Effect of Irrigation Frequency on Sedum Grown in Alternative Substrates

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Index words: container media, eastern red cedar, nursery crops, pine bark, *Sedum spectabile* 'Autumn Fire'

Significance to Industry: Increasing shipping costs of pine bark (PB) and demand from other uses such as for fuel, has accelerated the need to find alternative substrates for nursery crop production. This need is particularly important in the Great Plains region where no native pine stands are available for bark harvest. Eastern red cedar (*Juniperus virginiana* RC), however, is abundant and finding uses for it will help recover prairie ecosystems currently being lost to red cedar invasion. Recent research has suggested that eastern red cedar can be used as an alternative substrate, but its physical properties (high air space, low container capacity) tend to limit its use as a full replacement for pine bark. The purpose of this study was to evaluate irrigation frequency as a method to improve and potentially overcome some of the physical properties of eastern red cedar as a substrate. The results of this study demonstrate that Sedum does not benefit from increased frequency and can be grown in PB/RC and red cedar mixes.

Nature of Work: Pine bark has been used for many years as a substrate for nursery production. Due to increases in demand for alternative uses of PB, such as fuel, PB is becoming more difficult to locate for use in the horticulture industry (2, 3). A previous study by Murphy et al. (2010) evaluated Clean Chip Residual and *WholeTree* substrates as alternatives to PB. In the study Murphy et al. (2010) reported that 'New Gold' lantana (*Lantana camara* L. 'New Gold', 'Gold Mound' spirea (*Spiraea japonica* L.f. 'Gold Mound'), 'Amaghasa' azalea (*Rhododendron x* 'Amaghasa'), tea olive (*Osmanthus fragrans* Lour.), 'Roundifloia' ligustron (*Ligustrum japonicum* Thunb. 'Rotundifolia'), and Soft Touch' holly (*Ilex crenata* 'Soft Touch') grown in a greenhouse setting potted in PB amended with 75% alternative substrates were comparable to PB.

Eastern red cedar has been used as an alternative to PB in a nursery setting using Black-eyed Susan (*Rudbeckia fulgida* var *fulgida*) (4). In this study, RC was noted to have high container capacity and low air space (4), which may limit plant growth. Warren et al. (2002) reported that using Cotoneaster (*Cotoneaster dammeri* 'Skogholm') in a nursery setting and irrigating at 2-hour intervals in the afternoon before 18:00 HR had increased water utilization and thus grew better as they were less stressed.

The purpose of this study was to determine if adjusting irrigation frequencies would increase plant growth when using RC as an alternative substrate.

Materials and Methods: Eastern red cedar (Queal Enterprises. Pratt, KS) was processed through a hammer mill (C. S. Bell Co., Tiffin, OH, Model 30HMBL) with a 3/8-inch screen on 23 June 2011. On 22 July 2011, substrates consisting of 80% PB (SunGro, Bellevue, WA): 20% sand; 40% RC 40% PB: 20% sand (PB/RC); or 80% RC: 20% sand were mixed (by volume). Rooted liners of *Sedum spectabile* 'Autumn Fire' were obtained from Emerald Coast Growers (Pensacola, FL) and were transplanted into quart containers (Classic 200, Nursery Supply INC.) on 22 July 2011. Plants were placed in Throckmorton Plant Science Center greenhouse complex located in Manhattan, KS. Containers were top-dressed with 1 gram of Osmoform 18N-5P-13K 3 – 4 month slow release fertilizer (The Scotts Co. Maryville, OH) on 6 Aug 2011. Plants were watered by hand for 15 days after planting (DAP) to allow plugs to begin rooting into the new substrates and to make sure that the entire substrate profile was moist.

An irrigation system with five zones was designed to irrigate plants at four frequencies. A Rain Bird STP9PL (Tucson, AZ) irrigation controller was used to control the irrigation zones. All plants received 208 ml per day. Zones were broken into different times of watering with all times equaling a total of 208 ml total per day. Plants were watered 1, 2, 3, and 6 times per day using drip stakes (Angle Arrow Dripper 5/3, Netafim, Tel Aviv, Israel). Sedum irrigated 1x were irrigated at 0800 HR; 2x irrigated at 1100 and 1500 HR; 3x irrigated at 0900, 1200 and 1500 HR; and 6x irrigated at 0800, 1000, 1200, 1400, 1600, and 1800 HR. To help control the amount of water applied daily 0.5 gallons per hour (gph) pressure compensating drip emitters (0.5 gph Woodpecker Pressure Compensating Junior Drip Emitter, Netafim, Tel Aviv, Israel) were attached to the main line for each treatment. After 15 DAP the irrigation treatments were initiated. Electrical conductivity (EC) and pH were measured at 42, 62, and 81 DAP using the Pour-Through method (7). At the conclusion of the study, shoot and root dry weights were measured. Growth index (GI) was measured at 25 and 80 DAP and substrate shrinkage was measured at 42 DAP. Shoots were harvested at substrate level and roots were then washed of all substrate. Shoots and roots were placed into paper bags and placed in an oven (Grieve SC-350 Electric Shelf Oven. Round Lake, Il) at 71°C (160°F) until dry weight stabilized (13 days). The experiment was arranged in a randomized complete block factorial substrate by irrigation frequency. Data was analyzed using SAS 9.1 using Waller-Duncan's means separation.

