ISSN: 1412-4718, eISSN: 2581-138x

Hartati TM · Ishak L · Aji K · Roini C

Growth and yield of curly red chili (*Capsicum annum* L.) in response to mulching and chicken manure application in the erosion-prone area of Loto, Ternate island

Abstract. Information on soil resources in volcanic landscapes presents a high potential for agricultural land development, but its development is always faced with the potential for continuous land degradation. This study aims to reduce the rate of land degradation through the application of vegetative conservation in erosion-prone Loto agrotourism area, Ternate Island. The research location is focused on erosion-prone areas. The research consisted of a soil resource inventory and a vegetative conservation application. The vegetative conservation application method used a Randomized Block Design (RBD) pattern, composed of 2 factors. The first factor is mulching, namely: no mulching (M0) and mulching (M1), while the second factor is chicken manure-based organic fertilizer, specifically at 10 tons ha^{-1}(P1), and 20 tons ha^{-1}(P2). Observation parameters include soil parameters as well as plant growth and yield parameters. The results showed that the combination of mulching and chicken manure had an insignificant effect on plant height, number of flowers, number of fruits, or number of branches. However, the application of mulching was found to increase the fruit weight of curly chili plants. This finding implied that erosion-prone areas require improved land management, such as mulching, to optimize soil resources and reduce erosion risk.

Keywords: Curly red chilies · Geomorphic process · Land management · Volcanic landscapes

Submitted: 22 March 2025, Accepted: 4 June 2025, Published: 14 August 2025
DOI: https://doi.org/10.24198/kultivasi.v24i2.62421

Hartati TM[1*] · Ishak L[1] · Aji K[1] · Roini C[2]
[1] Department of Soil Science, Faculty of Agriculture, Universitas Khairun, Ternate, 97719, Indonesia
[2] Department of Biology Education, Faculty of Teacher Training and Education, Universitas Khairun, Ternate, 97719, Indonesia
*Correspondence: email: trimulyahartati@gmail.com

Hartati TM, Ishak L, Aji K, Roini C. 2025. Growth and yield of curly red chili (*Capsicum annum* L.) in response to mulching and chicken manure application in the erosion-prone area of Loto, Ternate island. Jurnal Kultivasi, 24 (2): 147-155.

Jurnal Kultivasi Vol. 24 (2) Agustus 2025
ISSN: 1412-4718, eISSN: 2581-138x

Introduction

Land resources are an important indicator to support the sustainability of agricultural sector development. In general, the function of soil is to serve as a medium for growing plants, providing nutrients, and regulating the water cycle. One of the developments in the agricultural sector is on volcanic landscapes. This landscape is widespread in Indonesia (Ashari & Purwantara, 2022; Hartati et al., 2023; Aji et al., 2024). Volcanic landscapes have high potential. This factor is supported by the soil's ability to provide complete nutrient availability derived from volcanic ash material.

Conversely, the topography of the region is distinguished by undulating and steep terrain, accompanied by a multitude of natural hazards, including erosion, landslides, and drought. These factors contribute to a heightened susceptibility to accelerated land degradation and the occurrence of land degradation events. Land degradation is indicated by a decrease in the ability of land to support the ecosystem conditions in it (Aji et al., 2020) and has an impact on reducing the level of soil fertility (Hartati et al., 2023). Erosion is one of the geomorphic processes that play a role in determining soil quality and crop productivity. Land mismanagement has been identified as a primary catalyst in the acceleration of geomorphic processes. Consequently, the development of an effective approach to mitigating the adverse effects of geomorphic processes on land functions is imperative. The application of vegetative conservation is regarded as a potential solution to decelerate geomorphic processes. Vegetative conservation activities include fertilization, the planting of ground cover plants, and the creation of terraces (Fronning et al., 2008), which are a subset of these activities. This approach has been previously explored by researchers, who have implemented diverse mechanical conservation measures on sloping terrain (Rofita et al., 2022). Conversely, the implementation of vegetative conservation measures within volcanic landscapes has been extensively documented, though their application in specific regions remains limited. Agritourism is defined as the integration of agricultural activities with tourism activities (Kurniasanti, 2019; Nasution et al., 2024). This concept is believed to improve economic, social, and cultural conditions (Kurniasanti, 2019) and can be used as an alternative in other aspects, such as educational and recreational facilities (Nurani et al., 2020). However, the implementation of vegetative conservation techniques in such contexts frequently overlooks the intricate interplay between cultivation practices and geomorphic processes. To address this knowledge gap, an approach centered on the study of geomorphic processes is imperative. This approach will facilitate a more profound understanding of the intricate interplay between vegetation, topography, and soil dynamics. Consequently, conservation strategies can be designed with greater specificity and efficacy, aligning with the unique characteristics of each local environment. A case study of an agrotourism area is relevant for testing the geomorphic process approach in a specific context and for providing practical recommendations for area managers in designing sustainable conservation strategies.

