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Assessment of Land Characteristics and Suitability for Citrus Development in Dry Land Punung, Pacitan Regency

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ABSTRACT

One of the Indonesian provinces where the agricultural industry drives the economy is Punung, Pacitan, which has local conditions that are particularly suitable for producing citrus, giving this product the potential to continue to expand in popularity. Land evaluation tries to provide information on its potential for a particular purpose. This research was conducted to know land suitability classes, limiting factors, and improvement efforts that can be made. This research is exploratory descriptive with a variable approach through field survey and using a purposive random sampling method based on Land Mapping Units. Data analysis was carried out using the matching method between land characteristics and conditions for growing citrus, a statistical test by ANOVA (Analysis of Variance), and Duncan's Multiple Range Test (DMRT) to find the factors that most determine land characteristics in Punung. The study results show that the actual land suitability class in Punung is marginally suitable. Improvements that can be made to increase the availability of nutrients in the soil in the form of available P_2O_5 with a low level of management is to apply P fertilization according to the needs of citrus. ANOVA results proved that the variety of soil types significantly influences some of the land characteristics.

Keywords: Actual, citrus, land characteristics, land suitability, potential

INTRODUCTION

The agricultural sector is a sector that plays a vital role in the national economy and development. Indonesia is a tropical country rich in plantation products such as fruits and vegetables. The people of Pacitan Regency, who belong to this region, make the agricultural sector one of the pillars of their economy. One of them is citrus, which was initially produced in Indonesia and is the main trading commodity of the Pacitan Regency (Kusuma et al., 2007). Citrus production data in Pacitan Regency reached 4004,6 Mg in 2018-2019 (BPS, 2020). Citrus production is essential to support export foreign exchange, employment opportunities, income, and public consumption.

The land evaluation aims to provide information about the potential of land for a particular purpose so that it can be used optimally and sustainably (Rahmawaty et al., 2020). Land evaluation is a way to assess land potensial (Sirappa et al., 2010). Land suitability analysis will show the most suitable areas (Sahdev & Kumar, 2020). Land suitability analysis is similar to selecting a suitable site for suitability mapping (Kumar & Biswas, 2013). Land evaluation is critical in determining the success of crop production. Land evaluation in this study helps determine the potential or capability of land for citrus in Punung, Pacitan Regency. It can be used as a guide in land management efforts to achieve average productivity (Hartono et al., 2018). This research was conducted using a survey method with field observations and soil sampling supported by laboratory analysis so that land use can be under soil quality (Kusumandaru et al., 2015). The results of land suitability evaluation for the development of citrus are presented as a map as a basis for rational land use planning to be optimal (Andrean et al., 2017). It can be used to make land management recommendations based on each strengths and weaknesses (Mujiyo et al., 2020).

Previous research on land suitability in Pacitan Regency has been carried out, namely the

Application of Land Suitability Analysis for the Development of Janggelan Plants in Pacitan Regency by (Supriyadi et al., 2017) to be precise in Nawangan District and Evaluation of Land Suitability for Several Forestry Plants and Plantation Plants in Sanggrahan Village, Kebonagung District, Pacitan Regency by (Meniasawara, 2012). However, research on land suitability for citrus has never been conducted in the Pacitan District. Therefore, this research is fundamental to determine the suitability of land suitable for citrus plants. The research results are expected to be used to optimize land according to its characteristics for the growth of citrus plants so that productivity can be optimized.

MATERIALS AND METHODS

Time and Site Location

This research was conducted from June to December 2021 in Punung, Pacitan Regency, East Java. Most of its area is limestone mountains, part of the Pegunungan Seribu series with astronomical conditions at 40.51º-40.36º South Latitude and 70.55º-80.17º East Longitude. The total area of Punung District is 108,81 km^2, which is 7.83% of the total area of Pacitan Regency.

Experimental Treatments and Design

The research was conducted in an exploratory, descriptive manner through a survey approach. The survey method is carried out by direct observation in the field and by taking soil samples, which will be analyzed in the laboratory. Descriptive research aims to describe the facts and characteristics of certain groups or subjects systematically, meticulously, and accurately. Explorative research is a type of data collection to answer problems of interest to researchers. This research method will involve the introduction of a particular symptom (Mudjiyanto, 2018). All data were analyzed as explorative descriptive, which means data obtained by researchers (Romdonny & Rosmadi, 2018).

Work maps for field surveys are made based on overlays of various maps, namely, a soil type map (Figure 1), a geological map (Figure 2), and a rainfall map (Figure 3) using the ArcGIS 10.3 application. The Land Mapping Units (LMUs) were used as the basis for determining sample points using the purposive random sampling method and served as a guideline for sampling to be carried out in the field (Table 1 and Figure 4).

