Human hair mats to maintain moisture of the soil

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Abstract

Hair matts, produced by needle punching, are able to reduce the water needed for a potted avocado plant by up to 48% and maintain moisture for 3 more days compared to the plant without the solution. Hair matts can be a sustainable solution to the problem of drought

Two plants were tested during 11 days + 1 hour: one (control) without the solution and one with a hair mat (cut as a disc).

Data was recorded with an Arduino One sensor module

Introduction

Water scarcity in Chile represents one of the main problems for the rural population of our country, affecting the quality of life of families and the development of daily and economic activities.

Part of the problem of water scarcity lies on the water needed for plantation like avocados, which require abundant and constant irrigation

Human hair through the needle punching method is transformed into 60x60 cm matts with a thickness of 1.3-1.5 cm.

Seen:
other materials such as cotton or plastic polymers are able to maintain moisture in their use as mulch

The hypothesis is that the semi-permeable barrier made with human hair is able to maintain moisture in the soil

Content

Materials and Methods

Materials:
2 avocado plants of approximately 1 meter
2 pots of 40cm diameter
Arduino One module
Soil Humidity Sensor YI-38 YI-69
Bme280 Temperature Pressure and Humidity I2C Sensor
sd module
wiring for Arduino

3d printed boxes used to protect circuits

Description of materials

FC-28 Soil Moisture Sensor

It allows you to easily measure soil moisture using 2 resistive electrodes. The operation of the sensor is based on measuring the resistance between 2 electrodes inserted into the ground, the resistance between the electrodes will depend on the humidity of the soil, so for a very wet soil we will have a very low resistance (short circuit) and for a very dry floor the resistance will be very high (open circuit). The electrode is connected to a conditioning card (YL-38) that delivers one digital and one analog output. The digital output (DO) is the output of an opamp in comparator mode, the digital output is activated when the humidity level is lower than the desired level, this level (threshold or threshold) can be adjusted with the card potentiometer. Analog output (AO) is the output of a voltage divider between a fixed resistor and the resistance between the electrodes, delivering an analog voltage from 0V for a very wet floor up to 5V for a very dry floor. For the connection to Arduino we can choose to use the analog output of the module connected to an analog input of the Arduino or to use the digital output (DO) connected to a digital input of the Arduino.

Humidity parameters are defined: the module gives us integers numbers between 0 and 1024. Numbers minors than 900 indicate wet soil, numbers bigger than 1000 indicate dry soil

Sensor BME280

The BME280 sensor integrates atmospheric pressure, temperature and relative humidity sensors into a single device, with high precision, low power consumption and an ultra-compact format. Based on BOSCH piezo-resistive technology with high EMC robustness, high precision and linearity, as well as long-term stability. Connects directly to a microcontroller via I2C or SPI.

In this case the module is programmed to collect temperature and humidity data from the environment.

Method

Before the experience began, the avocados were acclimated: the avocados were placed in their respective pots with the same amount and type of soil. They were watered at the same time with the same amount of water for a week.

The pots were located on a south-facing terrace, located on the seventh floor of an apartment on Ricardo Lyon avenue in the city of Providencia (Santiago, Chile). Both pots were protected from direct sunlight with a woven cloth (see photo)

In this space the avocado plants receive the same amount of sun during the day, being the conditions identical for both specimens.

After the week of acclimatization, the hair disc is installed on the pot. Arduino One module is installed, locating the sensors at the same distance from the main trunk and at the same depth.

The experience begins on 03.14.2021 at 20.51. At this time 600 ml of water is supplied to each plant.

The data collected by the Arduino module is stored in a microsd module. Arduino sensors are programmed to record data every 20000 milliseconds

