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Effects of Irrigation Frequency and A Water-Absorbing Polymer Amendment on Ligustrum Growth and Moisture Retention by a Container Medium[1]

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Abstract

Amending a 2 pine bark : 1 Canadian peat : 1 sand (by vol) container medium with 0, 1.2, 2.4, 3.6 or 6 kg/m^3 (0, 2, 4, 6 and 10 lbs/yd^3) of a water-absorbing polymer, Moisturite[3], did not influence the volume of water held at tensions less than 100 cm (39 in). Greenhouse-grown *Ligustrum japonicum* wilted when irrigated (920 ml/application; 31 oz) every 12 days; however, more frequent irrigation treatments (every 6 and 3 days) reduced shoot and root dry weights. Dry weights were not affected by polymer amendment rates nor were container medium temperatures different 1, 2 or 3 days after irrigation.

Index words: moisture-release curve, water stress, pine bark, peat, sand

Introduction

Water management is one of the most critical factors in production of quality container-grown plants. A proper balance between available water and aeration is essential (2, 3, 4). A container medium with adequate drainage is required for the rainy season with many consecutive days of rainfall, but this medium will require frequent irrigation during dry periods. The cost and availability of water during drought periods place constraints on nursery operators.

Water-absorbing polymers have been used in an effort to increase container media waterholding capacity (1, 5, 8). These polymers may be synthetic or hydrolyzed starch polymers. Banko (1) reported fall garden mums were larger and had more flower buds under reduced irrigation when the pine bark : sand (4:1 by vol) medium had been amended with Terra-Sorb 200[4], a starch polymer, at 1.2 kg/m^3 (2 lbs/yd^3). Gibson and Whitcomb (5) evaluated Terra-Sorb 200 as a substitute for peat in a pine bark based medium and found that 1.2 kg/m^3 (2 lbs/yd^3) resulted in good shoot and root growth of *Ulmus parvifolia* and *Juniperus procumbens*, but 2.4 kg/m^3 (4 lbs/yd^3) reduced root growth of juniper under the given irrigation management. *Ilex* 'Nellie R. Stevens' and *Cupressocyparis leylandii* 'Haggerston Grey' were grown under 5 irrigation regimes (2 times daily to every 4 days) outdoors in a pine bark based medium amended with 2 water-absorbing polymers or bentonite clay (8). Irrigation at the longest interval did not stress the test plants and the polymer amendments did not affect growth.

An experiment was conducted to evaluate the effects of 5 rates of a water-absorbing polymer and 3 irrigation frequencies on *Ligustrum japonicum* growth. The effects of the polymer on growth medium moisture retention were also determined.

Materials and Methods

Ligustrum japonicum rooted cuttings were potted June 24, 1985 in 3 l (#1) nursery containers with a medium of 2 parts pine bark : 1 part Canadian peat : 1 part builders' sand (by vol). The medium was amended with Perk[5] and dolomitic limestone at 1.8 and 3 kg/m^3 (3 and 5 lb/yd^3), respectively and Moisturite, a water absorbing polymer, at rates of 0, 1.2, 2.4, 3.6 or 6 kg/m^3 (0, 2, 4, 6 and 10 lbs/yd^3). Moisturite is a starch-grafted polyacrylate polymer manufactured by Celanese, Inc. Sufficient growth medium amended with the water-absorbing polymer was prepared for determination of a moisture release curve.

Additional containers were filled with the medium amended with 0, 1.2, 2.4 or 3.6 kg (0, 2, 4 and 6 lbs/yd^3) of water-absorbing polymer per m^3 and brass cylinders (8.5 cm dia × 6 cm ht) (3.3 in dia × 2.4 in ht) were inserted into the medium. These containers were watered daily for 2 weeks before the cylinders with intact, naturally compacted medium were extracted. These sample cylinders were placed in Tempe pressure cells[6] and water was added to saturation. After saturation was assured, each pressure cell with saturated sample was weighed. The pressure cells were weighed

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[3]Manufactured by Celanese, Inc., Louisville, KY.

[4]Distributed by Industrial Services International, Inc., Bradenton, FL.

[5]Micronutrient formulation by Estech, Inc., Winter Haven, FL.

[6]Manufactured by Soilmoisture Equipment Corp., Santa Barbara, CA.

again after allowing the growth medium sample to come to equilibrium with 10, 15, 30 or 100 cm (3.9, 5.9, 11.8, or 39 in) of tension. Most moisture utilized by container-grown plants is held at less than 100 cm (39 in) of tension (3, 7). The samples were then oven-dried and the weight was recorded. The water released from 2 samples of medium for each of the 4 rates of polymer incorporation plus the control was determined and repeated to yield 4 replicates. The amount of water remaining in the medium after equilibration with each tension was expressed as a percent of the cylinder volume.

Plants were grown in an unshaded glasshouse in Gainesville, Florida until January 16, 1986. Daylength was extended for the duration of the experiment by providing a night interruption with incandescent lights (14 umole/m^2/s) from 10:00 pm to 2:00 am. Twelve grams (0.4 oz) of Osmocote 18N-2.6P-9.9K (18-6-12) were surface applied at potting and every 90 days thereafter. Water was applied to the surface of each container through Dramm drip rings at the rate of 920 ml (approximately 1 in) per application at 3 frequencies. Plants were irrigated at either a low, medium or high frequency, corresponding to every 8, 4 or 2 days for the first 5 weeks then every 12, 6 or 3 days thereafter. The growth medium was consistently wet, generally moist, or dry to the point of wilting before irrigation for the high, medium and low irrigation frequencies, respectively. The factorial arrangement of treatments (3 irrigation frequencies × 5 polymer rates) was replicated 8 times in a randomized complete block design.