Determination of Soil

Soil sampling was carried out by carrying out several measurements directly in the field without conducting laboratory tests, observations which included altitude, slope, slope length, soil depth, effective soil depth, slope, flood hazard, erosion, surface rocks, rock outcrops, land use, landform, land use, vegetation, and soil morphology, as well as analysis of soil physical and chemical properties in the laboratory which includes soil texture (pipette method), soil CEC (extraction of ammonium acetate 1 N pH 7.0), base saturation (extraction of ammonium acetate 1 N pH 7.0), pH H_2O (pH meter), C-organic (Walkley & Black method), N-total (Kjeldahl method), P_2O_5 (Olsen method), K_2O (Spectrometry), salinity (conductometer), and alkalinity (titration).

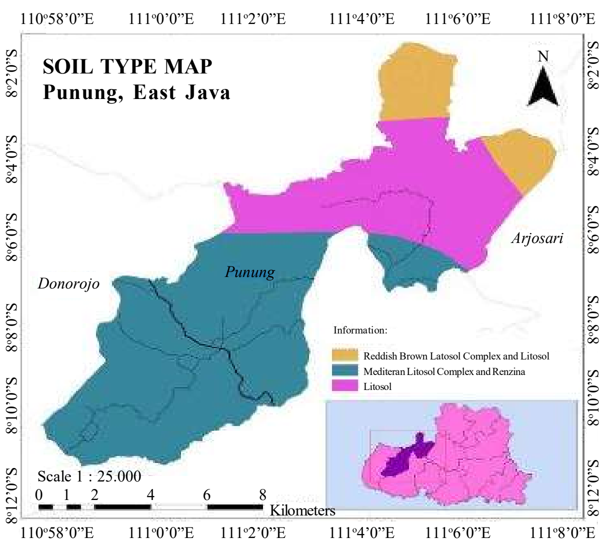

Figure 1. Soil type map.

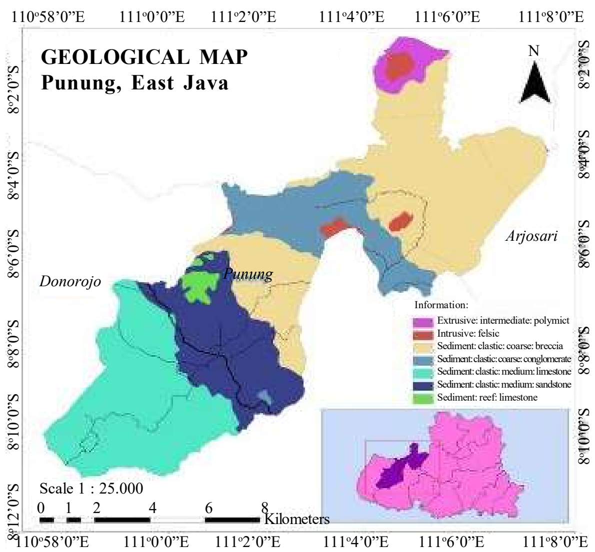

Figure 2. Geological map.

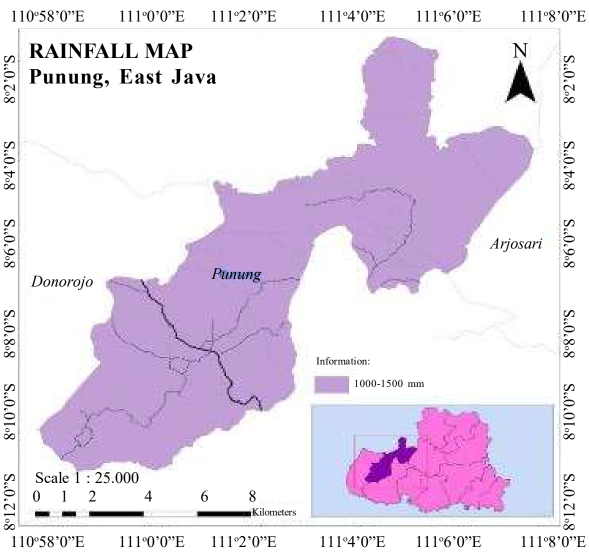

Figure 3. Rainfall map.

