SINTECHCOM: Science, Technology and Communication Journal
Vol. 3, No. 3, June 2023, pp. 95-100, DOI: 10.59190/stc.v3i3.236

Water seepage rate in composted soil

Zulkarnain[1], Rizka Kurniawati[1], Triwulandari[1], Ikhsan Rahman Husein[1], Ridho Kurniawan[2,*]
[1]Department of Physics, Universitas Riau, Pekanbaru 28293, Indonesia
[2]Industrial BARISTAND, Industrial Development and Research Agency, Banda Aceh 23230, Indonesia

ABSTRACT

Water infiltration is one important factor for plant growth. Water that cannot seep into the pores of the soil creates a pool of water so that soil permeability is low. From these conditions, it is necessary to conduct research to determine the rate of water seepage in the soil. This study aims to analyze. The rate of water seepage on the ground by utilizing the difference in floating voltage. Based on the difference in floating voltage, two-dimensional modeling of the stress distribution and the distribution of water infiltrate time into the ground using the method of adding water repeatedly. The sample in this study consisted of 2 types of soil, compost and sand. Land with high permeability can increase the rate of infiltration thereby reducing the rate of water. The results of this study concluded that the pore size and particle arrangement greatly affect the rate of water seepage.

ARTICLE INFO

Article history:

Received Apr 25, 2023
Revised Jun 17, 2023
Accepted Jun 29, 2023

Keywords:

Compost Soil
Floating Voltage
Soil Permeability
Water Infiltration Rate
Water Seepage

* **Corresponding Author**
E-mail address: ridhokurniawan@kemenperin.go.id

1. INTRODUCTION

The expansion of agricultural land in Indonesia is currently experiencing many obstacles due to the conversion of productive land into non-agricultural activities such as housing [1], industry [2], and business [3]. This is one of the drivers of biodiversity loss. To expand agricultural land commodities, land use is directed towards less fertile marginal lands [4, 5].

Soil, water, and air are important aspects of life, especially in the agricultural sector. Therefore, the condition of land, water, and air must always be maintained so that they can be used according to their function [6-8]. One aspect that can influence soil fertility is the rate of water seepage (permeability) in the soil. Each type of soil has different permeability capabilities [9, 10]. In agricultural exploration, the parameters of porosity and permeability are critical in water infiltration. This is because porosity is the main variable for determining the amount of fluid reserves contained in soil [11-13]. At the same time, permeability is a variable that determines the extent of the soil's ability to drain water in porous media or soil [14, 15]. Measuring the rate of water seepage is very important in the agricultural sector, for example, the entry of water into the soil, the movement of water to plant roots, the flow of drainage water, and the evaporation of water on the soil surface, these things greatly influence soil permeability [16-18]. The ability of the soil to absorb water is reflected in the vegetation on the surface of the soil. Vegetation function can effectively reflect the soil's ability to maintain or increase infiltration rates and indicate the ability to hold water or water retention capacity. The type of soil that is classified as fast in absorbing water is compost soil because compost soil contains organic material that has a high water-holding capacity [19, 20].

Previous research was conducted by Siregar et al. (2013), from the results of analysis and measurements of permeability rates in the laboratory and field, it can be categorized that the permeability rate in andepts and ultisol soils is relatively slow and the permeability rate in inceptisol soils is classified as moderate. Thus, inceptisol soil has a greater permeability rate than andepts and ultisol soil. The greater permeability rate in inceptisol soil is caused by the soil's porosity being greater than the porosity in andepts and ultisol soils. The soil permeability rate value using the laboratory test method is 1.34 cm/hour on andepts soil, 3.20 cm/hour on inceptisol soil, and 1.06 cm/hour on ultisol soil [16].

This modeling of water seepage into the soil was carried out to determine the rate of seepage into the soil based on the method used. The benefit of modeling water seepage in the ground is to know the amount of water and the direction of the water that will seep as well as the water tension in the ground due to the seepage so that water users can get an idea of how to conserve water resources in the ground so that they are maintained. This research aims to analyze the pattern of seepage distribution and the length of the wet zone in sandy soil and compost soil through laboratory observations using the floating voltage method and then compare the results.

2. RESEARCH METHODS

The materials used are water, sand, and compost. The tools used are plastic cups that will be used for soil media, scales as tool for weighing soil, rulers as a tool for measuring soil height, measuring cups used to measure water volume, multimeters used to measure voltage in soil, and Arduino which is connected to a laptop. to analyze the rate of water seepage entering the soil pores.

