Faculty and PostDoc, Sciences and Engineering

Hydrogel Sensors for the Agricultural Applications

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Introduction

The use of hydrogel in agricultural has become very valuable since, due to their use and efficiency in saving and reducing water for pant irrigation and have huge prospective to enhance physicochemical and biological properties of the soil [1]. The addition of hydrogel to agricultural soil leads to improvement of several properties like bulk density, porosity, and water retention of the soil [2]. Therefore, the usage of hydrogel ca be considered a viable prospect for enhancing agricultural production and is quite sustainable in the water-deprived areas. The low application rate of the hydrogel is beneficial for large range of crops particularly suitable for soil type and climate of Qatar [1, 4]. The upgradation in progression and harvest related to atmosphere and production of different kinds of field, ornamental and vegetable crops have already been testified for the usage of hydrogel [3]. The agricultural hydrogels possess the capability to absorb water along with gradually releasing it according to specific requirements of the plants, which is slightly different from superabsorbent polymers employed in hygienic applications, which must have the fast rate of fluid absorption as well as ability to retain it under high load. Systems with such type of structure are the Super Absorbent Polymers (SAPs). These SAPs were already well established in various applications such as disposable diapers, hygienic napkins, cement, drug delivery systems, sensors, and agriculture owing to their these exceptional properties. The most crucial properties among all such properties for applications are water absorbency and water retention. Arabic gum is a natural organic material that has huge effect and benefits on soil properties in retaining moisture and increasing soil binding.

Objectives

Development of superhydrophilic hydrogel and multi-sensory device that will work in correlation with each other, to control water sprinkler motor to improve soil efficiency.

Experimental Method

The procedure followed included five main steps

1. SEM Characterization

- Observing of morphology and structure of hydrogel polymer and Arabic gum soil with hydrogel using scanning electron microscope SEM.

2. Deswelling Index

- Determining the deswelling index " rate of water evaporation" of four soil samples, Soil, Hydrosoil, HydroGumSoil, and GumSoil. The samples were kept in sunlight for 60 min. The samples were weight, to test the efficiency of hydrogel and Arabic gum in retaining the water.

Fig 1. Soil mixing with hydrogel

Table 1. Four soil samples

	Soil	Hydrogel	Gum	Water	Seeds
Soil	30 g	0	0	30 g	2.8 g
HyrdroSoil	30 g	2 g	0	30 g	2.8 g
HydroGumSoil	30 g	2 g	5	30 g	2.8 g
GumSoil	30 g	0	5	30 g	2.8 g

3. Plant Growth

- The soils samples prepared in part (2) were observed for plantation in the course of four weeks.
- Sample containing Arabic gum and hydrogel showed the fasted pant growth

4. Fabrication of Sensor

- Sensor was prepared by attaching the hydrogel to the circuit shown above. When water contact with hydrogel, it will swell and off the NFC switch and in the dried state it will on the switch accordingly.
- Combine the NFC sensor with soil system to test the performance in keeping the soil moist.

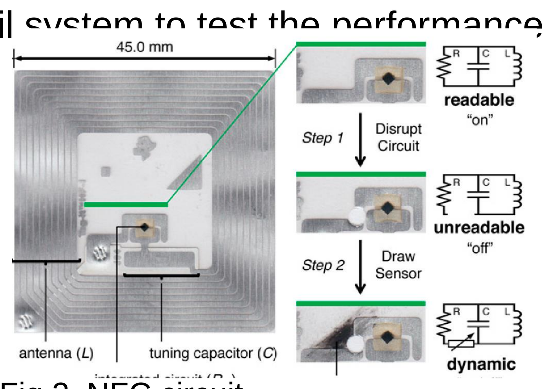

Fig 2. NFC circuit

5. Combination of hydrogel an sensor

- Combine the NFC sensor with soil system to test the performance in keeping the soil moist.

Results and Discussion

1. Scanning electron microscope

- Hydrogel SEM results showing a sponge-like structure with pore diameters at the micrometric level.

