PREPRINT

TROPICAL AGRICULTURAL SCIENCE

PERTANIKA JOURNALS

Journal homepage: http://www.pertanika.upm.edu.my/

Essential Dynamics of Rice Cultivated under Intensification on Acid Sulfate Soils Ameliorated with Composted Oyster Mushroom Baglog Waste

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ABSTRACT

This study examines the dynamics of essential macro-nutrients for rice cultivation in acid sulfate soils ameliorated with composted oyster mushroom baglog waste. A single factor randomized block design (RBD) was used, and the factors studied include the compost dose of oyster mushroom baglog waste, which consists of 5 treatment levels, namely 0 t ha^{-1} (control), 5 t ha^{-1}, 10 t ha^{-1}, 15 t ha^{-1}, and 20 t ha^{-1}. Furthermore, this study was carried out from May to September 2021 in the rice fields of the Faculty of Agriculture, Lambung Mangkurat University (ULM), Sungai Rangas Village, Banjar Regency, South Kalimantan. The rice plants were cultivated using an intensification technique, and the compost was applied based on the research treatment for two weeks on prepared land before planting. Also, Bartlett's test was carried out before analysis of variance, which had a significant effect of $P<0.05$, and was further tested using Duncan's Multiple Range Test (DMRT) at a 5% level. The results showed variations in the availability of macro-nutrients at five different growth stages: early planting, full vegetative, early panicle emergence, panicle filling, and harvesting phases. The highest levels of ammonium (NH_4^+) and nitrate (NH_3^-) were found in the full vegetative stage, while early planting had the lowest. Also, there was an increase in the available phosphorus (P) from the early planting to the full vegetative stage. The increase in exchangeable potassium (K) occurred at the transition of these stages. These increasing nutrients were due to the addition of the compost. The higher the NH_4^+, NO_3^-, available P, and exchangeable K in acid sulfate soils, the more nitrogen (N), P, and K uptake in rice plants. The

ARTICLE INFO

Article history:
Received: 03 December 2021
Accepted: 28 March 2022
Published:

DOI: https://doi.org/10.47836/pjtas.45.3.02

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ISSN: 1511-3701
e-ISSN: 2231-8542

provision of the compost supplied N, P, and K in available forms and reduced the amount of soluble alumunium (Al) and iron (Fe). Thereby the plant roots absorb the nutrients optimally. Additionally, the compost increased the essential macro-nutrient availability and plant uptake using the rice intensification technique from early planting to harvest.

Keywords: Acid sulfate soils, eco-friendly agriculture, rice intensification, suboptimal land

INTRODUCTION

Rice is the most important food crop in Indonesia and the main raw material for staple foods in most regions. In 2015, the consumption reached 33.3 million tons (Sulaiman et al., 2018). Currently, the largest production centers of this food crop are on the Java and Sumatra islands. During that period, production reached 17.51 million tons throughout the country (Prasetyo et al., 2021). Meanwhile, South Kalimantan could produce up to 0.67 million tons (Prasetyo et al., 2021). According to Statistics Indonesia (Badan Pusat Statistik, BPS) (2020), the population of this province which was 4.3 million, requires up to 0.4 million tons. However, rice demand will increase as the population increases, and predicting current natural conditions tends to be difficult.

Another problem arising is the increasingly limited availability of productive land in the province (Ritung, 2012). Suboptimal lands, such as peat and acid sulfate soils, require proper management when used as arable land (Nursyamsi et al., 2014). Peatland is difficult to manage because of its high environmental risk; hence, it is better to be conserved (Indonesian Agency for Agricultural Research and Development [IAARD], 2011). Meanwhile, acid sulfate soils are productive when managed with the right technology (Saputra & Sari, 2021).

The acid sulfate soils naturally occurred in coastal and inland areas when the sea level rose and immersed the land with sulfate. The sulfate from seawater blends with iron dioxides in the sediments and allows the micro-organisms to establish iron sulfides (FeS_2) under anaerobic conditions (Michael et al., 2015; Sundström et al., 2002). These conditions generate the formation of pyrite (FeS_2), which is the characteristic of acid sulfate soils. Also, land management requires improving soil drainage to provide good aeration for optimal root respiration. However, when the drainage is executed incautiously, the anaerobic condition of the pyrite layer is disturbed. As a result, the sulfide compounds present in the layer will be oxidized to form sulfuric acid and mineral jarosite, which negatively affects plant growth and depreciates macro-nutrients (Michael et al., 2017; Sudarmo, 2004; Sutandi et al., 2011). Another problem with this soil is the low availability of nutrients (Jumar et al., 2021) .

Rice plants need essential nutrients to complete growth and development. Plants that lack these nutrients will fail to germinate and grow roots, stems, leaves, and flowers (Naeem et al., 2017). The essential nutrient consists of macro-nutrients, which