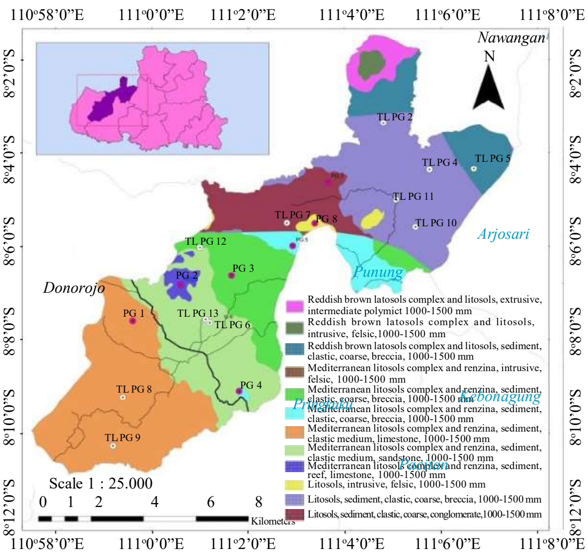

Figure 4. LMUs and soil sampling location.

Data Analysis

Land quality assessment analysis was carried out using a matching system between land quality/ characteristics from field and laboratory analysis results, which were inventoried in tabular form with the requirements for growing citrus plants determined by (Ritung et al., 2011). Land suitability assessment will be determined in terms of actual and potential conditions. The potential state is

Table 1. LMUs and their elements in the research area.

LMU	Soil Type	Geological	Rainfall (mm yr^{-1})	Slope (%)	Land Use
1	Reddish Brown Latosols Complex and Litosols	Extrusive; intermediate; polymict	1000-1500	0-3	Plantation
2	Reddish Brown Latosols Complex and Litosols	Intrusive; felsic	1000-1500	3-8	Plantation
3	Reddish Brown Latosols Complex and Litosols	Sediment; clastic; coarse; breccia	1000-1500	3-8	Crop Field
4	Mediterranean Litosols Complex and Renzina	Intrusive; felsic	1000-1500	3-8	Crop Field
5	Mediterranean Litosols Complex and Renzina	Sediment; clastic; coarse; breccia	1000-1500	3-8	Crop Field
6	Mediterranean Litosols Complex and Renzina	Sediment; clastic; coarse; conglomerate	1000-1500	8-15	Crop Field
7	Mediterranean Litosols Complex and Renzina	Sediment; clastic; medium; limestone	1000-1500	8-15	Plantation
8	Mediterranean Litosols Complex and Renzina	Sediment; ; clastic; medium; sandstone	1000-1500	8-15	Plantation
9	Mediterranean Litosols Complex and Renzina	Sediment; reef; limestone	1000-1500	8-15	Crop Field
10	Litosols	Intrusive; felsic	1000-1500	15-25	Plantation
11	Litosols	Sediment; clastic; coarse; breccia	1000-1500	15-25	Crop Field
12	Litosols	Sediment; clastic; coarse; conglomerate	1000-1500	3-8	Plantation

achieved after implementing efforts to improve each limiting factor to reach the potential state. The data that has been obtained will be used as material for making actual land suitability maps. The land is classified into highly suitable (S1), moderately suitable (S2), marginally suitable (S3), and unsuitable (N = non-suitable) classes.

Data analysis was also performed using the one-way ANOVA test to find the factors that most determine land characteristics in Punung, followed by Duncan's Multiple Range Test (DMRT) with a 5% confidence level to determine the average soil type with land characteristics in Punung. This statistical analysis uses Statistical Product and Service Solutions (SPSS) software. Research analysis includes validity analysis for testing a measure that indicates the validity or validity of a question instrument questionnaire (Arikunto, 2010).

RESULTS AND DISCUSSION

Land characteristic and classification of land suitability for citrus in Punung

Temperature (tc), water availability (wa), oxygen availability (oa), rooting zone (rc), nutrient retention (nr) and nutrient availability (na), toxicity (xc), erosion hazard (eh), flood hazard (fh), and land preparation (lp) were the characteristics of the land used in this research. After matching the soil characteristics in Punung with the requirements for citrus plants, it was possible to determine the level of land suitability classification for citrus plants in Punung. Through outdoor observation, laboratory analysis, and documentation, the soil properties in Punung can be seen. The matching technique was employed to calculate the probability of classifying land using the lowest value as the limiting factor in land evaluation. The result was subsequently arranged from best to worst based on its limiting factors. The most significant limiting factors for a land characteristic were low and negligible, while the worst ones were significant. The results of the matching method will show which land was suitable for growing citrus plants. Details of the results of evaluating the land suitability of citrus in Punung are shown in Tables 2, 3, and 4.Results of this study indicate that based on calculations using the Braak Formula, the average temperature in Punung was 22.808-26252 °C with an average rainfall of 1000-1500 mm yr^{-1} based on rainfall map obtained from precipitation data for 2011 - 2020 CRU TS v4.06, Climatic Research Unit (University of East Anglia) and Met Office. Punung had good drainage conditions. Soil texture consists of silty clay, clay, clay loam, silty clay loam, silt loam, and loam. The coarse material content in the Punung belonged to the few classes with a value <15% and moderately deep (50-75 cm) to deep (>100 cm) soil depth.

