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THE STUDY OF SOIL WATER INFILTRATION UNDER HORTICULTURAL AT THE UPSTREAM OF SUMANI WATERSHED

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ABSTRACT: Generally, the farming activities in the Sumani upstream watershed community are; cultivating horticulture or vegetables such as cabbage, onions, potatoes, carrots, and flowers. The land cultivation for these purposes is made possible due to the high fertility rate of the land in this region which is suitable for horticultural crops. The soil in this area (including the order Andisol) develops from the weathering of the residue from the eruption of Mount Talang. Most farmers do not implement soil and water conservation which invariably leads to erosion and in the long run, the land will finally be degraded.. The purpose of this research is to assess the capacity of water infiltration on some types of horticultural crops in the Sumani Upper watershed. The survey method is used to determine the sampling points and the measurement of the rate of infiltration is read using a ring infiltrometer. The soil samples were analyzed in the laboratory of the Department of Soil Science under the Faculty of Agriculture, Andalas University. While the infiltration rate of the data was processed using Horton's equation. To determine the main factor affecting the infiltration rate, the principal component analysis (PCA) was performed. The results showed that infiltration rate in three groups of farmers ranged from moderate to fast. The main factors affecting it are; bulk density, texture and depth of the root zone. The infiltration capacity, soil texture factor influence is more dominant and equals about to 61.7 percent.

Keywords: Horticulture, Infiltration capacity, Soil degradation

1. INTRODUCTION

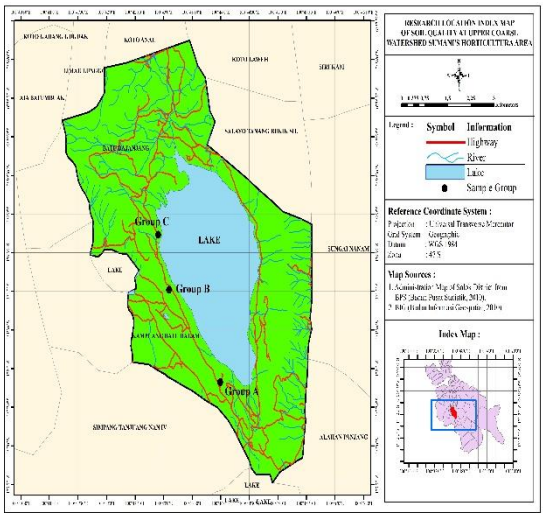
Water penetrates the soil through pores to the ground this process is also called infiltration. Infiltration is very important in restoring soil water loss due to evapotranspiration.

The characteristics of infiltration greatly depend on the soil's physical properties amongst other soil properties and is a good indicator of changes in the soil's physical and biological characteristics [1]. The availability of water in the soil greatly affects the process of plants taking up nutrients from the soil; this is because nutrients are taken up in the form of ions in solution. Water infiltration greatly affects the production of crops and also, the drainage of agricultural land [2].

Several factors influence the infiltration rate of the soil, some of them include; slope, texture and soil structure, vegetation cover, management system, soil moisture content, and organic material [1]. If the factors that affect infiltration are not kept in optimal conditions, more rainwater will flow and erode the soil surface and leading to the loss of many nutrients.

Infiltration is very important in soil and water conservation. It one of the components that very important due to the soil and water conservation that the principle is timeless, which regulate rainfall with water entering the ground. Entering the water into the ground is dependent on the soil infiltrate capacity. When the infiltration less then rainfall, hence surface flow will occur. This causes the surface flow will scrape the surface of the ground for erosion. Soil erosion will bring the

Figure 1. Map of Location Research on the



Watershed upstream Sumani.

Necessary plant nutrient elements out of farmland and into rivers and lakes. So that the farmland becomes infertile and rivers polluted by residual of chemistry.

Besides, the role of infiltration also into the ground and replenish groundwater. Available water capacity on groundwater is very important, especially for the growth of horticultural. The importance of water available in the rooting zone is to dissolve the nutrient elements will be taken up by the crops, which are cultivated by farmers.

Horticulture farming around the upstream of Sumani watershed is mostly practiced by farmers who do not apply soil and water conservation procedures. Allegedly, the land erodes every growing season. The soil is the main natural resource of the people living in the [3] upstream of Sumani watershed which is why they practice intensive farming to meet their life necessities. This dynamic and intensive farming causes rapid land degradation. Hydraulic properties of soil surface can be changed dramatically during the water above the ground level. Hydraulic properties will be changing are strongly influenced by soil management. The farmland was cultivated intensively for agriculture and horticulture. This farmland is treated each season very intensively. More of soil aggregates to be disintegration, into fine particles and covered the soil pore.

