Comparing the Growth of *Gymnocladus dioica* in a Pea Gravel Medium Amended With Calcined Clay or Expanded Shale©

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The Missouri Gravel Bed (MGB) is a system allowing trees and shrubs to be planted bare root, in full leaf at any time of the year (Gowdy et al., 2002). Dormant plants are placed with their roots in a frequently irrigated mixture of pea gravel and sand and can be removed from the rock for transplanting to the field or to containers with outstanding survival. Because rock and sand have low cation exchange capacity, it is often difficult to maintain the pH and mineral nutrient concentration in the root environment in a range in which minerals are continuously available for root uptake. In studies with *Syringa pubescens* subsp. *patula* 'Miss Kim' and *Nyssa sylvatica*, chlorosis has been a consistent problem. Testing of leachate from the MGB bed revealed that pH was often above 7.8, partially due to alkaline irrigation water. Although the addition of iron sulfate has reduced chlorosis somewhat, it has not proved a practical solution to the nutrient availability problem.

Calcined clay and expanded shale are sometimes used as inorganic soil amendments to improve soil porosity (Bigelow et al., 2000). Since these materials have higher cation exchange capacities than rock and sand, it is possible that, if incorporated into a gravel bed, they may aid in maintaining the pH and mineral content of the gravel mixture in a range more optimal for plant growth (Carlile and Bedford, 1988). The objectives of our study were: (1) to evaluate the effects of mixing a calcined clay (Turface MVP®) or an expanded shale (Haydite®) material in various percentages into pea gravel on growth of *Gymnocladus dioica* seedlings, and (2) to determine the effects of incorporating Turface and Haydite on the pH and conductivity of rinse leachates from pots receiving frequent applications of soluble fertilizer.

To evaluate the effects of amending pea gravel with calcined clay and expended shale on plant growth and nutrient status, mixtures were prepared containing 0%, 20%, 40%, 60%, 80%, or 100% (by volume) of either Turface or Haydite in pea gravel. Since the gravel in MGB contains a small quantity of sand, 10% sand was also incorporated into the gravel in this study prior to incorporating the other amendments. Five pots (1500 cm^3) per treatment were replicated three times in the Ashland greenhouse on the University of Missouri campus. Seeds of *G. dioicus* (Kentucky coffee tree) were soaked in aerated water for 24 h and scarified in

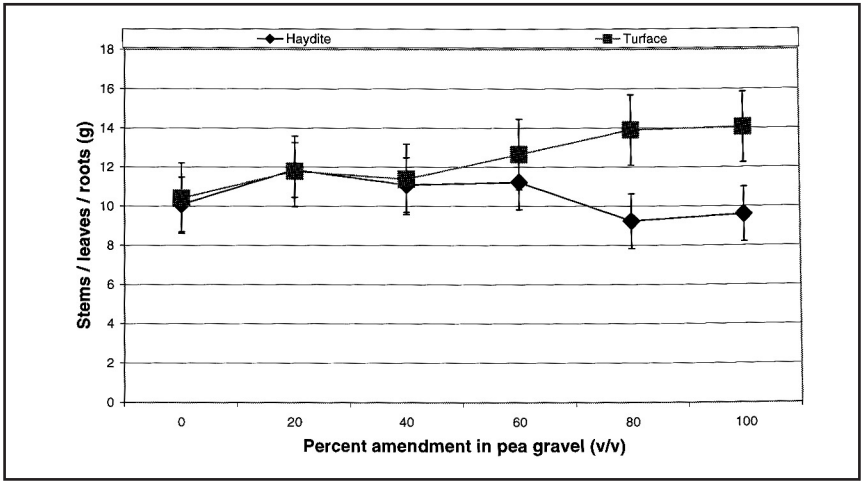

Figure 1. Effects of mixing a calcined clay (Turface MVP®) or an expanded shale (Haydite®) in various percentages into pea gravel on biomass growth of *Gymnocladus dioica* seedlings.

