Ain Shams University
Faculty of Engineering
Irrigation and Hydraulics Department

Improving Water Retention in Soil

A Thesis

Submitted in Partial Fulfillment of the Requirement for the Degree of

MASTER OF SCIENCE IN CIVIL ENGINEERING

Submitted By

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Statement

This thesis is submitted to Ain Shams University for the master's degree in Civil Engineering (Irrigation and Hydraulics).

The work included in this thesis was carried out by the author at the Department of Irrigation and Hydraulics, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis has been submitted for a degree or a qualification at any other University or Institution.

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Abstract

Limited water resources in many countries of the world, especially those suffering from arid climate, an increase of local population, and encroachment of refugees, such as in Jordan, Lebanon, and Egypt are threatened with water scarcity. Since agriculture consumes about 82.5% of total water consumption in Egypt. Besides, the Egyptian deserts, which represent about 96% of the total area of Egypt, are mostly sandy soils, which do not retain water and a large part of it seeps down into the deep aquifer. So, the optimal use of agricultural water realizing the highest irrigation efficiency is mandatory. This study is physical-based model research divided into two parts. The first part is to produce cellulose-based superabsorbent hydrogels extracted from agricultural waste to be used as additives to increase the water retention of the soil. That was produced in the framework of the research to simply obtain the hydrogel using the minimum amount of chemicals and energy. The research results proved that the best process owing to environmental aspect and produced yield can be attributed to the production of the hydrogel from the agricultural waste was the use of 0.5 mole of potassium hydroxide (1 gm to 10 mL) at 90^{o}C for 60 minutes for the extraction of the cellulose that was used with 1.5% potassium persulfate as initiator, 0.25% NN-Methylenebisacrylamide as a crosslinker, and acetic acid for neutralization to produce the hydrogels. Moreover, hydrogels and commercial products underwent laboratory tests (Infrared Spectroscopy with Fourier Transform, Energy Dispersed X-ray analysis, and Scanning Electron Microscopy). Which proved that Crude-gel is the best alternative in terms of the balance between increasing soil moisture retention taking into account environmental considerations. The other part is to apply different techniques for

improving soil water retention. Cylindrical plastic pots with depth 15 cm had been used as a bench-scale model, to simulate the water soil movement and ways to increase soil properties to ensure a larger water retention index. Within this work, soils have been sampled from different areas, to simulate the behavior of arable lands, under different water retention techniques. All soil samples (except for three control samples) surface layers have been mixed with additives, mulched, or separated by a physical barrier from the deep soil layers. Water retention has been measured using the gravimetric method of determining soil moisture content by oven drying, as well as the cultivated plants have been monitored to measure the impact on plant growth and irrigation efficiency. Subsequently, the techniques used to select the best alternatives were compared and found that the use of powdered rice straw and wheat straw as additives to the sandy soils can increase their water holding capacity by 165% and 203% respectively when they added with 30% of the total soil layer volume. Moreover, soil water retention increases with the fineness of the straw. Furthermore, the cellulose extracted from rice straw can be attributed to increasing the water holding capacity in sandy soils. Besides, the use of mulch can significantly decrease the evaporation and soil surface erosion resulting in improvements in soil water retention with 88%.

Keywords: Agricultural Waste, Environmentally Friendly, Soil Water Conservation, Sustainability.

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