BIOSOLIDS RECYCLING research notes

NORTHWEST BIOSOLIDS MANAGEMENT ASSOCIATION

Native Plant Restoration of Copper Mine Tailings: Part I. Substrate Effect on Growth and Nutrition Status in a Greenhouse

Researchers and Collaborators

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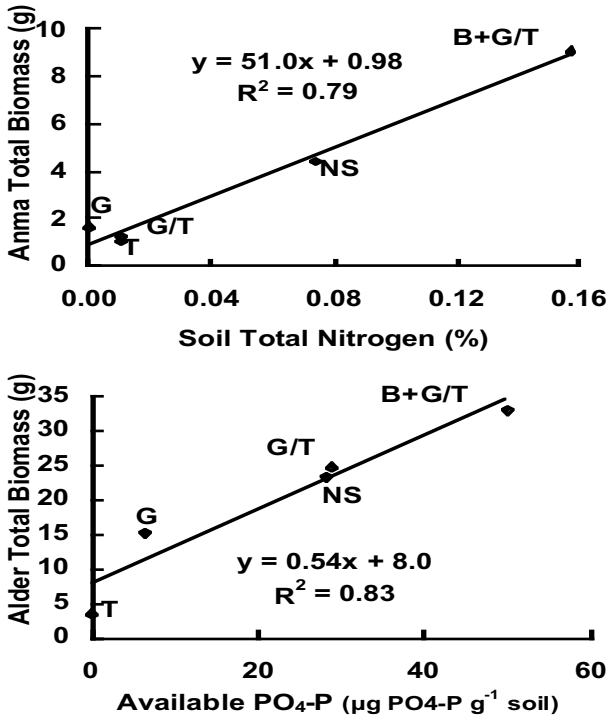

Anma = Anaphalis margaritacea (pearly everlasting), Alder = Sitka alder, G = gravel, T = tailings, G/T = gravel over tailings, B+G/T = biosolids amended G/T, NS = natural soil

Background

Lack of soil nutrients can be a major factor limiting ecosystem recovery. Successful restoration of environmentally damaged sites such as copper mine tailings piles may require amendment of the existing physical substrate to create conditions more favorable for plant growth. Copper mine tailings are difficult to revegetate due to nutrient deficiencies, high levels of acidity, and potential metal toxicities. Due to the lack of organic matter and severe nutrient limitations of mine tailings, an amendment of biosolids could serve to quickly correct the inadequacies of these materials as a plant growing medium. Biosolids could ameliorate harsh edaphic conditions through the addition of available nutrients, improvement of physical soil properties (e.g. increased water holding capacity), and possible lowering of toxic metal availability through complexation with organic matter. This study was conducted in a greenhouse in May to September 1996, with laboratory analyses performed in the fall of 1996 and into 1997.

Objectives

The objective of this study is to evaluate the effect of different substrates on the survival, growth, and nutritional status of native plant species. Native plant productivity and nutritional status is evaluated in relation

to selected soil chemical parameters. Amended and unamended copper mine tailings are contrasted with a natural soil and a glacial outwash gravelly sand for factors potentially limiting to plant growth. Environmental variables were controlled to isolate the effect of the soil on growth of these native plant species.

Methods

In a greenhouse, two native plant species [Alnus sinuata (Sitka alder) and Anaphalis margaritacea (pearly everlasting)] were grown in each of five different substrates; 1) copper mine tailings, 2) 15 cm gravelly sand over tailings (G/T), 3) 15 cm of gravelly sand over tailings, amended with biosolids plus sawdust/wood chips (B+G/T), 4) gravelly sand (from glacial outwash), and 5) natural soil (NS). Twelve replicates of each of the two native plant species were established in separate 3200 cm3 containers of each of the five different soils. The substrates were collected on or near the copper mine tailings piles at Holden, Washington. Soil samples were analyzed for pH, total carbon and nitrogen, available phosphate phosorous, cation exchange capacity (CEC), and exchangeable bases and aluminum. Native plant survival, height growth, biomass production, and nutrient and metal concentration of roots, stems, and leaves were determined.

Results

In comparison with G/T, B+G/T was higher in available P by 75%, CEC by 150%, exchangeable K by 100%, exchangeable Mg by 75%, exchangeable Ca by 170%, total nitrogen by 1500%, and total carbon by 4000%. The levels of total carbon and nitrogen and available P in B+G/T are significantly greater than in all other soils including NS. Biomass production of both species was significantly greater in B+G/T than in any other treatment, including NS. Anaphalis produced twice as much biomass in B+G/T as in NS, and seven times as much as in G/T. The increased growth of pearly everlasting was strongly correlated with the increase in its soil's total% nitrogen. In contrast, the increased growth of the nitrogen-fixing shrub Sitka alder was strongly correlated with the increase in soil available phosphorus. Elemental analysis of plant components showed increased and more balanced nutrient content of plants grown in the biosolids amended gravel over tailings.

Significance

These results indicate that applications of biosolids on tailings piles promote improved plant establishment and growth. Nitrogen-fixing Sitka alder is a species which shows great potential for being utilized in a full scale restoration efforts especially if adequate biosolids are not available to completely cover the tailings. With an amendment of biosolids, Anma shows potential as a species to initiate carbon sequestration and nutrient conservation, which may assist in the long term survival of longer-lived tree species.

Keywords: reclamation, growth-limiting, nutrient concentration, N/P deficiency, Al/Fe toxicity, revegetation
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