Ternate Island, with its hilly topography and many erosion-prone areas, has challenges in managing agricultural activities. The Loto agrotourism area is administratively located in Loto Village, West Ternate District. This village is used as an agrotourism-based agricultural development area that focuses on horticultural crops. This area has an area of 0.04 km^2. This area was initiated by the City Agriculture Office in collaboration with the Ternate City Tourism Office (Tourism Office, 2023). In addition, this sub-district has an area of 33.8 km^2 (BPS, 2021). Located on the volcanic slopes of Mount Gamalama, this area is strategically suited for tourism and vegetable cultivation, offering potential to boost productivity while serving as an educational site (Tourism Office, 2023).

Mulching is one of the important land management technologies to increase plant productivity that plays a role in protecting soil temperature fluctuations and moisture levels (Chakraborty et al., 2023; Kader et al., 2017; Guo et al., 2024), thus creating a conducive environment (Chakraborty et al., 2023) for plant growth. Mulching has also had a positive impact on crop yields. Similar research has also been conducted, but with a combination of mulch with biochar at regular intervals for three years, which increased the yield by 23.4% (Zhang et al., 2024). The use of mulch is believed to be an effective approach to reduce the impact of erosion (Iqbal et al., 2020). Mulch also helps protect the soil surface from direct rain. Furthermore, the application of manure is a type of vegetative conservation

ISSN: 1412-4718, eISSN: 2581-138x

action. Manure plays a role in soil aggregation systems, improving root systems, and plant productivity (Rofita et al., 2022). Chemically, organic fertilizers help in providing essential nutrients, increase soil biodiversity, and play a role in the formation of complex compounds (Pasang et al., 2019). Several similar studies have been conducted by previous researchers that manure has a positive effect on plant productivity (Liu, 2016; Syahputra, 2016; Emir, 2017; Risal & Mukhlishah, 2019; Risal & Halim, 2020).

Curly red chili plant (*Capsicum annum L.*) is one of the agricultural commodities that has been developed and neatly arranged in the Loto agrotourism area, but the production produced is still not optimal, especially when looking at the results of each slope, which still show different results. Curly red chili pepper (*Capsicum annum L.*) is also one of the important horticultural commodities that are widely cultivated because of its high economic value. Curly red chili has nutritional content such as protein, fat, carbohydrates, calcium, vitamins A and C (Rindani, 2015). The content of curly red chili has 90.9% water content, 31 calories, 1 g protein, 0.3 fat, 7.3 g carbohydrates, 29 mg calcium, 24 mg phosphorus, 47 mg vitamin A, and 18 mg Vitamin C (Sutrisni, 2016). This plant is also able to be grown in various topographic conditions, both in the highlands and in the lowlands.

This research aims to reduce land degradation through the application of vegetative conservation in erosion-prone areas. This research not only contributes to better management of land resources but also supports sustainable development goals, particularly in maintaining terrestrial ecosystems and promoting sustainable agricultural practices.

Materials and Methods

The research was carried out in the Loto agrotourism area, Loto Village, West Ternate District (Figure 1). The implementation time starts from March – October 2024. Laboratory analysis was carried out at the Soil Science Laboratory, Faculty of Agriculture, Universitas Khairun, and the Soil Laboratory, East Java Agency for Agricultural Assembly and Modernization. Furthermore, the materials used in this study include curly red chili seeds and chicken manure. Meanwhile, the tools used include hoes, meters, shovels, sample rings, plastic mulch, treatment nameplates, and writing stationery.