Results

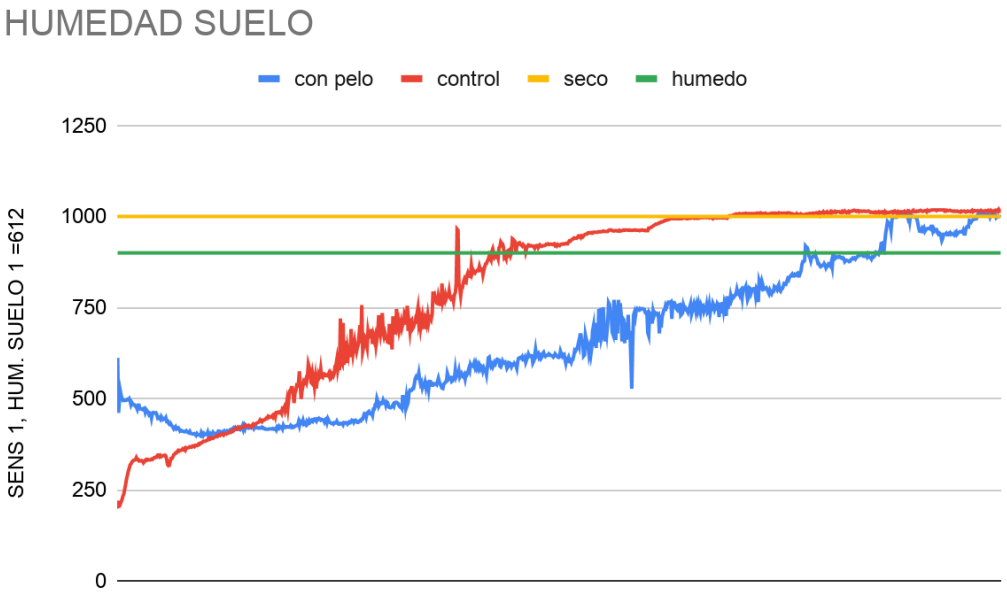
The experience is completed after 265 hours, corresponding to 11 days and 1 hour. Data stored in the sd module is collected and analyzed.

Graphs below represent the analyzed data.

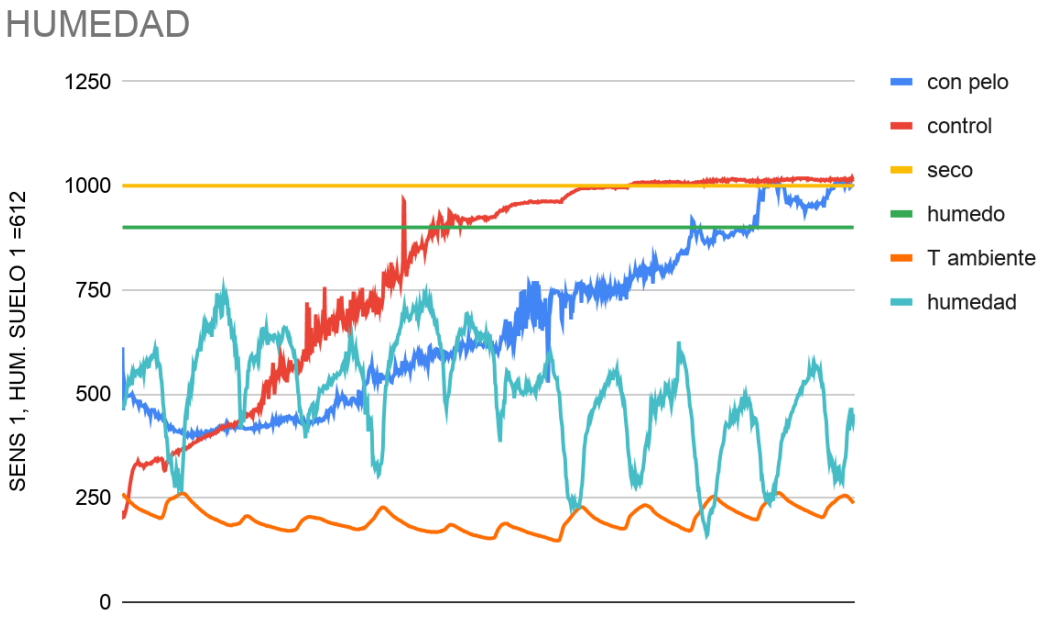
It is clear that, at the beginning of the experiment, the control plant (pot without hair solution) has a higher moisture level than the one with the hair mat. You may notice that the values of moisture equalize after 30 hours. Now on, hour 30 is considered as time 0 for the development of the experience.

The first part of the experience shows that the line on the chart representing moisture in the floor of the control plant has a much steeper slope; moisture loss is found to be faster in the control pot.

After 153 hours from the 0 time of the experience, the sensor in the control plant only gives higher values than 1000 (value defined as dry above), while the plant with hair matt shows constant values of dryness only after the 227th hour (74 hours later)



Regarding the increase or decrease in evaporation at some times of the day, which may be associated with the increasing of temperature or humidity in the air, a correlation may exist but is marginal in this experience



Conclusions

It is evident that human hair matts are able to retain soil moisture up to 48% more than plants without the system installed. This time is corresponding to 3 more days in a total experience of 11 days + 1 hour.

With this data, we have evidence to say that the use of hair matts with plants, particularly in avocados, is able to reduce up to 48% the water needed and therefore reduce the amount of irrigation needed in agriculture.