The research was carried out in a laboratory using sand and compost soil samples. Seepage rate measurements were carried out using the floating voltage method. The research used 2 samples with 3 tests. The parameters observed in this research are soil mass, soil volume, water volume, and the rate of water seepage into the soil.

Soil samples were taken from 2 types of soil. For each type of soil, 3 tests were carried out. Testing on each type of soil aims to determine the rate of seepage with each watering. The water seepage rate is measured using an Arduino program connected to a multimeter. After that, 50 ml of water is added to sample 1's soil media, then the water will seep through the soil pores. To find out if water has entered the ground, you can look at the water movement graph, where if the graph decreases drastically, then the water has entered a predetermined limit.

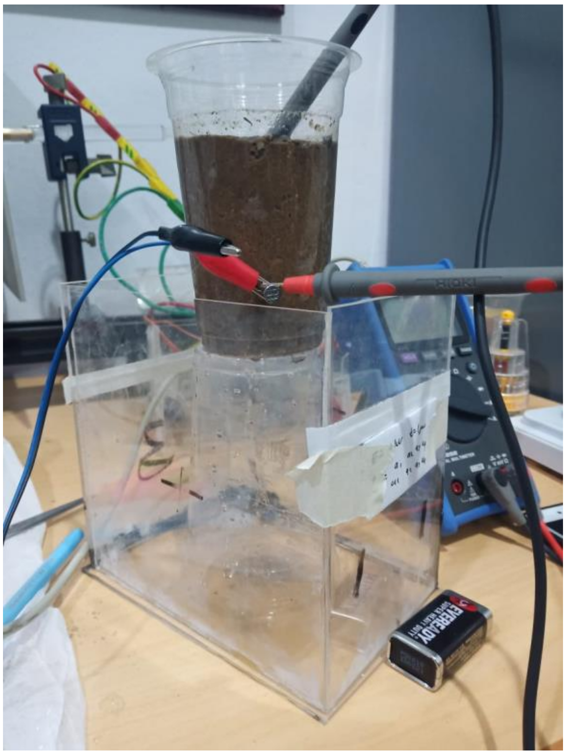

Figure 1. The range of tools used.

3. RESULTS AND DISCUSSIONS

Different types of soil on various agricultural lands show different results. In Figure 2 the rate of water seepage in sandy soil is very slow, in test 1 the soil's ability to absorb water is 0.167 cm/s, and water has seeped through the soil pores. According to Hardjowigeno (2003), one of the factors that influences soil porosity values is soil texture. Soils that contain more sand have macro pores (larger pore size) but have small pore spaces so their porosity is low. Porosity greatly influences the seepage rate, where the smaller the porosity, the smaller the water seepage rate, and vice versa [21]. Sandy soil contains more sand than compost soil.

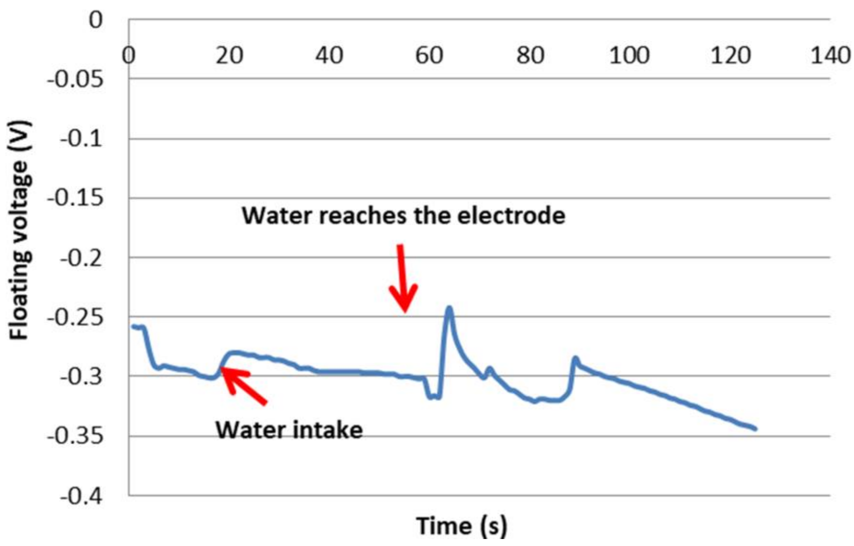

Figure 2. Results of water seepage rate analysis in test 1.

