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Research Article

Fertility Optimization in Humus Soils Using Digital Smart Biosoidam Technology with Real Time Simulation of the Number of Microbial Populations

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ABSTRACT

This research was conducted on humus soils, especially for vegetable plantations, aimed to determine the ability of the soil layer to distribute nutrients and restore soil health and fertility due to the use of chemical fertilizers and pesticides. Through microbial activity that is controlled by spreading through a horizontal biohole, this study observes in real time through a micro controller the changes in soil acidity, infiltration rate, electrolyte conductivity levels and porosity levels through soil infiltration rates.

Through simulations with the variable microbial population, it can be seen the level of EC and other parameters against the time of observation in real time. From the observations of graphs and EC standards, it can be seen that the ability of the soil fertility level has not reached=1500 uS/cm with a microbial population=103/cfu supports the planting schedule both during the vegetative growth period and during the generative growth period, so that we will know when is the right time to do: soil recovery, initial planting and when the tubers/flowers/fruit begin to be conditioned. Until cooked based on nutrient values observed through sensors that convert analogue parameters by the micro controller into digital information transmitted by Wi-Fi in real time.

The initial condition before simulating the soil fertility value with the Electrolyte Conductivity (EC) parameter is 744 uS/cm, the simulation results are: Simulation A: To start the growth period (vegetative) is achieved on the 8th day with a EC=1053 uS/cm and in the generative period it is reached on the 19th day with a EC=1529 uS/cm. Simulation B: To start the growth period (vegetative) is achieved on the 17^{th} day with a EC=1007 uS/cm and at the generative period it is reached on the 36nd day with a EC=1520 uS/cm. Simulation C: to start the growth period (vegetative) is achieved on day 32 with an EC=1050 uS/cm and during the generative period it cannot be observed because on observation until day 45 the electrolyte conductivity has not reach=1500 uS/cm.

Keywords: Biohole; Microbial; Alluvial; Micro controller; Soil acidity; Infiltration; Electrolyte conductivity; Biosoildam

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INTRODUCTION

The potential of alluvial land is very large for agricultural business, but the structure of this soil layer is also easily damaged if managed incorrectly. The ability of farmers also needs to be improved, especially in understanding the characteristics of this soil. So that with biosoildam technology it will save fertilizer use and increase crop production while preserving natural resources through soil and water conservation.

The current decline in carrying land capacity continues to expand (environment degradation). One of the main contributing factors is the decrease in the soil fertility, health and absorption (infiltration rate), triggered by excessive use of inorganic fertilizers (pesticides) (Widiasmadi N, 2020). To restore the land's capacity quickly and measurably and to restore soil productivity as well, infiltration is not enough. Biological agents (bio fertilizer) are needed to support soil and water conservation (Widiasmadi N, 2020). However, so far, there has not been any periodical and continuous/real-time measurement of the monitoring and assessment system of agricultural cultivation. Thus, accurate information on a soil parameter in achieving a harvest target is needed.

Infiltration is the process of water flowing into the soil which generally comes from rainfall, while the infiltration rate is the amount of water that enters the soil per unit time. This process is a very important part of the hydrological cycle which can affect the amount of water that is on the surface of the soil. Water on the surface soil will enter the soil and then flow into the river (Sunjoto S, 2011). Not all surface water flows into the soil, but some portion of the water remains in topsoil to be further evaporated back into the atmosphere through the soil surface or soil evaporation (Suripin IR, 2004).

Infiltration capacity is the ability of the soil to absorb large amounts of water into the ground and influenced by the microorganism activities in the soil (Widiasmadi N, 2020). The large infiltration capacity can reduce surface runoff. The reduced soil pores, generally caused by soil compacting, can cause a decreased infiltration. This condition is also affected by the soil contamination (Widiasmadi N, 2020) due to excessive use of chemical fertilizers and pesticides which hardens the soil as well.

