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PRELIMINARY RESEARCH ON SUPERABSORBENT HYDROGELS BEHAVIOR TO WATER AND FERTILIZERS ABSORPTION AND RELEASE

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INTRODUCTION

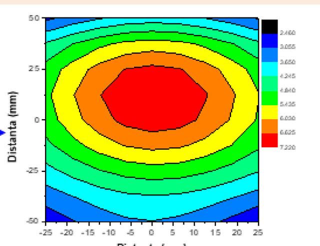
In recent decades, the requirements for food and agricultural production have increased dramatically and have been met mainly by the modernization of agricultural techniques including application of new pesticides and fertilizers. However, one of the main problems faced today is related to ensuring a sustainable use of water and nutrients from soil. To overcome these drawback, research was conducted in the development of biodegradable superabsorbent polymers (BSPs) in order to be applied in agriculture. The BSPs are biodegradable hydrogels with functional properties which allow them to absorb and retain impressive amounts of water and fertilizers which are later slowly released into soil, when necessary.

MATERIALS AND METHODS

Obtaining BSPs by irradiation with accelerated electrons (EA) was achieved using the existing electron accelerator (ALID 7, Figure 1) in the Electron Accelerator Laboratory, INFLPR. The monomeric solutions that form the basis of obtaining the hydrogels are introduced into medical syringes (10 ml) with a diameter of 1.5 mm and irradiated in atmospheric conditions and at a room temperature of 25 °C.

Figure 1. ALID 7 linear electron accelerator: Irradiation installation and control desk

m	-50	-25	0	25	50
-50	4.80	5.05	5.17	5.11	4.90
-25	5.70	6.05	6.21	6.12	5.84
0	6.38	6.80	6.98	6.86	6.50
25	6.60	7.03	7.21	7.07	6.68
50	6.25	6.64	6.80	6.67	6.30



mm	-50	-25	0	25	50
-50	1.77	1.79	1.80	1.79	1.78
-25	1.81	1.84	1.85	1.85	1.83
0	1.83	1.86	1.88	1.88	1.86
25	1.83	1.87	1.88	1.88	1.86
50	1.81	1.84	1.85	1.84	1.82

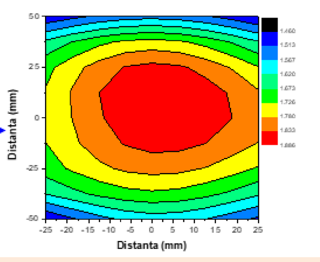


Figure 2. Surface distribution of the absorbed dose (isodoses in the horizontal plane) at different distances from the accelerator exit window: (a) 300 mm; (b) 680 mm

In order to determine the precise position of the elastomeric materials that must be irradiated, respectively the usable surface in the horizontal plane (the geometry of irradiation or the dimensions of the cross section, which delimits the surface of the sample to be irradiated) and the distance from the exit window of the accelerator (distance H), the ampoules with dosimetric solution were placed on a 100 mm x 100 mm surface. The results of the previously described experiments are presented in Figure 2 and represent the dose distribution on the surface irradiated for 120 sec (isodoses) for 2 distances from the accelerator exit window, namely 300 mm (Figure 5a) and 680 mm (Figure 2b).

RESULTS AND DISCUSSIONS

❖ **Development of BSP preliminary technical requirements for soil moisture and nutrient control.**

As part of this activity, experiments were carried out to evaluate the swelling and release capacity of water and nutrient solution of some degradable superabsorbent materials (BSPs) developed by partner P1 and presented in Table 1.

Degradable superabsorbent materials (BSPs) presented in Table 1, were tested in different conditions, using running water and a nutrient solution with pH 7. The behavior of the materials during swelling was followed, and the mass and diameter of the samples were determined of BSP, both after 24 hours and after 48 hours of immersion.

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Table 1. Hydrogels (BSPs) selected for testing

Hydrogel dode		Distilled water	
	Dose (kGy)	S_{max}(%)	*EWC*(%)
A - kGy	15	8180	97.79
A1 - kGy	15	12370	99.20
B - kGy	15	12369	99.20
B1 - kGy	15	16552	99.40
C - kGy	25	3791	97.43
C1 - kGy	25	3147	96.92
D - kGy	20	4881	97.99
D1 - kGy	20	3495	97.22

Figure 3. Appearance of samples immersed in water (left) and nutrient solution (right)

❖ **Evaluation of swelling capacity**

The swelling experiments were carried out in water from the network and in a commercial nutrient solution (Figure 3), at room temperature (25 ± 0.1°C) following the increase in mass depending on the time kept in the immersion environment (24 and 48 hours).

