Comparative Study of Infiltration Characteristics

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Abstract: Infiltration is a crucial process that determines the ability of soil to absorb and retain water. It is a critical factor in the water cycle and has a significant impact on plant growth and agricultural productivity. Infiltration helps in maintaining soil moisture, ground water table, water quality and also reduce soil erosion. The study was conducted in a field located in a rural area. The three soil types were selected based on their texture and location. This study investigates the infiltration characteristics of four different soil types, including sand, clay, murum and compacted clay. The double-ring infiltrometer method was used to measure the infiltration rate of each soil type, and the soil texture and structure were analyzed. The results showed that the infiltration rate was highest in sand soil (48 min/hr), followed by clay (38.47 min/hr), murum (32 min/hr), and compacted soil (9.3 min/hr). The soil texture and structure significantly affected the infiltration rate, with loam soil having the highest pore space, resulting in the highest infiltration rate. This study highlights the importance of understanding the infiltration characteristics of different soil types to manage water resources effectively and enhance agricultural productivity.

Keywords: Infiltration, Soil types, Soil texture, Soil structure, Agricultural productivity.

INTRODUCTION

Infiltration is a fundamental process in the water cycle that describes the movement of water into the soil. It is a critical aspect of the water balance, as it determines how much water is available for plant growth and groundwater recharge. The infiltration process is influenced by several factors, including soil properties, vegetation cover, and rainfall intensity. Understanding the infiltration characteristics of different soil types is essential for predicting water availability for plants, groundwater recharge, and water quality.

Soil texture is an essential factor that influences infiltration rates. Soil texture refers to the relative proportions of sand, silt, and clay particles in soil. Soil structure is that influences infiltration rates. Soil structure refers to the arrangement of soil particles into aggregates or clumps. Soil aggregates play a vital role in promoting infiltration by increasing soil porosity, which is the volume of empty space between soil particles. Soil porosity allows water to move into and through the soil, providing plants with access to water and nutrients. Organic matter refers to the remains of plant and animal material in soil. Organic matter plays a crucial role in promoting soil aggregation, increasing soil porosity, and enhancing soil water-holding capacity. The addition of organic matter to soil can improve infiltration rates by promoting soil structure and increasing water-holding capacity.

Compaction also influences infiltration rates. Compaction refers to the compression of soil particles, reducing the volume of pore space and limiting water movement into the soil. Compaction can occur naturally or through human activities such as agriculture, construction, and recreation. Compaction can reduce infiltration rates and promote surface runoff, leading to erosion and nutrient loss.

Vegetation cover refers to the amount and type of plants covering the soil surface. Vegetation cover can promote infiltration by promoting soil aggregation, increasing soil organic matter content, and reducing soil erosion. Different vegetation types can influence infiltration rates differently. For example, grasses and legumes promote infiltration by promoting soil aggregation and increasing soil organic matter content. In contrast, trees can reduce infiltration rates by intercepting rainfall and promoting evapotranspiration. Rainfall intensity refers to the amount of rainfall falling in a given time. Intense rainfall can cause surface runoff, limiting water movement into the soil. In contrast, low-intensity rainfall can promote infiltration by allowing water to move into the soil slowly.

METHODOLOGY

The double-ring infiltrometer is a common tool used in soil science to measure the rate at which water infiltrates into soil. The method involves the use of two concentric rings, which are placed on the soil surface, and water is poured into the inner ring. The rate of water infiltration is then measured by recording the time it takes for the water level to drop in the inner ring. The double-ring infiltrometer method is widely used due to its simplicity, low cost, and relative ease of use. The following is a description of the methodology involved in using the double-ring infiltrometer to measure soil infiltration rates.

1. Site selection: The first step in using the double-ring infiltrometer is to select an appropriate site. The site should be representative of the area under study and should not be influenced by surface runoff or other factors that may affect the infiltration rate. The soil should be relatively uniform in texture and structure, and the area should be flat and free of obstructions.

2. Preparation of equipment: The double-ring infiltrometer consists of two concentric rings, typically made of metal or plastic. The inner ring should be placed in the center of the outer ring, leaving a gap of 10-20 cm between the two rings. The height of the rings should be at least 5 cm to ensure that the water does not overflow. A measuring cylinder and a stopwatch are also required to measure the volume of water and the time taken for the water to infiltrate into the soil.

3. Pre-wetting the soil: Before beginning the experiment, it is essential to pre-wet the soil to ensure that it is at field capacity. This can be achieved by adding water to the soil until there is no further uptake, and the water level remains constant for at least 24 hours.

4. Measuring the initial water level: The water level in the inner ring should be measured and recorded before water is poured into it.

5. Adding water to the inner ring: The next step is to pour a known volume of water into the inner ring. The volume of water added should be sufficient to cover the soil surface and should not exceed the height of the inner ring.

6. Timing the infiltration: The stopwatch should be started as soon as the water is poured into the inner ring. The time taken for the water level in the inner ring to drop by a certain amount (usually 1 cm) should be recorded at regular intervals (e.g., every 30 seconds) until the infiltration rate becomes constant. The experiment is usually conducted until the infiltration rate becomes constant or until a specified time limit is reached.

7. Data analysis: The infiltration rate can be calculated using the following equation: Infiltration rate = (Volume of water added) / (Total time taken for the water level to drop by a certain amount). The experiment can be repeated at several locations within the study area to obtain an average infiltration rate.

OBJECTIVES

1. To understand the movement of water through the soil: Studying infiltration helps to understand the rate and pattern of water movement through soil. This information is essential for predicting water availability for plants, groundwater recharge, and water quality.