Nutrient retention such as Cation Exchange Capacity (CEC) ranged from 7.99-20.50 cmol(+) kg^{-1} or low to medium. Base saturation ranged from 32.160-78.373% or low to high. Punung had an acid-to-neutral pH ranging from 5.45-7.17 and organic-C ranging from 0.765-3.384% or low to high.

Salinity in Punung had a low value. ranging from 0.053-0.136 dS m^{-1}. These conditions benefitted citrus because high salinity would interfere with plant growth (Pratiwi et al., 2021). Elevated salinity levels in the soil will inhibit C fixation because closing stomata reduces CO_2 in leaves and causes plant dehydration (Sari et al., 2022).

The availability of N-total nutrients was low to medium, with values ranging from 0.103-0.416%. Santoso et al. (2019) stated that the low N element in the soil is thought to be due to leaching. carried away by evaporation. and this element is utilized by soil organisms and plants quickly. Available-P ranged from 0.310 to 3.939 ppm or very low. Element P is immobile. so it is hoarded and becomes less available (Yuniarti et al., 2020). Available-K ranged from 0.320-1.147 cmol(+) kg^{-1} or low to remarkably high. Low K can be caused by leaching or plant absorption without efforts to restore it, such as calcification or fertilization (Jawang, 2021).

Terrain conditions in Punung ranged from 8-25% with a shallow to medium erosion hazard level. The condition of the slope of an area can influence erosion hazards. (Liuto et al., 2022) stated that slope has the most significant impact on runoff and erosion. Punung had a low level of flood hazard, inferred from data on flood height of 0-25 cm and flood duration <1 day.

The condition of surface stoniness and surface outcrops had a value of <5%, so this was a good condition because if the volume is too high, it will inhibit the soil's ability and disrupt plant growth (Hilungka et al., 2020).

Land suitability for citrus in Punung had Class S3 (marginally suitable) with the limiting factor of the rooting zone (rc) in the form of soil depth and nutrient availability (na) in the form of available P_2O_5 (Figure 5).

Limiting factors and land suitability improvements

Based on the results above, the actual condition of the land shows that each land unit had different boundaries. It was limiting factors that were not

Table 2. Land suitability for citrus in Punung, Pacitan Regency

Parameter	Land Mapping Units															
	1				2				3				4			
	Score	KA	TP	KP	Score	KA	TP	KP	Score	KA	TP	KP	Score	KA	TP	KP
Temperature (tc)																
Average temperature (°C)	26.252	S1	√	S1	26.215	S1	√	S1	24.894	S1	√	S1	26,188	S1	√	S1
Water availability (wa)																
Rainfall (mm/years)	1000-1500	S1	√	S1	1000-1500	S1	√	S1	1000-1500	S1	√	S1	1000-1500	S1	√	S1
Oxygen availability (oa)																
Drainage	Good	S1	√	S1	Good	S1	√	S1	Good	S1	√	S1	Good	S1	√	S1
Rooting zone (rc)																
Texture	Silty clay	S2	-	S2	Clay	S2	-	S2	Clay loam	S1	√	S1	Silty clay loam	S1	√	S1
Coarse material (%)	<15	S1	√	S1	<15	S1	√	S1	<15	S1	√	S1	<15	S1	√	S1
Soil depth (cm)	79	S2	-	S2	71	S3	-	S3	74	S3	-	S3	>120	S1	√	S1
Nutrient retention (nr)																
CEC (cmol(+) kg^{-1})	7.99	S2	+	S1	14.25	S2	+	S1	11.79	S2	+	S1	18,69	S1	√	S1
Base saturation (%)	55.009	S1	√	S1	78.373	S1	√	S1	57.891	S1	√	S1	52,676	S1	√	S1
pH H_2O	6.49	S1	√	S1	5.45	S2	+	S1	6.47	S1	√	S1	6,23	S1	√	S1
Organic C (%)	1.036	S2	+	S1	0.765	S2	+	S1	2.829	S1	√	S1	1,460	S1	√	S1
Nutrient availability (na)																
Total N (%)	0.122	S2	+	S1	0.107	S2	+	S1	0.230	S1	√	S1	0,222	S1	√	S1
P_2O_5 (mg 100 g^{-1})	1.441	S3	+	S2	1.760	S3	+	S2	2.909	S3	+	S2	0,331	S3	+	S2
K_2O (mg/100 g^{-1})	0.506	S1	√	S1	0.774	S1	√	S1	0.588	S1	√	S1	0,320	S2	+	S1
Toxicity (xc)																
Salinity (dS m^{-1})	0.053	S1	√	S1	0.106	S1	√	S1	0.136	S1	√	S1	0,063	S1	√	S1
Erosion hazard (eh)																
Slope (%)	0-3%	S1	√	S1	3-8%	S1	√	S1	3-8%	S1	√	S1	3-8%	S1	√	S1
Erosion	Very low	S1	√	S1	Very low	S1	√	S1	Very low	S1	√	S1	Very low	S1	√	S1
Flood hazard (fh)																
- Flood depth (cm)	0-25	S1	√	S1	0-25	S1	√	S1	0-25	S1	√	S1	0-25	S1	√	S1
- Flood duration (day)	< 1	S1	√	S1	< 1	S1	√	S1	< 1	S1	√	S1	< 1	S1	√	S1
Land preparation (lp)																
Surface stoniness (%)	< 0.1	S1	√	S1	< 0.1	S1	√	S1	< 0.1	S1	√	S1	< 0,1	S1	√	S1
Surface outcrops (%)	0	S1	√	S1	0	S1	√	S1	0	S1	√	S1	0	S1	√	S1

