Tropical Wetland Journal
Journal homepage: twj.ulm.ac.id | Published by Postgraduate Program - Lambung Mangkurat University | e-ISSN: 2654-279X

Original article
DOI 10.20527/twj.v9i1.117

Amelioration of Planting Media in Chili Cultivation with Floating System in Lebak Swamp

Nada Banjar Wulandari*, Agung Nugroho, Akhmad Rizalli Saidy, Bambang Joko Priatmadi, Ihsan Noor

Master Program of Environmental and Natural Resources Management, Lambung Mangkurat University, Banjarbaru, South Kalimantan, Indonesia 70714

* Correspondence: Nadabanjar21@gmail.com

Received: 26 May 2023; Accepted: x September 15, 2023 ; Published: November 22, 2023

ABSTRACT

The aim of this research is to investigate the effect of chicken manure compost and agricultural lime on the growth media used for floating system chili cultivation. The study involved the application of 500 g of chicken manure compost and 6 g of agricultural lime to each floating medium. Chili plants were chosen as the subject for observation of their growth and yield. Based on descriptive data analysis, it was found that the application of 500 g of chicken manure compost per planting hole was able to improve the observed chemical parameters, namely pH and available nitrogen (NH4+, NO3-).

Keywords: Chicken Manure Compost, Chili, Floating Agriculture

1. Introduction

Lebak swamp is a specific agroecosystem in Indonesian agricultural land that has distinctive characteristics, resulting in a unique farming system different from other agroecosystems (Fatah, 2017). According to the Daha Selatan Sub-district Program 2021, the total area of lebak swamp in Daha Selatan Sub-district is 8,332 hectares. Out of this, 3,172 hectares are functional lebak swamp land used for food and horticultural crops, while 5,160 hectares of potential lebak swamp land remains untapped (Programma Kecamatan Daha Selatan, 2021).

The main challenges faced in lebak swamp land are high water levels and unpredictable water influx. The adoption of floating agriculture system becomes necessary as a form of adaptation for farmers to cope with the rainy season (flooding) that occurs annually. One innovative solution during the rainy season is implementing floating farming techniques (Alwi, 2017). The use of floating farming systems provides benefits to farmers, as during flooding, the cultivated plants remain afloat and are not affected by the floodwaters (Hasbi et al., 2017).

Floating farming techniques are widely practiced in other regions and even in other countries. Bangladesh, for instance, has successfully implemented floating agriculture systems for horticultural cultivation. Farmers in Nazirpur Pirojpur, Bangladesh, utilize a growing medium called "dhep" made from decomposed water hyacinth. Dhep is placed on rafts with a thickness of 0.6 m, width of 1.2 m, and length of 54 m. Typically, vegetables such as legumes, eggplants, bitter gourd, pumpkin, tomatoes, and chili peppers are grown on dhep floating beds (Rahman, 2013; Hasbi et al., 2017).

The local vegetation abundant in Daha Selatan Sub-district includes water mimosa and water hyacinth, which can be used as floating growing media in the floating agriculture system. A farmer in Daha Selatan Sub-district has experimented with using these local vegetation as floating growing media for chili pepper cultivation. Based on personal experience, the farmer states that the use of this growing

media supports successful chili pepper cultivation with a floating system during the rainy season (floods). The researcher is interested in adding an additional treatment to this experiment, which involves applying chicken manure compost and agricultural lime to observe their effects on chili pepper growth and the chemical properties of the growing media in the floating agriculture system to be implemented. Chili pepper is a profitable agricultural commodity with stable prices. Floating cultivation of chili peppers can provide greater benefits compared to conventional farming methods. Therefore, further research is needed to understand the effects of applying chicken manure compost and agricultural lime on the chemical properties of the growing media in the floating agriculture system in Daha Selatan Sub-district.

2. Materials and Methods

Materials

This research was conducted for five months in Daha Selatan Sub-district, South Hulu Sungai Regency. The treatments used in this study are as follows: 1) A1: Control, 2) A2: Lime 6 g/plant, and 3) A3: Chicken manure compost 500 g/plant. Each treatment was applied to the same growing media, and 12 chili pepper plants were planted for each treatment.

