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PROPAGATION OF THREE NATIVE ALPINE LEGUMES

Paper presented
by
N.A. Willey
Faculty of Forestry
University of Victoria

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The selection of native plants for subalpine/alpine coal mine reclamation must consider not only soil amelioration but also wildlife forage. This is particularly so in the Northeast Coal Block of British Columbia. Three native alpine legumes which meet these criteria are Oxytropis podocarpa, O. sericea (O. spicata) and Hedysarum alpinum. As nitrogen fixing plants these legume's provide nitrogen to the soil, as well as promote soil stability through extensive taproots. While the Oxytropis spp. ("locoweeds") contain alkaloids toxic to livestock (Mueggler, 1970), both Oxytropis spp. provide summer forage for Mountain Goats and Bighorn Sheep (Saunders, 1955; Stelfox, 1976).

DESCRIPTION AND DISTRIBUTION

Both Oxytropis species are alpine plants of the Rocky Mountains. O. sericea Nutt. (Silky Locoweed), recognized by its clumped habit, gray-green pubescent leaflets and pale yellow flowers, extends from the southern Yukon to New Mexico. O. podocarpa is the inflated seed pod (legume). Hedysarum alpinum L. (Aipine Hedysarum) is generally a plant of lower elevations in B.C., found throughout the Province from forested valleys into the upper subal pine. This plant is recognized by its more open branching, red-purple flowers and cup-like stipules. As with O. podocarpa the most distinguishing feature of H. alpinum is the fruit, a segmented loment. Recognition of the Oxytropis spp. during the dormant season is not too difficult since the persistent basal stipules remain on the plant. Usually a remaining seed pod will further aid recognition. Hedysarum alpinum recognition is much more difficult before new growth occurs. A diligent search for a remaining leaf rachis with its cup-like stipule may be rewarded, but most of the plant occurs below ground. H. alpinum in its dormant state is obviously more difficult.

While the Oxytropis spp. extend higher in elevation than Hedysarum alpinum, all three legumes are adapted to well drained gravelly soils of low fertility. Soil creep, water erosion and frost heaving are also significant physical features of their habitat. To the east of the continental divide these species are most often found on alpine ridge-tops with a south to west aspect. These locations are often below the regional tree-line, but due to the higher solar radiation influx of this aspect and the year-round exposure to prevailing westerly winds, an alpine community has developed. In their adaptation to this dessieating environment these legumes can be rated for moisture requirements as follows:

Hedysarum alpinum, Oxytropis sericea, O. podocarpa.

The alpine ridge-tops share similar physical constraints to growth as spoils of the same aspect in the Southeast Coal Block (B.C.) (Harrison, 1977). Although spoil color may be improved by a judicious selection of overburden strata for placement on the spoil surface, the problems of aspect and exposure remain. Revegetation of these spoils will obviously require plants adapted to such conditions. In light of this, the employment of these native legumes seems not only prudent but inevitable.

PROPAGATION BY "CUTTINGS"

The easiest method of acquiring Oxytropis podocarpa, O. sericea and Hedysarum alpinum is to uproot the plants during the dormant season. All three legumes are plentiful in their habitat, allowing one collector to gather up to fifty plants per hour. The plants are lifted with a shovel after severing the taproot about 10 cm below the ground surface. As this provides only a portion of the mature plant (including the shoot meristem) these can be treated as rooted cuttings and are herein referred to as such for brevity. Ideally these cuttings should be lifted in early spring when the planting site is just clear of snow. Both Oxytropis and Hedysarum occur on wind cleared ridge-tops and will be available early in the spring. The lifting operation will usually result in a jagged end on the taproot; this will need to be pruned above the injury and then dipped in a fungicide such as Benomyl. While it is not necessary to have a large portion of the taproot for new growth, it is of utmost importance that the fine root system be maintained. This is especially true of O. podocarpa where fine root removal will result in unacceptably high mortality rates. Legume cuttings can be stored at or below O degrees C provided any bare roots do not become dessicated. Drying and warming are the major considerations of handling these cuttings, and both should be avoided before planting on spoils.

