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Chemical Characgteristics of oil Under Persimmon Tree Stand (STANDS (Diospyros kaki) Used as Cover Crop of Coffee Plants at Gayo Highlands. Aceh

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Abstract

The study was conducted to examine the chemical characteristics of soil under persimmon tree stands (Diospyros kaki) that were used as a cover crop for coffee plants at the Gayo Highlands, Aceh (Bener Meriah and Central Aceh Regency). The chemical characteristics consisted of pH, Cation Exchange Capacity, Base Saturation, Organic-C, and C/N Ratio. The study was conducted from January to July 2022, using ex-post facto method, and was designed using factorial randomized block design consisting of 2 factors, namely the gradient of the slope, consisting of L1 (flat, 0-3%), L2 (sloping, 3-8 %), L3 (undulating, 8-15%) and L4 (hilly, 15-25%); and the soil depth, consisting of D1 (0-20 cm) and D2 (30-60 cm). The data then were analyzed using Analysis of Variance (ANOVA) and Duncan's Multiple Range Test. The results showed that the chemical characteristics of the soil were not significantly different at different gradients. The soil's Organic-C content was significantly higher at 0-20 cm depth but there were no significant differences in pH, Cation Exchange Capacity, Base Saturation, and Soil C/N ratio between the different depths. Persimmon tree stands at the Gayo Highlands need to be maintained and improved by adding other non-coffee plants such as leguminous trees.

Keywords: Persimmon Tree; Coffee Plant; Soil Chemical Properties; Slope Gradient; Soil Depth.

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INTRODUCTION

The persimmon tree (Diospyros kaki) can still be found in several places on the islands of Java and Sumatra. On the island of Java, it ranges from West Java to East Java. Its existence is still protected by some farmers, especially as a cover crop in coffee plantations, besides its use as a fruit-bearing plant with high-quality fruit and relatively large production capacity. In contrast, on the island of Sumatra, the number of persimmon trees is declining, despite being originally widespread, especially in North Sumatra, West Sumatra, and Aceh. Some areas outside of Java where persimmon trees can still be found in small numbers are Karo Regency in North Sumatra, Central Aceh Regency in Aceh, and Bener Meriah Regency in Aceh, where they are also used as cover crops in coffee plantations.

Persimmon trees grow well at 1000 meters altitude, which is also suitable for the cultivation of Arabica coffee, especially in active mountain areas with volcanic ash soil. Other than at an altitude of at least 1000 meters, persimmon trees can also grow well in subtropical climates, with different fruit qualities. The quality of persimmon fruit is determined by its tannin content. Persimmon with higher tannin content is considered of higher quality.

The use of persimmon trees as a cover crop for coffee plantations, along with other plants such as Albazia, stink bean, jengkol, and avocado means that most coffee plantations in the highlands, including in Aceh's Gayo Highlands, are considered to be agroforestry. The agroforestry system is the use of a plot of land for the combined cultivation of multiple forestry commodities, annual crops, and other agricultural commodities including livestock and fish, forming a multi-layered, multi-species canopy. Agroforestry potentially reduces erosion and surface runoff, maintains soil organic matter, improves soil properties, improves nitrogen fixation, and promotes efficient nutrient cycling. The types of plants in agroforestry affect the quantity and quality of their organic matter input and its nitrification potential (NH4+ release). The more diverse the tree species, the higher the rate of decomposition. The rate of decomposition is an important process for the release of nutrients, especially nitrogen. Nitrogen is the most limiting nutrient for land productivity (Priyadarshini et al., 2020).

A mixed crop of various species of trees will result in differing rates of litterfall and differing litter types so it has the opportunity to provide more organic matter, compared to a crop of single tree species. Agroforestry has higher biodiversity so the ecosystem balance is better for litter-decomposer microorganisms. With a more conducive ecosystem, the microorganisms' ability to decompose litter is also relatively higher. As result, in mixed tree agroforestry the number of Organic-C, total N, and organic matter are relatively high, including the coarse organic matter, indicated by a high C/N ratio due to the high rate of accumulation of litterfall (Sudomo and Handayani, 2013).

Agroforestry systems can maintain the organic matter content of the soil. The existence of diverse types of plants will produce a large and diverse litter. Differing sources and amounts of organic matter will donate differing effects on the organic matter content of the soil (Munawar, 2013). The presence of organic matter on the soil surface can increase and maintain nutrient levels through the soil's organic acids. Such conditions can affect the chemical properties of the soil. In this regard, a study was conducted to examine the chemical characteristics of soils with different slope gradients and soil depths under persimmon tree stands in the Gayo Highlands, Aceh Province.

RESEARCH METHODS

The study was carried out from January to July 2022 on coffee-based agroforestry areas in the Gayo Highlands of Aceh, namely in Bener Meriah and Central Aceh Regencies. The study was conducted using the survey method and is based on the Ex-Post Facto concept, namely research and observation that aims to examine cause-and-effect relationships that are not manipulated or treated by researchers but are available in nature or in the field.