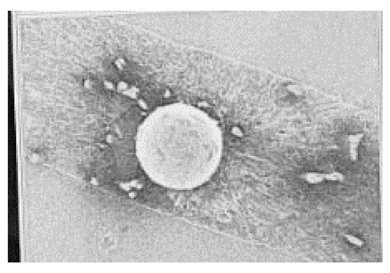

Fig 3. Hydrogel surface 1

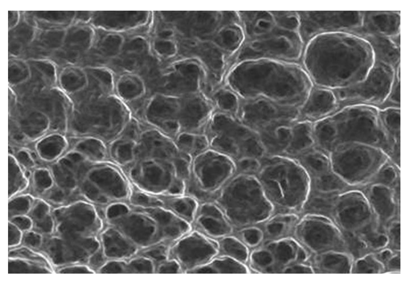

Fig 4. Hydrogel surface 2

- HydroGumSoil SEM results shows more binding of soil due the addition of Arabic gum compared to soil only.

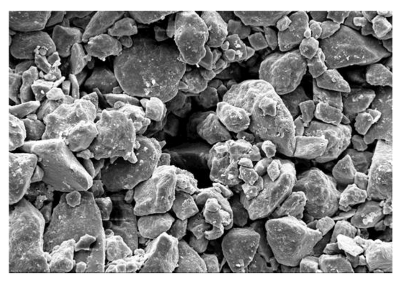

Fig 5. Soil only

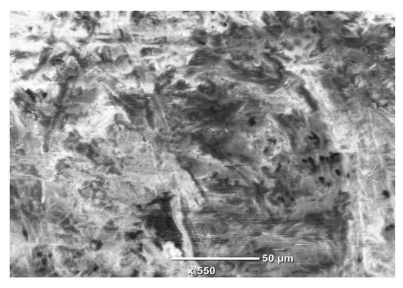

Fig 6. HydroGumSoil

2. Deswelling Index

- The graph below shows that HydroGumSoil sample has the most water content and retained more water then the other samples.

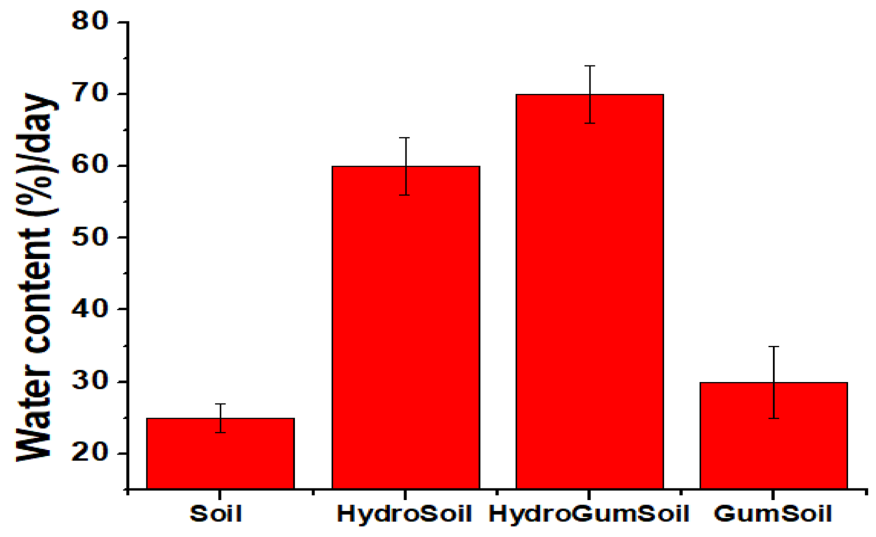

Fig 7. Water content in four samples of soil

- Soil only sample has the least water content due to evaporation.

3. Plant Growth

- HydroGumSoil exhibit excellent plant growth comparative to other samples. This is due to Arabic gum acting as binder between hydrogel and soil.
- Arabic gum increases the productivity of soil leading to faster pant growth by fixing nitrogen and increasing fertility.

Fig 8. Plant growth after 7 days

Fig 9. Plant growth after 5 days

Summary and Future Directions

1- Implement the new agriculture system on large scale to test its efficiency.
2- Use solar energy for the motor
3- Search for more natural materials that enhances the soil productivity.

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