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Soil Microbial Biomass and Diversity Amended with Bagasse Mulch in Tillage and No-tillage Practices in the Sugarcane Plantation

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Abstract

Biomass residues in plantation farms and process industries still have valuable materials and can be recycled as other materials. Gunung Madu Plantation (GMP) in Lampung Province, Indonesia where this study was observed had used bagasse as mulch 80 tons (wet weight) per hectare. This study observed the effect of tillage and bagasse much on soil microbes in sugarcane plantation. Each treatment was used in conjunction with or without bagasse mulch in a split-plot experimental design. Previous study showed bagasse mulch had increased litter fungal biomass and communities in the soil. However soil microbial community structure has not been comprehensively investigated. Quinone profile method was used to analyze the community structure amended with bagasse mulch in the sugarcane plantation. Quinone profile method reflectively estimated the microbial biomass and the diversity. The no-tillage with bagasse mulch had the highest microbial biomass (1.026 μmol kg^{-1} dry soil) compare to the no-tillage without bagasse mulch, the conventional tillage with bagasse mulch and the conventional tillage without bagasse mulch. The Diversity index (DQ) and Shannon-Wiener diversity index (H) was also the highest in the no-tillage amended with bagasse mulch. Therefore mulch treatment in combination with no-tillage is an effective residue management of biomass residue to improve soil quality.

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Nomenclature	
NT	No-tillage without bagasse mulch
NTM	No-tillage with bagasse mulch
CT	Conventional tillage without bagasse mulch
CTM	Conventional tillage with bagasse mulch
UQ	Ubiquinone
MK	Menaquinone
DQ	Diversity based on quinone profile
H'	Shanon's diversity index

1. Introduction

1.1. Overview

Intensive cultivation in sugarcane plantation could impact to crop productivities, nutrients in the soil and soil biota. Meanwhile, processing biomass produces commercial products and also biomass residues. Biomass residue such as bagasse is a valuable material that can be used as organic mulch.

There are many kinds of activities that could improve soil conditions such as tillage, fertilization and mulching. In this research, conventional tillage (a tillage system that used cultivation as major means), organic mulch (bagasse mulch), organic and synthetic fertilizer were used. All activities should be managed, not only for plant production but also for environmental sustainability.

Previous study by Miura [1] at the same study site showed that bagasse mulch had increased litter fungal biomass and richness. Meanwhile, these study focuses on soil microbial biomass and diversity amended with bagasse as organic mulch in tillage and no-tillage practices in the sugarcane plantation based on Quinone profile

Soil quality is influenced by microbial process. Thus the relationship among the activity, size, and composition of microbial community in soil should be elucidated. However sensitive methods have been lacking for determining temporal changes in the activity, size, and composition of the soil microbial communities [2]. The quinone profile method has been successful to elucidate the changes in microbial community structure in soil with different fertilization history [2,3]. The total amount of quinone has a linier relationship to microbial biomass in soil [4]

1.2. Objective

The objective of this study was to evaluate the microbial biomass and diversity in soil using Quinone profiling method, in the sugarcane plantation area, under factorial design of tillage (conventional, and no-tillage) and mulching with bagasse as an organic residue.

2. Materials and Methods

2.1. Site description

The sugarcane (*Saccharum officinarum*) plantation area (4º40'S, 105º13'E, altitude c.a 45 m) is in Sumatra, Indonesia. The site was in a large plantation area (approximately 25,000 ha). Split plot design was used with soil tillage as the main factor and bagasse mulch as the secondary factor. Each plot was 25 x 25 m and 5 m buffer zone from the road. Furthermore, 80 tons (wet weight) per hectare of organic BBA fertilizer (five parts of bagasse, three parts of blotong of filter cake, and three parts bagasse ash) were spread before plough in the conventional tillage plots. Meanwhile, 80 tons of organic BBA fertilizers were spread after planting in the no-tillage plots. Inorganic fertilizers (N; P; K 120:80:180 kg/ha) were spread in all treatments at the time of planting.