In the second test (see Figure 3), the sandy soil absorbed water more slowly, namely 0.04 cm/s, this was because the soil was at its optimum water content so that it reached the densest state. The permeability will decrease with increasing density levels and will reach the smallest value at optimum water content [22]. In dense soil, the influence of water on the soil is very small. The denser the soil, the slower the seepage rate will be.

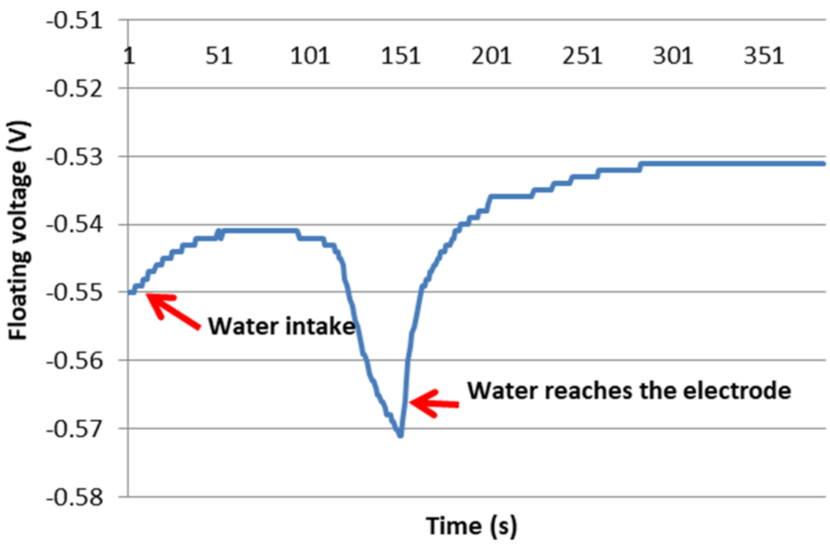

Figure 3. Results of water seepage rate analysis in test 2.

In the third test using sand soil samples (see Figure 4), the seepage rate was faster than in the second test. The third test seepage rate is 0.05 cm/s. At a higher water content, the level of soil density will decrease because the soil pores become filled with water so that the water absorbs more quickly.In general, it can be seen that water permeation in compost soil is faster than in sand soil. The seepage rate in the first test was 0.185 cm/s, in the second test 0.07 cm/s, and the third test 0.04 cm/s. The rate of water seepage is also influenced by the amount of organic material found in the soil. By adding compost to the soil, the soil will become loose so it is easier to carry water into the soil. Soil with a lot of organic material content has a higher ability to hold water so that the seepage rate increases [23]. This is to the statement of Hakim et al (1986) [24] which states that organic materials influence the physical properties of soil, including increasing the ability to hold water, turning the color of the soil from brown to black, stimulating aggregate granulation, and solidifying it, and reducing plasticity, cohesion, and properties. Another bad thing about clay.

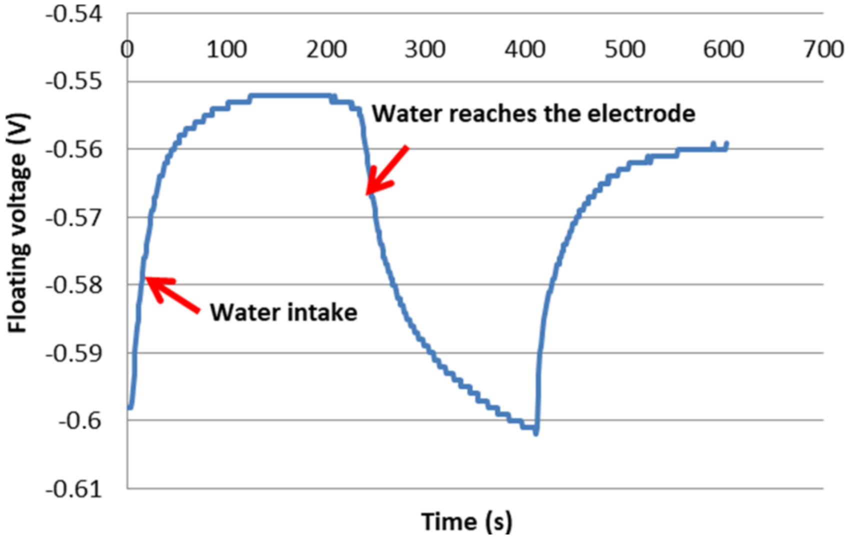

Figure 4. Results of water seepage rate analysis in test 3.