Source: Matching analysis result. Description: KA: Actual suitability, KP: Potential Suitability, TP: Management level, S1: Highly suitable, S2: Moderately suitable,S3: Marginally suitable, N: Not suitable, - : Irreparable, +: Reparable (S3 becomes S2), ++ : Very reparable (S3 becomes S1), V: No repair needed

Table 3. Land suitability for citrus in Punung, Pacitan Regency

Parameter	Land Mapping Units															
	5				6				7				8			
	Score	KA	TP	KP	Score	KA	TP	KP	Score	KA	TP	KP	Score	KA	TP	KP
Temperature (tc)																
Average temperature (°C)	24.492	S1	√	S1	24.709	S1	√	S1	24.275	S1	√	S1	24.083	S1	√	S1
Water availability (wa)																
Rainfall (mm $year^{-1}$)	1000-1500	S1	√	S1	1000-1500	S1	√	S1	1000-1500	S1	√	S1	1000-1500	S1	√	S1
Oxygen availability (oa)																
Drainage	Good	S1	√	S1	Good	S1	√	S1	Good	S1	√	S1	Good	S1	√	S1
Rooting zone (rc)																
Texture	Silt loam	S1	√	S1	Silty clay loam	S1	√	S1	Clay	S2	-	S2	Silty clay	S2	-	S2
Coarse material (%)	<15	S1	√	S1	<15	S1	√	S1	<15	S1	√	S1	<15	S1	√	S1
Soil depth (cm)	80	S2	-	S2	73.3	S3	-	S3	75.3	S2	-	S2	74	S3	-	S3
Nutrient retention (nr)																
CEC (cmol(+) kg^{-1})	15.43	S2	+	S1	20.50	S1	√	S1	15.80	S2	+	S1	14.88	S2	+	S1
Base saturation (%)	66.521	S1	√	S1	60.931	S1	√	S1	59.878	S1	√	S1	59.472	S1	√	S1
pH H_2O	6.61	S1	√	S1	7.17	S1	√	S1	6.85	S1	√	S1	7.11	S1	√	S1
Organic C (%)	1.656	S1	√	S1	1.600	S1	√	S1	2.434	S1	√	S1	1.304	S1	√	S1
Nutrient availability (na)																
Total N (%)	0.259	S1	√	S1	0.261	S1	√	S1	0.293	S1	√	S1	0.244	S1	√	S1
P_2O_5 (mg 100 g^{-1})	1.224	S3	+	S2	0.618	S3	+	S2	1.389	S3	+	S2	2.564	S3	+	S2
K_2O (mg 100 g^{-1})	1.147	S1	√	S1	0.542	S1	√	S1	0.807	S1	√	S1	0.948	S1	√	S1
Toxicity (xc)																
Salinity (dS m^{-1})	0.090	S1	√	S1	0.086	S1	√	S1	0.088	S1	√	S1	0.102	S1	√	S1
Erosion hazard (eh)																
Slope (%)	3-8%	S1	√	S1	8-15%	S2	+	S1	8-15%	S2	+	S1	8-15%	S2	+	S1
Erosion	Very low	S1	√	S1	Low- medium	S2	+	S1	Low- medium	S2	+	S1	Low- medium	S2	+	S1
Flood hazard (fh)																
- Flood depth (cm)	0-25	S1	√	S1	0-25	S1	√	S1	0-25	S1	√	S1	0-25	S1	√	S1
- Flood duration (day)	< 1	S1	√	S1	< 1	S1	√	S1	< 1	S1	√	S1	< 1	S1	√	S1
Land preparation (lp)																
Surface stoniness (%)	< 0.1	S1	√	S1	0.1-3	S1	√	S1	< 0.1	S1	√	S1	< 0.1	S1	√	S1
Surface outcrops (%)	0	S1	√	S1	0	S1	√	S1	0	S1	√	S1	0	S1	√	S1

