Performance and Theoretical Advantages of Polyacrylamide Hydrogel

An appropriate blend of growing media components increases water holding capacity and reduces irrigation frequency. Synthetic commercial materials, referred to as “hydrogels,” have remarkable hydrating properties, but can add significantly (~15%) to the cost of growing media. The question remains: do hydrogels work as media amendments for container agriculture?

The physical properties of polyacrylamide hydrogel (PAM) was characterized by itself with different water qualities and in the electron microscope (Figs. 1 and 2). New Guinea impatiens (*Impatiens hawkeri* Bull) were grown with substrate containing different amounts of PAM and plant growth, quality, and irrigation needs were measured.

Figure 1. Scanning electron micrographs of hydrated structure of PAM in 0.1 M $Ca(NO_3)_2$ (A), 0.05 M $Ca(NO_3)_2$ (B), tap water (C), and reverse osmosis water (D).

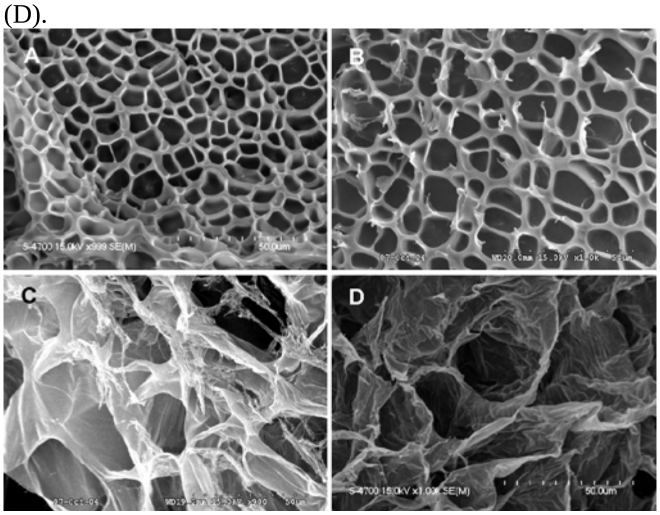
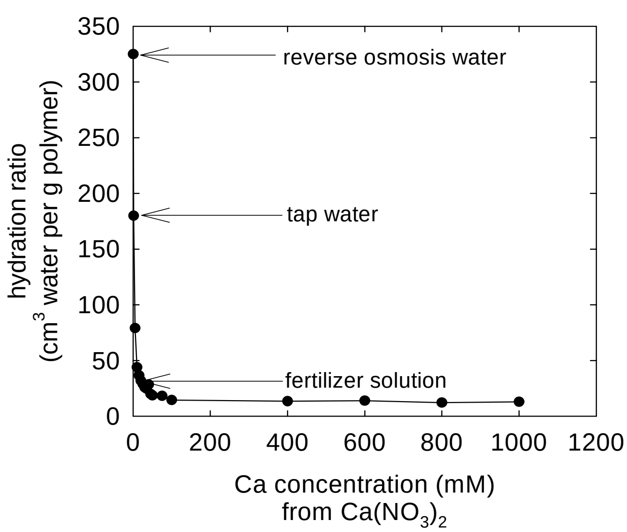


Figure 2. Effect of water quality and $Ca(NO_3)_2$ on hydration properties of PAM.



Total flower numbers and flower longevity of New Guinea impatiens decreased with increasing amount of PAM (16.7% or higher) in the media. PAM incorporation reduced the need for irrigation early in production for both species, but by the end of production, those New Guinea impatiens plants were smaller (less shoot dry mass) and required irrigation as often as plants grown without PAM (Table 1). This effect coincided with reduced media volume, air capacity, and total porosity in PAM-containing media.

Table 1. Days between irrigation events for the New Guinea impatiens hanging baskets that contained different amounts of hydrated polyacrylamide hydrogel in Experiment 4, and the total number of irrigations for the 100-day growing period.

Polymer content (% hydrated volume)	Irrigation Event 1st	3rd	5th	7th	9th	Total irrigations
0	4	8	8	6	6	13
16.7	8	7	7	6	6	12
28.6	13	9	9	7	4	10
37.5	14	10	10	8	4	10
44.4	15	9	9	7	4	10

Potential for Irrigation Savings: Consumers

Typical C3 plants have water use efficiencies of at least 300 g of water used per g biomass formed. Assuming an average of 30 moles photons per m^{-2} d^{-1} × radiation capture (assume a value of 90% for these finished, mature plants) × photosynthetic or quantum efficiency of 0.04 moles C fixed per mol photons = 1.08 moles C fixed per m^{-2} d^{-1}. Assuming that plants are composed primarily of carbohydrates, this translates to 32.4 grams of biomass m^{-2} d^{-1} (dry weight). To achieve this, 5.8 L of water was needed per pot per day (32.4 × 300 cm^3 H_2O/g biomass, plant area of 0.6 m^2; 1 g H_2O = 1 cm^3 H_2O). This is far more water than is available with a media mix that consists of 85% peat, and after the media volume and hydration capacity of PAM is decreased throughout production, is far greater than that available with a media mix containing substantial PAM.

Overall, the use of PAM may be beneficial to growers desiring less frequent irrigations for their plants, but if used, watering techniques must change to accommodate slower rewetting time, its use will likely minimally decrease flower number, decrease some plant species’ size, decrease media porosity with time, and lose its effectiveness after the initial three weeks of plant production.

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