After conducting a correlation test for the relationship between the rate of water seepage in samples of sand soil and compost soil, it was concluded that the rate of water seepage in sand soil was longer than in compost soil. This is because sandy soil has low porosity. With low porosity, permeability is also low.

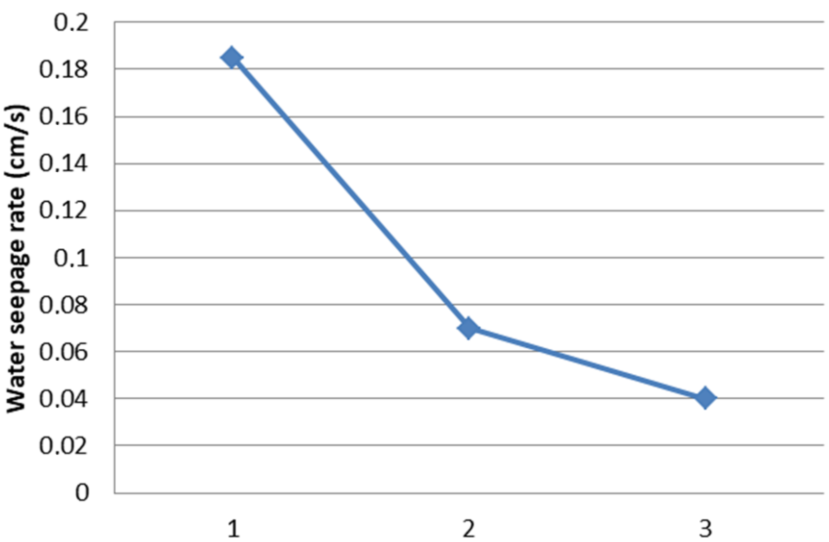

Figure 5. Rate of water seepage in compost soil.

Composted soil has a denser soil density so it absorbs water quickly. The seepage rate is also influenced by the amount of organic material contained in the soil. From the graph above it can be said that permeability will decrease with increasing soil density. At the first watering, the soil is in the compaction phase so the soil is at the highest level of permeability. In the second watering, the water content in the soil is at an optimum state so that little water is absorbed by the soil, so the seepage rate is longer because the soil is already dense. In the third test, the water will seep more quickly because the soil pores are filled with water so the soil is wet/saturated [25].

4. CONCLUSION

The water seepage rate in test 1 of the sand soil sample was 0.167 cm/s, in test 2 it was 0.04 cm/s and in test 3 it was 0.05 cm/s. while the rate of water seepage in the compost soil, namely in test 1 was 0.185 cm/s, in test 2 it was 0.07 cm/s and in test 3 it was 0.04 cm/s. A good water seepage pattern for agricultural land is compost soil because compost soil has a loose soil texture so water can seep quickly. The pattern of water seepage in sandy soil takes quite a long time. Sand soil has small porosity which can be seen from the size of the sand particles. Soil density also affects permeability. The higher the soil density, the greater the soil permeability, and vice versa.

REFERENCES

[1] Wahanisa, R., Niravita, A., Mahfud, M. A., & Aminah, S. (2021). Public participation by optimizing rural spatial planning to prevent functional conversion of agricultural land to non-agricultural use. *Universal Journal of Agricultural Research*, **9**(5), 149–155.

[2] Prasada, I. M. Y. & Masyhuri, M. (2019). The conversion of agricultural land in urban areas (Case study of Pekalongan City, Central Java). *AGRARIS: Journal of Agribusiness and Rural Development Research*, **5**(2), 112–118.

[3] Suardi, I. D. O., Arisena, G. M. K., Suyarto, R., & Krisnandika, A. A. K. (2022). Management policies implication for the agricultural land conversion sustainable control strategy in Bali Province. *Journal of Environmental Management & Tourism*, **13**(3), 721–731.

[4] Simbolon, H. B., Sumono, S., & Panggabean, S. (2018). Pembenahan sifat fisika tanah oxisol dengan perlakuan kompos. *Jurnal Rekayasa Pangan dan Pertanian*, **6**(1), 49–56.

[5] Lanz, B., Dietz, S., & Swanson, T. (2018). The expansion of modern agriculture and global biodiversity decline: an integrated assessment. *Ecological Economics*, **144**, 260–277.

[6] Wassie, S. B. (2020). Natural resource degradation tendencies in Ethiopia: A review. *Environmental Systems Research*, **9**(1), 1–29.