The issue above causes damage to the soil's biophysical properties in horticulture, such as soil pores and infiltration rate. If water absorption interferes with I the root zone of plants, this affects the development of the plant roots in this zone and in turn will reduce the productivity of the soil.

The purpose of this research is to study the infiltration capacity under horticulture farming in the upstream area of the Sumani watershed.

Figure 2. Picture of activity sampling at location research on the Watershed upstream Sumani.

2. MATERIALS AND METHODS

2.1 Time and Location

The has been done from February 2018 to June 2018. It was conducted at several sample points on the horticultural lands in Watershed upstream of Sumani, (Figure 1) Solok Regency, West Sumatera. The soil Quality Indicator Analysis was carried out in the Laboratory of the Department of Soil Science under the Faculty of Agriculture, Andalas University

2.2. Research Tools and Materials

The materials used were aqua, chemicals, as well as materials for the analysis of the physical properties of the laboratory. The tools used to

Figure 3. Picture of a farmer was harvesting red onions in farmland.

Identify the soil quality for horticultural biomass productivity in the field includes GPS, loops, maps, sample rings, knives, plastics, label paper — the double ring infiltrometer for infiltration capacity in a field.

The tools used for Laboratory analysis includes desiccators, ovens, Erlenmeyer, bottles, measuring cylinders, analytical scales, estimator, trophy glasses, wet screen, filter, mouthpiece, Kjeldhal tube, burette, distillation flask, stative, and measuring pipette

2.3. Research Methodology

The research was conducted in the field to collect secondary and primary data. Secondary data was taken from rainfall data, interview with farmers and related institutions. (1) Primary data were land samplers from several points of land units in the three horticultural farmer's field. The data collected were 1) soil parameters (texture, soil structure, soil permeability, and soil effectiveness). The infiltration capacity measured directly in the field using double ring infiltrometer. and data are analyzed by using Horton formula i.e; $F = fc + (fo-fc)\ ^{e-kt}$... The soil samples were taken by means of purposive random sampling as an example of

representative land from established land units (Figure 2).

The soil samples taken were natural soil samples for analysis of the soil's physical properties. While the altered soil samples were taken for analyzing the chemical and biological properties of the soil. Soil samples were taken from a 20 cm depth.

Procedure for measurement of infiltration in the field are as follows: a. the land location will be measured to clean. b. Immerse the double ring infiltrometer (cylinder) into the soil as deep as ± 10 cm, and part is above the soil surface. Usually on the soft soil can be done quickly. Whereas, in the lands that are more dense with high clay content then the ring infiltrometer is somewhat more difficult and requires effort. (2) Secondary data was required in this research and was collected in the form of the area's condition and an aspect of horticultural cultivation of the area. The technique of collecting secondary data by collecting data from several related agencies and interviews with the farmers as supporting data. Results of interviews with farmers were being scored, and the results of these scores were used as supporting information on the horticultural productivity in the upstream of Sumani watershed, Solok. (3) The data analysis method which is determined based on the least influential nature in determining the quality of the soil or at least the Minimum data set (MDS) using Minitab 17.0 software. Minimum Data Set obtained from the calculation of Principal Component Analysis (PCA).

3. RESULT AND DISCUSSION

3.1. Principal Component Analysis of Soil Physical Characteristics

The main component in determining the main properties of the soil determines the infiltration capacity of the soil. Based on the PCA, the eigenvalue is greater than one, i.e. There are four main components, i.e. PCA1, PCA2, PCA3 and PCA4 (table 1). The selected variables from PCA 1 to PCA4 are taken as factors to determine the rate of infiltration capacity in horticultural farming

The main components selected are the four variables which are highly influential in infiltration capacity, i.e. bulk density, sand-fraction texture, the effective depth of soil, and dust fraction.

3.2. Infiltration Capacity

The high rate of infiltration capacity in the horticultural farming area in upstream of Sumani watershed is strongly influenced by the soil 's physical nature, and the dominant soil is micropore. Lands dominated by macropores will have a higher infiltration rate compared to the land dominated by micropores. The land of the horticultural field in the study has infiltration capacity of 6cm/h to 12cm/h with the medium to fast range. Farmer groups A and B lands have a moderate level of infiltration capacity. The infiltration capacity of farmer group C land is on the quick range. The variations in infiltration capacity of the three horticultural farming groups (Figures 4, 5 and 6) are due to the differences in soil properties and planted crops as well as land management practices conducted by farmers.

