Effect of Hydrogel on the Plants Growth

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Abstract

In the next long-duration exploration, plant systems will become important components: the farther and longer humans go away from Earth, the greater the need to be able to grow plants for food and atmosphere recycling.

Thus, MDRS mission would have to capitalize study of plants in particular environments and with limited equipment. We propose to study the effect of hydrogels on the plants growth in the Greenhouse. Hydrogels are polymers absorbing large quantities of water and fixing seedling roots. Thus, they can considerably reduce stress water of the plant and improve their growth and survival. Easily prepared, already use in arid regions, they could be of particular interest for growth of plants in unfavorable environments.

1 Introduction

Greenhouses for future space exploration will deal with many challenges, among which the lack of disposable water for irrigation and lack of suitable media for plant growth. Indeed, Martian soil contains elements (e.g. magnesium, sodium, potassium and chlorine) which are necessary nutrients for growth of plants, but with very low water retention due to its rocky or sandy texture. The purpose of this study is the short-term assessment of young seedling growth and survival parameters by amending soil with hydrogel. Hydrogels are polymers absorbing large quantity of water and fixing seedling roots (see Figure 1). Thus, they can considerably reduce water stress of the plant and improve their growth and survival.

We propose to study the (i) appropriateness of reducing irrigation water with hydrogels and (ii) the effect of hydrogel on different soils types: classical loam soils and loam soils mixed with soil powder surrounding MDRS station, as Mars soil analogue. Experiments imply control group of untreated plants and hydrogel-treated plants groups, and monitoring length, survival rates on seedlings, and Germination Index on seeds.

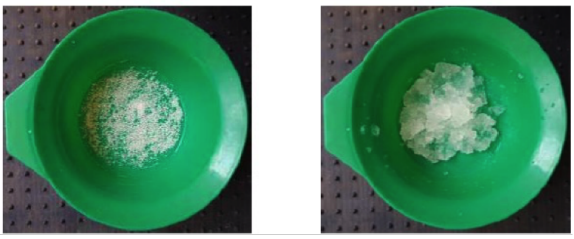

Figure 1: Dry (left) and hydrated (right) Hydrogel [1].

This report presents the experimental plan of studies to be conducted at Mars Desert Research Station (MDRS) about the effect of hydrogels on the plants growth and survival.

2 Seedling length and survival rates

We propose a completely randomized experimental design with 6 seedlings for each treatment: soil amended hydrogel (0.1% (w/w) hydrogel Stockorb) and control soil. For reduced irrigation water experiments, plants will be watered each 4 days. For soil types experiments, loam will be mixed with soil powder surrounding MDRS station (see Table 1). Plants length and survival rates will be followed daily.

3 Germination index

Germination index (Gindex) is defined as [3]:

$$G_{index} = \frac{G}{G_o} \cdot \frac{L}{L_o} \cdot 100$$

where G and L are the number of germinated seeds and root length in presence of hydrogel, respectively.

	Reduced irrigation	Control	Loam w/ soil powder	Control	Reduced irrigation + loam w/ soil powder	Control	Normal condition
Irrigation	4 days	4 days	2 days	2 days	4 days	4 days	2 days
Hydrogel	+	-	+	-	+	-	-
Soil powder	-	-	+	+	+	+	-

Table 1: Survival rates.

G_o and Lo are respectively the number of germinated seeds and root length in the control conditions, where dishes are filled with 10 mL of distilled water (control) or with hydrogel (previously reduced in powder) saturated with water. Dishes are placed at 25 °C for 72 h in dark conditions.

4 Conclusions and perspectives

Hydrogel amendment of soil, despite halving the frequency of watering, already showed a positive impact on the development of seedling's parameters while keeping similar survival rates, and a general overall enhancement of plant growth and quality [3]. The results obtained in arid regions or sandy soils showed that the amendment of the soil by hydrogel has saved the irrigation water, reduced the effects of water stress after transplantation of seedlings [1, 2].

This study proposes to analyze the effects of hydrogels in the particular context of space exploration Greenhouse: limited equipment, limited space and water, and local soils generally considered as less suitable for plant growth. Hydrogels could provide a robust and innovative equipment to set up a Greenhouse enhancing growth and quality and/or allowing the use of in situ loam from Martian soil powder to support good plant growth.

5 Material

- Hydrogel Stockorb 1kg

About the author

Frédéric Peyrusson will assume the role of biologist and medic of the MDRS crew. After a master degree of Health Engineering and a master degree of Pharmaceutical Sciences, Frédéric started his PhD in 2013, in Bacteriology, at Université catholique de Louvain, Belgium. His topic deals with persistence of Staphylococcus aureus, especially the ability and survival strategies of the bacteria to survive in particularly unfavorable environments.

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