BIOSOLIDS RECYCLING research notes

NORTHWEST BIOSOLIDS MANAGEMENT ASSOCIATION

Native Plant Restoration of Copper Mine Tailings: Part II. Field Survival, Growth, and Nutrient Use Efficiency

Researchers and Collaborators

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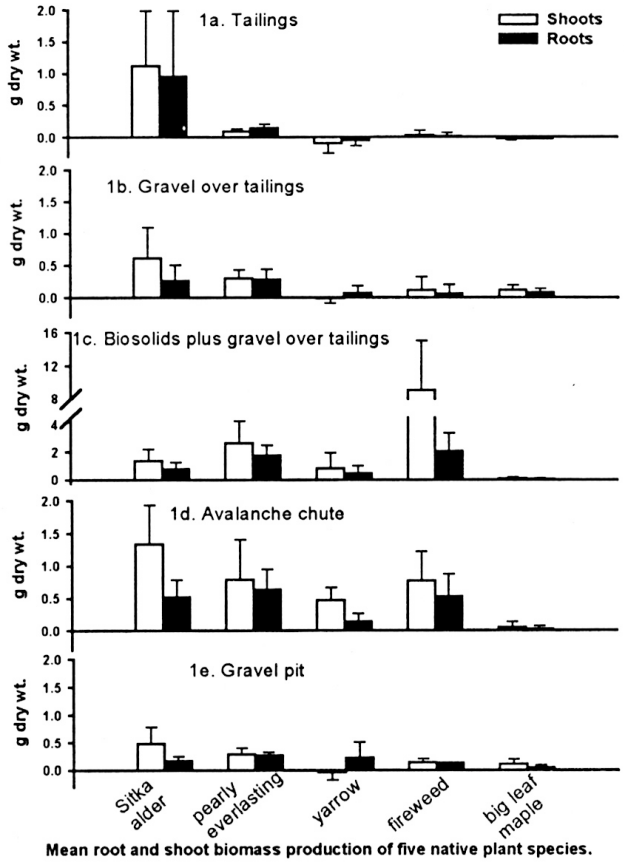

Mean root and shoot biomass production of five native plant species.

Background

Copper mine tailings are difficult to revegetate due to nutrient deficiencies, high levels of acidity, and potential metal toxicities. Selection of appropriately adapted species is critical to restoration success. In restoring environmentally damaged sites, we may benefit from knowledge of successional processes of ecosystem recovery following natural disturbance such as fire, glacial retreat, or volcanic eruption. Studies in primary succession show that the accumulation over time of organic matter and increase in available nitrogen are extremely important to ecosystem development. Nitrogen fixing species have been shown to be instrumental in accelerating soil development and plant succession through facilitation. Use of nitrogen fixing species in restoration may reduce the need for repeated nutrient additions to a site. An alternative strategy that may promote site restoration is to amend the existing substrate with biosolids and to utilize early seral (ruderal) native plant species that possess the capacity for rapid growth and nutrient cycling. Field research was conducted in the summer of 1996, lab analyses of samples was performed in fall of 1996 and into 1997.

Objectives

The study objective was to evaluate the performance of five native plant species in each of five different soils/substrates on or near the copper mine tailings piles at Holden, Washington. Additionally, the purpose of this study was to evaluate the effect of an amendment of biosolids on the survival, growth, biomass production, and nutritional status of five native plant species. We investigated the response of five native plant species to vastly different edaphic conditions.

Methods

This study was conducted on and near the copper mine tailings at Holden, Washington. Twelve individuals of each of five native plant species [Acer macrophyllum (big leaf maple), Achillea millefolium (western yarrow), Alnus sinuata (Sitka alder), Anaphalis margaritacea (pearly everlasting), and Epilobium angustifolium (fireweed)] were grown in individual field plots representing different substrates: 1) copper mine tailings, 2) 15 cm of 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) gravel pit (gravelly sand from glacial outwash), and 5) natural soil in an avalanche chute (NS). Native plant survival, growth, biomass production, and nutrient and metal concentration of roots, stems, and leaves were determined. Soil samples were analyzed for pH, total carbon and nitrogen, available phosphate phosphorous, cation exchange capacity (CEC), and exchangeable bases and Aluminum.

Results

The amendment of biosolids to G/T increased total carbon and nitrogen >40 times that of G/T. Available phosphorus was almost doubled with the amendment of biosolids to G/T. Cation exchange capacity and exchangeable calcium, potassium, and magnesium were tripled. Overall native plant survival increased from T (42%) to G/T (72%) to B+G/T (90%). In the biosolids amendment, plant survival essentially matched the survival in NS (92%). All species except big leaf maple attained their highest survival in B+G/T. Production of dry matter in B+G/T increased by 62, 25, 7.6, and 2.4 times over that in G/T for fireweed, yarrow, pearly everlasting, and Sitka alder respectively. Plant analysis indicated a dramatic increase in nutrient content with the biosolids amendment. Fireweed demonstrated exceptional performance in the biosolids-amended gravel over tailings. The growth and nutrient uptake of fireweed far exceeded that of other species in B+G/T.

Significance

Results indicate that the biosolids amendment has ameliorated unfavorable edaphic conditions resulting in improved native plant survival and growth. Fireweed utilized in combination with an amendment of biosolids may be an effective method of initiating the processes of carbon sequestration and nutrient cycling for the long-term ecological restoration of copper mine tailings. Nitrogen-fixing Sitka alder is well adapted to tolerate the harsh growing conditions (e.g. low nutrients, high acidity and high exchangeable aluminum), and shows excellent potential to improve site productivity through additions of organic matter and nitrogen. Results demonstrate that applications of biosolids over additional areas of the tailings piles would promote improved plant establishment and growth. Overall, biosolids improved the survival, growth, and nutritional status of native plant species tested on the copper mine tailings.

Keywords: revegetation, nutrient uptake, growth-limiting factors, Al/Fe toxicity, N/P deficiency, reclamation, alder
Revision Date: 1996-1997