Water Absorption of Hydrophylic Polymers (Hydrogels) Reduced by Media Amendments[1]

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Abstract

Water absorbency of 4 commercially available hydrophylic polymers (hydrogels) (Agrosoke, Liqua-gel, Mizuace and Terra-sorb HB) in response to 4 media amendments (Micromax, Osmocote 18N-2.6P-10.0K (18-6-12), gypsum and dolomitic limestone) and the combination of 4 amendments was determined. Water absorbency of 4 hydrogels was reduced by all amendments except Osmocote added to Liqua-gel. Generally, hydrogel absorbency was reduced most by Micromax and the combination of media amendments, followed by gypsum, Osmocote, and dolomitic limestone. None of the hydrogels functioned as advertised.

Index words: hydrogel, starch copolymer, polyacrylamide copolymer

Significance to the Nursery Industry

Water-absorbing hydrogels can absorb many times their weight in water. However, their absorbency is greatly reduced by Micromax, gypsum, Osmocote 18N-6.2P-10K (18-6-12), and dolomitic limestone, compounds which are frequently used as amendments to nursery and floriculture potting media. This reduction in hydrogel absorbency appears to result from the presence of free ions, primarily cations, released by incorporated media amendements. Functioning of hydrogels in amended media is not likely to occur as advertised and there use is not recommended.

Introduction

Water absorbing hydrophylic polymers (hydrogels), which can absorb up to 1000 times their weight in water, are being promoted as media amendments to reduce watering frequency of container-grown plants (2, 5, 14, 15), enhance plant growth (2) and increase media nutrient retention (8) and shelf-life of pot crops (2, 5, 6, 14). However, these purported benefits have not always been supported by research (1, 3, 7, 9).

During 3 years of testing, hydrogel added to media of containerized nursery stock did not alter irrigation frequency, and minimally influenced foliar and growth medium nutrient levels and plant growth (12).

Conflicting results in hydrogel absorbency may be due to free ions in irrigation water or to hydrogel type. Gel absorbency was reduced by saline irrigation water containing high concentrations of divalent cations (11). Water absorbing properties of the 3 main chemical families of hydrogels (starch acrylate copolymers, polyvinylalcohol copolymers and polyacrylamide copolymers) are affected differently by the nature and concentration of dissolved salts in irrigation waters (11). In this study, the influence of several standard media amendments on the absorbency of 4 commercial hydrogels was assessed.

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Materials and Methods

Agrosoke[4], Liqua-gel[5], Mizuace[6] and Terra-sorb HB[7] were used at manufacturers' suggested incorporation rates of 1.3, 3.0, 1.8, and 1.2 kg/m^3 (2.3, 5.1, 3.0 and 2.3 lb/yd^3), resp. These 4 hydrogels are promoted as absorbing 30 to 40, 600 to 800, 500, and 300 to 400 times their weight in water, resp. Each hydrogel was blended with one of 4 commonly used media amendments and the combination of all 4 amendments at recommended incorporation rates and placed in 250 ml (8.5 oz) beakers with 200 ml (6.8 oz) of deionized water. Amendments and rates included Micromax at 0.9 kg/m^3 (1.5 lb/yd^3), Osmocote 18N-2.6P-10K (18-6-12) at 7.1 kg/m^3 (12.0 lb/yd^3), dolomitic limestone at 3.6 kg/m^3 (6.0 lb/yd^3) and gypsum ($CaSO_4$) at 1.2 kg/m^3 (2.0 lb/yd^3). A control containing deionized water and hydrogel was also included with each set of treatments. Beakers were shaken gently for 4 hours and excess water filtered through a sieve and weighed. The difference between the weight of water added and the weight of water decanted was the amount of absorbed water. No plants were grown in the gel medium. The experimental design consisted of 5 replicates of 3 beakers in a randomized complete block design. Data were analyzed using ANOVA and treatment means were compared using Duncan's multiple range test.

Results and Discussion

Micromax, Osmocote, dolomitic limestone, gypsum and the combination of 4 amendments reduced absorbency of all 4 hydrogels, compared to the control (Table 1). Only Osmocote treatments in Liqua-gel absorbed similarly to the control.