Methods

The working procedures carried out in this research are as follows: 1) Construction of Bamboo Floating Rafts The floating rafts are made of bamboo and serve as floating platforms for placing the growing media and cultivating plants in a floating agriculture system. The construction of the floating rafts involves preparing six bamboo poles, each 16 meters long, which are then cut into two parts and arranged alternately. The parts are joined together using rubber bands to ensure the bamboo floats. The assembled bamboo structure is then tested for buoyancy by gradually adding weight until the desired buoyancy is achieved, 2) Preparation of Growing Media The growing media is prepared by placing it on a base made of water mimosa plants, which are cut and rolled to a thickness of 15 cm, with a length of 2.3 m and a width of 1.7 m (first layer). The second layer is created by cutting water mimosa plants and rolling them into rolls measuring 23 cm in diameter and 30 cm in width, with a thickness of 10 cm (three rows are prepared for each treatment), with a spacing of 20 cm between the rolls. The third layer consists of kiambang plants with a thickness of 10 cm, a length of 23 cm, and a width of 30 cm. The prepared growing media is left undisturbed for seven days to undergo decomposition. After seven days, the soil and predetermined treatments are placed on the rolls, and the media is covered with 250 grams of organic mulch made from kiambang plants. It is left undisturbed for another 14 days, after which the growing media is ready for chili seedlings to be planted, 3) Chili Planting The chili seedlings used in this study are hybrid chili (F1) of the Pelita variety. The chili seedlings are planted after they are 25 days old from the nursery. Only healthy and uniformly tall chili seedlings with 3-4 leaves are selected for planting on the floating media. The seedlings are planted on the soil part present on the floating growing media, with the soil level reaching the root neck. The soil around the chili plants is then compacted by pressing it down (Prasetya, 2014). The planting distance between each chili plant is 60 x 50 cm, and 4) Soil Sampling Soil samples are taken at the beginning, before applying the treatments, then after the completion of the incubation period for the chicken manure compost and agricultural lime treatments (one week), and finally after the first harvest. The soil samples are collected for laboratory analysis to measure the soil pH and available nitrogen (NH_4^+ and NO_3^-).

The variables observed in this research were the chemical content of the planting media, namely soil pH, ammonium and nitrate. This research uses descriptive statistics to explain laboratory results from the observed variables, namely soil pH, ammonium and nitrate.

3. Results and Discussion

PH of Soil

Soil pH in the final week of observation, soil samples were collected from the growing media used in this study. The samples were taken three times for each treatment. The soil samples were collected along the plant rows. The following are the average results of pH, N- NH_4^+, and N- NO_3^- measurements. These measurements were conducted in two stages: after the incubation period of the treatments and after the first harvest.