Table 1. Principal component analysis results (PCA)

Eigenvalue	2.9122	2.0070	1.4565	1.0767
Proportion	0.364	0.251	0.182	0.135
Cumulative	0.364	0.615	0.797	0.932
Variable	PCA1	PCA2	PCA3	PCA4
Infiltration capacity	0.404	0.285	0.314	-0.295
Bulk density	0.522	-0.214	0.018	-0.295
Total of pore space	-0.522	0.214 -	0.018	0.295
Organic matter	0.033	-0.456	0.496	-0.191
Soil Depth	0.053	0.460	0.516	-0.152
Sand	-0.023	0.527	0.527	0.023
Dust	0.396	-0.107	0.287	0.605
Clay	-0.360	-0.343	0.169	-0.559

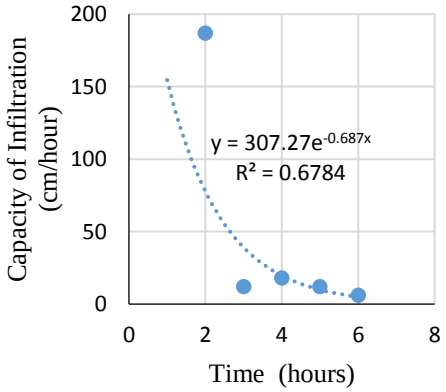


Figure 4. Infiltration capacity at farmland A

Based on regression analysis seen in the equation of the line on the farmers group A is exponential with value R2 = 0.678 While in group B the equation of the line of exponential infiltration capacity with value R2 = 0.935 In farmer group C, the equation of the line of exponential infiltration capacity with value $R^2 = 0.162$. Based on the simple regression equation it can be seen that land on a farmer's Group B has a higher R2 value. This means that the capacity of infiltration on land the farmer's groups are strongly influenced by soil

properties such as texture, depth, and bulk density is effective.

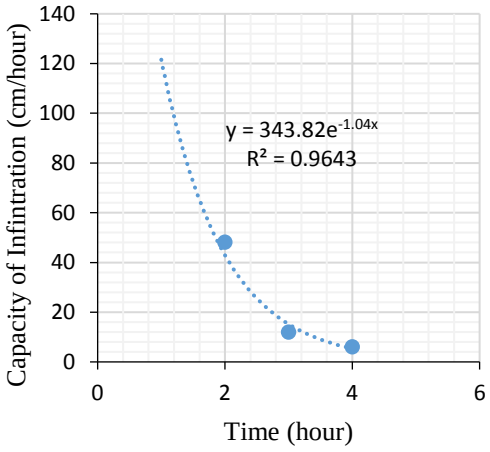


Figure 6. Infiltration capacity at farmland C

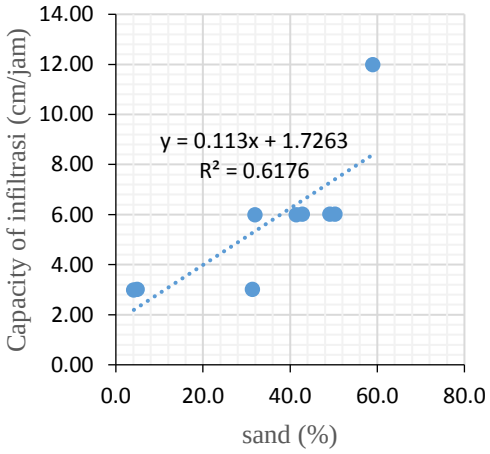


Figure 7. Sand percentage correlation with infiltration capacity

The infiltration capacity is a dynamic trait that can change significantly during certain precipitation events, in response to seasonal changes in groundwater, temperature, and plant type, as a result of annual farming activities. Increasing infiltration capacity decreases the flow of water in the soil surface. Conversely, a smaller infiltration capacity is due to a large number of clogged soil pores, the surface water flow increases [4]. Furthermore, [5] regarding hydrology, infiltration is important as it marks a shift from the surface of the earth that moves rapidly into the water in the slow-moving ground.

The infiltration capacity of the soil is influenced by its physical properties and its degree of ability, water content, and permeability of the subsurface layers.