Smart-Biosoildam is a Biodam technology development that involves microbial activity in increasing the measured and controlled inflation rate. Biological activities through the role of microbes as agents of biomass decomposition and soil conservation become important information for soil conservation efforts in supporting healthy food security (Widiasmadi N, 2020). Such development has used a microcontroller to effectively monitor the activities of the said agents through the electrolyte conductivity parameter as an analogue input of EC sensors embedded in the soil and further converted to digital information by the microcontroller (Widiasmadi N, 2020).

To control the activities of biological agents, other variables are needed, such as information on pH, humidity (M) and soil temperature (T) obtained from pH sensors, T sensors, M sensors. These sensors are connected to a microcontroller which can be accessed through a pin that functions as a GPIO (General Port Input Output) in the ESP8266 Module so as to provide the additional capability of a WIFI-enabled microcontroller to send all analogue responses to digital in real-time, every second, minute, hour, day and monthly. Furthermore, we can display this data in info graphics and numeric tables to be stored and processed in the WEB (Wasisto S, 2018).

METHODOLOGY

Study design

To maximize yields, optimal soil nutrient content is required ranging from vegetative growth to generative growth so as to save the use of organic fertilizers and other nutrients. This research is to observe the number of microbes that spread radially through the horizontal bio hole as the center of microbial distribution which is observed in real time using soil parameter sensors. This research will show soil characteristics in its ability to increase natural fertility and the ability to nourish the soil from toxins that come from water and air pollution.

The study was conducted on alluvial land which for decades has been the source of livelihood for the community of Legundi village Karangjati district Ngawi regency. Land management lacks soil and water conservation. People use chemical fertilizers and pesticides excessively which harden the soil texture, acidify the soil and decrease the yields. Hardened agricultural land also triggers floods, since the soil's ability to absorb decreases. This research that took place from January-June 2020, intends to restore the carrying capacity of the land.

Tools and materials used in research are: Mikrokontroler Arduino UNO,Wifi ESP8266, Soil parameter sensor : Temperature (T) DS18B20, humidity (M) V1.2, Electrolit Conductivity (EC) G14 PE, Acidity pH) Tipe SEN0161-V2 , LCD module HD44780 controller, Biohole as Injector for Biosoildam, Biofertilizer Mikrobia Alfafaa MA-11, red union straw as microbial nest, Abney level, Double Ring Infiltrometer (Figure 1A and 1B), Erlemeyer, penggaris, Stop watch, plastic bucket, tally sheet, measurement glass, micro scale , hydrometer dam water (Douglas MG, 1988).

Figure 1 A: Double ring infiltrometer and sensors

Hammer Erection | Without Leakage | Instal the scale | Watering | Recording of Water Drop

Figure 1 B: Installation of double ring infiltrometer

Determining plot and sensor points

To determine plots and sensors, this study uses purposive sampling at various distances: 1.5; 2; 3 metre from the center of bio hole with a diameter of 1 meter as the central radial distribution of the biological agent Microbe Alfaafa MA-11 through the water injection process. Infiltration rate and radial biological agent distribution can be controlled in real-time through measurement sensors with parameters: EC/salt ion (macronutrients), pH, humidity and soil temperature. And as a periodical control, the infiltration rates with a double ring infiltrometer on the variable distance from the center of the bio hole are manually measured. Next, soil samples are also taken to analyse their characteristics, such as soil texture, organic material content and bulk density (Douglas MG, 1988).

Data processing

Catalysis discharge: Smart biosoildam innovation uses runoff discharge as a media for biological agent's distribution through the inlet/inflow (Biohole) as a centre for the microbial populations distribution with water (Widiasmadi N, 2020). The runoff discharge calculation as a basis for the Inflow Biosoildam formula requires the following stages:

1. Conducting a rainfall analysis,
2. Calculating the catchment area, and
3. Analysing the soil/rock layers.

Biosoildam structure can be made with holes in the soil layer without or using water pipes/reinforced concrete pipes (RCP) with perforated layer that will let microbes to spread radially. We can calculate the discharge entering biohole as a function of the catchment characteristic with a rational formula:

$$Q=0,278\ CIA \qquad (1)$$

Where C is the runoff coefficient value, I is the precipitation and A is the area (Sunjoto S, 2011). Based on this formula, the table presents the results of runoff discharge.