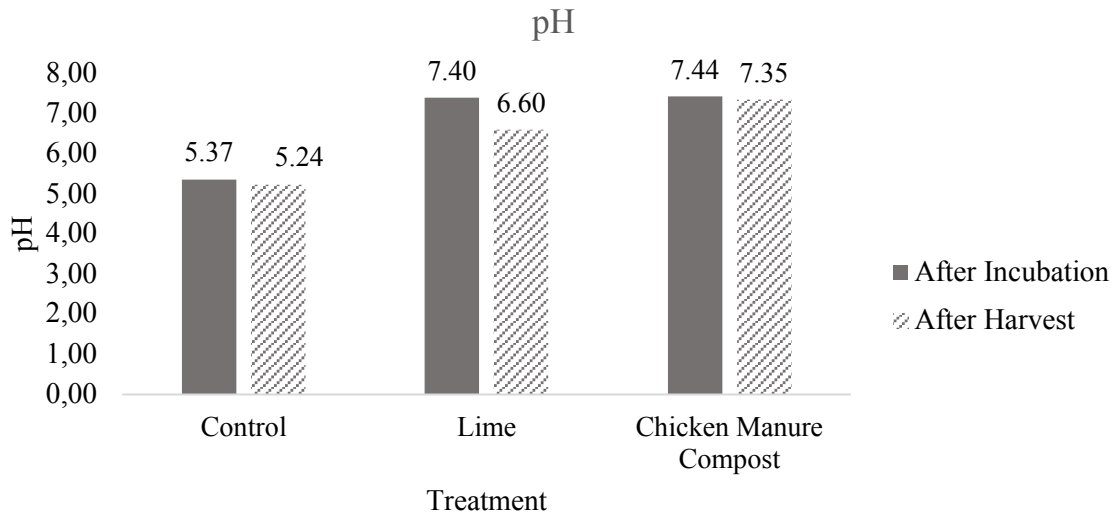

Figure1. Soil pH on various growing media

The pH measurements in the laboratory, as shown in the graph above, were conducted after the incubation period of the treatments and after the first harvest. The acidity level (pH) of the control treatment after incubation was 5.37, and after the harvest, it was 5.24. The application of 6 g of lime increased the initial soil pH from 4.73 to 7.40 after a 7-day incubation period, but it decreased to 6.60 after the harvest. The application of 500 g of chicken manure increased the soil pH from 4.73 to 7.44 after the incubation period and decreased to 7.35 after the harvest.

These pH dynamics can occur due to various factors. Generally, soil acidity is easily influenced by treatment application and other factors such as rainfall. This is consistent with the findings of Syofiani et al., (2020), who stated that high rainfall can affect soil properties, especially soil chemical properties. High rainfall intensity can cause soil to become acidic due to the leaching of basic cations in the soil.

Chicken manure is an organic material that is widely used as organic fertilizer which affects the availability of nutrients and improves soil structure which is very deficient in organic nutrients and can fertilize plants. Chicken manure can affect plants and can improve the physical, chemical and biological properties of the soil. Increased activity of soil microorganisms in the presence of organic matter derived from chicken manure can increase the availability of soil nutrients, besides that organic matter can also reduce soil acidity and increase pH (Hilwa et al., 2020).

Amonium (NH4+) The Planting Media

The measurement results of ammonium (NH4+) were conducted after the incubation of treatments and after chili harvest. The measurement results can be seen in the graph below:

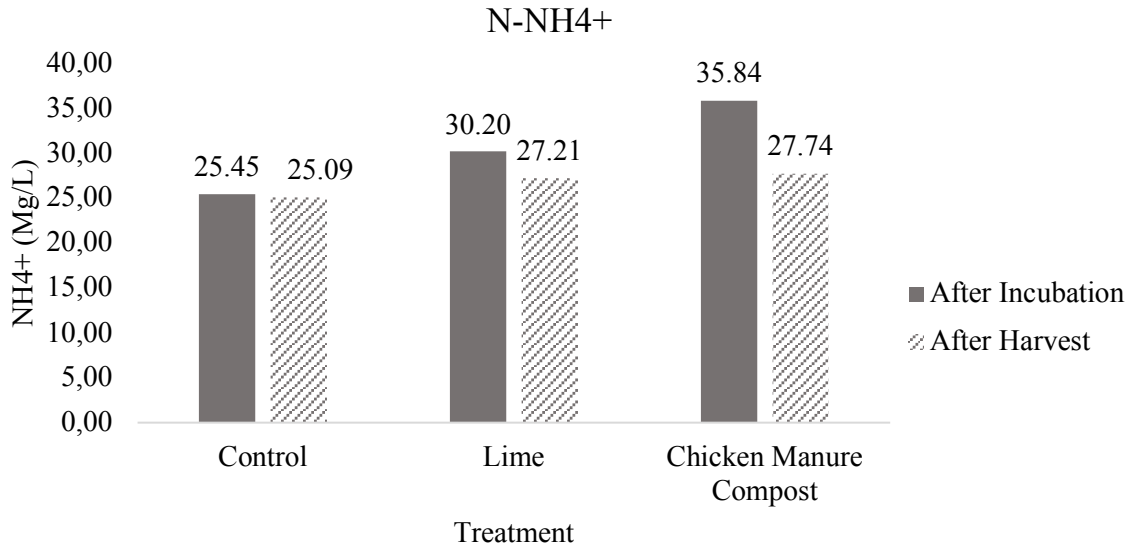

Figure 2. Ammonium content on various growing media

The initial ammonium content in the soil (soil without treatment) was 18.08 mg/L. There was an increase in the control treatment after incubation, reaching 25.45 mg/L, and after harvest, it was 25.09 mg/L. The lime treatment had an ammonium content of 30.20 mg/L when measured after incubation, while it decreased to 27.21 mg/L after harvest. The chicken manure treatment had an ammonium value of 35.84 mg/L after incubation, which decreased to 27.74 mg/L after harvest. This occurred because chicken manure contains organic matter that stimulates microbial activity in the soil, leading to the release of nitrogen from the organic material into ammonium form. During incubation, the organic matter in the manure starts to decompose, producing nitrogen that is subsequently found in the form of ammonium in the soil. Over time, soil microorganisms utilize this ammonium as a nitrogen source for growth and metabolism, resulting in a decrease in the ammonium content in the soil. This is why the measured ammonium content decreases after chili plant harvest.

Nitrogen is converted into ammonium when it is present in the soil. Ammonium, as a form of nitrogen, is another form that plants can optimally utilize. Besides ammonium, nitrogen can also be used by plants in the form of nitrate. However, plant utilization of nitrogen in the ammonium form is more favorable compared to nitrate form. This is because nitrate is more easily leached and more likely to contribute to the formation of N2O through denitrification processes (Lukman et al., 2012). Nitrogen in the form of ammonium must first be decomposed by microorganisms so that it can be absorbed by plants, in contrast to nitrate which can be directly absorbed by plants. The denitrification process has unwanted consequences (Sianipas et al., 2020). Ammonium ions (NH4+), which carry a positive charge, are readily absorbed by negatively charged soil colloids and organic matter. This prevents soil leaching caused by rainfall runoff. In contrast, nitrate ions (NO3-), which carry a negative charge, cannot be retained by the soil and are thus prone to leaching. Consequently, nitrogen can be lost from the soil, reducing soil fertility (Heryanita, 2017).

Research conducted by Damayanti et al., (2018) states that the concentration of available nitrogen, namely ammonium and nitrate, can have an effect on plant height. This effect is suspected because ammonium and nitrate are able to influence the vegetative growth of plants. The right ratio between ammonium and nitrate in the soil can encourage an increase in leaf chlorophyll synthesis in plant tissues so that photosynthetic activity and carbohydrates from photosynthesis also increase. These carbohydrates are then able to increase protein synthesis and increase protoplasm as a constituent of cells to encourage vegetative growth, especially plant height.

Chicken manure contains complete nutrients needed by plants for growth, such as containing three times more N than other manure. An increase in the soil pH index with the application of chicken manure can occur due to the influence of the organic acids produced so that they can chelate ions that cause soil acidity and control H+ secretion from the reaction of soil and plant roots (Indriani et al, 2023). This is in accordance with research conducted by Wijaya and Damanik (2017) that the application of chicken

manure has a significant effect on increasing soil pH. This is because chicken manure contains humic and carboxyl acids and phenols which are able to increase pH by binding to soil acidity.

Nitrat (NO3-) The Planting Media

Nitrate is one of the nitrogen compounds available in a form that can be measured. Nitrate measurement is conducted to determine the nitrate content in the growing media that has been subjected to various treatments, allowing for a comparison with the observed chili plant growth.