2. To determine soil characteristics: Infiltration testing can provide information about soil properties such as porosity, permeability, and water-holding capacity. This information is useful for determining soil suitability for different land uses.

3. To evaluate the effectiveness of conservation practices: Infiltration testing can help to assess the effectiveness of different conservation practices aimed at improving infiltration rates. For example, testing can determine the effectiveness of conservation tillage or cover crops in promoting infiltration.

4. To assess the impact of land use changes: Changes in land use can affect infiltration rates, which in turn can impact water availability and quality. Infiltration testing can help to evaluate the impact of land use changes on infiltration rates.

5. To design appropriate land management practices: Studying infiltration is important for designing appropriate land management practices that maximize water availability for plants and promote sustainable water use.

Soil parameters:

1. Porosity:

Sandy soils: typically have a higher porosity than other soil types, i.e. 40%.

Clayey soils: tend to have a lower porosity than sandy soils, i.e. 32%.

Murum soils: are a type of gravelly soil found in some regions, and their porosity is 25%,

Compacted clay soils: can have a very low porosity of 14%, due to their high density and low permeability.

2. Moisture content:

Sandy soils: typically have a lower moisture content than other soil types, i.e. 8%.

Clayey soils: tend to have a higher moisture content than sandy soils, i.e. 25%.

Murum soils: can have a wide range of moisture content, depending on their particle size and shape, i.e. 6%.

Compacted clay soils: can have a very low moisture content, ranging from 5%, due to their high density and low permeability

3.Density:

Sandy soil: 1.6 g/cm³

Clayey soil: 1.8 g/cm³

Murum: 1.9 g/cm³

Compacted clay: 2.2 g/cm³

4. Soil Structure:

Sandy soils typically have a loose & porous structure with low water and nutrient retention capacity.

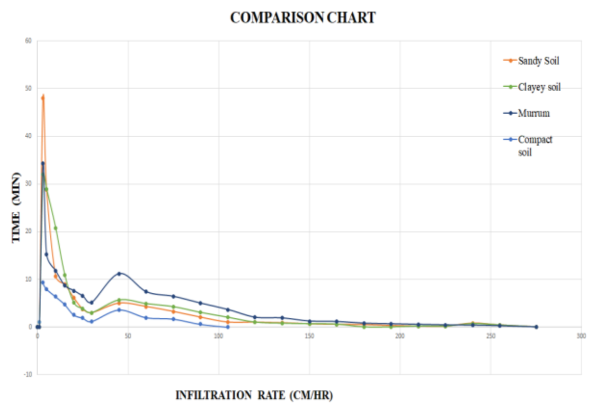
Clayey soils, on the other hand, have a tight and compact structure due to the small size of their particles.

Murum soils have a gravelly structure and are generally composed of a mixture of sand, silt, and clay.

Compacted clay soils have a tightly packed structure and are dense due to the pressure of overlying materials.

RESULT

The field infiltration is calculated at the interval of (0, 3, 5, 10, 15, 20, 25, 30, 45, 60, 75, 90, 105, 120, 135, 150, 165, 180, 195, 210, 225, 240, 255, 275)in different types of soil. And as a result from graph we found the infiltration rate in Sandy soil 48min/hr, in clayey soil 38.47min/hr, in murum 32min/hr and in compacted soil 9.3min/hr. from this readings we got to know that the infiltration rate in sandy soil is highest than other types of soil and the infiltration rate of compacted soil is lowest as compared to other types of soil.



Time in Min	Sandy Soil	Clayey soil	Murrum	Compacted soil
0	0	0	0	0
1	0	0	0	0
3	48	34.37	32	9.3
5	28.8	15.26	29	8
10	10.68	11.81	20.8	6.4
15	8.96	8.71	10.96	4.8
20	6.12	7.63	5.12	2.6
25	3.72	6.49	3.82	1.9
30	3	5.2	3	1.2
45	5	11.2	5.66	3.6
60	4.28	7.38	4.88	2
75	3.24	6.42	4.24	1.7
90	2.04	4.99	3.04	0.6
105	1.02	3.66	2.02	0
120	1	2.03	1	
135	0.88	1.89	0.78	
150	0.64	1.23	0.66	
165	0.54	1.14	0.58	
180	0.48	0.78	0	
195	0.28	0.66	0	
210	0.16	0.53	0.19	
225	0.14	0.42	0.16	
240	0.8	0.37	0.7	
255	0.4	0.24	0.4	
275	0	0	0	

CONCLUSION

Infiltration is an important process that affects the movement of water in soil. The characteristics of infiltration are dependent on the type of soil. Sandy soils have a high infiltration rate due to their high permeability, low porosity, and low water-holding capacity. Clayey soils have a low infiltration rate due to their low permeability, high porosity, and high water-holding capacity. Murum soils have a moderate infiltration rate due to their moderate permeability, moderate porosity, and moderate water-holding capacity. The results obtained from the infiltration tests conducted on the different types of soil showed that sandy soil had the highest infiltration rate, followed by murum soil and clayey soil. Compacted clay had the lowest infiltration rate among the tested soils.

SCOPE OF WORK

I,Infiltration rates typically involves the installation of devices such as infiltration trenches, drywells and sump pumps to collect and redirect stormwater runoff away from buildings and other structures. Construction of swales and rain garden to slow and store runoff on the site.

ii. The infiltration of soil involves the installation of soil and moisture management system in an area of non-native vegetation.

iii. The techniques may include the installation of permeable pavement to allow stormwater to pass directly through the surface of the pavement and the soil.

iv. The project will utilize a variety of clandestine method, including physical infiltration, cyber infiltration and information welfare.

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