Infiltration: Infiltration is the process by which water on the ground surface enters the soil. It is commonly used in both hydrology and soil sciences. The infiltration capacity is defined as the maximum rate of infiltration. It is most often measured in meters per day but can also be measured in other units of distance over time if necessary. The infiltration capacity decreases as the soil moisture content of soils surface layers increases. If the precipitation rate exceeds the infiltration rate, runoff will usually occur unless there is some physical barrier. Infiltrometers, permeameters and rainfall simulators are all devices that can be used to measure infiltration rates. Infiltration is caused by multiple factors including; gravity, capillary forces, adsorption and osmosis. Many soil characteristics can also play a role in determining the rate at which infiltration occurs.

The spread of microbes as a biomass decomposing agent can be controlled through the calculation of the infiltration rate at point radius from biohole as the centre of the spread of microbes by using the Horton method. Horton observed that infiltration starts from a standard value fo and exponentially decreases to a constant condition fc. One of the earliest infiltration equations developed by Horton is:

$$f(t)=fc+(fo-fc)e-kt \qquad (2)$$

Where-

k is a constant reduction to the dimension [T-1] or a constant decreasing infiltration rate.

fo is an infiltration rate capacity at the beginning of the measurement.

fc is a constant infiltration capacity that depends on the soil type.

The fo and fc parameters are obtained from the field measurement using a double-ring infiltrometer. The fo and fc parameters are the functions of soil type and cover. Sandy or gravel soils have high values, while bare clay soils have little value, and for grassy land surfaces, the value increases (Widiasmadi N, 2019).

The infiltration calculation data from the measurement results in the first 15 minutes, the second 15 minutes, the third 15 minutes and the fourth 15 minutes at each distance from the centre of Biohole are converted in units of cm/hour with the following formula:

Infiltration rate=$(\Delta H/t \times 60)$ (3)

Where-

ΔH=height decrease (cm) within a certain time interval, T=the time interval required by water in ΔH to enter the ground (minutes) (Huang Z, *et al.*, 1997). This observation takes place every 3 days for one month.

Soil characteristics: The porosity of soils is critical in determine the infiltration capacity. Soils that have smaller pore sizes, such as clay, have lower infiltration capacity and slower infiltration rates than soils that have large pore size, such as sands. One exception to this rule is when clay is present in dry conditions. In this case, the soil can develop large cracks which lead to higher infiltration capacity.

Soil compaction is also impacts infiltration capacity. Compaction of soils results in decreased porosity within the soils, which decreases infiltration capacity. Hydrophobic soils can develop after wildfires have happened, which can greatly diminish or completely prevent infiltration from occurring (Widiasmadi N, 2020).

Soil moisture content: Soil that is already saturated has no more capacity to hold more water, therefore infiltration capacity has been reached and the rate cannot increase past this point. This leads to much more surface runoff. When soil is partially saturated then infiltration can occur at a moderate rate and fully unsaturated soils have the highest infiltration capacity (Sunjoto S, 1988).

Organic materials in soils: Organic materials in the soil (including plants and animals) all increase the infiltration capacity. Vegetation contains roots that extent into the soil which create cracks and fissures in the soil, allowing for more rapid infiltration and increased capacity. Vegetation can also reduce surface compaction of the soil which again allows for increased infiltration. When no vegetation is present infiltration rates can be very low, which can lead to excessive runoff and increased erosion levels. Similarly to vegetation, animals that burrow in the soil also create cracks in the soil structure (Huang Z, *et al.*, 1997)

Microbial population: This analysis uses MA-11 biological agents that have been tested by the Microbiology Laboratorium of Gadjah Mada University based on Ministerial Regulation standards: No 70/Permentan/SR.140/10 2011 includes (Table 1).