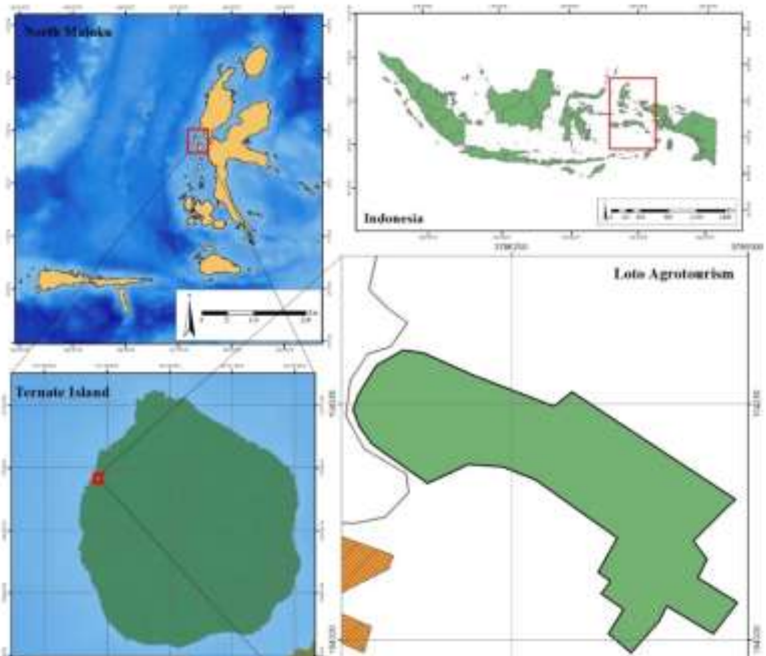


Figure 1. Administrative Map of the Research Area

ISSN: 1412-4718, eISSN: 2581-138x

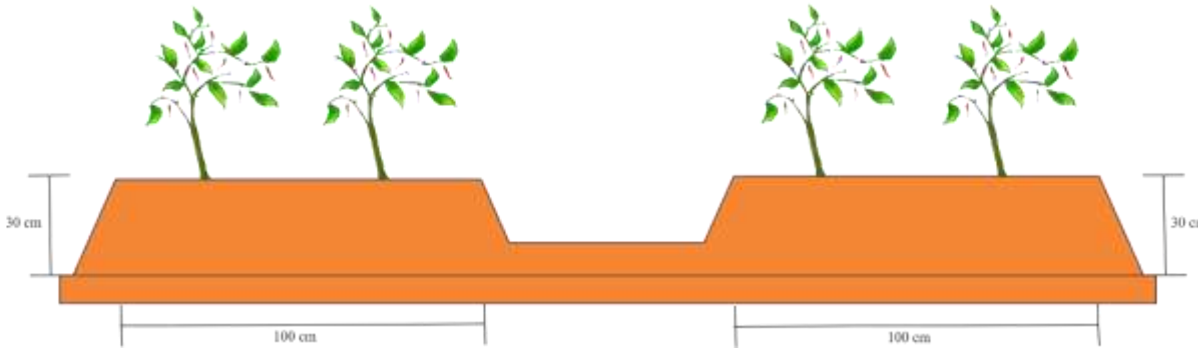


Figure 2. Chili Plant Bed

The study focused on erosion-prone locations with steep slopes (25 – 45%). The study was carried out in two stages: first, soil sampling for preliminary analysis; second, vegetative conservation through red chili cultivation. The soil sampling method employing the soil boring technique is based on the USDA Field Book Procedures for Describing and Sampling Soils (Schoeneberger et al., 2012), and soil properties are analyzed using the standard of the Agricultural Instrument Standardization Agency of the Ministry of Agriculture. Soil physicochemical analysis includes analysis of bulk density (ring method), particle density (pycnometer method), soil porosity, soil texture (hydrometer method) with based on the principle of sedimentation or deposition of soil grains in water. The texture classification criteria based on USDA classification including, clay (Φ: <0.002 mm), silt (Φ: 0.05 mm - 0.002 mm) and sand (Φ: 2 mm - 0.05 mm), soil pH (1:5) (electrometric method; pH meter), soil organic carbon (Walkley & Black method), soil total nitrogen (Kjeldahl Titrimetric method), soil P_2O_5 content (Olsen method; Spectrophotometer), soil K_2O content (AAS method), exchangeable cations (K, Na, Ca, Mg,), and Soil CEC (Percolation method NH_4OAc 1 M, pH 7 + NaCl 10%; Titrimetric). The second phase of research involved manufacturing beds of 1 x 3 m with a height of 30 cm each (Figure 2). This step employs the Randomized Block Design (RBD), which includes two elements, namely mulching and chicken manure-based organic fertilizer (Table 1).

Each treatment combination was repeated five times, yielding a total of 20 experimental units (2x2x5). Plant growth and yield metrics are monitored, such as plant height, number of flowers, number of fruits, number of branches, and fruit weight.

Table 1. Combination of Treatments

Code	Combination of Treatments
M0P1	No mulching + 10 tons ha^{-1} chicken manure
M0P2	No mulching + 20 tons ha^{-1} chicken manure
M1P1	Mulching+ 10 tons ha^{-1} chicken manure
M1P2	Mulching + 20 tons ha^{-1} chicken manure

The analysis of soil observation data was carried out in a composite manner in each treatment, while the data from plant observation was analyzed by multi-fingerprint analysis (ANOVA). The treatment with a real effect will be further tested using the Duncan multiple range test (DMRT) at the 5% significance level by using Minitab software ver.18.