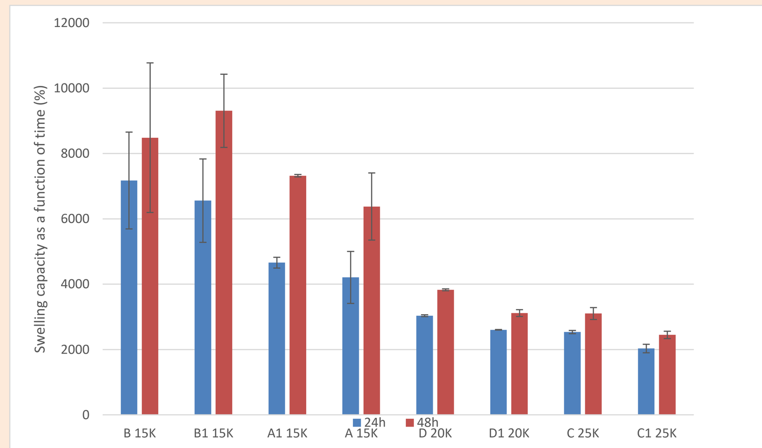

Figure 4. Swelling capacity as a function of time of the samples held in water

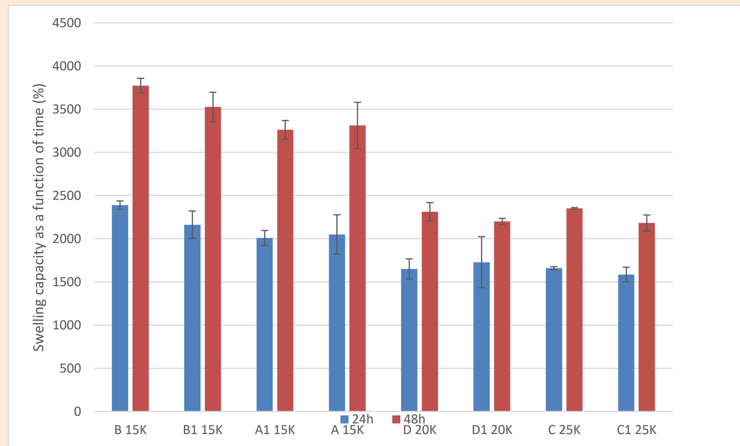

Figure 5. Swelling capacity as a function of time of samples kept in nutrient solution

Following the experiment performed, it can be observed that the samples B 15K, B1 15K, A1 15K and A 15K presented a high capacity to absorb water (Figure 4), but also of the nutrient solution (Figure 5) compared to the rest of the studied samples . However, the amount of water absorbed is twice the amount of nutrient solution absorbed, for all samples studied.

❖ **Evaluation of the capacity to release water and nutrient solution**

Next, the samples were removed from the water and nutrient solution and buried in a natural soil (Figure 6) to determine their release capacity. The results obtained are presented below.

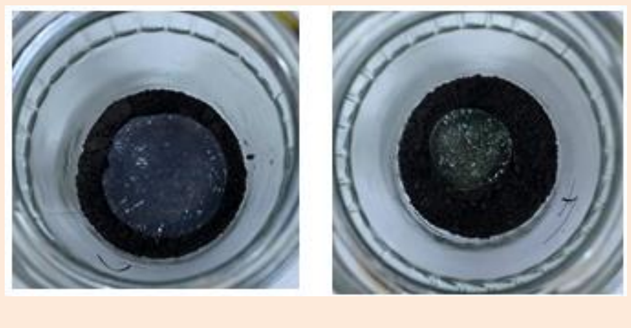

Figure 6. Appearance of samples swollen in water (left) and nutrient solution (right) before burial in soil

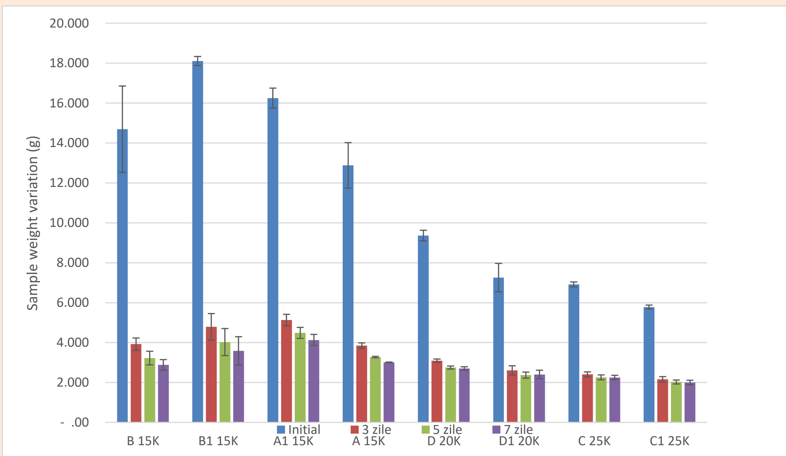

Figure 6. Variation of the weight of the water-inflated samples during the analysis period

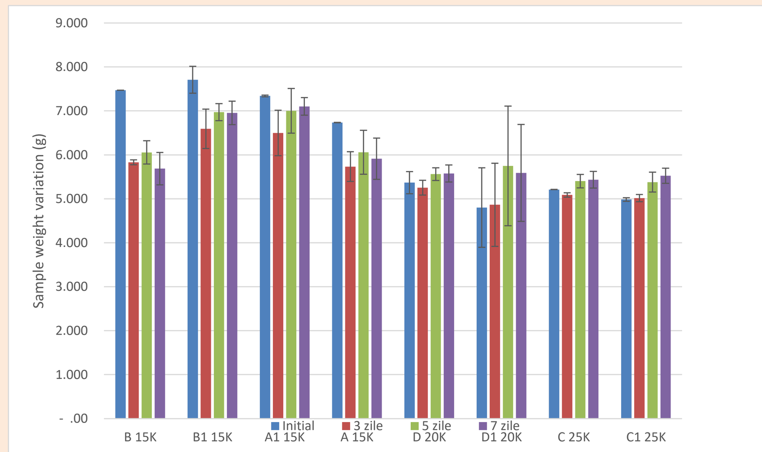

Figure 7. Variation of the weight of samples swollen in nutrient solution, during the analysis period

It can be seen that a large amount of water (more than half of the retained amount) was released by the samples during the first 3 days of retention in the soil (Figure 6), after which the release was slow and in small amounts. Related to the samples immersed in the nutrient solution (Figure 7), a slow and small release of the solution can be observed for all tested samples.

CONCLUSIONS

The obtained results are promising, showing that the capacity of absorption and release depend on various factors including the obtaining method and composition of the BSPs or pH of the tested solutions.