Table 1: Microbes analysis

No	Population Analysis	Result
1	Total of micobes	18.48 × 108cfu
2	Selulotik micobes	1.39 × 108cfu
3	Proteolitik micobes	1.32 × 108cfu
4	Amilolitik micobes	7.72 × 108cfu
5	N Fixtation micobes	2.2 × 108cfu
6	Phosfat micobes	1.44 × 108cfu
7	Acidity	3.89
8	Ure-amonium-nitrat decomposer	Positive
9	Patogenity for plants	Negative
10	Contaminant E-Coly and Salmonella	Negative
11	Hg	2,71 ppb
12	Cd	<0.01 mg/l
13	Pb	<0.01 mg/l
14	As	<0.01 ppm

Its application in Biosoildam is concentrating the microbes into "population media", as a source of soil conditioner for increasing infiltration rates and restoring natural fertility.

Microcontroller against nutrient content, acidity, temperature and soil moisture: Indications of microbial activity on fertility can be controlled through acidity. The number of nutrients contained in the soil is an indicator of the level of soil fertility due to the activity of biological agents in decomposing biomass (Widiasmadi N, 2020). Important factors that influence the absorption of nutrients (EC) by plant roots are the degrees of soil acidity (soil pH), temperature (T) and humidity (M). Soil Acidity level (pH) greatly influences the plant's growth rate and development (Laflen JM, *et al.*, 2000).

Microbial activity as a contributor to soil nutrition from the biomass decomposition results can be controlled through the salinity level of the nutrient solution expressed through conductivity as well as other parameters as analogue inputs. Conductivity can be measured using EC, Electro conductivity or Electrical (or Electro) Conductivity (EC) is the nutrients density in solution. The more concentrated the solution is, the greater the delivery of electric current from the cation (+) and anion (-) to the anode and cathode of the EC meter. Thus, it results in the higher EC. The measurement unit of EC is mS/cm (millisiemens) (Boardman CR, *et al.*, 1966).

This study uses an Arduino Uno microcontroller which has 14 digital pins, of which there are 6 pins used as Pulse Width Modulation or PWM outputs, namely the pins D.3, D.5, D.6, D.9, D.10, D.11, and 6 analogue input pins for these soil parameter elements, namely EC, T, pH, M. Analogue input on Arduino Uno uses C language and for programming uses a compatible software for all types of Arduino (Greengard S, 2017). Arduino Uno microcontroller can facilitate communication between Arduino Uno with computers including smartphones. This microcontroller provides USART (Universal Synchronous and Asynchronous Serial Receiver and Transmitter) facilities located at the D.0 (Rx) pin and the D.1 (Tx) pin.

This research uses the ESP8266 data transmission system with the firmware and the AT Command set that can be programmed with Arduino. The ESP8266 module is an on-chip system that can be connected to a WIFI network. Besides, several pins function as GPIO (General Port Input Output) to access these ground parameter sensors that are connected to Arduino, so that the system can connect to Wi-Fi (Schwab K, 2018). Thus, we can process analogue inputs of various soil parameters into digital information and process them via the web.

RESULTS AND DISCUSSION

Rainfall design and Frequency Duration Intensity (FDI)

The rainfall design intensity was determined using rainfall data from Ngawi Station in 2009-2017 Statistical analysis was performed to determine the distribution type used, which in this study was the Log Person

III's. Distribution checking on whether rain opportunities can be accepted or not is calculated using the Chi Square test and the Kolmogorov Smirnov test. Next, the design rainfall intensity is calculated using the mononobe formula.

Discharge plan

The discharge plan as a MA-11 microbial catalyst uses the rainfall intensity for 1 hour since it is estimated that the most predominant rainfall duration in the area studied is 1 hour. The runoff coefficient for various surface flow coefficients is 0.70-0.95 (Suripin IR, 2004), while in this study we use the smallest flow coefficient value, which is 0.70.