Results and Discussion

Soil Analysis Results. The soil order in the research region is classified as Entisols, with the subgroup Typic Udorthents. This type of soil is distinguished by little soil profile development and a distinctive okric horizon above the soil surface (Fiantis, 2016). The physicochemical analysis results are utilized to determine the carrying capacity for vegetative conservation applications. The initial soil analysis of the location where vegetative conservation is applied shows that sand fractions dominate, with 90% in the upper layer and 85% in the lower layer, followed by clay and dust fractions, resulting in a clay-sand texture (Table 2). With such a texture, this soil has a low ability to store soil moisture, as well as water and nutrient storage capacity, due to the vast pore space, which requires a large amount of water to meet field capacity.

Table 2. Initial soil analysis before treatment

No	Properties of Soil	Depth	
		0 - 30 cm	30 - 60 cm
Physical Properties of Soil:			
1.	Texture (%):		
	Sand	90	85
	Silt	3	8
	Clay	7	7
	Texture Classes	Loamy sand	Loamy sand
2.	Bulk Density (g.cm^{-3})	1.89	1.77
3.	Particle Density (g.cm^{-3})	2.56	2.62
4.	Porosity	26.25	32.53
Chemical Properties of Soil:			
1.	pH H_20	7.4	7
	pH KCl	6.3	5.8
2.	Organic Carbon (%)	1.5 (l)	1.16 (l)
3.	Total Nitrogen (%)	0.02 (vl)	0.13 (l)
4.	C/N Ratio	75 (h)	8.92 l)
5.	Organic Matter (%)	2.60	2.01
6.	P_2O_5 available (ppm)	21 (m)	12 (vl)
7.	P_2O_5 Potensial (mg.100 g^{-1})	73	57
8.	K_2O (mg.100 g^{-1})	57 (h)	12 (l)
9.	Cations can be exchanged:		
	K (cmol (+) kg^{-1})	0.26 (l)	0.4 (l)
	Ca (cmol (+) kg^{-1})	3.99 (l)	2.93 (l)
	Mg (cmol (+) kg^{-1})	0.82 (l)	0.04 (vl)
	Na (cmol (+) kg^{-1})	0.3 (l)	0.22 (l)
10.	CEC (cmol (+) kg^{-1})	5.26 (l)	4.63 (vl)
11.	Base Saturation	102.09 (vh)	71.92 (h)

Source: the Soil Laboratory, East Java Agency for Agricultural Assembly and Modernization (2024) and Soil Science Laboratory of the Faculty of Agriculture, Universitas Khairun (2024)
Description: (1) vl: Very Low; (2) l: Low; (3) m: moderate (4) T: High; (4) st: Very High

The BD value in the upper layer was 1.89 gr cm^{-3}, while the lower layer was 1.77 gr cm^{-3}, indicating that the soil at the research site is quite dense. The weight of the volume can describe the density of the soil; the higher the weight, the higher the proportion of solids or the more compacted. In general, coarse-textured soils (Ø 2.00 mm) have a higher volume weight than fine-textured soils (Ø 0.002 mm). The assumption is that plant roots will have an easier time penetrating soil with a high bulk density because there is enough pore space for air and groundwater. On the other hand, in soils with a low soil volume weight, plant roots will be difficult to develop since the density level is likewise low, causing the roots to climb to the surface in search of nutrients (Aji et al., 2020) and water to promote production.