Source: Matching analysis result. Description: KA: Actual suitability, KP: Potential Suitability, TP: Management level, S1: Highly suitable, S2: Moderately suitable,S3: Marginally suitable, N: Not suitable, - : Irreparable, +: Reparable (S3 becomes S2), ++: Very reparable (S3 becomes S1), V: No repair needed

Table 4. Land suitability for citrus in Punung, Pacitan Regency.

Parameter	9				10				11				12			
	Score	KA	TP	KP	Score	KA	TP	KP	Score	KA	TP	KP	Score	KA	TP	KP
Temperature (tc)																
Average temperature (°C)	23.816	S1	√	S1	23.349	S1	√	S1	24.308	S1	√	S1	24.149	S1	√	S1
Water availability (wa)																
Rainfall (mm/years)	1000-1500	S1	√	S1	1000-1500	S1	√	S1	1000-1500	S1	√	S1	1000-1500	S1	√	S1
Oxygen availability (oa)																
Drainage	Good	S1	√	S1	Good	S1	√	S1	Good	S1	√	S1	Good	S1	√	S1
Rooting zone (rc)																
Texture	Clay	S2	-	S2	Silty clay loam	S1	√	S1	Silty clay loam	S1	√	S1	Loam	S1	√	S1
Coarse material (%)	<15	S1	√	S1	<15	S1	√	S1	<15	S1	√	S1	<15	S1	√	S1
Soil depth (cm)	70	S3	-	S3	78	S2	-	S2	81.25	S2	-	S2	90	S2	-	S2
Nutrient retention (nr)																
CEC (cmol(+) kg^{-1})	10.72	S2	+	S1	12.18	S2	+	S1	9.58	S2	+	S1	12.75	S2	+	S1
Base saturation (%)	74.422	S1	√	S1	32.160	S1	√	S1	68.889	S1	√	S1	60.895	S1	√	S1
pH H_2O	5.80	S1	√	S1	6.07	S1	√	S1	5.99	S1	√	S1	5.74	S1	√	S1
Organic C (%)	3.384	S1	√	S1	1.338	S1	√	S1	1.318	S1	√	S1	2.001	S1	√	S1
Nutrient availability (na)																
Total N (%)	0.416	S1	√	S1	0.228	S1	√	S1	0.142	S2	+	S1	0.103	S2	+	S1
P_2O_5 (mg 100 g^{-1})	0.310	S3	+	S2	0.503	S3	+	S2	3.936	S3	+	S2	0.972	S3	+	S2
K_2O (mg 100 g^{-1})	0.638	S1	√	S1	0.355	S2	+	S1	0.610	S1	√	S1	0.680	S1	√	S1
Toxicity (xc)																
Salinity (dS m^{-1})	0.054	S1	√	S1	0.056	S1	√	S1	0.073	S1	√	S1	0.059	S1	√	S1
Erosion hazard (eh)																
Slope (%)	8-15%	S2	+	S1	15-25%	S2	+	S1	15-25%	S2	+	S1	3-8%	S1	√	S1
Erosion	Low- medium	S2	+	S1	Medium	S2	+	S1	Medium	S2	+	S1	Very low	S1	√	S1
Flood hazard (fh)																
- Flood depth (cm)	0-25	S1	√	S1	0-25	S1	√	S1	0-25	S1	√	S1	0-25	S1	√	S1
- Flood duration (day)	< 1	S1	√	S1	< 1	S1	√	S1	< 1	S1	√	S1	< 1	S1	√	S1
Land preparation (lp)																
Surface stoniness (%)	0.1-3	S1	√	S1	0.1-3	S1	√	S1	< 0.1	S1	√	S1	0.1-3	S1	√	S1
Surface outcrops (%)	0	S1	√	S1	0	S1	√	S1	0	S1	√	S1	0	S1	√	S1

Land Mapping Units: 9, 10, 11, 12.

