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A test of soil amendments to restore native plant species in a post-mining landscape

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Abstract

The mining industry in British Columbia plays a crucial role in the economy of the province by creating employment opportunities, driving industrial growth and generating revenues. Environmental disturbance caused by mining operations poses challenges to ecosystem reclamation, particularly with respect to the re-introduction of native plant communities. The goal of this greenhouse study was to explore effective strategies to facilitate ecosystem reclamation of a mine-impacted site at Highland Valley Copper Mine. The study examined the growth response of thirteen native plant species grown in three different soil amendments (zeolite, leonardite, and coconut husk) with and without fertilization on a standardized medium of tailings (10 cm) overlaid by mine overburden (20 cm). The plant species included three tree species (*Picea glauca, Pinus ponderosa, Pseudotsuga menziesii*), two shrub species (*Amelanchier alnifolia, Shepherdia canadensis,*), three forb species (*Balsamorhiza sagittata, Antennaria microphylla, Lupinus sericeus*) and five grass species (*Elymus trachycaulus, Festuca idahoensis, Koeleria macrantha, Poa secunda*, *Pseudoroegneria spicata*). Plants were grown in a controlled greenhouse for twelve weeks at ~22ºC, 16-hour photoperiod and ~60% humidity, then harvested, dried and weighed. Data on survival, above-ground and below-ground biomass were collected. Species survival rate was ~75% in the combination of fertilizer and coconut husk. Zeolite showed no variation of impacts on survival rate with or without fertilizer. The survival rate of *Balsamorhiza sagittata and Poa secunda* increased without fertilizer and decreased with the application of fertilizer. *Elymus trachycaulus* showed greater vegetative biomass than root biomass in the presence of fertilizer. Overall, the findings of the study provide valuable insight into the impacts of various amendments and fertilizer combinations regarding the survival and growth of native plant species on mine tailings and overburden materials.

Materials & Method

Highland Valley Copper mine is a copper and molybdenum operation, located about 50 kilometers southwest of Kamloops, British Columbia and approximately 17 kilometers west of Logan Lake (50°28′25″N, 121°01′18″W; approximately 4,900-5,200 ft above sea level). Tailing samples were collected from a tailing storage facility of Highland Valley Copper and overburden were collected from stockpiles at HVC. The greenhouse trial experiment was conducted at the greenhouse located at Thompson Rivers University, Kamloops, British Columbia from Winter 2023 to Spring 2024. The compost used in the experiment was low N, high P and K 10:15:19 kelp-based fertilizer. The amendments used (Zeolite, Leonardite, and Coconut husk) were sourced locally and reasonably inexpensive. Seedlings were placed in a PVC tube of 35 cm height, in which the soil substrate consisted of 10 cm tailings at the bottom of the tube with a 20 cm layer of overburden above the tailings. Depending on the treatment, overburden was mixed with Zeolite, Leonardite, and coconut husk (10g each) and 3.63 g of fertilizer. In total, there were ten treatment combinations (amendments and fertilizer) including one control treatment and nine replications of

each treatment were done for each species. The greenhouse was regulated on a 16h/8h day/night lighting schedule with three 1,000W lamps. Humidity was regulated by automatic misters at ~60% to keep the substrate moist but not wet. At the end of the experiment, species survival was assessed. Next, species were harvested, and above and below-ground biomass were collected separately. Above-ground biomass was clipped at the same level as the soil, and below-ground biomass was gently collected from the soil. The wet above and below biomass were then placed in an oven at a temperature of 68°C for 48 hours, and later the dry above and below biomass were weighed.

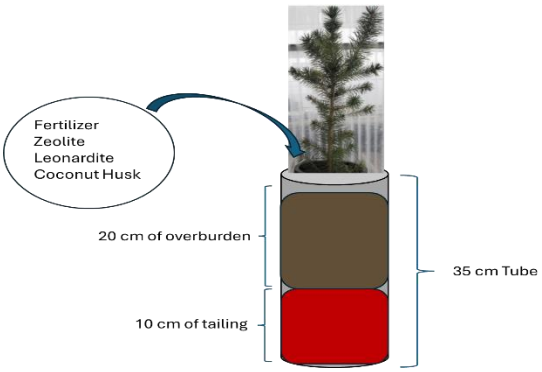

Figure 1: A schematic model illustrating tailings and overburden within the tube with the growth of species and the addition of amendments.

Figure 2: experimental setup at the greenhouse.

Results, Observations, Conclusions

For the statistical analysis, we performed a mixed Generalized Linear Model (GLM) to assess the effect of fertilizer addition and soil amendment group. The results of the mixed Generalized Linear Model (GLM) demonstrate a highly significant effect of species ($p < 0.001$). Among the tree species, *Picea glauca, Pinus ponderosa*, and *Pseudotsuga menziesii* exhibit maximum growth rates close to 1. In contrast, shrubs display a lower survival rate compared to trees. This discrepancy is particularly notable with *Shepherdia canadensis* and *Antennaria microphylla*, which exhibit survival rates of approximately 0.57 and 0.6, respectively. However, the shrub *Amelanchier alnifolia* shows a high survival rate (close to 1), comparable to that of tree species.

Novel Information

The grass species *Poa Secunda* shows greater survival rate, and root and shoot biomass in the absence of fertilizer than in the presence of fertilizer.

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