As a reclamation technician, the use of such cuttings is not very practical. The number of plants collected from one site will be limited and will contribute to the man-hour costs of acquisition. Helicopter time may be involved as well. Moreover, the collection process will significantly damage the plant community structure by removing many of the nitrogen-fixing members. Nonetheless, this method can be seriously considered when it is desirable to set up a seed nursery or when the plants are available on future overburden. In the latter case the plants would be salvaged just prior to the stripping operations (open pit mining), however, this requires a well thought-out reclamation plan for the entire mine operation.

PROPAGATION BY SEED

In contrast to cutting propagation, production of reclamation stock by seed is economical and straight forward. Seeds are readily available from the alpine ridge-top communities, with seed pods easily picked by hand. Quantities of *Oxytropis* seed per litre of pods are shown in Table 1; *Hedysarum* seed occur in non-dehiscent loments and therefore are rated by weight inclusive of pods.

Table 1 Seed Weight/Volume

SPECIES	Weight of Seeds (g) per litre pods	Weight (g) per litre seeds*
Oxytropis podocarpa	ca. 16	736
Oxytropis sericea	ca. 21	709
Hedysarum alpinum		113

*Dry weight (viable); estimated by linear regression from small volumes.

Seeds should be collected as soon as the pods turn brown (or light brown); this will be about mid-August to early September. Air drying of the Oxytropis pods will open them for seed removal, which is accomplished by tumbling. Hedysarum pods should also be tumbled after drying to break the loments into individual seed-containing segments. Seeds of both genera can be stored when dry but should be kept at or below O degrees C. Moist seeds will germinate in darkness at 2 degrees C - an amazing adaptation to life in a cold, adverse climate. As shown in Table 2, stratification is not essential but will improve the rate of germination. Decrease in percent germination shown were due to an excessive stratification period and the development of mold. Maximum stratification time at 2^0C to 5^0C should not exceed five days.

Following a brief period of stratification, seeds can be transferred to containers. To ensure germination success, either sow several seeds per container or prick-off the seeds from the stratification medium when the radicle emerges from the seed coat. As taproot plants, these legumes will quickly acquire a linear root growth habit and are best suited to containers such as the Spencer-Lemaire. Standard potting mixes utilizing peat will probably be adequate; a 50:50 peat-sand mix is suggested. With seed costs being much greater than agronomic legumes, hand-planted container stock is suggested over direct seeding of mine spoils.

The perennial problem with Rhizobium inoculation of legumes will also be a concern with native legumes grown from seed. Non-nodulated plants placed on "sterile" spoils will behave as any plant lacking the ability to fix nitrogen, essentially requiring a soil nitrogen source. This is self defeating, of course, and partially eliminates the advantage of either Oxytropis spp. or Hedysarum alpinum. Furthermore, the fine roots should be exposed to the correct soil fungi to develop endomycorrhizae. This symbiotic plant/fungus relationship will enhance the plants' ability to glean phosphorus at low soil concentrations and thereby reduce fertilizer costs. Several means are available to introduce both mycorrhizal fungi and Rhizobium bacteria. However, the cheapest and least involved method most suited to an on-site nursery utilizes mineral soil as an inoculum. The top 10 cm of what is usually a Bm horizon (Figure 1) is collected from the same location as the legumes. This material is then screened to remove stones and added as a small portion of the sand in the potting mix. Ideally the Bm inoculum would come from a future overburden site, again emphasizing the importance of long term reclamation planning.

