K11	K10	K6
	K10	K7	K7
	K3	K3	K3
	K8	K8	K8
	K4	K4	K10
	K6	K6	K4
	K1	K5	K1
	K5	K1	K2
	K2	K2	K5
	K9	K9	K9

4 Conclusions

The ameliorants used were tea pruning litter compost, weed litter compost, mucuna cover crop compost, fluff (waste of tea product) compost, sheep manure, chicken manure, cow manure, biogas waste of cow manure, worm casting (Vermimanure), humic acid liquid, and control. Completely Randomized Design was applied consisting 11 treatments including a control with 3 replications.

Based on Table 6 showing the summary of growth indicator after 90 days of ameliorant incubation, the measurements namely plant height (Table 2), stem diameter (Table 3) and number of leaves (Table 4), provided conclusions that the best 3 ameliorants that were worm casting (vermimanure), weed litter compost and sheep manure. The result of this study was in accordance with changes in increasing zero point of soil charge status that support to improve better vegetative growth. Further study needs to observe phosphate retention values as a unique indicator in Andisols property.

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