



Sultanate Of Oman
Ministry Of Education

Al Batinah North Governorate
Hind bint Al-Muhallab Basic
Education School (Grades 5–10)

The Effect of Soil Capillarity on Water Retention in Arid Environments

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Abstract

With the increasing scarcity of water in arid environments due to low rainfall and the continuous depletion of water resources, the agricultural sector faces major challenges related to the limited ability of soil to retain water and its rapid exposure to dryness. This negatively affects crop productivity and threatens the sustainability of agricultural systems. In this context, soil capillarity plays a crucial role as a key physical property that directly influences the movement of water within soil pores and its ability to retain moisture over extended periods.

This study aims to investigate the effect of soil capillarity on water retention in arid environments by examining the pore structure of different soil types, analyzing water-movement behavior through them, and evaluating their capacity to reduce water loss caused by evaporation or deep percolation. The research also seeks to explore the relationship between soil structure and capillary action, and its impact on improving irrigation efficiency and supporting sustainable agriculture in water-scarce regions.

Research questions

1. What is the effect of soil capillarity on water movement and retention in arid environments?
2. How does soil pore structure contribute to improving water-retention efficiency and reducing water loss?
3. To what extent do variations in soil capillarity influence soil properties and plant growth under the same conditions?

Research Methods

Scientific Interview

An interview was conducted with agricultural engineer Nasser Al-Hinai from Sultan Qaboos University. The interview focused on understanding the physical and structural characteristics of soil, particularly the role of pore structure and layered composition in capillary water movement, and how these properties influence moisture retention and reduce water loss when compared with conventional agricultural soil.

2. Experimental Study An experiment was conducted using two groups of marigold seedlings planted in two different soil types:

a layered soil structure designed to enhance capillary behavior and water-retention capacity, and conventional agricultural soil for comparison.

Throughout the experiment, several soil properties were measured — including permeability, salinity, moisture content, and pH — in addition to monitoring plant growth over specific time intervals, in order to analyze the influence of soil capillarity on moisture behavior and water availability around plant roots.

Research Procedures

Information Collection: The required data were collected from books available in the Learning Resource Center and through online information sources.

Research Planning: A comprehensive research plan was developed, including the identification of objectives and the timeline for implementation.

Conducting the Interview: An interview was conducted with Agricultural Engineer Nasser Al-Hinai from Sultan Qaboos University to obtain specialized insights on Layered soil and its impacts.

Engineering the Layered soil Model: A Layered soil sample was engineered with precise specifications to serve as a core component of the experiment.

Protocol Identification: Appropriate protocols for implementing the study were determined based on scientific and environmental standards.

Selection of Tools and Instruments: The necessary devices and instruments were selected for conducting the experiment, including a pH meter, a salinity and conductivity meter, a measuring tape, and a soil-moisture sensor.

Conducting the Experiment: An experimental research approach was adopted to study the effect of two soil types on the growth of marigold seedlings, while monitoring environmental and soil characteristics.

Data Collection: The data and results obtained from the experiment were collected, organized into clear and accurate tables, and represented graphically.

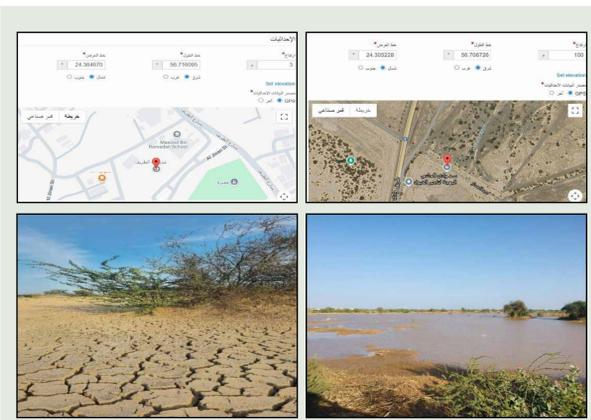
Data Entry: The collected data were entered into the official GLOBE Program website for monitoring and analysis.

Data Analysis: The results were analyzed and discussed, with graphical representations used to illustrate the findings.

Conclusions and Recommendations: The main research findings were extracted, and appropriate recommendations were proposed to support the effective use of Layered soil.

Study Location

The study was conducted in Sohar, North Al Batinah Governorate. A field visit to Wadi Al-Hilti Dam examined soil structure and its effect on water retention. The experiment was carried out at the school using a layered soil model, and data were recorded using GPS and entered into the GLOBE platform.

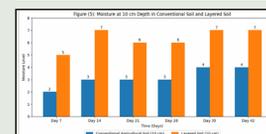
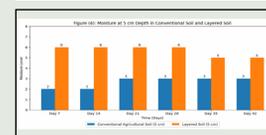
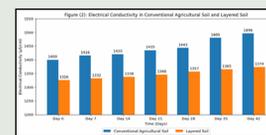
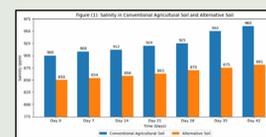


Data Collection and Analysis

Data for this study were collected using field observations and a controlled experimental approach in accordance with the GLOBE Program protocols. A scientific interview was conducted with an agricultural engineer, followed by a field visit to Wadi Al-Hilti Dam to examine the natural layered soil structure and its role in capillary water movement and moisture retention.

The experimental part of the study involved cultivating marigold seedlings in two different soil types: a layered soil model designed to enhance capillary action, and conventional agricultural soil. Both groups were exposed to the same environmental conditions, including irrigation rate and sunlight, over a period of 42 days.

Throughout the experiment, soil properties such as moisture content, salinity, pH, electrical conductivity, and permeability were measured at regular intervals using standard measuring instruments. Plant growth indicators, including plant height and number of flowers, were also recorded. The collected data were organized into tables and graphs and analyzed through direct comparison between the two soil types. All results were documented and uploaded to the official GLOBE platform to support accurate analysis and validation of the findings.



Construction of a Layered Soil Model for the Experimental



Conclusion

The results of this study demonstrate that soil capillarity plays a significant role in improving water retention and supporting plant growth in arid environments. The layered soil model showed a higher ability to retain moisture, reduce salinity accumulation, and maintain more stable pH levels compared with conventional agricultural soil. These properties contributed to better plant growth and reduced irrigation requirements. The findings confirm that enhancing soil structure to improve capillary action can be an effective and sustainable approach to improving agricultural productivity under water-scarce conditions.

References

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