TABLE 2

Germination Testing for Unstratified and Stratified Seed

	Unstratified			Stratified		
Species	%G	%GC	R_{10} (days)	%G	%GC	R_{10} (days)
Hedysarum alpinum	72+1.8	88+2.2	6+0.2	60+2.7	88+4.9	1+0
Oxytropis sericea	49+2.2	87+1.3	5+0.4	14+0.9	78+1.8	5+0.4
Oxytropis podocarpa	14+1.8	92+1.3	14+0.9	13+1.8	90+0.9	2+0.4

%G = percent of total seed germinated

%GC = percent germination capacity, disregarding time; %GC = %G + % sound seed at end of test

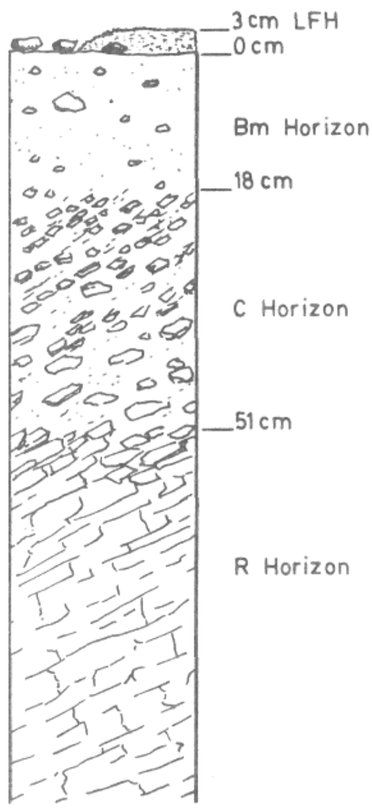
R_{10} = rate in days required to germinated 10% of %GC (Willey 1982)

Values are the mean of five replications, plus or minus the standard error: a Jacobsen-Zepher Germinator was used for this testing; day length was 12 hours under Gro-lux lamps.

Figure 1

ORTHIC EUTRIC BRUNISOL SOIL PROFILE

(N.E. COAL BLOCK, B.C.)



Stockpiling the mineral soil for long periods of time (2 to 3 years) may depress the inoculum potential, although drying should not be a problem. The drawback to this system is the lack of control over fungus introduction, and while beneficial fungi will be present, so too will pathogenic fungi. Good nursery sanitation and healthy seedlings should overcome this problem. Excessive watering of seedlings should be avoided to maintain an aerobic growth medium in the containers.

Finally, applications of starter and maintenance fertilizers during container growth, and after planting-out, will need to be kept at low levels. High levels will inhibit both nitrogen fixation and mycorrhizal development. In field application rates, this will mean the equivalent of perhaps 20 kg/ha or less in starter fertilizer. A fertilizer guideline for these species is currently being developed. Where these legumes are planted-out as a follow-up to a preliminary sowing of agronomic grasses and fertilizer (NPK), it will likely be unnecessary to apply a second application of fertilizer. Excess fertilizer at any stage of seedling development and utilization will be at the expense of the Rhizobium bacteria and mycorrhizal fungi. Because these native plants thrive in a low nutrient environment, the advantage gained in their utilization can be easily negated by fertilizer application. As a general rule, go very light on fertilizers, and if in doubt, do not fertilize.

THE ROLE IN RECLAMATION

The anticipated growth rate of the native legumes will be slow in comparison to fertilized agronomic grasses. Because of this they are poor candidates for immediate erosion control on new spoils, however, their strengths lie in longevity, soil amelioration and wildlife forage. In such roles they will be best suited to a second stage of reclamation when the initially applied grasses regress in cover value. To promote the regression, maintenance fertilizer used on the grasses will need to be cut back. The employment of shorter-lived grass species, such as Agrostis scabra. would also fit such a scheme quite well (Winterhalder, 1976; Amiro & Courtin, 1980). Nonetheless, these native legumes will have limitations of use in a similar fashion to the various Salix species. Reclamation sites will need to mimic the snow loading of the alpine ridge-tops and receive adequate sunlight. This will apply to convex subalpine spoils with a south to west aspect; snow must blow clear by the end of April. Since this describes one of the more adverse sites for reclamation, the native legumes could be a useful tool in promoting long term recovery.

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