Results and Discussion: Substrates at 42 DAP were significantly affected by pH with PB/RC having the highest pH (Table 1). However 62 and 81 DAP pH was similar between RC and PB/RC which were both higher than PB. Irrigation frequencies were unaffected by pH at any of the DAP measured (data not shown). EC levels were unaffected by substrates until 81 DAP where a difference was seen between PB and PB/RC. RC showed similarities between PB and PB/RC, which were only slight differences (Table 1). Throughout the entire study pH levels were higher then the recommended range of 4.5 to 6.5 according to Yeager et al. (2007). EC levels were low compared to recommendations by Yeager et al. (2007) which are 0.8 to 1.5 dS/m. EC readings were below the recommended levels reading 0.46 to 0.52.

At 25 DAP, PB growth index (GI) of Sedum grown in PB was significantly greater than RC whereas, PB/RC showed similarities to PB and RC, then by 80 DAP RC was significantly lower than the other two substrates (Table 2). During the duration of the study, irrigation frequencies did not have an impact on GI. Shoot dry weight was affected by substrate with PB being greater than RC and PB/RC. In contrast, shoot dry weight was unaffected by irrigation frequency (Table 2). Sedum grown in PB had root dry weight greater than Sedum grown in PB/RC; PB and RC were similar as well as RC was comparable with PB/RC. Root dry weight was significantly affected by irrigation frequencies with 1x being greater than 3x and 6x. This shows that for Sedum better root growth was obtained when watered once per day, but also could tolerate irrigating twice.

In conclusion, this study showed that irrigation had an effect on root dry weight of Sedum, a plant that is able to withstand dry conditions and a high pH range 5.5 to 7.0 (1, 5), The greatest growth was obtained with Sedum planted in PB and irrigated once per day. These results demonstrate that eastern red cedar may be used as a partial replacement for PB when growing Sedum. This study will be replicated with species that are high water users and less tolerant to drought in order to determine if increasing irrigation frequencies can overcome undesirable physical properties for species that are more susceptible to environmental stresses.

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Table 1. Solution pH and electrical conductivity (EC) of substrates[z]

	42 DAP[y]		62 DAP		81 DAP		42 DAP
Substrate	**pH**	**EC (dS/m)**	**pH**	**EC (dS/m)**	**pH**	**EC (dS/m)**	**Shrinkage[w]**
Pine Bark	7.19 c[x]	0.46 a	7.20 b	0.47 a	7.38 b	0.44 b	1.24 b
Red Cedar	7.78 a	0.45 a	7.54 a	0.49 a	7.62 a	0.49 ab	1.93 a
PB/RC	7.48 b	0.52 a	7.52 a	0.49 a	7.66 a	0.50 a	1.34 b

[z]pH and EC of solution obtained by the pour-through method.
[y]Days after planting.
[x]Mean separation within column by Waller-Duncan Multiple Range test ($\alpha = 0.05$, n = 16).
[w]Measurement taken from top of container to surface of substrate.

Table 2. Effect of substrate and irrigation frequency on the growth of *Sedum s.* 'Autumn Fire'

Substrate	**25 DAP GI[z]**	**80 DAP GI**	**Shoot Dry Weight (g)[y]**	**Root Dry Weight (g)[x]**
Pine Bark	12.8 a[w]	19.4 a	7.3 a	10.2 a
Red Cedar	9.4 b	14.8 c	4.4 c	8.6 ab
PB/RC	11.0 ab	17.8 b	5.8 b	7.8 b
Irrigation Frequency				
1x per day	12.0 a	17.7 a	6.0 a	10.6 a
2x per day	12.0 a	17.1 a	6.0a	9.7 ab
3x per day	10.5 a	17.5 a	6.1 a	7.2 c
6x per day	9.6 a	17.1 a	5.3 a	8.0 bc

[z]Growth Index = (height + width + perpendicular width) / 3 (1cm = 0.397 in.).
[y]Shoots harvested at container surface and oven dried at 71°C for 13 days (1 g = 0.0035 oz).
[x]Roots barerooted and oven dried at 71°C for 13 days (1 g = 0.0035 oz).
[w]Mean separation within column by Waller-Duncan Multiple Range test ($\alpha = 0.05$, n = 18).