Source: Matching analysis result. Description: KA: Actual suitability, KP: Potential Suitability, TP: Management level, S1: Highly suitable, S2: Moderately suitable,S3: Marginally suitable, N: Not suitable, - : Irreparable, +: Reparable (S3 becomes S2), ++: Very reparable (S3 becomes S1), V: No repair needed permanent need to be repaired. Improvement efforts in Punung were carried out with low, medium, and high management levels, adjusted to the economic conditions of the farmers and land managers at the research location. The following were efforts to improve land in Punung for limiting factors that can be improved.

Rooting zone (rc)

The rooting zone in the form of soil depth was a limiting factor at the research location. According to Syaifuddin et al. (2022), soil depth is a limiting factor that cannot be repaired even with a high management level. This opinion was also followed (Firdaus et al., 2021), which stated that, in general, soil depth cannot be repaired.

Nutrient availability (na)

The limiting factor for available nutrients was available P. It was because the condition of P in most research locations was deficient. The presentation of data from previous research also states that the soil fertility status of Punung was low (Supriyadi, 2017; Hartati et al., 2012). Plant growth will undoubtedly be disrupted, and productivity will decrease if nutrient needs are unmet. Applying P fertilization following the requirements of citrus is one way to increase the availability of nutrients in the soil in the form of available P with minimal management (Yasar et al., 2022). According to (Kaya et al., 2014), excellent and effective fertilization can be done with integrated nutrient management, combining organic and inorganic fertilizers. The land suitability class can go from S3 (marginally suitable) to S2 (moderately suitable) with a low management level. This method was chosen with the hope that farmers can make improvements with adequate productivity to be profitable (Darma, 2022). P fertilization was suggested by Citrus and Subtropical Fruit Research Institute (Balitjestro, 2014), as shown in Table 5. Plants need element P to reproduce because this element can form plant organs that function for reproduction and flower primordia, which are helpful for fruit formation (Arifah et al., 2019).

Analysis of Variance

The land-forming factors in Punung were soil type, geology, rainfall, slope, and land use. Based on ANOVA results it proved that the variety of soil types had a significant influence on some land characteristics, including texture (F-count = 4.272, P-value = 0.028), CEC (F-count = 4.097, P-value = 0.031), pH (F-count = 5.113, P-value = 0.016), N-total (F-count = 3.823, P-value = 0.038), slope (F-count = 8.263, P-value = 0.002), erosion (F-count = 6.776, P-value = 0.005). With a level test of 5% trust, soil types significantly differed in texture, CEC,

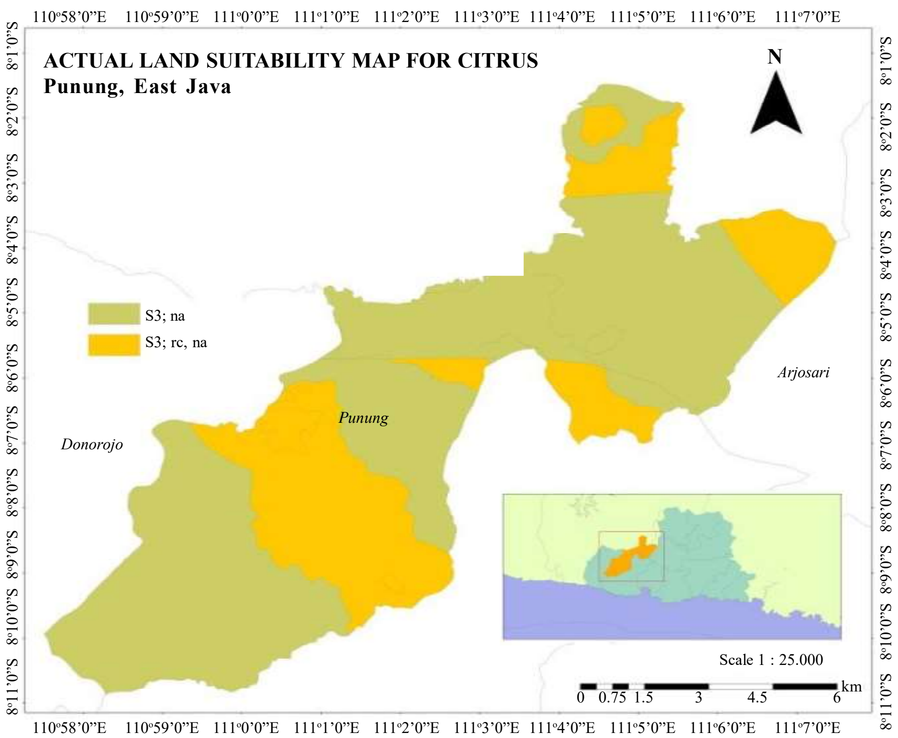

Figure 5. Actual land suitability map for citrus in Punung, Pacitan Regency.