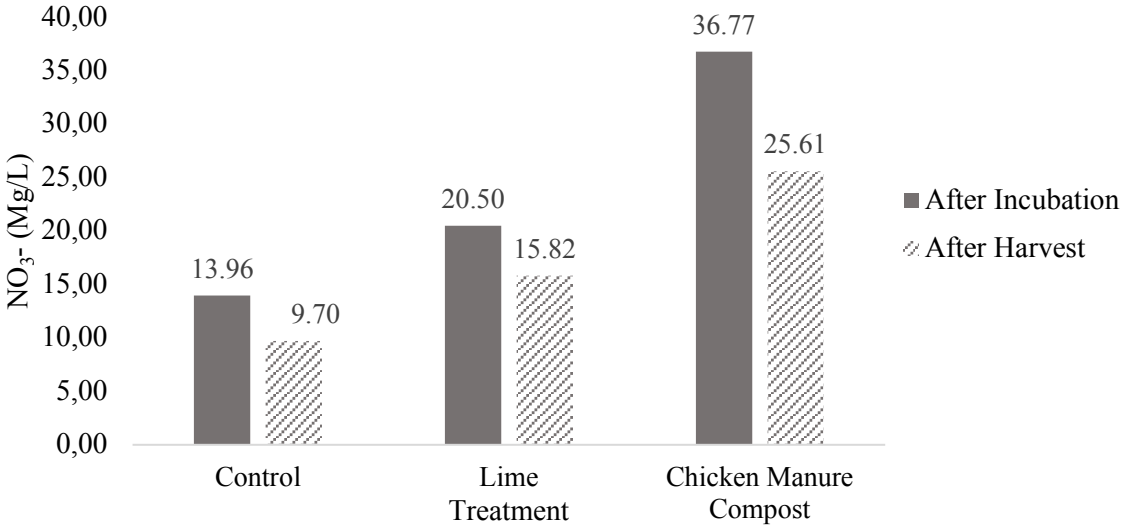

Figure 3. Nitrate (NO3-) content on various growing media

In the above graph, it can be observed that in the control treatment, the nitrate content is 13.96 mg/L after treatment incubation, while the measurement conducted on the growing media after harvest shows a decrease to 9.70 mg/L. The application of lime increases the nitrate content from 13.21 mg/L before treatment to 20.50 mg/L after treatment incubation, and then decreases to 15.82 mg/L after harvest. The application of chicken manure increases the nitrate content in the growing media from 13.21 mg/L to 36.77 mg/L after treatment incubation, and then decreases to 25.61 mg/L after harvest. This phenomenon is also observed in the untreated soil due to the application of organic mulch in the form of water hyacinth plants, which helps prevent direct contact of the soil with rainwater splashes that can cause nutrient leaching. The decrease in nutrient content is generally the same in all treatments after harvest. This is strongly suspected to be due to nutrient uptake by the plants. Nitrate uptake is higher in acidic pH, while ammonium uptake is higher in neutral pH. Nitrate compounds generally move towards the roots through mass flow, while ammonium compounds move through mass flow and diffusion due to their immobile nature (Irawan et al., 2021).

Nitrogen is a nutrient that is needed in the greatest amount for plant growth. Nitrogen plays an important role in the formation of protein compounds in plants. Most of the nitrogen in the soil is in the form of soil organic compounds and is not available to plants. This organic N fixation is about 95% of the total N in the soil. Nitrogen can be absorbed by plants in the form of nitrate ions (NO3-) and ammonium (NH4+). Nitrate (NO3-) is formed more when the soil has warm, moist conditions and has good aeration. Nitrate absorption is more at low pH while ammonium at neutral pH. Nitrate compounds generally move towards the roots due to mass flow, while ammonium compounds through mass flow and diffusion because they are not mobile (Purnomo et al., 2017).

During the decomposition process of organic material, nitrogen is released in the form of NH4+ (ammonium) cations, the speed of this process depends on the ratio between the carbon-nitrogen elements (C/N). The liberated NH+ ions can be directly absorbed by plants and utilized by soil microorganisms or converted into NO3- (nitrate) anions so that in the soil more nitrogen is found in the form of nitrate compared to the ammonium form which in general plants absorb more nitrogen in the form of nitrate to growth process (Panjaitan et al., 2019).

4. Conclusions

The treatment that is capable of increasing soil pH and available N (NH4+, NO3-) in the growing media used for floating cultivation of chili plants is by applying 500 g of chicken manure fertilizer per plant.

Acknowledgments

The author would like to express gratitude to the supervising lecturer and the academic community of the Environment and Natural Resources Management Study Program from 2021 until now. Also, thank you to fellow students of the 2021 batch of PSDAL for their support.

References

Alwi, M. (2017). Potensi dan Karakteristik Lahan Rawa Lebak. repository.pertanian.go.id.