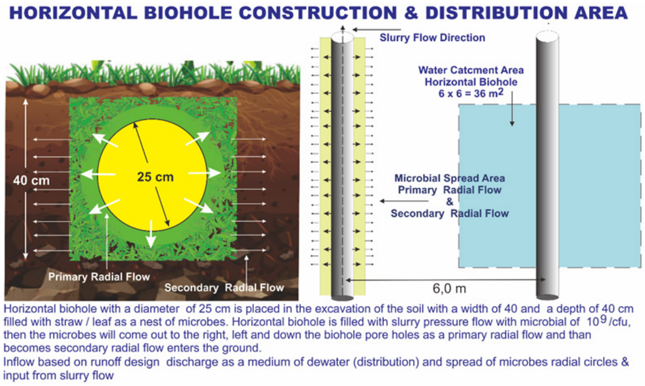
The discharge plan has various catchment areas, between 9 m^2 to 110 m^2 with a proportional relationship. The larger the plot, the greater the plan discharge generated as a biohole inflow. The depth of biohole in the study area in the 25-year return period ranges from 0.80m to 1.50m. The absorption volume will determine the maximum capacity of water contained in biohole. The greater the volume of biohole is, the greater the water container is.

Horizontal biohole design

Biohole walls use natural walls with a 0.25 m diameter and a 0.4 m depth or the storage area of 36 m^2.

Organic material (solid pressed padi straw waste) is used as a place for microbial populations/microbial sources. The top is coated with a 5 cm thick rock which acts as an energy-breaking medium. Thus, when filled with organic material water, it remains stable to maintain the radial spread of microbes (Widiasmadi N, 2019).

The Biohole volume capacity for that dimension is 0.125 m^3, with a catchment of 36 m^2 and the 25 year-discharge=0.0000841 m^3/sec and will be fully filled in about 15 to 20 minutes. This figure considers natural resources in the form of rainfall intensity of the study area which adjusted to the spread of microbes. Therefore, the water-emptying phase and the microbial population formulation phase can take place optimally (Figure 2).


HORIZONTAL BIOHOLE CONSTRUCTION & DISTRIBUTION AREA

Horizontal biohole with a diameter of 25 cm is placed in the excavation of the soil with a width of 40 and a depth of 40 cm filled with straw / leaf as a nest of microbes. Horizontal biohole is filled with slurry pressure flow with microbial of 10^9/cfu, then the microbes will come out to the right, left and down the biohole pore holes as a primary radial flow and than becomes secondary radial flow enters the ground.

Inflow based on runoff design discharge as a medium of dewater (distribution) and spread of microbes radial circles & input from slurry flow

Figure 2: Distribution and biohole structure

Soil coating effect on biohole

If land is covered by impermeable surfaces, such as pavement, infiltration cannot occur as the water cannot infiltrate through an impermeable surface. This relationship also leads to increased runoff. Areas that are impermeable often have storm drains which drain directly into water bodies, which means no infiltration occurs.

Vegetative cover of the land also impacts the infiltration capacity. Vegetative cover can lead to more interception of precipitation, which can decrease intensity leading to less runoff, and more interception. Increased abundance of vegetation also leads to higher levels of evapotranspiration which can decrease the amount of infiltration rate (Sutanto S, 2012). Debris from vegetation such as leaf cover can also increase infiltration rate by protecting the soils from intense precipitation events.

Geomorphology of agricultural land and its surroundings is in the form of humus lands (Figure 3). Humus soil is soil that has organic content as a habitat for soil fertilizing microorganisms, so that the soil is rich in nutrients needed by plants. The humus found in the soil also makes the soil have the ability to hold water better and protect it from the risk of erosion.

Figure 3: Humus soil layers

Humus in the soil consists of a mixture of decomposed organic matter such as dead leaves, twigs and grass. Content such as aliphatic hydroxides, phenols and carboxylic acids are substances that exist in humus and are useful for plant fertility. Therefore, in simple terms, humus soil is a type of soil that is formed from the decay of organic matter over a certain period of time.