Three replicate containers of medium with each polymer rate were placed on an outdoor gravel bed in July. These containers without plants were watered daily (920 ml) for 1 week before temperature fluctuations were recorded using an Esterline-Angus datalogger with welded copper-constantan thermocouples. Temperatures were recorded in the center of the medium and 2 mm from the interface between the container and the medium on the western exposure. Temperatures were recorded every 15 min for 3 consecutive days after irrigation.

Results and Discussion

There were no interactive effects of irrigation and water-absorbing polymer amendment rates on plant height or shoot and root dry weights. *Ligustrum japonicum* height, and shoot and root dry weights decreased with increasing irrigation frequency (Table 1). Water-absorbing polymer amendment rate did not affect shoot or root dry weight, but plant height was reduced slightly by increasing rates of polymer incorporation. The low frequency of irrigation resulted in plant wilting between irrigations, but also resulted in the greatest growth. There were no visible differences in wilt occurrence among plants in the media at the 5 polymer rates. Beardsell, et al. (2) reported that marigolds did not wilt in a pine bark medium for up to 8 days, while the same plant species wilted in peat or a sandy loam container media. Plant wilting was not directly related to available soil moisture without consideration of such factors as the differences in evaporation loss between media. Plant performance remains the most meaningful method of evaluating water relations in container media.

The water-absorbing polymer made no measurable difference in the moisture retention over the range of 0 to 100 cm (0 to 39 in) of tension (Fig. 1). Sixty-two to 68 percent of the medium volume was occupied by water at saturation regardless of polymer treatment. Only 38 to 40 percent of the growth medium volume was filled with water held at tensions greater than 15 cm (5.9 in). This means that approximately 50% of the water at saturation was held at tensions less than 15 cm (5.9 in).

An average of 22 percent of the water volume at saturation was held at tensions greater than 100 cm (39 in) regardless of polymer amendment rate. DeBoodt and Verdonck (4) reported that the amount of moisture held at tensions greater than 100 cm (39 in) in a peat-based media was important for floricultural crops. It has been observed by the authors that the relatively low volume of water available to the plant in porous, pine bark-based media, especially in small containers, would support normal evapotranspiration for a relatively short period. Water stress would occur quickly during a hot summer day if the water supply in the growth medium is not replenished by irrigation before water held at tension less than 100 cm (39 in) is depleted.

Temperatures recorded at the two positions in the container medium were not influenced by polymer amendment at either 1, 2 or 3 days after irrigation (data not shown). Temperature extremes and the general pattern of tempera-

Table 1. Effects of irrigation frequency and water-absorbing polymer amendment rate on height and shoot and root dry weight of container-grown *Ligustrum japonicum*.[z]

Irrigation[y] frequency	Polymer rate (kg/m^3)	Height (cm)	Shoot dry weight (g)	Root dry weight (g)
Low		59.4	26.2	16.8
Medium		50.8	19.7	14.8
High		35.6	10.6	10.5
Significant effects		linear	linear	linear
PR > F		.0001	.0001	.0001
	0	52.0	19.5	13.5
	1.2	52.9	19.9	12.7
	2.4	46.1	18.6	15.1
	3.6	48.0	17.9	13.4
	10.0	44.1	18.3	15.3
Significant effects		linear	ns	ns
PR > F		.03		

[z]There was no significant interaction of irrigation frequency and polymer rate.

[y]Low, medium and high irrigation frequencies correspond to every 8, 4 and 2 days for 5 weeks, and 12, 6 and 3 days thereafter, respectively.

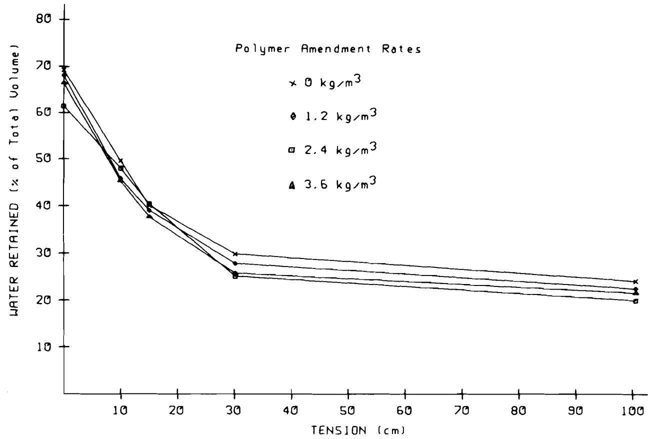

Fig. 1. **Water retained in a 2 pine bark : 1 peat : 1 sand (by vol) medium at tensions less than 100 cm (39 in) as affected by water-absorbing polymer amendment rates. (2.54 cm = 1 in)**

ture fluctuations were similar to those published previously (6).

Significance to the Industry

Amending a 2 pinebark : 1 Canadian peat : 1 sand (by vol) growth medium with Moisturite water-absorbing polymer did not alter moisture retention at tensions less than 100 cm (39 in) or affect *Ligustrum japonicum* growth. This research would question the suggested benefit from this polymer in this pine bark based medium. Greenhouse-grown ligustrum wilted when irrigated every 12 days during summer months; however, irrigation every 6 or 3 days resulted in reduced plant growth. Nursery operators scheduling irrigation should consider that moderate wilt between irrigations did not reduce ligustrum growth or quality.

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