Damayanti, D. P. O., T. Handoyo, dan S. Slameto. (2018). Pengaruh ammonium (NH4+) dan nitrat (NO3-) terhadap pertumbuhan dan kandungan minyak atsiri tanaman kemangI (Ocimum basilicum) dengan sistem hidroponik. Agritrop: Jurnal Ilmu-Ilmu Pertanian (Journal of Agricultural Science), 16(1), 164-175.

Fatah, H. L. (2017). Lahan rawa lebak: Sistem pertanian dan pengembangannya

Hasbi, H., B. Lakitan, dan Herlinda, S. (2017). Persepsi Petani terhadap Budidaya Cabai Sistem Pertanian Terapung di Desa Pelabuhan Dalam, Kecamatan Pemulutan, Ogan Ilir. Jurnal Lahan Suboptimal: Journal of Suboptimal Lands, 6(2), 126-133.

Hilwa, W., D.E. Harahap, dan M. Zuhirsyan. (2020). Pemberian pupuk kotoran ayam dalam upaya rehabilitasi tanah ultisol desa janji yang terdegradasi. Agrica Ekstensia, 14(1).

Heryanita, R. (2017). Optimasi pembentukan ammonium pada slow release fertilizer (Doctoral dissertation, Politeknik Negeri Sriwijaya).

Indriani, I., M.H. Abdillah, N.A. Putri, M.R. Said, R. Roby, dan A. Santi. (2023). Pengaruh Perbandingan Dosis Pupuk Kandang Ternak Ayam dan Sapi Terhadap Biomassa Jagung dan Dinamika Kation Tanah. ZIRAA'AH MAJALAH ILMIAH PERTANIAN, 48(1), 13-20.

Irawan, S., K. Tampubolon, E. Elazhari, dan J. Julian. (2021). Pelatihan Pembuatan Pupuk Cair Organik Dari Air Kelapa Dan Molase, Nasi Basi, Kotoran Kambing Serta Activator Jenis Produk EM4. J-LAS (Journal Liaison Academia and Society), 1(3), 1-18.

Panjaitan, E., S. Silaen, dan R.D. Damanik. (2019). Respon Pertumbuhan dan Produksi Tanaman Selada (Lactuca sativa L.) terhadap Pemberian Pupuk Kandang dan Mikroorganisme Lokal (MOL). Agrotekma: Jurnal Agroteknologi dan Ilmu Pertanian, 4(1), 1-10.

Prasetya, M. E. (2014). Pengaruh pupuk NPK mutiara dan pupuk kandang sapi terhadap pertumbuhan dan hasil tanaman cabai merah keriting varietas arimbi (Capsicum annuum L.). Agrifor: Jurnal Ilmu Pertanian dan Kehutanan, 13(2), 191-198.

Purnomo, E. A., E. Sutrisno, dan S. Sumiyati. (2017). Pengaruh variasi C/N rasio terhadap produksi kompos dan kandungan kalium (K), pospat (P) dari batang pisang dengan kombinasi kotoran sapi dalam sistem vermicomposting (Doctoral dissertation, Diponegoro University).

Sianipar, E. M., C.J.F. Manalu, dan R. Saragih. (2020). Efektivitas Penggunaan Pupuk Kandang Ayam Dan POC Terhadap Ph, C-Organik, N-Total Tanah Serta Produksi Tanaman Pakcoy (Brassica Chinensis L.). Majalah Ilmiah Methoda, 10(2), 74-80.

Syofiani, R., S.D. Putri, dan N. Karjunita. (2020). Karakteristik sifat tanah sebagai faktor penentu potensi pertanian di Nagari Silokek Kawasan Geopark Nasional. Jurnal Agrium, 17(1).

Wijaya, R., dan M.M.B. Damanik. (2017). Aplikasi Pupuk Organik Cair dari Sabut Kelapa dan Pupuk Kandang Ayam Terhadap Ketersediaan dan Serapan Kalium serta Pertumbuhan Tanaman Jagung pada Tanah Inceptisol Kwala Bekala: The application of liquid organic fertilizer from coconut fibre and manure chicken on the availability and absorption of potassium as well as the growth of corn on the Inceptisol Kwala Bekala. Jurnal Agroekoteknologi, 5(2), 249-255