The organic material that makes up the humus comes from organic waste which decomposes and produces small particles with negative charges. Then the negative particles are in charge of absorbing nutrients such as calcium and magnesium. The negatively charged small particles can absorb positively charged nutrients such as calcium and magnesium which are needed by plants. Therefore, in general, humus-rich soils are characterized by dark colours with white spots. The need for humus plants varies from one another. There are plants that require high humus content in the soil to thrive, but there are plants that can survive in soils with low humus content.

Soil type humus according to the process of its formation, humus soil can be divided into several types, namely:

- Soil is rich in humus due to dust or sand sediment activity
- Topsoil rich in humus formed from rocks whose surface is overgrown with moss or pioneer plants
- Humus-rich soil formed from weathering of rocks or plants that decay due to chemical factors, wind, sun, water and others

The type of humus can also be distinguished from the source of the nutrients present in it. For example, soil formed from animal dung and soil made from the remains of dead trees.

Characteristics of soil rich in humus as a fertile land because it is rich in humus, here are the characteristics it has:

- The soil is dark, black or brown and there are white spots. It has such a texture because it is formed from the weathering of plants and becomes a source of energy for soil microorganisms, making the soil dark.
- The soil structure is loose and contains a lot of organic substances
- High water absorption compared to other soil types. This property is called colloidal and amorphous, where this property is also owned by clay. However, humus soil and clay soil are different, because the topsoil has high water absorption, and the texture is loose and very fertile.
- Rich in nutrients such as magnesium, calcium and potassium. In addition, this fertile soil also has the ability to multiply the elements in the soil so that if plants grow in the topsoil it will be very fertile.
- There are soil fertilizing microorganisms
- Humus-rich soil is flammable
- Humus-rich soil has a slippery texture when exposed to water
- Humus-rich soil is a smelly soil

This soil is soft and easy to work on. This soil type is widely distributed in the Ngawi plains area. Humus soil fertility simulation based on the number of microbial populations with (Table 2) (Figure 4).

Table 2: Increase in EC per microbial population

Time (Day)	EC (uS/cm)		
	Population		
	10^8/cfu	10^5/cfu	10^3/cfu
1	590	590	590
2	600	627	594
3	650	636.5	603
4	700	649.8	615.6
5	750	649.8	615.6
6	900	760	620
7	950	779	630
8	1053.4	807.5	650
9	1099.4	845.5	670
10	1127	855	690
11	1179.9	893	710
12	1230.5	912	725
13	1253.5	912	750
14	1311	959.5	775
15	1334	959.5	790
16	1426	959.5	796
17	1449	1007	800
18	1483.5	1083	805
19	1529.5	1083	810
20	1541	1083	825
21	1552.5	1102	840
22	1650	1121	842.4
23	1700	1130.5	842.4
24	1750	1130.5	842.4
25	1780	1130.5	842.4
26	1800	1130.5	864
27	1870	1140	900
28	1900	1140	920
29	1938.9	1140	940
30	1984.9	1178	970
31	2076.9	1254	990
32	2191.9	1349	1050
33	2237.9	1387	1130
34	2306.9	1444	1180
35	2352.9	1482	1200
36	2398.9	1520	1210
37	2456.4	1567.5	1230
38	2525.4	1624.5	1260
39	2571.4	1662.5	1290
40	2605.9	1691	1300
41	2651.9	1729	1350
42	2697.9	1767	1342.8
43	2734.7	1795.5	1369.8
44	2737	1805	1378.8
45	2743.9	1805	1378.8

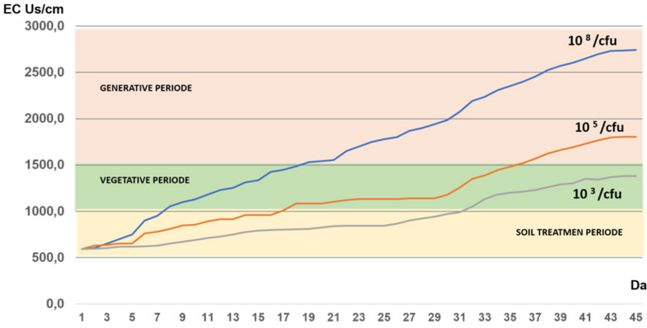


Figure 4: Graph of EC vs. time

- Varible 1=Microbial Population 10^8/cfu.
- Varible 2=Microbial Population 10^5/cfu.
- Varible 3=Microbial Population 10^3/cfu.