concentrated sulfuric acid for 2 h (Dirr and Heuser, 1987). Seeds were germinated in perlite, and germinants transplanted to pea gravel and amendment mixture in late March after shoots reached 2 cm in length. We applied 250 ml of Technigro® 20N–9P–20K Plus water-soluble fertilizer with sulfur (1.4% by vol) at 350 ppm nitrogen once a week for the first 2 months and twice a week for the last 2 months of the study. Pots were watered with 250 ml of tap water 2 days after fertilization, and the leachate was collected once a week and analyzed for pH and conductivity. After 15 weeks, seedling height and diameters measurements were taken before plants were dried at 55 ºC to determine plant dry (root, stem, and leaf) weights. Three-way analysis of variance and Duncan's multiple range tests were used to test for significant interaction for type of amendment, amendment concentration, and/or time after germination and for treatment differences.

Mean seedling biomass grown in Turface mixtures was greater than that of seedlings grown in Haydite mixtures (Fig. 1). Dry weight of seedlings grown in 100% Turface was over 42% greater than that of seedlings grown in 100% Haydite or gravel. Seedling height was not statistically different at amendment concentrations less than 40%. Mean height of seedlings grown in 60% Turface was 27% greater than of those grown in 60% Haydite. There were no statistical differences in diameters of seedlings grown in Turface- and Haydite-amended gravel.

Differences in conductivity and pH of the rinse leachate increased with increasing seedling size, especially for Turface-amended gravel. During the last month of the study, the leachate conductivity from Turface-amended gravel averaged 2 to 2.7 $mS \cdot cm^{-1}$ (Table 1). Leachate conductivity was consistently higher than that from Haydite-amended gravel, which averaged only 1 to 1.5 $mS \cdot cm^{-1}$ when averaged over all amendment concentrations (5% LSD = 0.34 $mS \cdot cm^{-1}$). Mean pH of leachate from Turface-amended mixtures decreased from 7.7 at the beginning of the study to 7.3 by the end of the 15-week growing period, while the mean pH for the Haydite-amended mixtures only decreased from 7.9 to 7.7.

Table 1. Effects of incorporating Turface MVP and Haydite on the conductivity of rinse leachates from pots receiving frequent applications of soluble fertilizer (5% LSD = 0.34 $mS \cdot cm^{-1}$).

		Haydite				
	Pea gravel ($mS \cdot cm^{-1}$)	20% ($mS \cdot cm^{-1}$)	40% ($mS \cdot cm^{-1}$)	60% ($mS \cdot cm^{-1}$)	80% ($mS \cdot cm^{-1}$)	100% ($mS \cdot cm^{-1}$)
Week 5	1.029	1.048	1.052	1.046	1.06	1.076
Week 10	0.980	0.984	0.959	0.854	0.89	0.859
Week 15	1.233	1.107	1.179	1.008	0.97	0.968
		Turface MVP				
	Pea gravel ($mS \cdot cm^{-1}$)	20% ($mS \cdot cm^{-1}$)	40% ($mS \cdot cm^{-1}$)	60% ($mS \cdot cm^{-1}$)	80% ($mS \cdot cm^{-1}$)	100% ($mS \cdot cm^{-1}$)
Week 5	1.029	1.077	1.116	1.052	1.054	0.880
Week 10	0.980	1.432	1.556	1.474	1.510	1.413
Week 15	1.233	1.920	2.418	2.611	2.379	2.686

In summary, *G. dioica* seedlings grown in pea gravel containing at least 60% Turface had greater heights and dry weights than those grown in Haydite-amended or un-amended pea gravel. Based on pH and electrical conductivity of rinse leachates, it appears that incorporation of Turface can significantly improve the availability of nutrients in a gravel-based growing medium. We conclude adding calcined clay in the form of turface, kitty litter, or an oil absorbent into the top 6 to 12 cm of pea gravel could provide increased cation exchange capacity to small plant liners improving availability of essential elements and reducing chlorosis.

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