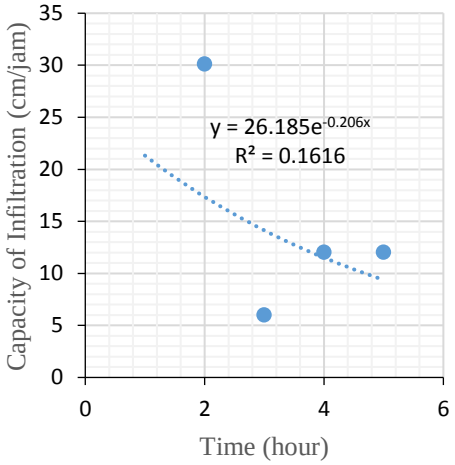


Figure 5. Infiltration capacity at farmland B

3.3. Effect of Texture on Infiltration Capacity

Soil texture at the research location of farmer group A was clay, farmer group B was dust, and group C with the texture of fine clay. According to [6] the soils with coarse fraction, the level of the aeration is good, and water conductivity is fast, but the holding power of the water is low. Because the soil is dominated by macropores, Figure 7 shows the effect of soil texture of the study sites on infiltration capacity.

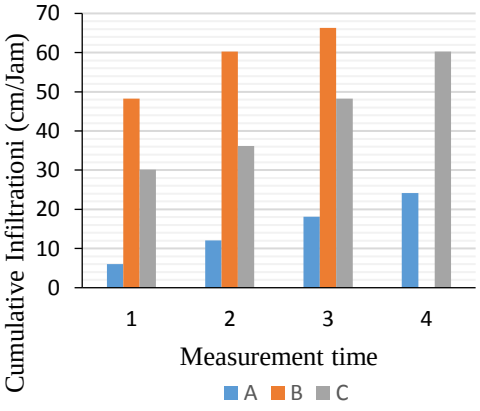


Figure 8. The cumulative infiltration rate at three land farmer groups (A, B, and C)

Based on simple regression analysis, the relationship between infiltration capacity and the texture was quite close with R^2 value as 0.617 This meant that infiltration capacity of 61.7 percent was influenced by the soil texture of the research

locations in farmer groups A, B, and C, the influence from other factors amounted to 38.3 percent. This proved that soil texture greatly influenced the infiltration rate of the soil. For the infiltration capacity of the farming land, routine management is required to increase the soil absorption matrix by adding organic fertilizer or crop residue to the soil to retain the groundwater ensure it doesn't penetrate to the lower layers of the root zone. The addition of organic material from remaining plants acts as a cemented agent for soil grains, nutrient sources, increasing CEC and energy for soil microbes [7].

3.4. Cumulative Infiltration

Cumulative infiltration is incoming water into the soil in a specific time and duration in a certain amount of volume, depending on the total soil pore space to store and hold it.

Cumulative infiltration in the three locations of the farmland group is shown in Figure 8. Cumulative infiltration varied considerably between the three types of land farming groups based on measurement time. Higher cumulative infiltration is found in group B, followed by group C then next, group A. This was caused by soil type and crop management which troubled each of farming group. Group B farmers usually return the rest of the plant to the land to increases the ability of soil to absorb water. It caused the rest of the plant will produce organic acid as a cemented agent. And the improved the soil physical properties.

Good management of soil can improve soil quality such as cumulative infiltration. According to the study [8], it also showed that improving soil quality may increase cumulative infiltration up to five times. However, continuous land acquisition without proper management can reduce cumulative infiltration. According to the results of the study, [9] the improvement in infiltration capacity and cumulative infiltration is by addition of materials that can increase total pore space of soil such as ameliorant material from rice husk biochar. This is because biochar is active charcoal capable of increasing the soil cavity and biochar is not easily decomposed by soil microbes. Additional Soil organic matter is an important soil quality indicator because it has a strong relationship to critical soil functions like an infiltration, productivity, erodibility, and the capacity of the soil to act as an environ-mental buffer by absorbing or transforming potential. According to [10] Increased organic matter to loamy sand increased aggregate stability and water infiltration. Soil structure improves when cultivated land is put into the grass. Soil aggregate distribution, stability, air permeability, and hydraulic conductivity improve with time in a horticultural culture.

According to [11], solid soil naturally or else due to reducing the rate of infiltration. Increased high density the soil then the cumulative infiltration a low land, and instead, relative soil loose then the cumulative infiltration was higher. According to [9] append real ameliorate can increase the capacity and cumulative infiltration. This is due to ameliorate materials such as biochar can make land more nests so that the movement of water into the soil faster.

4. CONCLUSION

Based on the research of the infiltration capacity in the upstream watershed of Sumani, it can be concluded that; the research area of soil infiltration capacity is influenced by soil physics properties, i.e. bulk density, texture, and depth of root zone. The rate of infiltration in the three farmer groups of the study sites was from the moderate to the rapid range. From the equation of infiltration capacity, soil texture factor influence is more dominant and equals about to 61.7 percent among the three group farmers A, B, and C, only farmers group B which returns the rest of the plant to the land. Therefore it's land to a high cumulative infiltration.

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