The initial nutrient content prior to the simulation using the Electrolyte Conductivity (EC) parameter is 744 uS/cm. Soil nutrient conditions will be improved based on total organic farming standards, namely plant growth (vegetative period) which requires soil nutrients at least 1000 uS/cm and fertilization period (generative period) which requires soil nutrients at least 1500 uS/cm (Figure 5).

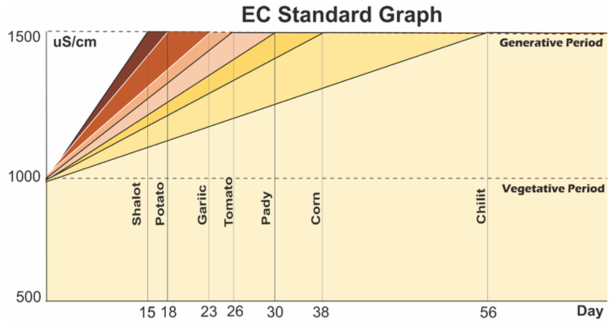


Figure 5: EC standard graph

Simulation results based on the variable number of microbial populations are produced:

1. Simulation A: To start the growth period (vegetative) is achieved on the 8th day with a fertility rate (Electrolyte Conductivity)=1053 uS/cm and in the generative period it is reached on the 19th day with a fertility level (Electrolyte Conductivity)=1529 uS/cm. This activity is

stimulated by microbes with a population=108/cfu. So that the time needed to reach optimal nutrient levels is 9 days.

2. Simulation B: To start the growth period (vegetative) is achieved on the 17th day with a fertility rate (Electrolyte Conductivity)=1007 uS/cm and at the generative period it is reached on the 36nd day with a fertility rate (Electrolyte Conductivity)=1520 uS/cm. This activity is stimulated by microbes with a population=105/cfu. So the time needed to reach optimal nutrient levels is 15 days

3. Simulation C: To start the growth period (vegetative) is achieved on day 32 with a fertility rate (Electrolyte Conductivity)=1050 uS/cm and during the generative period it cannot be observed because on observation until day 45 the electrolyte conductivity has not reach=1500 uS/cm. This activity is stimulated by microbes with a population=103/cfu.

4. The soil parameters mentioned above can be controlled against the level of the infiltration rate (Figure 6), where the infiltration rate graph shows a constant value at a level of 80 to 110 cm/hour which is reached after the 30th day.While the EC value in stable conditions is achieved on day 30 with a value between 950-1200 uS/cm. So that the activity of biological agents on andosol soil with the infiltration level will be optimal on day 35.

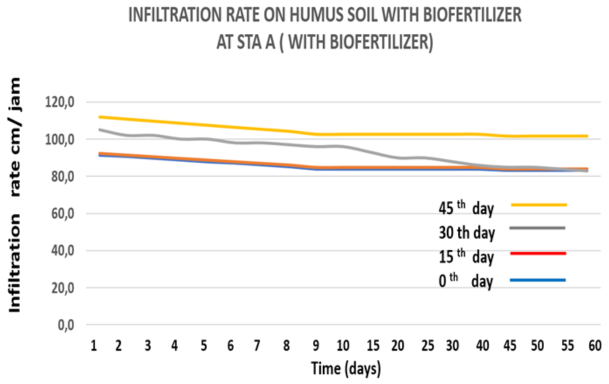


Figure 6: Graph of infiltration rate

CONCLUSION

In simulations with a microbial population of 108/cfu, it is very effective to be applied to humus soil because the increase in the minimum nutrients needed in the growth period can be achieved within 8 days and nutrient availability in the generative period is obtained at 19 days because the available nutrient values are according to standards 1529 uS/cm because it is more than 1500 uS/cm. In simulations with a microbial population of 105/cfu, it is still effective and is also applied to humus soil because the increase in minimum nutrients needed in the growth period can be achieved within 17 days and including nutrient availability in the generative period is reached at 1520 uS/cm so that it meets the standard .

