GROWING NATIVE PLANTS FOR MINE RECLAMATION[1]

Carol E. Jones[2]

Mine soils are often coarse textured materials with high coarse fragment content and low nutrient status. The same is often true for forest roads and landslides which require rehabilitation. Application of a fertilizer is typically used to initiate a nutrient pool in these disturbed soils. Legume species, such as clover or alfalfa which have rhizobial associations that fix atmospheric nitrogen are often seeded to improve the nitrogen content. At some sites a cover of these agronomic species may not be compatible with the end use objectives of forestry or wildlife habitat, and on these sites the establishment of woody native species is more desirable. Native species are selected for these sites based on their ability to improve the nutrient status of the soil and on their palatability to wildlife.

NITROGEN FIXATION

Actinorhizal perennial woody trees and shrubs can fix nitrogen and increase the soil nitrogen content. Various species of actinorhizal shrubs and trees are grown in western Canada for use in mine land reclamation. These species include *Alnus rubra* (Red alder), *Alnus crispa* spp. *sinuata* (Sitka alder), *Ceanothus velutinus* (snowbrush), *Elaeagnus commutata* (wolf-willow), and *Shepherdia canadensis* (buffaloberry). While these plants have the capability for association with a bacteria (*Frankia* spp.) and the potential to form root nodules this often does not occur in container grown nursery stock. A survey conducted of seven nurseries located in Alberta and British Columbia indicated that *Elaeagnus commutata* and *Shepherdia canadensis* seedlings did not become nodulated in their first year and that planting stock generally lacked nitrogen fixing ability (Danielson and Visser 1990). The conclusion of this survey supported our observation that container grown nursery stock of *Elaeagnus commutata* and *Shepherdia canadensis* were lacking *Frankia* nodulation. In monitoring programs conducted at various mine sites planted with these two species it was also our observation that the initial growth of these two species planted on reclaimed mine sites was poor. The soils at these mine sites, in addition to having low nutrient conditions, did not contain potential *Frankia* inoculum. Occasionally, a number of years subsequent to planting, the actinorhizal species would begin to grow rapidly and could be shown to have become nodulated. This was particularly noticeable with *Shepherdia canadensis* where the leaf colour would change to a dark green shade. This type of on-site nodulation must be due to inoculum from adjacent forest areas being transferred to the reclaim site.

To effectively use actinorhizal plants in land rehabilitation it is necessary to ensure that the seedlings were inoculated with the appropriate *Frankia* species before they were planted on the site. We experimented with collecting nodules from plants growing in natural forest sites and applying a slurry of the ground nodules to our nursery stock. The results from these initial experiments had limited success. We then contacted Mikro-Tek, a company in Ontario with experience in growing bacterial cultures of *Frankia* for the inoculation of *Alnus*. At that time they had not grown *Frankia* inoculum for either *Shepherdia* or *Elaeagnus* but believed they could provide us with a suitable culture. We collected nodulated roots from these species and sent them in coolers to their laboratory where they processed the nodules and initiated the cultures. The growth of these *Frankia* species were much slower than Mikro-Tek had experienced with other *Frankia* cultures, but with adjustments to their media they were able to successfully culture these bacteria. We also collected nodules from a northwestern British Columbia population of *Alnus crispa* spp. *sinuata* and were provided with a suitable culture for this stock.

We have experimented with the method and timing of application of the *Frankia* to the seedlings. With the first method the bacterial culture is mixed into the soil media at the time of seeding encapsulated in peat moss beads called Mikro-Beads. It is important to mix the appropriate number of Mikro-Beads in to the soil media to ensure that the bacteria are evenly distributed to each cavity and available to the young roots. In the second method the bacterial culture is directly watered onto the seedings. This method is relatively simple, the inoculum can be hand watered or can be introduced onto the overhead watering system. To utilize and overhead watering system it is important to remove and filters in the system which could trap the bacteria. We have applied the inoculum using hand watering in the spring as the seedlings are just starting to root, but plan to try a late summer treatment in 1998.

---

[1]Jones, C.E. 1999. Growing native plants for mine reclamation. In: Landis, T.D.; Barnett, P.J., tech. coords. National proceedings: forest and conservation nursery associations—1998. Gen. Tech. Rep. SRS-25. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 154-155.
[2]C.E. Jones and Associates Ltd. Suite 104, 645 Fort Street, Victoria, BC V8W 1G1, Canada; TEL: 250/383-8375; FAX: 250/383-9354.