Table 5. General recommendations P_2O_5 fertilization for citrus-based plant age.

Age (year)	P_2O_5 (g plant^{-1})	Application (times yr^{-1})
1	5-10	2-3
2	15-20	3-4
3	25-40	3-4
4	50-75	2-3
5	80-100	2

Table 6. Effect of soil type on texture with DMRT test.

Soil Type	Texture
Reddish Brown Latosols Complex and Litosols	2.25a
Mediterranean Litosols Complex and Renzina	3.92b
Litosols	4.86b

Notes: A number followed by the same letter indicates not significantly different in the DMRT level test 5% trust

Table 7. Effect of soil type on CEC with DMRT test.

Soil Type	CEC
Reddish Brown Latosols Complex and Litosols	11.4550a
Mediterranean Litosols Complex and Renzina	16.4877a
Litosols	10.8571a

Notes: A number followed by the same letter indicates not significantly different in the DMRT level test 5% trust

Table 8. Effect of soil type on pH with DMRT test.

Soil Type	pH
Reddish Brown Latosols Complex and Litosols	6.2175a
Mediterranean Litosols Complex and Renzina	6.7792b
Litosols	5.9300a

Notes: A number followed by the same letter indicates not significantly different in the DMRT level test 5% trust

Table 9. Effect of soil type on N-total with DMRT test.

Soil Type	Total N
Reddish Brown Latosols Complex and Litosols	0.2037ab
Mediterranean Litosols Complex and Renzina	0.2707b
Litosols	0.1433a

Notes: A number followed by the same letter indicates not significantly different in the DMRT level test 5% trust

Table 10. Effect of soil type on slope with DMRT test.

Soil Type	Slope
Reddish Brown Latosols Complex and Litosols	1.75a
Mediterranean Litosols Complex and Renzina	2.69b
Litosols	3.43b

Notes: A number followed by the same letter indicates not significantly different in the DMRT level test 5% trust

pH, N-total, slope, and erosion. Then, the DMRT test was conducted to determine the average soil type with land characteristics that showed statistically significant results.

The DMRT test results in Table 6 showed that in terms of texture, the soil types of Reddish-Brown Latosols Complex and Litosols were significantly different from Mediterranean Litosols Complex and Renzina and also Litosols. Other than that, the Mediterranean Litosols Complex and Renzina soil types were not significantly different from Litosols. Table 7 shows the results of the DMRT test for the effect of soil type on CEC; the result was that the three soil types were not significantly different. Then Table 8 shows that the results of the DMRT test at pH, Mediterranean Litosols Complex, and Renzina significantly differed from Litosols and Reddish-Brown Latosols Complex and Litosols. Besides that, Reddish Brown Latosols Complex and Litosols were not significantly different from Litosols.

The DMRT test results in Table 9 show that in N-total , the soil types Mediterranean Litosols Complex and Renzina were significantly different from Litosols, but not significantly different from Reddish Brown Latosols Complex and Litosols, as well as litosols, which were not significantly different from Reddish Brown Latosols Complex and Litosols. Litosol. On the slope, the DMRT test results in Table 10 show that the Reddish-Brown Latosols Complex and Litosols were significantly different from the Mediterranean Litosols Complex and Renzina and Litosols. In addition, the Mediterranean

Table 11. Effect of soil type on erosion with DMRT test.

Soil Type	Erosion
Reddish Brown Latosols Complex and Litosols	1.00a
Mediterranean Litosols Complex and Renzina	1.69ab
Litosols	2.43b

Notes: A number followed by the same letter indicates not significantly different in the DMRT level test 5% trust

Litosol Complex and Renzina were not significantly different from litosols. Table 11 shows that the DMRT test results on erosion, soil types of Reddish-Brown Latosols Complex and Litosols were significantly different from Litosols but not significantly different from Mediterranean Litosols Complex and Renzina, as well as litosols, which were not significantly different from Mediterranean Litosols Complex and Renzina.

CONCLUSIONS

The actual land suitability class in Punung is marginally suitable (S3) with the limiting factors of rooting zone (rc) and nutrient availability (na): S3; na and S3; rc, na. The limiting factors in the land suitability class in Punung were rooting zone (rc) in the form of soil depth and nutrient availability (na) in the form of available P_2O_5. Improvements that can be made to increase the availability of nutrients in the soil in the form of available-P with a low level of management are applying P fertilization according to the needs of citrus. A low management level is chosen with the hope that farmers can make improvements with adequate productivity so that it is profitable. ANOVA results at a 5% trust level test proved that the variety of soil types had significantly differed in texture, CEC, pH, N-total, slope, and erosion.

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