# Polyacrylamide Hydrogel Properties for Horticultural Applications

Polyacrylamide (PAAm) hydrogels are commonly employed to ensure soil hydration in horticulture, but studies have shown mixed results in effects on crop life and quality. The properties of PAAm hydrogels can be adjusted by synthesis conditions, copolymerization with other monomers, and chemical modification; however, the exact composition and structural properties of available commercial hydrogels are not known. The objective of this study was to synthesize PAAm hydrogels of different compositions and compare their water absorption and retention properties under simulated plant growth conditions with those of commercial hydrogels.

The swelling ratios of the synthesized PAAm gels were much smaller than the commercial gel (Table 1). This suggests the commercial gels are modified, either chemically or synthetically to facilitate greater swelling. Scanning electron microscopy analysis showed pore sizes between the two gels were similar, negating the possibility the commercial gel was synthesized with porosity generators (Figure 1). Further synthesis of PAAm gels with ionic groups and decreased cross-linker concentrations increased swelling ratios to near that of the commercial gel, suggesting commercial hydrogels are modified in this manner (Table 2).

Table 1. Comparison of swelling of typical samples of commercial and synthesized gels.

| | Commercial gel | Synthesized gel |
|---|---|---|
| Composition | Unknown | 2 g AAm, 1 mg MBAAm, and 20 mL DI water |
| Swelling ratio | 326.2 | 71.9 |

Table 2. Effect of reaction with NaOH and triethylamine (TEA) solutions to form ionic groups on the swelling of synthesized gels.

| | | Swelling ratio | | |
|---|---|---|---|---|
| Gel composition | Texture | Unmodified | NaOH hydrolysis | TEA hydrolysis |
| 4 g AAm, 100 mg MBAAm, and 10 mL water | Hard | 13.8 | 75.2 | 47.2 |
| 2 g AAm, 1 mg MBAAm, and 20 mL water | Soft | 71.9 | 349.3 | 409.7 |

The ability to absorb water many times their weight makes hydrogels susceptible to breakage under small force; which becomes an issue when gels are placed in compacted soils. The results from both the synthesized hydrogels and commercial gels indicated an inverse relationship between the compressive strength and the gel swelling ratio. In dehydration studies, both commercial gels and the synthesized gels lost almost all their available water within 10 hours. Degradation studies illustrated no discernible trends in PAAm breakdown over time.

In summary, it is most likely that commercial gels are not pure PAAm hydrogels, but modified ionic ones. Their poor performance in horticultural applications is from poor water retention properties, not PAAm degradation. In order for PAAm hydrogels to be successful in growth media, the mechanical strength of hydrogels has to be carefully balanced with water-absorbing properties. Improved properties need to be developed.

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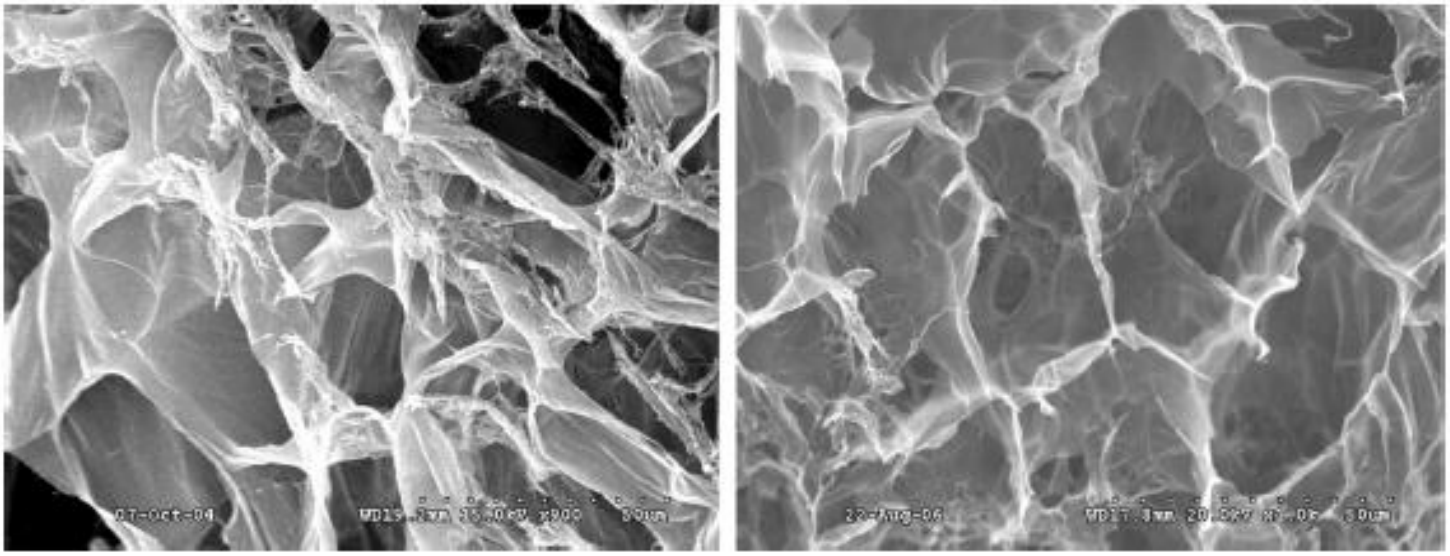

Figure 1. Scanning electron microscope images of swollen commercial and synthesized hydrogels showing their pore structure: (a) commercial structure, and (b) low cross-linked synthesized hydrogel. Scale in the lower right of each picture indicates 50µm.

Kim, S., G. Inyer, A. Nadarajah, A. Spongberg, and J.M. Frantz. 2010. Polyacrylamide hydrogel properties for horticultural applications. International Journal of Polymer Analysis and Characterization. 15:307-318.