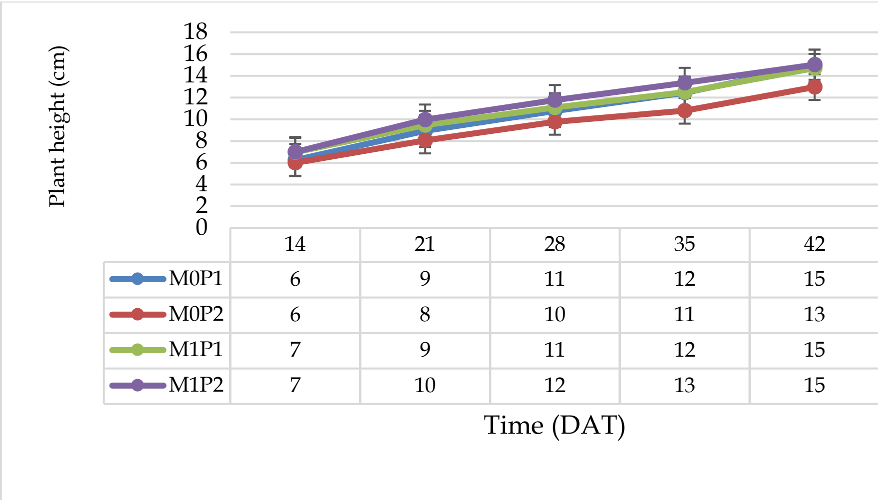
Soil chemical analysis at the research site typically yields very low to low values. The total nitrogen content of 0.02% qualifies as very low. Nitrogen is lost into the atmosphere as a result of its volatile nature and is oxidized to generate ammonium. Furthermore, the washing process in the soil body may contribute to nitrogen loss (Xiao et al., 2019; Chen et al., 2021; Batubara et al., 2024). Furthermore, the low P concentration is available because the P factor is bound by Al and Fe metals, making it unavailable to plants. The potassium component in the form of K_2O has a rather high yield, 57 mg per 100 g. This is due to the inorganic nature of the K concentration in the soil, which allows it to move freely throughout the soil body and easily deliver nutrients to plants. In addition, volcanic landscapes contribute potassium content through orthoclase [(K, Na)$AlSi_3O_8$], Microlins [(Na, K)$AlSi)_4$], Muscovite [K$(AlSi)_3$ $O_{10}(OH)_2$], and Biotite [K$(Mg.Fe^{2+})_3AlSi_3$ $O_{10}(OH)_2$]. Furthermore, the benefit of family planning and CEC is inversely related. This is because the soil pedogenesis process is influenced by soil texture factors, which are still dominated by sand fractions, resulting in a low exchange capacity of cations in

ISSN: 1412-4718, eISSN: 2581-138x

the soil. After all, the soil is easily washed out, causing alkaline cations to be lost through the surface through erosion or washed through eluviation in the soil body.

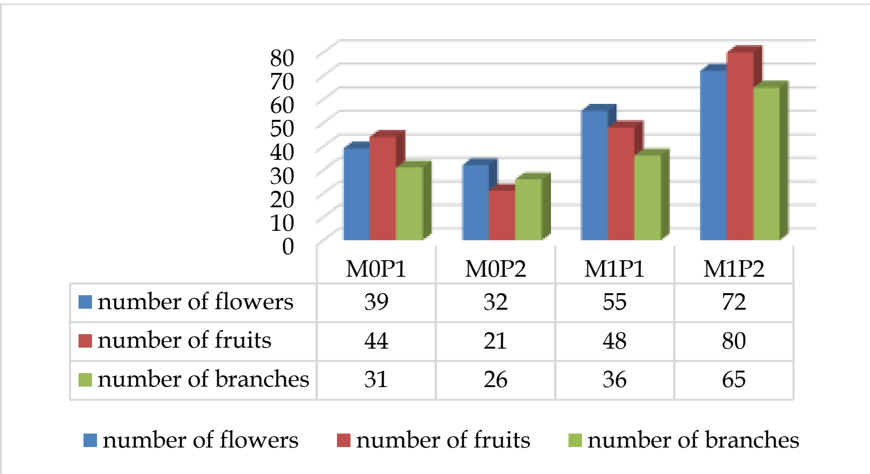
Chili Plants Growth and Yield. The analysis of variance revealed that while the treatment had no significant influence on plant height, number of flowers, number of fruits, or number of branches, it did have a significant effect on fruit weight. The average results of plant height in each treatment produce values that differ; this condition can be seen in the graph of plant height rise at each observation (Figure 3).

The M0P2 treatment (no mulching + 20 tons ha^{-1} chicken manure) had the lowest plant height, while the M1P2 treatment (mulching + 20 tons ha^{-1} chicken manure) had the greatest (Figure 3). The addition of chicken manure to soil can improve its high water absorption, in certain cases it may facilitate the easy mineral accessibility to plants (Widowati, 2004; Suryana, 2008). Furthermore, mature organic fertilization can also benefit the soil by increasing colloidal humus, which facilitates the release of nutrients (K, Ca, and Mg) (Brar et al., 2015; Neina, 2019). On the other hand, using the same fertilizer but also applying mulch might increase the height of chili plants.