The Mikro-Bead method has the advantage of being able to store the product for a longer period of time over a wider range of temperature conditions. The liquid cultures are shipped in a growth media and must be shipped and stored in refrigerated conditions. Additionally, the liquid cultures must be applied quickly after reaching the nursery.

Our experience over the past few years suggests that the application of the inoculum in the liquid culture has been more successful than with Mikro-Beads. This year we want to try application of the inoculum in the late summer to determine if we can achieve a higher nodulation rate when the seedlings are not receiving high application rates of chemical fertilizers. In conditions of high amounts of nitrogen, the rate of nodulation is known to be reduced. Therefore we will try to apply the inoculum just prior to shipping the plants to the reclaim site for planting.

We intend to monitor the nodulation rate and growth characteristics of the actinorhizal shrubs grown in our nursery that have been planted in various mine reclamation projects. We expect that the successful inoculation of these species with appropriate *Frankia* species in the nursery will result in superior growth at the mine sites. In a field trial conducted on oil sands tailings, Visser and others (1991) reported that both *Elaeagnus* and *Shepherdia* had greater height growth, and produced heavier shoots and roots when inoculated with soil containing *Frankia* than did the uninoculated controls.

WILDLIFE HABITAT

Ungulates are the major wildlife resource in the vicinity of several mines in British Columbia. At the Fording River Coal mine in southeastern BC, elk (*Cervus elaphus nelsoni*) are the most abundant, although Big Horn Sheep (*Ovis canadensis canadensis*) are also year round residents. The availability of winter range is the limiting factor for the elk population, therefore research efforts have focused on providing good quality winter range through reclamation. Experiments began in 1985 to develop the technology necessary to rehabilitate suitable waste dump slopes to elk winter range. The physical conditions which are required to provide this habitat include steep high elevation slopes with south or southeast aspects. These sites characteristics result in challenging conditions for establishment of the required vegetation. A major component of elk winter range is the development of areas of woody plant species which provide important browse. Selected species include: *Prunus virginiana* (choke cherry), *Amelanchier alnifolia* (saskatoon), *Symphoricarpos albus* (common snowberry), *Ceanothus velutinus* (redstem ceanothus), *Populus tremuloides* (trembling aspen), *Elaeagnus commutata, Cornus sericea* (red-osier dogwood), *Acer glabrum* (Douglas maple), *Salix scouleriana* (Scouler's willow), *Shepherdia canadensis* (buffalo-berry), *Spiraea betulifolia* (birch-leaved spirea) and *Rosa acicularis* (prickly rose).

Results of initial experiments indicated that survival of browse species planted on these exposed slopes was very low, ranging from 0 to 58 percent, and that the same seedling stock planted on other less exposed areas of the mine site achieved much higher rates of survival. The greatest loss to survival usually occurs in the first year after planting and these losses are presumed to be due to two factors: the site exposure; and wildlife browsing.

Trials have been established to determine if plant protectors installed at the time of planting would improve shrub establishment and survival by providing additional shelter for the seedlings from the adverse climatic conditions and wildlife browsing. Plant protectors have been installed on fifty percent of the seedlings and various types of protectors have been tested.

The results to date indicate that the shrubs and trees in the protectors were generally in better condition than the unprotected ones: protected plants are larger and leafed out earlier in the spring. The majority of the unprotected deciduous shrubs were heavily browsed and some were uprooted by animals. The results of this trial will be used to determine the optimal type of plant protector, the best season for planting, and the appropriate combination of browse species. This trial has illustrated that valuable browse species can be established on these types of exposed sites and that the important native shrub component of the wildlife habitat can be developed.

REFERENCES

Danielson, R.M.; Visser, S. 1990. The mycorrhizal and nodulation status of container grown trees and shrubs reared in commercial nurseries. Canadian Journal of Forest Research. 20: 609-614.

Visser, S.; Danielson, R.M.; Parkinson, D. 1991. Field performance of *Elaeagnus* commutata and *Shepherdia canadensis* (*Elaeagnaceae*) inoculated with soil containing Frankia and vesicular-arbuscular mycorrhizal fungi. Can. J. Bot. 69: 1321-1328.