The soil was observed and sampled using the purposive sampling technique, namely deliberate sampling based on criteria that met agroforestry land use, designed using Factorial Randomized Block Design (RAK Factorial) with 2 factors, namely slope gradient and soil depth. Slope gradient factor (L) consisted of L1 = slope gradience of 0-3% (flat); L2 = slope gradience of 3-8% (sloping); L3 = slope gradience of 8-15% (undulating); and L4 = slope gradience of 15-25% (hilly). The soil depth factor (D) consisted of D1 = soil depth of 0-20 cm; and D2 = soil depth of 30-60 cm. Eight treatment combinations were obtained, namely L1D1; L1D2; L2D1; L2D2; L3D1; L3D2; L4D1; L4D2. The study was repeated 3 times to obtain 24 units of analysis. Soil samples used were composite samples from 3-4 sampling points for each treatment. Soil analysis was carried out on the chemical properties of each composite sample, consisting of pH, Cation Exchange Capacity, Base Saturation, Organic-C, and C/N ratio. The data then were analyzed statistically using Analysis of Variance (ANOVA) and Duncan's Multiple Range Test with a data-significance level of 5%.

RESULTS AND DISCUSSION

The effects of using persimmon trees cover for coffee plants on the chemical properties of the top and bottom layers of the soil as well as on the different slope gradients in the Gayo Aceh highlands is presented in Table 1.

Table 1. Chemical characteristics of soil under persimmon tree stands used as cover crop of coffee plantations in the Gayo highlands of Aceh.

Treatment	pH.H_2O	Cation Exchange Capacity (me/100g)	Base Saturation (%)	Organic-C (%)	C/N ratio
L1 (flat)	4,97	23,85a	16,04	3,59	10,49
L2 (sloping)	4,91	12,76b	12,02	3,13	7,29
L3 (undulating)	4,95	18,59ab	14,49	3,42	9,81
L4 (hilly)	5,16	20,43a	19,47	3,51	10,33
D1 (*topsoil*)	4,98	19,45	12,93	3,89a	8,94
D2 (*subsoil*)	5,02	18,37	18,08	2,93b	10,02
L1D1	5,01	25,38	13,96	4,06	10,09
L1D2	4,94	22,32	18,12	3,11	10,89
L2D1	4,87	13,09	7,20	3,91	8,60
L2D2	4,94	12,42	16,84	2,34	5,98
L3D1	4,91	18,68	12,93	3,29	7,69
L3D2	4,98	18,51	16,05	3,54	11,92
L4D1	5,11	20,64	17,62	4,03	9,38
L4D2	5,21	20,22	21,31	2,99	11,28

Note: The means in the same columns and treatment groups that are followed by the same notation or letter did not have significant differences at p.05 according to the Duncan's Range Test.

From Table 1 it can be seen that statistically, the difference in slope gradient and soil depth did not significantly affect pH, base saturation, and soil C/N ratio. Slope gradient had a significant effect on the cation exchange capacity of the soil and soil depth had a significant effect on the Organic-C content of the soil.

Based on the Assessment Criteria for Soil Analysis Results published by the Indonesian Agency for Agricultural Research and Development (2012) and the Indonesian Soil Research Institute (2009), the pH of the soil in the study area was classified as acidic (4.5-5.5), the cation exchange capacity was generally classified as moderate. (17-24 me/100g), base saturation was low to very low (<20%), soil organic-C content was generally high (3-5%) and C/N ratio was generally low.

This proves that the use of persimmon trees as a cover crop in coffee plantations which can be classified as an agroforestry-oriented form of land management (coffee-based agroforestry) can maintain the chemical characteristics of the soil, even on undulating land (slope gradient of 8-15%) and hilly land (slope gradient 15-25%), which did not differ from the assessment criteria for soil analysis result (Indonesian Soil Research Institute, 2009; Indonesian Agency for Agricultural Research and Development, 2012) and also did not have a statistically significant different soil chemistry when compared to flat and sloping land.

CONCLUSION

The chemical characteristics of soil under persimmon trees in coffee plantations at the Gayo Highlands, consisting of pH, Cation Exchange Capacity, Base Saturation, Organic-C content, and C/N ratio, were relatively the same (not significantly different) on different slopes (flat to hilly). The Organic-C content of the soil under persimmon trees in coffee plantations at the Gayo Highlands was higher at the depth of 0-20 cm and significantly different from Organic-C content at the depth of 30-60 cm, but the pH value, Cation Exchange Capacity, Base Saturation, and soil C/N ratio were relatively the same (not significantly different). The use of persimmon trees as cover crop in coffee plantations a the Gayo Highlands of Aceh needs to be maintained and improved by adding non-persimmon plant components that have an effect on increasing soil fertility such as leguminous trees (Albazia, stink bean, jengkol, and others), accompanied with managing plant residues to be used as mulch and compost material to help the efficiency of chemical fertilizers in coffee cultivation.

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