In simulations with a microbial population of 103/cfu, it is still effective but is applied for a long time to humus soil because the minimum increase in nutrients needed in the growth period can be achieved within 32 days but nutrient availability in the generative period is only achieved at a relatively small figure of 1378 uS/cm so it is not optimal even though it is close to 1500 uS/cm. Humus land is quite effective for short-term crops or seasonal crops such as horticulture, rice etc., including if applied for long-term or annual crops such as cacao, coffee, rubber etc., because the level of microbial activity takes place maximally working on humus soil.

Topsoil is very suitable for agricultural activities, but if it is used as a soil and water conservation activity, a terracing or drainage system is needed that can hold surface runoff because the soil texture of the humus is easily dissolved by water.

REFERENCES

1. Widiasmadi N. Soil improvement and conservation based in biosoildam integrated smart ecofarming technology (applied in java alluvial land and arid region in east Indonesia). Int J Innov. 2020; 5(9).
2. Widiasmadi N. Analisa of the effect of biofertilizer agent activity on soil electrolit conductivity and acidity in the real time with the smart biosoidam. Journal of Mechanical and Civil Engineering. 2020.
3. Sunjoto S. Teknik drainase pro-air. yogyakarta: Fakultas Teknik Universitas Gadjah Mada. 2011.
4. Suripin IR. Sistem drainase perkotaan yang berkelanjutan. Andi. 2004.
5. Wasisto S. Aplikasi Internet of Things (IoT) dengan Arduino and Android : Penerbit Deepublish Yogyakarta. 2018
6. Douglas MG.Integrating conservation into farmimg system. The Malawi Experience. 1988.
7. Widiasmadi N. Analisa ec and keasaman tanah menggunakan smart biosoildam sebagai usaha peningkatan daya dukung lahan pasir: Syntax literate. Jurnal Ilmiah Indonesia. 2020; 5(11).
8. Widiasmadi N. Peningkatan laju infiltrasi and kesuburan lahan dengan metode biosoildam pada lapisan tanah keras and tandus. Prosiding SNST ke-10 Tahun 2019 Fakultas Teknik Universitas Wahid Hasyim. 2019; 1(1).
9. Huang Z, Shan L. Action of rainwater use on soil and water conservation and suistanable development of agricukture. Bulletin of Soil and Watr Conserv.1997; 17(1): 45-48.
10. Widiasmadi N. Analisa elektrolit konduktifitas and keasaman tanah secara real time menggunakan smart biosoildam. Proceedings of the NCIET National Seminar. 2020; 1: 11-24.
11. Sunjoto S. Optimalisasi sumur resapan air hujan sebagai salah satu upaya pencegahan intruksi air laut. Gadjah Mada University. 1988.
12. Widiasmadi N. Analysis of soil fertlity and acidity in real time using smart biosoildam to improe agricultural land. Int J Res Anal Rev. 2020; 7(3): 194-200.
13. Laflen JM, Tian J, Huang CH. Soil Erosion and Dryland Farming. CRC Press. 2000.
14. Boardman CR, Skrove J. Distribution and fracture permeability of a granitic rock mass following a contained nuclear explosion. Journal Pteroleum Technologi 1966; 15(5): 619-623.
15. Greengard S. "The Internet of Things" covers how IoT works in our current world, as well as the impact it will have in the long run on society. Amazone. 2017.
16. Schwab K. The Fourth Industrial Revolution. Amazone. 2018.
17. Sutanto S. Desain sumur peresapan air hujan. Laporan Penelitian. Yogyakarta: Fakultas Geografi Universitas Gadjah Mada. 2012.