	14	21	28	35	42
M0P1	6	9	11	12	15
M0P2	6	8	10	11	13
M1P1	7	9	11	12	15
M1P2	7	10	12	13	15

Figure 3. The increase in chili plant height from 14 to 42 days after transplanting is insignificantly affected by mulching and chicken manure treatment
Note: no mulching + 10 tons ha^{-1} chicken manure (M0P1), no mulching + 20 tons ha^{-1} chicken manure (M0P2), mulching+ 10 tons ha^{-1} chicken manure (M1P1), mulching + 20 tons ha^{-1} chicken manure (M1P2)



	M0P1	M0P2	M1P1	M1P2
number of flowers	39	32	55	72
number of fruits	44	21	48	80
number of branches	31	26	36	65

Figure 4. The number of flowers, fruits, and branches of chili plant is insignificantly affected by mulching and chicken manure treatment
Note: no mulching + 10 tons ha^{-1} chicken manure (M0P1), no mulching + 20 tons ha^{-1} chicken manure (M0P2), mulching+ 10 tons ha^{-1} chicken manure (M1P1), mulching + 20 tons ha^{-1} chicken manure (M1P2)

Similar to the data on plant height in the flower count, the mulching treatment also increased the number of fruits and branches (Figure 4). The average differential test findings for mulching treatment on the weight of chili plants also revealed a significant difference compared to no mulching (Figure 5). This scenario demonstrates that mulching can boost chili plant growth and productivity. Plastic mulch can boost microbial activity, which in turn can boost plant growth and yield by raising the carbon dioxide content in the planting area. Some research results also show that the use of black and silver plastic mulch increases the yield of several vegetable crops such as red chili peppers (Harsono, 1997; Syamiah, 1997; Fahrurrozi et al., 2006; Soetiarso, 2006), tomatoes (Decoteau et al., 1988; Decoteau et al., 1989), and paprika (Decoteau et al., 1990).

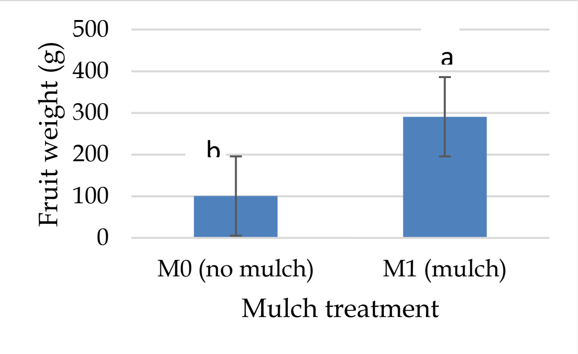


Figure 5. The fruit weight of chili plant is significantly affected by mulching

The effects of environmental factors on productivity and growth are correlated and interconnected. One of them is the soil type. The presence of an early-stage soil type in the study area is due to the dominance of Entisols. This soil type is often found in erosion-prone regions (Soil Survey Staff, 2022). Open agricultural practices in erosional zones in the research site further promote severe erosion. Unsuitable spatial and temporal land conversion is believed to accelerate this process (Rahmadi & Wibowo, 2023). If not addressed, such conditions can lead to ongoing soil degradation (Sartohadi et al., 2012; Nasution et al., 2024). Erosion commonly strips away the topsoil layer (Sulaeman & Westhoff, 2020), which is the most fertile part of the soil because it contains high levels of organic matter, minerals, and essential nutrients for plant growth.

Conclusion

Mulching and chicken manure application, as vegetative conservation treatment, are thought to be important and potential strategies to increase the productivity of curly red chili in the erosion-prone or nutrient-poor land. However, the combination of mulching and chicken manure application had no significant influence on plant height, number of flowers, number of fruits, or number of branches. On the other hand, mulching has been found to significantly increase the fruit weight, implying the urgency of this practice in erosion-prone cultivation land.

Acknowledgments

The author would like to thank the Rector of Khairun University for providing financial assistance for this research through the 2023 Unkhair DIPA funds through the Assignment Agreement for the Superior Competitive Research Program for Higher Education (PKUPT) at the Postgraduate Level No: 431/PEN-PKUPT/PG.03/2024.

References

Aji K, Maas A, Nurudin M. 2020. Relationship between soil morphology and variability of upland degradation in Bogowonto Watershed, Central Java, Indonesia. Journal of Degraded and Mining Lands Management 7(3): 2209-2219.

Aji K, Nasution LA, Sufia R, Robo S, Hartati TM. 2024. Soil Geomorphological Characteristics in Holocene Volcanic Quaternary Geological Formations in North Maluku Region. Ecosolum Journal, 13(2): 130-143.

Ashari A & Purwantara S. 2022. Indonesia's Volcanic Landscape: Physical and Cultural Aspects. UNY Press. Yogyakarta.

Batubara SF, Ulina ES, Chairuman N, Tobing JM, Aryati V, Manurung ED, Purba HF, Parhusip D. 2024. Evaluation of Macro-nutrient Status of Nitrogen, Phosphorus and Potassium in Irrigation Rice Fields in Deli Serdang Regency, North Sumatra. Journal of Agriculture 2024, 35(1): 59-70.