[7] Zulkarnain, Z., Hikma, N., Izzah, R. F., & Devira, N. (2023). Temperature stabilization based on passive cooling technology in the initial design of an eco-friendly mini greenhouse. *Science, Technology and Communication Journal*, **3**(2), 49–52.

[8] Gavrilescu, M. (2021). Water, soil, and plants interactions in a threatened environment. *Water*, **13**(19), 2746.

[9] Jotisankasa, A. & Sirirattanachat, T. (2017). Effects of grass roots on soil-water retention curve and permeability function. *Canadian Geotechnical Journal*, **54**(11), 1612–1622.

[10] Hamdan, S. & Amiruddin, E. (2022). Schrödinger's equation as a Hamiltonian system. *Science, Technology and Communication Journal*, **3**(1), 19–24.

[11] Zhang, Y. & Schaap, M. G. (2019). Estimation of saturated hydraulic conductivity with pedotransfer functions: A review. *Journal of Hydrology*, **575**, 1011–1030.

[12] Rubiyana, T. F. & Hutabarat, P. (2021). Membangun model neutron porosity bawah permukaan dengan properti fisik data seismik pada reservoir karbonat. *Komunikasi Fisika Indonesia*, **18**, 179–190.

[13] Singh, V. K., Kumar, D., Kashyap, P. S., Singh, P. K., Kumar, A., & Singh, S. K. (2020). Modelling of soil permeability using different data driven algorithms based on physical properties of soil. *Journal of Hydrology*, **580**, 124223.

[14] Zhai, Q., & Rahardjo, H. (2015). Estimation of permeability function from the soil–water characteristic curve. *Engineering Geology*, **199**, 148–156.

[15] Holthusen, D., Brandt, A. A., Reichert, J. M., & Horn, R. (2018). Soil porosity, permeability and static and dynamic strength parameters under native forest/grassland compared to no-tillage cropping. *Soil and Tillage Research*, **177**, 113–124.

[16] Siregar, N. A., Sumono, S., & Munir, A. P. (2013). Kajian permeabilitas beberapa jenis tanah di lahan percobaan kwala bekala usu melalui uji laboratorium dan lapangan. *Jurnal Rekayasa Pangan dan Pertanian*, **1**(4), 138–143.

[17] Agriona, S., & Muhammad, J. (2021). Survei hydrochemical air tanah dangkal dan sifat karakteristik tanah dilahan pertanian palawija di Marpoyan Damai. *Komunikasi Fisika Indonesia*, **18**, 197–203.

[18] El-Beltagi, H. S., Basit, A., Mohamed, H. I., Ali, I., Ullah, S., Kamel, E. A., Shalaby, T. A., Ramadan, K. M., Alkhateeb, A. A., & Ghazzawy, H. S. (2022). Mulching as a sustainable water and soil saving practice in agriculture: A review. *Agronomy*, **12**(8), 1881.

[19] Soediono, B. (1989). Sifat fisik tanah dan kemampuan tanah meresapkan air pada lahan hutan, sawah, dan permukiman. *Journal of Chemical Information and Modeling*, **53**(2), 160.

[20] Karamina, H., & Fikrinda, W. (2020). Soil amendment impact to soil organic matter and physical properties on the three soil types after second corn cultivation. *AIMS Agriculture and Food*, **5**(1), 150–169.

[21] Hardjowigeno, S. (2003). *Pedogenesis and soil classification*. Akademika Pressindo, *Jakarta*.

[22] Sumarno, Z. F. (2003). *Hubungan antara tingkat kepadatan tanah dengan tingkat konsolidasi tanah pada tanah latosol darmaga*. Skripsi Fakultas Teknologi Pertanian, IPB, Bogor.

[23] Surya, J. A., Nuraini, Y., & Widianto, W. (2017). Kajian porositas tanah pada pemberian beberapa jenis bahan organik di perkebunan kopi robusta. *Jurnal Tanah dan Sumberdaya Lahan*, **4**(1), 463–471.

[24] Hakim, N., Nyakpa, M. Y., Lubis, A. M., Nugroho, S. G., Saul, M. R., Diha, M. A., Hong, G. & Bailey, H. H. (1986). *Dasar-dasar ilmu tanah*. Universitas Lampung, Lampung.

[25] Hannastry, M. (2009). *Pola penyebaran air rembesan didalam tubuh model tanggul berbahan tanah gleisol*. Skripsi Departemen Teknik Pertanian, Fakultas Teknologi Pertanian, Institut Pertanian Bogor.