The magnitude of reduction in water absorbency compared to the control treatment varied with amendments and hydrogels. The variation ranged from 67.5–96.5% with Mi-

[4]Polyacrylamide copolymer, Grosoke International, Forth Worth, TX 76118.

[5]Starch-acrylate potassium copolymer, Miller Chemical and Fertilizer Corp., Hanover, PA 17331.

[6]Starch-acrylate sodium copolymer, Sanyo Chemical Industries, Kyoto, Japan.

[7]Acrylamide copolymer, Industrial Services International, Bradenton, FL 33507.

Table 1. Effects of media amendments on the absorption of deionized water by four commercially available hydrogels.

Amendment	Rate (kg/m^3)	Hydrogel			
		Agrosoke	Liqua-gel	Mizuace	Terra-sorb HB
		g water absorbed/g hydrophylic polymer			
Micromax	0.9	21.7 de[z]	20.2 d	30.3 e	20.9 e
Osmocote 18-6-12	7.1	24.9 cd	272.9 a	485.7 b	121.6 c
Dolomitic limestone	3.6	38.5 b	246.1 b	399.1 c	196.3 b
Gypsum	1.2	19.1 e	69.4 c	133.7 d	57.8 d
Combination[y]	12.8	28.9 c	28.9 d	18.0 e	23.9 e
Deionized water		66.8 a	289.4 a	866.5 a	243.9 a

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

[y]Contained Micromax, Osmocote 18N-6.2P-10K (18-6-12), dolomitic limestone and gypsum.

cromax with all 4 hydrogels, to 4.4–50.1% with Osmocote, to 14.9–53.6% with dolomitic limestone, to 71.4–84.5% with gypsum, and to 56.8–97.9% with the combination of all 4 amendments. The greatest reduction in water absorbency was when Micromax or the combination of all 4 amendments was added to hydrogels, followed by gypsum. Both Osmocote and dolomitic limestone had the least effect on water absorbency. Plants were not grown in the gel medium which may have influenced the amount of water absorbed by the gel.

Differences in the influence of the 4 amendments on hydrogel absorbency are probably due to their ability to yield free ions in solution and to the type of free ions released. For example, Micromax, which dramatically reduced water retention, releases various hydrated ions in water (10). Gypsum, which reduced absorbency more than dolomitic limestone, has a solubility of 0.241 g (.0085 oz) per 100 cc (3.4 oz) of water, while the solubility of dolomitic limestone is 0.032 g (.0011 oz) per 100 cc (3.4 oz). Osmocote 18N-2.6P-10K (18-6-12), which along with dolomitic limestone had the least influence on absorbency, has immeditely available nutrients of only 1.4% (13). Multivalent ions, particularly the divalent cations Ca^{2+}, Mg^{2+}, and Fe^{2+}, have previously been shown to decrease hydrogel water absorbency (4, 11), probably by actively dislodging and replacing water at polarized sites upon and within the gel copolymer (10). Micromax in contact with moisture slowly releases Fe^{2+}, Mn^{2+}, Zn^{2+}, and Cu^{2+}, among other cations, over an 18 month period. Gypsum and dolomitic limestone release Ca^{2+} and Ca^{2+} plus Mg^{2+}, resp. Osmocote 18N-2.6P-10K (18-6-12) releases the cations NH_4^+, K^+ and Ca^{2+} over an 8- to 9-month period at 21.1°C (70°F). Reduced absorbency by hydrogels in the presence of fertilizer salts is supported by previous research (4, 10, 11).

Although Agrosoke, Liqua-gel, Mizuace and Terra-sorb HB represent 2 distinct families of hydrogels, they were not similarly influenced by fertilizer amendments. Mizuace absorbed the greatest amount of deionized water but the least when all 4 amendments were present. However, for Agrosoke the amount of water absorbed alone seemingly had no correlation with the amount of water absorbed in amended media. Perhaps differences in reported performance of hydrogels related to amounts and type of media amendments in addition to irrigation water quality and type of hydrogel.

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