Brar BS, Singh J, Singh G, Kaur G. 2015. Effects of long term application of inorganic and organic fertilizers on soil organic carbon and physical properties in maize wheat rotation. Agronomy 5(2): 220–238.

Central Statistics Agency. 2021. Ternate City in 2021 Figures.

Chakraborty D, Nagarajan S, Aggarwal P, Gupta VK, Tomar RK, Garg RN. 2008. Effect of mulching on soil and plant water status, and the growth and yield of wheat (*Triticum aestivum* L.) in a semi-arid environment. Agric Water Manag, 95:1323–1334.

Chen L, X Liu, Z Hua, H Xue, S Mei, P Wang, S Wang. 2021. Comparison of nitrogen loss weight in ammonia volatilization, runoff, and leaching between common and slow-release fertilizer in paddy field. Water, Air and Soil Pollution, 232(4):132.

Decoteau, DR, Kasperbauer, MJ, Daniels, DD & Hunt, PG. 1988. Plastic mulch color effects on reflected light and tomato plant growth. *Scientia Horticulture*, 34: 169-75.

Decoteau DR, Kasperbauer MJ, Hunt PG. 1989. Mulch surface color affects yield of fresh tomato. J. Amer. Soc.Hort.Sci., 114: 216-19.

Decoteau DR, Kasperbauer MJ, Hunt PG. 1990. Bell pepper plant development over mulches of diverse colors. Horti. Sci., 25: 460-62.

Emir NM, Aini N, Koersniharti. 2017. Effect of Organic and Inorganic Fertilizer Application on the Growth and Yield of Red Pepper Plants (*Capcium annum* L.). Journal of Plant Production. 5(11): 1845-1850.

Fahrurrozi KA, Stewart, Jenni S. 2001. The early growth of muskmelon in mulched minitunnel containing a thermal-watertube. I. The carbon dioxcide concentration in the tunnel. J. Am.Soc. for Hort. Sci., 126: 757-63.

Fahrurrozi N, Setyowati, Sarjono. 2006. The effectiveness of reusing black and silver plastic mulch with nitrogen fertilizer application on chili growth and yield. Bionatura, 8: 17-23.

Fronning BE, Thelen KD, Min DH. 2008. Use of manure, compost, and cover crops to supplant crop residue carbon in corn stover removed cropping systems. Agronomy Journal, 100(6): 1703–1710.

Guo W, Li J, Wu Z, Chi G, Lu C, Ma J, Hu Y, Zhu B, Yang M, Xin Chen X, Huiying Liu H. 2024. Biodegradable and conventional mulches inhibit nitrogen fixation by peanut root nodules – potentially related to microplastics in the soil. Journal of Hazardous Materials, 480: 136423.

Harsono P. 1997. Study of plastic mulch on soil microenvironment and chili yield (*Capsicum annuum* L.). J. UNIB Research, 8(3): 34-8.

Hartati TM, Sunarminto BH, Utami SHN, Purwanto BH, Nurudin M, Aji K. 2023. Distribution of soil morphology and physicochemical properties to assess the evaluation of soil fertility status using soil fertility capability classification in North Galela, Indonesia. Journal of Degraded and Mining Lands Management, 10(3):4405-4415.

Hartati TM, Teapon A, Indrawati USYV, Aji K. 2023. Analysis of Infiltration Capacity in Several Types of Tegalan Land in Sasa Village, South Ternate District. Journal of Agriculture, 34(3): 401 – 410.

Kader MA, Senge M, Mojid MA, Ito K. 2017. Recent advances in mulching materials and methods for modifying soil environment. Soil Tillage Res, 168: 155–166.

Iqbal RMAS, Raza M, Valipour MF, Saleem MS, Zaheer S, Ahmad M, Toleikiene I, Haider MU, Aslam MA, Nazar. 2020. Potential agricultural and enviromental benefits of mulches. a reviewer Bull. Natl. Res. Cent., 44: 1-16.

Kurniasanti SA. 2019. Analysis of Agrotourism Development Strategies (Case Study of Siamese Orange Fruit Farmers Village in Bangorejo-Banyuwangi District). Journal of Tourism and Creativity, 3(1):65-76.

Liu T, Chen X, Hu F, Ran W, Shen Q, Li H, Whalen JK. 2016. Carbon-rich organic fertilizers to increase soil biodiversity: Evidence from a meta-analysis of nematode communities. Agriculture, Ecosystem & Environment Jurnal, 232: 199-207.

Nasution L, Aji K, Sufia R, Tangge NA. 2024. Environment-Based Agrotourism Development Strategy in Loto Village, West Ternate District. Spatial Journal of Geographic Communication and Information Vehicles, *24*(1): 32–40.

Neina, D. 2019. The role of soil pH in plant nutrition and soil remediation. Applied and Environmental Soil Science, 2019(3): 1–10.

Nurani R, Roessali W, Ekowati T. 2020. Jollong Agrotourism Development Strategy in Pati Regency. Journal of Tourism, 7(2).

Pasang YH, Jayadi M, Neswati R. 2019. Increasing Ultisol Soil Phosphorus Nutrients Through the Application of Manure, Compost and Pellets. Ecosolum Journal, 8(2): 86–96.

Rahmadi, & Wibowo, A. 2023. Changes in Vegetation Cover in Landslide-prone Areas in Cianjur Regency, West Java Province. Spatial Journal of Geographic Communication and Information Vehicle, 23(2): 180-185.

Rindani M. (2015). Suitability of Red Chili Crop Land in Jorong Central City, Kenagarian Lubuak Batingkok, Harau District, Fifty Kot Payakumbuh Regency. National Ecopedon, 2(2): 28 – 33.

Risal D, Mukhlishah N. 2019. Effectiveness of Organic Fertilizer of Combustion of Horse Manure on the Growth of Curly Red Pepper Plants (*Capcium annum* L.). Ecosolum Journal, 8(1).

Risal D & Halim A. 2020. Organic Fertilizer Test for Curly Pepper Growth in Nutrient Poor Soils.Ecosolum Journal, 9(1): 19–27.

Rofita, Utami SNH, Maas A, Nurudin M. 2022. Effects of manure and chemical fertilizers on maize performance in the steep hillside with and without terraces in North Halmahera, Indonesia. Ilmu Pertanian (Agricultural Science), 7(1): 56–67.

Sartohadi J, Jamulya, Dewi N IS. 2012. Introduction to Soil Geography. Student Library. Yogyakarta.

Schoeneberger, P.J., Wysocki, D.A., Benham, E.C. and Soil Survey Staff. 2012. Field Book for Describing and Sampling Soils. In Natural Resources Conservation Service, National Soil Survey Center, USDA. Lincoln, NE.

Soetiarso TA, Ameriana M, Prabaningrum L, Sumarni N. (2006). Growth, yield, and financial feasibility of using mulch and artificial fertilizer in off-season red pepper farming. J. Hort., 16(1): 63-76.

Soil Survey Staff. 2022. Keys Soil Taxonomy, Thirteenth Edition. Washington. USDA. 410p.

Sulaeman D & Westhoff T. 2020. How to Reduce the Risk of Soil Erosion in Indonesia [internet]. Available in: https://wriindonesia.org/id/wawasan/cara reduce-risk-land-in-indonesia.

Suryana NK. 2008. Effect of shade and manure on the growth and yield of pepper plants (*Capsicum annum* var. Grossum). Journal of Agriscience, 9(2):89-95.

Sutrisni A. 2016. Activity test of bioactive compounds of mold (*Gliocladium* sp) against fusarium oxysporum, capsici that causes wilting in chili plants in-vitro. Bachelor Thesis. University of Muhammadiah Purwokerto, Central Java.

Syahputra E, Astuti KR, Indrawaty A. 2017. Agronomic Study of Red Pepper Plants (*Capcisum annum* L.) On various types of compost materials. Journal of Agrotekma, 1(2): 92-101.

Syamiah. 1997. Effect of mulch and irradiation frequency on the growth and yield of red chili plants in rainfed rice fields. Agrista, 1(2): 39-45.

Ternate City Tourism Office. 2023. The Ternat City Government has begun to develop agro-tourism in agricultural areas [internet]. Available at http://pariwisata.ternatekota.go.id/berita/read/pemkot-ternate-mulai-kembangkan-agrowisaya-di-kawasan-pertanian.

Van Reeuwijk LP. 2002. Procedures for Soil Analysis. International Soil Reference and Information Centre.Den Haag: Netherlands.

Widowati. 2004. Effect of Organic Fertilizer Compost Enriched with Mineral Materials and Biological Fertilizers on Soil Properties, Nutrient Uptake and Organic Vegetable Production. Agribusiness Development Program Research Project Report. Soil Research Institute.

Xiao M, Y Li, J Wang, X Hu, L Wang, Z Miao. 2019. Study on the law of nitrogen transfer and conversion and use of fertilizer nitrogen in paddy fields under water-saving irrigation mode. Water. 11(2): 218.

Zhang P, Dongmei WD, Zhang Z, Xinyu LX, Guo Q. 2024. How biochar curbs the negative impacts of plastic mulching on soil enzymes and microorganisms while elevating crop yields in ridge-furrow systems. Environmental Research, 263(2).